Jim Watson

From: Rachel Zwillinger <RZWILLINGER@defenders.org>
Sent: Friday, August 10, 2018 12:48 PM
To: Jim Watson
Subject: Meeting with NGOs to discuss Sites
Attachments: Sites_Environmental minimums_8.6.18.pdf

Hi Jim,

As I've mentioned to you previously, several conservation organizations have been working on environmental parameters for Sites that we believe would allow the project to be built and operated in an ecologically responsible manner. I've attached a copy of those parameters, and we would be interested in meeting with you, Rob, and anyone else associated with the JPA who would like to talk through the document. If you're interested in meeting and want to send along names and email addresses of folks associated with the JPA who would like to join, I'd be happy to put together a doodle poll to pick a date in late August or early September.

Rachel

Rachel Zwillinger
Water Policy Advisor

Defenders of Wildlife
980 9th St., Suite 1730, Sacramento, CA 95814
Tel: (415) 686-2233
rzwillinger@defenders.org | www.defenders.org

SITES RESERVOIR:
CRITERIA FOR AN ENVIRONMENTALLY RESPONSIBLE PROJECT

- Upper Sacramento River bypass flows: Flows of at least 15,000 cfs past all Sacramento River points of diversion for Sites Reservoir are required prior to the diversion of water into the reservoir during the months of October to June to protect out-migrating juvenile salmonids. (*See* Table A)

- Lower Sacramento River flows: Diversions of water into the reservoir should not occur from October to June unless flows at Freeport are greater than 35,000 cfs. Lower Sacramento River bypass flows in October and June shall be based on real time monitoring for salmonids. (*See* Table A)

- Flows for the San Francisco Bay-Delta Estuary: Per Table B, diversions of water into the reservoir should occur only when sufficient Delta inflows and outflows are available to meet the needs of Delta smelt, longfin smelt, migrating Chinook salmon, and other flow-dependent species.

- Floodplain inundation: Diversions must not reduce the frequency or duration of inundation of the Yolo Bypass and the Sutter Bypass, as floodplain inundation is beneficial for rearing salmon, migratory birds, and other wildlife.

- Overhead powerlines: Any new overhead powerlines associated with the project should be sited along exiting transmission corridors and not run along the Delevan National Wildlife Refuge. The power lines should also conform to current Avian Power Line Interaction Committee guidelines.

- Refuge water supplies: Water supply availability for federal, state, and private wildlife refuges must not be negatively affected, and a detailed description of conveyance methods should be provided for any publicly funded Level 4 refuges water supplies.

- Mitigation for construction impacts: Detailed plans must be developed showing how all temporary and permanent impacts of the project on golden eagles, giant garter snakes, vernal pools, and other species and habitats will be mitigated according to law, including appropriate assurances and performance standards.

- Releases of water from Sites Reservoir to the Sacramento River: Additional analysis of the water quality impacts of reservoir releases is necessary, given concerns regarding water temperature, algal blooms, and other water quality parameters.

Table A: Sites Reservoir bypass flows triggered by Sacramento River fish and wildlife protections

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Notes
Sacramento River at Freeport	real time	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	real time				Based on NGO proposed WaterFix minimum bypass flow of 35,000 cfs at Freeport Nov-May. The 35,000 cfs bypass flow is also in effect in Oct and Jun if real time observations show salmon are present.
Sacramento River at all Points of Diversion for	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs				Minimum bypass flow. Based on CDFW 2016 recommendation.
Max diversion rate	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%				When Net Delta Outflow Index (NDOI) is above minimum flows identified in Table A and Table B but below 60,000 cfs, diversions to Sites limited to a maximum of 2% of the river flow. When NDOI exceeds 60,000 cfs, diversions to Sites limited to 5% of Sacramento River flow.

Table B: Sites Reservoir bypass flows triggered by downstream water quality protections

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Notes
Delta Outflow				42,800 cfs		44,500 cfs			42,800 cfs				Bypass flow, based on longfin smelt flow need but will benefit salmon and other species as well (SWRCB 2017)
	11,400 cfs in W and AN years, 7,400 cfs all other yr types	11,400 cfs in W and AN years, 7,400 cfs all other yr types								7,100 cfs	7,100 cfs	11,400 cfs in W and AN years, 7,400 cfs all other yr types	Bypass flow, consistent with proposed NGO terms and conditions for California Water Fix regarding Delta Smelt
X2	74 km (W) or 81 km (AN)	No diversions in AN or W years	No diversions of X2-related releases in AN or W years									74 km (W) or 81 km (AN)	No diversions when diversions would result in noncompliance with current Delta smelt RPA requirements to maintain Fall X2 position in Sept-Dec period following a W or AN year
OMR, E:I, etc.	Water supply releases, water transfers, and refuge releases for SOD delivery are subject to all water quality and endangered species protections in the Delta.												

Save California Salmon

California Sportfishing Protection Alliance
CSPA
Since 1983

Pacific Coast Federation of Fishermen's Associations
PCFFA
Stewards of the Fisheries

Environmental Water Caucus

california water impact network

Planning and Conservation League

Institute for Fisheries Resources

CRAB BOAT OWNERS ASSOCIATION, Inc.
2907 Jones Street
San Francisco, California 94133-1115
415-885-1180

Since 1971
the Northcoast Environmental Center
www.yournec.org

S.A.F.E.
Alternatives for our Forest Environment

Southern California Watershed Alliance

California Native Plant Society
Sacramento Valley Chapter

EJCW
Water Justice for All

PARC
protect american river canyons

Butte Environmental Council
Protecting Butte County's Land, Air & Water Since 1975

Fly Fishers
Davis, California

Friends of the River
since 1973

Sacramento River Council

California Wilderness Coalition

GoldenGate Salmon Association

FLY FISHERS INTERNATIONAL
NORTHERN CALIFORNIA COUNCIL

The Bay Institute

Winnemem Wintu Tribe
Middle River People

Coast Action Group

March 17 2019

Mr. Jim Watson
Sites Project Authority
P.O. Box 517
Maxwell, CA

Re: Request For A Recirculated Draft Sites Reservoir EIS/EIR

Dear Mr. Watson:

It is our understanding that the Sites Project Authority (SPA) is planning on release of a final EIS/EIR in March 2020. We are requesting a revision and recirculation of the Draft Sites Reservoir EIS/EIR (DEIS/EIR) prior to release of a final EIS/EIR because the initial DEIS/EIR was inadequate under the law to fully describe the project, reasonable alternatives, impacts and appropriate mitigation measures. The inadequacy of the DEIS/EIR was clearly pointed out in comment letters by numerous organizations and individuals, including many of our organizations and the California Department of Fish and Wildlife (CDFW).[1]

The DEIS/EIR was inadequate to meet the legal requirements of CEQA and NEPA as described in detail below, but more importantly, the project as described to date does not resolve the fundamental issue of what will be the minimum bypass flows for the Sacramento River. This is a key issue that underlies the basic water yield and economic feasibility of this project.

The California Department of Fish and Wildlife has recommended a much higher minimum bypass flow in the Sacramento River than is being proposed by the SPA (13,000 cfs compared to 3,250 cfs at Red Bluff, 4,000 cfs at Hamilton City and 5,000 cfs at Wilkins Slough).[2] The impacts to the Sacramento River fishery have not been adequately described in the DEIS/EIR, nor is there an alternative analyzed in the DEIS/EIR that would provide the flow recommendations by CDFW.

---

[1] See Friends of the River's website on Sites Reservoir for comment letters on the Sites DEIS/EIR at https://www.friendsoftheriver.org/our-work/rivers-under-threat/sacramento-threat-sites/

[2] See CDFG letter of 1/12/18, page 9 "*CDFW recommends the Project proponents revise the bypass flow requirement to maintain at least 13,000 cfs past all diversion facilities prior to the diversion of water to reduce impacts on out-migrating juvenile salmonids.*" Accessed at https://www.friendsoftheriver.org/wp-content/uploads/2018/09/1-12-2018-CDFW-Sites-Project-Letter.pdf

It is impossible for anybody to know if this project is cost effective and promised environmental public benefits can be delivered until the Sacramento River minimum bypass flow issue is resolved. The SPA's recommendation for Sacramento River minimum bypass flows appears to justify a finding of financial feasibility, but how feasible will the project be if CDFW's minimum bypass flows are legally required? We believe this issue must be fully and adequately analyzed in the DEIS/EIR, prior to any water rights hearing or other permitting process that will rely on the information in the DEIS/EIR.

Due to the extensive and significant issues listed above, a recirculated draft document addressing these deficiencies is necessary for the Sites Project to comply with NEPA and CEQA. The existing DEIS/EIR is inadequate and cannot be relied upon for preparation of a Final EIS/EIR. Therefore, we urge you to prepare a recirculated draft EIS/EIR for the proposed Sites Reservoir to fully disclose impacts, alternatives and mitigation measures. You would do a disservice to your own cause to do otherwise.

Sincerely,

Tom Stokely, Director
Save California Salmon
tstokely@att.net

Bill Jennings, Executive Director
California Sportfishing Protection Alliance
deltakeep@me.com

Carolee Krieger, Executive Director
California Water Impact Network
caroleekrieger7@gmail.com

Conner Everts
Facilitator: Environmental Water Caucus
Executive Director: Southern California Watershed Alliance
connere@gmail.com

Ron Stork
Senior Policy Advocate
Friends of the River
RStork@friendsoftheriver.org

Noah Oppenheim, Executive Director
Pacific Coast Federation of Fishermen's Associations &
Institute for Fisheries Resources
noah@ifrfish.org

Larry Glass, Executive Director
Northcoast Environmental Center
Safe Alternatives for our Forest Environment
Larryglass71@gmail.com

Natalie Carter
Executive Director
Butte Environmental Council
natalie.carter@becnet.org

Dr. Glen Holstein
Chapter Botanist
Sacramento Valley Chapter of the
California Native Plant Society
holstein@cal.net

Gary Estes
Board Member
Protect American River Canyons (PARC)
gary.estes@wdlikenoname.net

Lowell Ashbaugh
Conservation Chair
Fly Fishers of Davis
ashbaugh.lowell@gmail.com

Alan Levine, Director
Coast Action Group
alevine@mcn.org

Rebecca Wu
Volunteer for Friends of the River
rebeccadawnwu@yahoo.com

Tryg Sletteland
Founder and former Executive Director
Sacramento River Council
tbsletteland@gmail.com

Jonas Minton
Senior Water Policy Advisor
Planning and Conservation League
jminton@pcl.org

Colin Bailey, Executive Director & Managing Attorney
The Environmental Justice Coalition for Water
colin@ejcw.org

John McManus
President
Golden Gate Salmon Association
john@goldengatesalmon.org

Mark Rockwell
Vice President for Conservation
Fly Fishers International
Northern California Council
mrockwell1945@gmail.com

Greg Reis, Scientist
The Bay Institute
greg@bayecotarium.org

Caleen Sisk, Chief
Winnemem Wintu Tribe
caleenwintu@gmail.com

Konrad Fisher, Director
Water Climate Trust
k@omrl.org

Mary Kay Benson
Steering Committee Manager
Chico 350
mkbe.sparkles3@gmail.com

Jean Hays, ED Leadership Team
Women's International League for Peace
And Freedom Earth Democracy
Skyhorse3593@sbcglobal.net

Attachment: Kamman Hydrology Analysis of Sites DEIS/EIR on Trinity River

cc: California Water Commission Members
Representative Jared Huffman
Karuk Tribe
Hoopa Valley Tribe
Yurok Tribe
Humboldt County Board of Supervisors
Trinity County Board of Supervisors
Eileen Sobeck, Executive Officer SWRCB
Charlton Bonham, Director CDFW

Specific List of Issues That Must Be Addressed in a Recirculated Draft EIS/EIR For The Sites Project

1. **Foreseeable Impacts to Trinity River Water Temperature Objectives Associated with Sites Project Operations Need to be Evaluated with an Accurate Temperature Model.** The revised Trinity River Division water operations associated with the Sites Project (shifting diversions to winter/spring from summer/fall in dry years) violates the 2000 Trinity Record of Decision and will lead to increased water temperatures in Lewiston Reservoir and downstream in the Trinity River. The Draft EIS/EIR does not disclose the impact, even though the proposed operation would clearly increase river temperatures, meaning that the temperature model is not accurate. Any increase in the temperature of water released to the Trinity River would degrade water quality conditions and increase the potential for violations of North Coast Basin Plan water quality (temperature) objectives protective of adult spring and fall Chinook, as well at the water temperature objectives established under the Trinity River Record of Decision to protect outmigrating juvenile salmonids. The water temperature model developed by USGS for the Trinity River should be used to evaluate the impacts to Trinity River water temperatures and attainment of water temperature objectives See detailed comments in attached memo from Kamman Hydrologics.

2. **Foreseeable Impacts to Trinity River Associated with Trinity Lake Carryover Storage.** The Sites Project water operation and temperature analyses assume a minimum Trinity Reservoir carryover storage volume of 600TAF, thereby impacting Trinity River water temperatures. Water temperature modeling for the Trinity River, including studies by the Bureau of Reclamation, indicate that initial October 1 carryover storage volumes of 600- and 750-TAF are not sufficient to satisfy Trinity River temperature objectives for a single dry/critically dry water year-type, let alone multi-year droughts. It is reasonable to foresee that current implementation of the ROD Flows without sufficient carryover storage will not achieve Trinity River temperature objectives during critically dry year-types and possibly not meet objectives of the ROD for the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River. Additionally, Trinity Reservoir storage has no chance of being replenished during multi-year droughts. See detailed comments in attached memo from Kamman Hydrologics.

3. **Inaccurate Existing (Baseline) TRD Water Operations.** The water operations analysis for Sites Project EIR/S did not include an analysis considering use of Humboldt County's 50 TAF water contract included as a provision of the Trinity River Division Act of 1955. The ROD for the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River (Lower Klamath ROD) identifies Humboldt County's 50 TAF water contract as a volume of water available to release into the Trinity River to reduce the probability of a fish kill in the Lower Klamath River. The omission of the Humboldt County 50 TAF contract and the Lower Klamath ROD in the DEIR/S analyses could have significant effects on projected CVP water deliveries and the water quality conditions and potential impacts to both the Trinity and Sacramento Rivers. Therefore, the DEIR/S should be considered incomplete in the analysis of the effects of the Site Project operations on the Trinity River. See detailed comments in attached memo from Kamman Hydrologics.

4. **Incomplete Cumulative Impact Assessment Pertaining to TRD Operations.** Several issues were not evaluated as part of the cumulative impact assessment that will likely have adverse impacts on the Trinity River including (1) the impact of the 600 TAF minimum carryover storage in meeting Trinity River water temperature objectives during multi-year droughts, (2) accounting for Humboldt County's 50 TAF water contract, and (3) the influence of climate change on meteorology and hydrology of northern California rivers. See detailed comments in attached memo from Kamman Hydrologics.
.

5. **Mitigation for Trinity/Lower Klamath Impacts.** Effective mitigation measures must be recommended to ensure that fishery/fish habitat management objectives for the Trinity River and lower Klamath River will be met. The Bureau of Reclamation has used the auxiliary outlet on Trinity Dam to release colder water during drier years, but this action results in the loss of power generation and this impact on CVP power generation needs to be evaluated as it relates to revised Trinity operations as proposed for Sites.

6. **Narrow Scope of Alternatives.** The DEIS/EIR should include a wider range of alternatives rather than only alternatives that maximize attaining project benefits of increasing water supply. Alternatives that achieve varying levels of project objectives while minimizing project impacts should be developed and evaluated.

7. **No Action Alternative and Existing Conditions.** Assuming the existing conditions and No Action alternatives are the same is inappropriate, compromises the ability to compare impacts across alternatives, and may minimize the magnitude of some of the impacts. The faulty assumption that State and Federal water contractors would be projected to use their full contracted water volumes (2030 projected conditions) does not reflect the current water management (existing condition) and likely provides inaccurate impact results. Because of this, the no action alternative minimizes potential impacts and greatly reduces the mitigation responsibilities required under CEQA.

8. **Sites Project Water Rights and Potential Unforeseen/Undisclosed Impacts**. The DEIS/EIR does not sufficiently address the acquisition of water rights for the Sites Project nor does it address water over-allocation issue in the Central Valley. Also, potential impacts of acquiring these water rights and the associated water to be stored in Sites Reservoir on other streams/watersheds must be evaluated.

9. **Cumulative Impacts.** The conclusion presented in the DEIS/EIR that there are no cumulative impacts associated with the Sites Project is flawed. An evaluation of cumulative impacts is necessary to comply with the law. With the declining status of the fishery resources in the Sacramento-San Joaquin Basin and the Delta, reduction of flows in the Sacramento River by the proposed Sites Project operations would contribute to the decline of these populations in a cumulative manner. Changes in proposed diversions from the Trinity Basin would also have cumulative impacts on the fishery resources of the Klamath-Trinity Basin. Additionally, many

actions are not identified in the cumulative impacts section and need to be included in the cumulative impacts analysis including: the ROD for the Trinity River Mainstem Fishery Restoration (without modifications to diversions to the Sacramento River as proposed in the DEIS/EIR), the ROD for the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River (as proposed), the lower American River Modified Flow Management Standard, California Water Fix, the Temperance Flat Dam proposal, the proposed enlargement of Shasta Dam, the State Water Project Contract Extension, the Agricultural Drainage Selenium Management Program, the West Sacramento Levee Improvements Program, the Central Valley Flood Protection Plan, FloodSAFE,, the Lower Yolo Restoration Project, the Contra Costa Water District Intake and Pump Station (Alternative Intake Project), 2009 National Marine Fisheries Service Biological Opinion and Conference Opinion for the Coordinated Long-Term Operation of the CVP/SWP, , the new Biological Assessment and NOAA Fisheries consultation regarding the State and Federal Water Projects, the 2008 United States Fish and Wildlife Service Biological Opinion for Delta smelt for the Coordinated Long-Term Operation of the CVP/SWP, the Draft Environmental Impact Statement for Revisions to the Coordinated Long-Term Operation of the Central Valley Project and State Water Project, the Central Valley Flood Management Program, the San Joaquin River Restoration Program, the Recovery Plan for Sacramento-San Joaquin Delta Native Fishes, the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan, Bay Delta Phase 2 plan updates, the California Water Action Plan, California EcoRestore, and the Davis-Woodland Water Supply Project.

10. **Sites Reservoir Operating Procedures/Priorities Absent.** The operating /accountable entity of the Sites Project is not identified, and no operating rules/procedures are provided. The DEIS/EIR identifies four potential uses of stored water (supplemental deliveries to TC Canal, GC Canal and RD108 settlement contractors; increasing deliveries to wildlife refuges; increasing water reliability for CVP and SWP contractors; and releases for delta water quality) but no rule set with priorities and volumes to be used to meet these uses are provided. These procedures must include integration of the Sites Project with CVP, SWP, and other water management projects.

11. **Tribal Consultation and Mitigation Absent.** There is no Tribal consultation outside the footprint area and there are cultural resources within the foot print area with no mitigation measures discussed for their protection. AB-52 tribal consultation is now required and federal Tribal consultation has always applied.

12. **Compliance with California Endangered Species Act (CESA).** As identified in the DEIS/EIR, CESA protected species may be affected (take) by the Sites Project and any take must be authorized by CDFW by a CESA permit which is also subject to CEQA. Impacts, mitigation actions with an associated monitoring and reporting program much be included in the CEQA document supporting the CESA permit. In addition, Klamath River spring Chinook are now a candidate species under CESA and must be considered.

13. **Hydropower Licensing.** Since it is likely that hydropower facilities would be constructed as part of the project, a detailed descriptions and operation protocols of the proposed facilities and analyses of potential impacts should be presented in the DEIS/EIR. A description of the steps, including timelines, that will be taken to obtain FERC approval for the project should also be provided.

14. **Environmental Baseline/Modeling**. The source of much of the information used in the modeling and impact assessment appears to be outdated (it is difficult to discern the source of some of the data) and likely does not reflect the current understanding of the system using the best available data. Without the use of updated, contemporary models the information presented in the document on potential impacts are highly questionable.

15. **Bypass Flows and Diversion Rates.** The DEIS/EIR indicates diversions to the Sites Project would reduce flows in the Sacramento River and Delta outflows, especially in the winter in spring. Potentially significant flow reductions in the Sacramento River, especially during dry and critically dry water years, will likely have significant biological impacts on fish species in the river at those times. The proposed bypass flows of 3,250 cfs at Red Bluff, 4,000 cfs at Hamilton City and 5,000 cfs at Wilkins Slough are less than those needed to restore native fish and wildlife identified in the State Water Resources Control Board report "*Scientific Basis Report in Support of New and Modified Requirements for Inflows from the Sacramento River and its Tributaries and Eastside Tributaries to the Delta, Delta outflows, Cold Water Habitat, and Interior Delta Flows*" (https://www.waterboards.ca.gov/water_issues/programs/peer_review/docs/scientific_basis_phase_ii/201710_bdphaseII_sciencereport.pdf). Justification for these flow magnitudes should be presented and impacts of these flows that are insufficient for restoration of native fish species should be thoroughly evaluated. The timing of the Sites Project diversions during winter and spring will eliminate or greatly diminish the effectiveness of higher releases of water from Shasta Dam to meet environmental needs if it remained in the river. Additionally, potential mitigation measures to address these decreased flow impacts such changing diversion timing and magnitude, a variety of pulse flows to improve outmigration conditions for fishes, and other physical/biological/ecological processes should be proposed and evaluated. An alternative using Sacramento minimum bypass flows of no less than 13,000 cfs recommended by CDFW should be fully analyzed.

16. **Reduced Delta Outflows and impacts on Delta Smelt and Other Important Bay-Delta Species.** The draft EIS/EIR erroneously states there is no relationship between winter/spring Delta outflows and Delta smelt abundance. Information presented in the Interagency Ecological Delta Smelt Management Analysis and Synthesis Team report (2015) shows a positive relationship between larval Delta smelt abundance and winter-spring Delta Outflows. The impacts on larval Delta smelt abundance resulting from reduced winter-spring Delta outflows due to Sites Project operations needs to be evaluated and necessary mitigation actions identified. Additionally, the impacts of reduced Delta outflows on the zooplankton community should be evaluated because of their critical importance as food for larval fishes.

17. **Delta and Longfin Smelt Impacts due to Old and Middle River Reverse Flows.** The DEIS/EIR acknowledges the potential increase of Old and Middle River reverse flows during some summer, fall, and winter months due to increased pumping at the CVP and SWP facilities but does not adequately assess the impact on Delta smelt and Longfin smelt. In addition to the estimated losses due to entrainment in the CVP/SWP facilities, losses in Old and Middle River (and other affected waterways) occurring before the diversion facilities, the areas where the majority of mortality occurs, must be evaluated.

18. **Water Quality and Beneficial Use Impacts.** Diverting higher-quality water from the Sacramento River will likely lead to water quality degradation at downstream sites and these potential impacts are not evaluated. The Sacramento River and Delta already suffer from water quality impairments (temperature, heavy metals, nutrients, pesticides) and decreasing flows will only exacerbate these problems. This not only impacts the aquatic resources but also potentially agricultural and domestic uses of these waters.

19. **Sacramento River Flow and Temperature Modeling.** The use of an outdated version of the CALSIM II model not calibrated to current data is inappropriate. This model is based on a monthly timestep which is not appropriate for modeling impacts on habitat availability and water temperature. Water temperature analyses should be based on daily time steps because of the potential sub-lethal and lethal effects of temperatures on aquatic organisms due to daily or weekly changes. The water quality analyses that use the weekly time-step information from CALSIM II would not capture this shorter timeframe impacts. The shorter timestep for habitat modeling such as weekly would be more appropriate.

20. **Sacramento River Temperature Effects.** The assumption that a multi-level outlet structure to manage releases water temperatures to match those of the Sacramento River needs to be evaluated and appropriate information presented. The Sites Reservoir will be a relatively shallow and large surface area impoundment that may not provide the stratification and resulting cold water pool necessary to effectively manage water temperature releases to preserve cold water fishes. Modeling of reservoir water volume and thermal dynamics, using information from similar reservoirs, should be conducted, and potential impacts on attaining the objective of releasing the same water temperature as the Sacramento River disclosed. Incorporation of operations procedures using the multi-level outlet should be presented and an evaluation of how these procedures, using anticipated volumes of cold-water storage and release patterns, is needed to evaluate the effectiveness of this component of the proposed action. Additionally, an explanation and modeling data of how Sites Project operations will be incorporated CVP and SWP operations in meeting temperature objectives should be presented.

21. **Impacts to Floodplain Habitat.** Sites Project operations will reduce flows in the Sacramento River and may impact the timing and duration that fish have to high quality habitat in the Yolo

and Sutter bypasses. An annual time-series analyses of flow impacts on access to, duration of connectivity and extent of habitat availability of these floodplain habitats is needed.

22. **Evaluation of Fishery Impacts Lacking.** Fishery resources in the Sacramento-San Joaquin and Klamath-Trinity Basins contribute to significant tribal, commercial, and recreational fisheries within these river systems and along the coasts of California and Oregon. An evaluation of the cultural, social and economic impacts on these fisheries must be included in the document to fully disclose potential impacts. The is no supporting documentation on how the fishery impact information presented in the DEIS/EIR were derived and many statements pertaining to fishery impacts are unsupported. There is no information concerning the potential impacts on spring and fall Chinook salmon, Coho salmon, and steelhead populations in the Klamath-Trinity. The DEIR/EIS should evaluate how alternatives would impact different runs and species as well as the fisheries that depend on these resources, including impacts on port facilities, marinas, bait shops, motels, and restaurants that benefit from these fisheries.

23. **Water Quality – Toxic Metals.** Potential significant water quality issues pertaining to toxic metals are not evaluated in the DEIS/EIR. Although data are limited, the source water for the Sites Reservoir (Sacramento River, Funks and Stone Corral creeks) indicate high levels of many metals that exceed water quality standards. In addition to the high concentrations of metals present in streams inundated by the project, additional leaching from soils under the reservoir, known for high concentrations of mercury, will occur when these soils are inundated. The impacts of toxic metals on water quality in the reservoir and impacts to the Sacramento River water quality from Sites Project release needs to be analyzed. Additionally, the potential impacts to the reservoir fishery due to chronic toxicity/mortality and public health/fish consumption concerns needs to be evaluated.

24. **Methylmercury.** Many impoundments near the proposed Sites Project (Black Butte, Colusa Drain, Indian Valley Stony Gorge) have fish advisories due to elevated mercury levels. There is a potential for methylmercury creation and subsequent bioaccumulation in fish resulting from the implementation of the Sites and this should be modeled, evaluated and any potential mitigation measures proposed.

25. **Noxious Algal Blooms**. Blue-green algal are common in shallow reservoirs in California near the proposed Sites Project as well as downstream in the Delta. The potential for noxious algal blooms should be evaluated under the proposed operation plan and potential mitigation measures to minimize algal blooms and minimize public health issues should be proposed.

26. **Water Quality – Salinity**. Sites Reservoir will inundate areas where known saline springs exist. The impact of these salt springs on the water quality of the reservoir and the releases into the Sacramento needs to be evaluated.

27. **Geomorphology.** The problematic geomorphic analyses (errors/inconsistencies in data presented on geomorphic impacts, inappropriate citations, apparent analyses of alternatives that are different than the proposed alternatives) requires reanalysis of the potential geomorphic impacts. Increases in sediment entrainment of 55% in the Tehama-Colusa Canal and 46% in the Glenn-Colusa Canal suggest that there are significant undisclosed geomorphic impacts which could affect riverine and riparian habitats adjacent to these canal intakes.

28. **Entrainment Losses of Native Fish**. The amount of water available to be pumped through the Federal and State pumping facilities will be increased with the Sites Project. The potential impacts to larval and juvenile fishes (salmonids, Delta smelt, white and green sturgeon, Pacific Lamprey, and other native species) should be evaluated. This evaluation should not just estimate losses of entrainment as was done in the draft EIS/EIR but also estimated losses in southern delta channel prior to fish reaching the screening facilities. The mitigation actions to address the potentially significant impacts of impingement, entrainment and stranding are not sufficiently defined to ensure that impacts are minimized. These mitigation actions need to be developed with appropriate performance criterial so the effectiveness of these actions can be assessed.

29. **Fish Screens**. Effectiveness of fish screens and fish mortality associated with entrainment into the Sites Project or impinged on screens should be evaluated. With the majority of the diversions occurring during the winter and spring, impacts to larval and small juvenile fishes migrating past the Sites Project can be significant.

30. **Impacts on Funks and Stone Corral creeks**. Impacts to the instream habitats and dependent fish populations in Funks and Stone Corral creeks are not evaluated. No justification for the instream flows of "up to 10 cfs" in these creeks is provided. The method for establishing this flow level should be provided. An evaluation of how these flow levels will impact physical processes necessary to maintain stream habitats and impacts to aquatic habitats and fish populations should be included.

31. **Reservoir Fishery Impacts from Pumping Plant Operation:** Since a recreational fishery is an anticipated benefit of the Project, the potential impacts of the pumping/power generation between the reservoirs should be evaluated in the context of the sustainability of a recreational fishery. Stating that a fishery impact analysis was not conducted because no reservoir exists is not sufficient. Mitigation measures to minimize pumping/power generation impacts to recreational fisheries such as screening or timing of operations should be proposed.

32. **Recreation.** The presentation of potential recreation benefits of the Sites Project presented in the DEIS/EIR is insufficient. Only boat ramp accessibility is evaluated, presumably to inform fishing/boating use, but no information on other recreational activities (swimming, bird watching, camping, hunting, etc.) are provided. Additionally, the potential for the development of a reservoir fishery should include a fish management plan. While the development of a

warm-water reservoir fishery may be a recreational benefit, the potential impact of increased non-native predators on native fish populations needs to be evaluated.

33. **Wildlife Mitigation Actions**. Future agreements with other public or private entities for mitigation actions to address significant wildlife and terrestrial habitat impacts are not acceptable because there is no guarantee these actions will be implemented. Mitigation actions should be feasible and the agency needs to commit to ensuring these actions are fully implemented to reduce project impacts to less than significant prior to project approval.

34. **Need for a Natural Community Conservation Plan (NCCP).** A plan for the development and implementation of a NCCP must be included because the Sites Project affect several species that may occur in the Sites Project area.

35. **Nesting Birds.** Sites Project activities must be implemented in a manner that eliminates disturbance to the nests/nesting birds protected under the Migratory Bird Treaty and Fish and Game Code. Depending on the species, the disturbance distance of activities may be variable and, if established buffer distances are found to be ineffective at minimizing disturbance through monitoring of nests, the buffer must be increased to eliminate the disturbance.

36. **Giant Garter Snake.** The Giant Garter Snake, a CESA protected species, may occur in the areas within the Sites Project and the Project would negatively alter giant garter snake habitats resulting in significant impacts to this species. Implementable and enforceable actions must be included to address these significant impacts and appropriate CESA permits obtained.

37. **Botanical Surveys.** Information contained in the DEIS/EIR is insufficient to determine the impacts on botanical resources within the Sites Project area. Botanical surveys must be redone, data included in the DEIS/EIR are from the late 1990's and early 2000's, and must include all areas affected by the project. Accepted scientific protocols should be used to conduct these surveys.

38. **Botanical Resources Mitigation.** Using information from updated botanical surveys, implementable actions, with the commitment to fully implement them until they effectively mitigate for project impacts, need to be include in the document. These actions must include sufficient detail to allow for determination of their feasibility and likelihood for success.

Kamman Hydrology & Engineering, Inc.
11 Valencia Avenue, San Rafael, CA 94901
Telephone: (415) 491-9600
Facsimile: (415) 680-1538
Email: greg@KHE-Inc.com

January 21, 2019

Mr. Noah Oppenheim, Pacific Coast Federation of Fishermen's Association (PCFFA)
Mr. Thomas Stokely, Save California Salmon

Subject: Review of Draft Environmental Impact Report/Statement
Sites Reservoir Project

Dear Mr. Oppenheim and Mr. Stokely:

I have reviewed the Draft Environmental Impact Report/Draft Environmental Impact Statement (DEIR/S) for the Sites Reservoir (Sites) Project located in Glenn and Colusa Counties, California. The focus of my review was to evaluate if the Sites Project and associated Trinity River Division (TRD) of the Central Valley Project (CVP) operations would potentially impact the hydrology and water quality of the Trinity River. I am familiar with how TRD operations affect water temperatures as I have completed numerous water temperature modeling studies related to alternative operations of Trinity and Lewiston reservoirs with a focus on effects on downstream temperatures in the Trinity River. These studies were completed from 1997 through 2004. A copy of my resume is attached.

The DEIR/S indicates that the project poses less than significant impacts on the water quality to the Trinity River downstream of Trinity and Lewiston reservoirs. However, based on my review and analysis of the DEIR/S and other available information, I have identified a number of notable deficiencies in the water quality assessment that fail to identify and correctly analyze revised water operation impacts on Trinity River water quality (temperature) and, in turn, biological resources. Therefore, it is my opinion that the information presented in the DEIR/S is inadequate in evaluating potential adverse impacts to the water quality of the Trinity River. Nor does it propose mitigation measures for reasonably foreseeable adverse impacts to water quality and aquatic resources of the Trinity River. A discussion of the identified deficiencies is provided below.

1. Foreseeable Impacts to Trinity River Associated with Sites Project Operations

Based on my knowledge and experience in analyzing water temperature conditions of the TRD of the CVP, it is my opinion that the revised TRD water operations associated with the Sites Project will lead to increased water temperatures in Lewiston Reservoir and releases to the Trinity River. Any increase in the temperature of water released to the Trinity River would degrade water quality conditions and increase the potential for violations of North Coast Basin Plan[1] water quality (temperature) objectives as well at the water temperature objectives

---

[1] "Water Quality Control Plan for the North Coast Region" Footnote 5, Table 3-1, page 3-8.00: Accessed at http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/083105-bp/04_water_quality_objectives.pdf

established under the Trinity River Record of Decision (USDOI 2000) to protect outmigrating juvenile salmonids[2].

I reached this conclusion through analysis of water resources system modeling results provided in Appendix 6B of the DEIR/S. Tables 1 through 3 are taken from Appendix 6B and present Trinity Reservoir storage, Trinity River flow and Clear Creek Tunnel diversion modeling results for both the Sites Project No Action Alternative and Alternative D under a variety of water year types. Table 1 presents a comparison of end of month (EOM) storage in Trinity Reservoir. The DEIR/S suggests incorrectly that the small differences between the No Action Alternative and Alternative D are not significant per the following statement (page 6-36).

> *The CALSIM II model monthly simulation of real-time daily (or even hourly) operation of the CVP and SWP results in several limitations in use of the CALSIM II model results. The model results must be used in a comparative manner to reduce the effects of use of monthly assumptions and other assumptions that are indicative of real-time operations, but do not specifically match real-time observations. Given the CALSIM II model uses a monthly time step, incremental flow and storage changes of 5 percent or less are generally considered within the standard range of uncertainty associated with model processing, and as such flow changes of 5 percent or less were considered to be similar to Existing Conditions/No Project/No Action flow levels in the comparative analyses using CALSIM II conducted in this EIR/EIS.*

Table 2 presents the monthly average releases to the Trinity River from Lewiston Reservoir. Apart from the 8.9% decline during December of Wet years, 8.6% to 31.2% decline in flows during February and March of Above Average water year-types, and the 24.2% drop during February of the Below Average water year-type, there are no reductions in flow under Alternative D that are considered significant in the DEIR/S.

Table 3 presents the changes in flow through the Clear Creek Tunnel, which represent diversions from Lewiston Reservoir (via the Carr power plant) to the Sacramento River and potentially Sites Reservoir. A general pattern seen in the these data is a shift in operations under the Project Alternative that increase the rate of diversions through the winter months (December-March) and reduce diversion rates through the summer/fall months (July-November) during dry and critically dry year types. I assume this change in operations is intended to provide more water to the Sacramento River during the winter to enhance

---

Daily Average Not to Exceed	Period	River Reach
60°F	July 1- Sept 15	Lewiston to Douglas City Bridge
56°F	Sept 15-Oct 1	Lewiston to Douglas City Bridge
56°F	Oct 1- Dec 31	Lewiston to North Fork Confluence

[2] Trinity River Outmigrant Juvenile Salmonid objectives at Weitchpec (Trinity River Flow Evaluation (USFWS and HVT 1999) accessed at http://www.trrp.net/library/document/?id=226

Normal, Wet and Extremely Wet	April 1-May 22	<13.0 C (<55.4 F)
	May 23-June 4	<15.0 C (<59.0 F)
	June 5-July 9	<17.0 C (<62.6 F)
Dry and Critically Dry	April 1-May 22	<15.0 C (<59.0 F)
	May 23-June 4	<17.0 C (<62.6 F)
	June 5-July 9	<20.0 C (<68.0 F)

the opportunity for diversion to Sites Reservoir. However, this change in operations would have a significant negative effect on the water temperatures in Lewiston Reservoir as well as the temperature of releases to the Trinity River.

Table 4 was developed in order to compare the total average flow through Lewiston Reservoir under the Sites Project No Action Alternative and Alternative D operations. The total flow through Lewiston Reservoir was computed by summing the average monthly flow values of releases to the Trinity River (Table 1) and flow through Clear Creek Tunnel (Table 3).

Due to its geometry and operations of the TRD, water temperatures in Lewiston Reservoir are highly variable. During the summer when there are relatively low and constant releases to the Trinity River and Carr power plant diversions are at capacity, the rate of flow through Lewiston Reservoir is sufficient to displace its entire volume in about 2.5 days and water temperatures remain relatively cool (Brown et al., 1992)[3]. On the other hand, when the Carr power plant is not operating, flow through Lewiston Reservoir stagnates and thermal stratification develops within days, typically leading to the warming of summer surface waters to between 60 and 70 F (15.6 and 21.1 C) (Ibid).

Modeling that I have completed suggests that total flow rates through Lewiston Reservoir (i.e. the sum of Carr power plant diversions and river releases) should be between approximately 800 cubic feet per second (cfs) during the late summer/early fall months of normal year-types and up to 1900 cfs during the summer/fall months of critically dry year-types in order to comply with downstream temperature objectives (Kamman, 1999a)[4]. The maximum late summer/early fall daily releases for releases to the Trinity River under the Trinity ROD range from 300 to 450 cfs. Thus, Carr power plan diversions (i.e., flow through Clear Creek Tunnel) would need to be maintained between 1450 and 1600 cfs to meet summer/early fall temperature needs during normal and critically dry years, respectively.

Based on this this information, it can be inferred that any decrease on total flow through Lewiston Reservoir during the summer/fall period would lead to increased temperatures in water released to the Trinity River as well as that diverted via the Carr power plant and Clear Creek Tunnel. Comparison of total flow rates through Lewiston Reservoir for Alternative D (Table 4) indicates significant reductions during most summer/fall months of the representative dry and critically dry year-types. Most notable are the reductions in flow and likely reservoir heating during the month of October, where flow through Lewiston Reservoir is reduced by 165% and 56% during dry and critically dry year-types, respectively, a time when meeting downstream temperature objectives is already compromised (Kamman, 1999b)[5].

Evaluation of average monthly temperature results for releases to the Trinity River presented in Appendix 7E (River Temperature Modeling) of the DEIR/S do not corroborate the anticipated increase in Lewiston Reservoir temperatures. Table 5 presents the DEIR/S temperature modeling results and

[3] Brown, R., Yates, G., and Field, J. (1992) "Temperature Modeling of Lewiston Lake with the BETTER two-dimensional reservoir flow mixing and heat exchange model." *Rep*., Department of Transportation and Planning, Trinity County, Weaverville, CA.
[4] Kamman, G.R., 1999a, Temperature Analysis of Proposed Trinity River Fish and Wildlife Restoration Flow Alternatives using the BETTER Model: Prepared for: Trinity County Planning Department, June, 80p.
[5] Kamman, G.R., 1999b, Addendum to Temperature Analysis of Proposed Trinity River Fish and Wildlife Restoration Flow Alternatives using the BETTER Model: Cumulative Effects. Prepared for: Trinity County Planning Department, September, 7p.

suggests (contrary to the discussion above) that water temperatures in Lewiston Reservoir (i.e., temperature of releases to Trinity River) would decrease as total flow through the reservoir decreases. In fact, the temperature decreases are most pronounced during some dry and critically dry months of greatest reduction in flow rates through Lewiston Reservoir, when water temperatures would be increasing. This leads me to call into question the validity of the temperature model analysis of TRD operations presented in the DEIR/S.

More important is that the proposed change in TRD operations by the Sites Project directly conflicts with and reverses intended operations stipulated in the Secretary of Interior's 2000 Record of Decision (ROD) for the Trinity River Mainstem Fishery Restoration project. As you are aware, the modeling and temperature analysis work I completed for Trinity County back in the late 1990's contributed significantly to development of the instream flow and Carr power plant and Clear Creek Tunnel diversion schedules for the Trinity Preferred Alternative in order to better meet downstream temperature objectives. This work was accomplished through lengthy and focused analyses and meetings with project stakeholders and resulted in final preferred alternative operations with increased late summer CVP diversions to the Sacramento River. Acknowledging that even the river releases and temperatures from Lewiston Reservoir associated with the Preferred Alternative may not satisfy downstream temperature objectives, the Trinity Project ROD stipulates the following (page 20): "*Under the Preferred Alternative, the TRD would be operated to release additional water to the Trinity River, and the timing of exports to the Central Valley would be shifted to later in the summer to help meet Trinity River instream temperature requirements*". By proposing to reduce late summer CVP diversions to the Sacramento River, the Sites Project creates a foreseeable potential impact on Trinity River water quality by reversing the very operations associated with the Trinity River ROD that are intended to satisfy downstream water temperatures objectives and protect instream beneficial uses, particularly for salmon and steelhead.

This potential shift in TRD operations is concerning due to the fact that there are frequent exceedances of water temperature objectives under the current TRD ROD operations and flows. Recent studies completed by the U.S. Fish and Wildlife Service[6] provide data on how the TRD operations and ROD flows comply with downstream Basin Plan and Restoration Project temperature objectives. Appendix A from David and Goodman (2017), presented below, summarizes the exceedances to the Basin Plan (DGC and NFH locations) and Trinity River Restoration Project (TRWEI location) temperature objectives for the period 2001 through 2016.

---

[6] David, A.T. and Goodman, D.H., 2017, Performance of water temperature management on the Klamath and Trinity Rivers, 2016. U.S. Fish and Wildlife Service, Arcata Fisheries Technical Report TR 2017-29, November, 72p; and
Polos, J. 2016. Adult salmon water temperature targets. Trinity River Restoration Program Performance Measure. Trinity River Restoration Program.

Appendix A. Number of days exceeding numeric water temperature objectives for the three specified locations on the Trinity River, 2001-2016. DGC = Trinity at Douglas City; NFH = Trinity above the North Fork Trinity; TRWE1 = Trinity above the Klamath.

Year	Objective locations			Forecast water year type	Actual water year type
	DGC	NFH	TRWE1		
2001	--	--	33[a]	Dry	Dry
2002	0	--	54	Normal	Normal
2003	11	--	34	Wet	Wet
2004	0	--	43	Wet	Wet
2005	--	1	21[b]	Normal	Wet
2006	6	0	18	Ex. Wet	Ex. Wet
2007	3	0	19	Dry	Dry
2008	1	4	0	Normal	Dry
2009	31	2	21	Dry	Dry
2010	6	7	10	Normal	Wet
2011	0	0	7	Wet	Wet
2012	0	1	25	Normal	Normal
2013	0	0	26	Dry	Dry
2014	18	15	53	Crit. Dry	Crit. Dry
2015	--	18	65	Dry	Dry
2016	14	3	52	Wet	Wet

[a] Data unavailable prior to 5/3 for TRWE1 in 2001. We assumed mean daily temperatures did not reach or exceed 15.0 C before this date.
[b] Data unavailable prior to 4/4 for TRWE1 in 2005. We assumed mean daily temperatures did not reach or exceed 13.0 C before this date.

These exceedances occur during all water year types, but with highest frequency during dry and critically dry year types. Of note in this Appendix are the high number of exceedances during the wet water year 2016. As reported by David and Goodman, the exceedances during 2016 are, in part, due to depletion of the cool water pool (carry-over storage) during the preceding 3-year drought period (2013-2015).

2. Foreseeable Impacts to Trinity River Associated with Trinity Lake Carryover Storage

Ordinarily in late summer, water temperatures in Trinity Reservoir are well stratified, displaying a layer of warm water above a deeper pool of much colder water. During this time, releases from Trinity Reservoir to Lewiston Reservoir occur through a submerged powerhouse outlet. If the reservoir is drawn down to a relatively low level, the upper warm layer may intersect the powerhouse outlet, releasing warm water to Lewiston Reservoir. In turn, these warm temperatures are propagated through Lewiston Reservoir to the Trinity River. As presented below, a number of studies have been completed to quantify the minimum October 1st carryover storage volume that is needed to protect against the introduction of warm summer water releases during various water year types and droughts.

In 1998, Trinity County retained KHE to evaluate how an intense multi-year drought would affect carryover storage in Trinity Reservoir (Kamman, 1998)[7]. The study approach included an

[7] Kamman, G.R., 1998, Carryover Storage Analysis – Simulated (1928-1934) period. Prepared for: Trinity County Planning Department, May 22, 3p

interannual accounting of Trinity Reservoir storage during a series of representative water year-types similar to those experienced during the 1928-1934 drought.[8] Water releases from Trinity Lake were based on the water year type for Trinity Division operations[9] under the ROD Flows. A series of interannual Trinity Reservoir water budgets were developed with initial carryover storage volumes ranging from 750- to 2000-TAF.

Study results (Kamman, 1998) indicate that under CVP operations to meet ROD Flows, there is a net annual increase in Trinity Reservoir storage during normal (1928) year-types, but decrease during dry (-17.5 TAF) and critically dry (-341 TAF) year-types. Thus, when starting with 750 TAF of storage, Trinity Reservoir storage would have dropped below 200 TAF after the third year of the drought, primarily driven by storage reductions experienced during critically dry years. Study results also indicate that a starting storage volume of 1250 TAF is required to maintain a minimum carryover storage of 600 TAF through the drought. However, modeling results (Kamman, 1999a and 1999b) indicate that even 600 TAF of carryover storage does not fully achieve compliance with temperature objectives during dry and critically dry year types. This study suggests that a minimum carryover storage volume of between 1250- and 1500-TAF during the first year of drought is likely required in order to provide the necessary water release temperatures to the Trinity River to meet downstream temperature objectives during subsequent years.

In addition to the work cited above, I am aware of other studies focused on identifying the minimum Trinity Reservoir carryover storage to provide the necessary cold water releases to satisfy river temperature objectives. In their 1992 testimony to the State Water Board, Finnerty and Hecht (1992)[10] concluded that Trinity Reservoir carryover storage of 900 TAF or slightly more may be needed to meet downstream temperature objectives during 90% of all years. Their conclusion was based on analysis of hydrology, reservoir operations and temperatures for 1991, a single critically dry year-type. The second study, completed by Deas in 1998[11] on behalf of Trinity County, included water temperature simulations of Trinity Reservoir using the Water Temperature Simulation Model (WTSM). Deas evaluated temperature compliance under 1990 dry year-type conditions assuming initial reservoir storage volumes of 750-, 1250- and 1500-TAF. Model simulation results indicated elevated water temperatures at the powerhouse intake elevation for the 750 TAF carryover storage scenario and minimal to no temperature concerns at initial carryover storage volumes of 1250- and 1500-TAF, respectively. Deas' findings of elevated temperatures associated with 750 TAF of carryover storage are corroborated in the 2012 report by Reclamation[12], which found that a September 30 carryover storage requirement of less than 750 TAF is "problematic" in meeting state and federal Trinity River temperature objectives

---

[8] The interannual water budget accounting started in 1928, a normal water year type.

[9] It is likely that CVP operations would change during drought periods. However, we did not have the knowledge or expertise to define such changes. Thus, the analysis used operations consistent with the earlier PROSIM simulations.

[10] Hecht, B. and Finnerty, A.A., 1992, Testimony to the State Water Resources Control Board regarding Carryover Storage in Trinity and Lewiston Reservoirs to Protect Public-interest Resources. State Water Resources Control Board Water Right Phase of the Bay-Delta Estuary Proceedings, June 26, 7p.

[11] Deas, M.L., 1998, Trinity Reservoir Carryover Analysis. Prepared for: Trinity County Planning Department, Natural Resources Division, August, 26p.

[12] U.S. Department of Interior, Bureau of Reclamation, 2012, Trinity Reservoir Carryover Storage Cold Water Pool Sensitivity Analysis – Technical Service Center (TSC) Technical Memorandum No. 86-68220-12-06. August 20, 7p.

protective of the fishery.

The Sites Project water operation and temperature analyses assume a minimum Trinity Reservoir carryover storage volume of 600TAF. The study findings presented above indicate that initial October 1 carryover storage volumes of 600- and 750-TAF are not sufficient to satisfy Trinity River temperature objectives for a single dry/critically dry water year-type, let alone multi-year droughts. Thus, it is reasonable to foresee that current implementation of the ROD Flows without sufficient carryover storage will not achieve Trinity River temperature objectives during critically dry year-types. Modeling results indicate that critically dry water year-types deplete reservoir carryover storage volumes at much higher rates than occurs during dry years. Whether dealing with dry or critically dry year-types, reservoir storage has no chance of being replenished during multi-year droughts under the current and proposed Sites Project CVP operations.

As determined by Finnerty and Hecht, a minimum baseline carryover storage volume of 900 TAF is required to meet Basin Plan temperature objectives on the Trinity River during a single dry year. Studies by Deas and Kamman suggest this baseline carryover storage volume is likely higher for critically dry year-types. Significantly higher carryover storage volumes over the baseline value are required to preserve the necessary reservoir cool water pool during multi-year drought periods, in order to achieve temperature objectives. Modeling studies suggest first year drought carryover storage volumes of around 1750 TAF are sufficient to maintain adequate carryover storage to meet temperature objectives during multi-year droughts. Thus, a single minimum carryover storage volume cannot be developed without revising CVP operations that focus on preserving Trinity Reservoir carryover storage, most likely by reducing water that is diverted out of the Trinity River basin.

The Sites Project DEIR/S presents the results of their modeling analyses as monthly average values of flow, storage and water temperature for multiple years within designated water-year type classifications. This presentation masks the impacts from a single extreme dry year as well as repeated impacts associated with a continuous multi-year drought. These are the periods of greatest concern and potential damage to aquatic resources, but they are not identified or described in the DEIR/S. Prior to 2016, the USGS[13] developed a water temperature model that accurately simulates daily mean water temperature along the course of the Trinity River, from Lewiston Dam to the Klamath River confluence. This model would be a more appropriate tool to evaluate how changes in TRD water operations associated with the Sites Project would satisfy water temperature objectives in the Trinity River.

3. Inaccurate Existing (Baseline) TRD Water Operations

The water operations analysis for Sites Project EIR/S did not include an analysis considering use of Humboldt County's 50 thousand acre feet (TAF) water contract included as a provision of the Trinity River Division Act. The following is an excerpt from the Statutory Authority Appendix contained in the DEIS for the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River (Lower Klamath LTP)[14] describing Humboldt County's 50 TAF water contract.

---

[13] Jones, E.C., Perry, R.W., Risley, J.C., Som, N.A. and Hetrick, N.J., 2016, Construction, calibration and validcation of the RBM10 water temperature model for the Trinity River, Northern California. U.S. Department of Interior, U.S. Geological Survey, Open-File Report 2016-1056, prepared in cooperation with the U.S. Fish and Wildlife Service and the Bureau of Reclamation, 56p.

[14] U.S. Department of Interior, Bureau of Reclamation, 2016, Long-Term Plan to Protect Adult Salmon in the Lower Klamath River, Humboldt County, California Draft Environmental Impact Statement, October.

Construction of the Trinity River Division (TRD) of the Central Valley Project (CVP) was authorized by the Act of August 12, 1955 (Public Law 84-386) (TRD Act). In section 2 of the 1955 TRD Act, Congress directed that the operation of the TRD should be integrated and coordinated with the operation of the CVP, subject to two conditions set forth as distinct Provisos in section 2 of that Act. The first of these two Provisos states that the Secretary of the Interior is authorized and directed to "adopt appropriate measures to insure the preservation and propagation of fish and wildlife" including certain minimum flows in the Trinity River deemed at the time as necessary to maintain the fishery. The second Proviso directs that not less than 50,000 acre-feet of water shall be released and made available to Humboldt County and other downstream users[15].

The recently released Solicitor's Opinion, M-37030, concludes that each of the two Provisos in section 2 of the TRD Act are "separate and independent limitations on the TRD's integration with, and thus diversion of water to, the CVP" and that the two Provisos may "require separate releases of water as requested by Humboldt County and potentially other downstream users pursuant to Proviso 2 and a 1959 Contract between the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and Humboldt County."[16] M- Opinion 37030 at 2. Formal 18 opinions of the Solicitor are binding on the Department of the Interior and its bureaus.

Chapter 6 and Appendix 6A of the Sites Project DEIR/S state that the project water operations modeling analyses adhered to 2000 Trinity River ROD releases to the Trinity River downstream of Lewiston Reservoir to meet instream flow requirements. The DEIR/S states, "The total volume of water released to the Trinity River ranges from approximately 368,600 AF in critically dry years to 815,000 AF in extremely wet years, depending on the annual water-year type (hydrology) determined as of April 1st (DOI, 2000). Table 6-2 shows the annual volumes, peak flows, and peak flow duration by water type." Table 6-2 from the DEIR/S is presented below. However, there is no mention of Humboldt County's 50 TAF annual water contract being integrated into the DEIR/S water resources system modeling and analysis. It is not possible to compare total annual modeled Trinity River releases from the DEIR/S (Table 2, attached) to the annual Trinity River ROD flow volumes (Table 6.2 below) as they represent different water year type classification schemes[17]. The USFWS report by David and Goodman (2017) indicates how the Humboldt County 50 TAF water contract has been especially important for flow augmentation during dry years to meet flow and temperature targets in the lower Klamath River to reduce the probability of an adult fish kill. The omission of the Humboldt County 50 TAF contract in the DEIR/S analyses could have significant effects on the water quality conditions and potential impacts

---

[15] Reclamation's water permits from the State of California includes the following condition:
"Permittee shall release sufficient water from Trinity and/or Lewiston Reservoirs into the Trinity River so that not less than an annual quantity of 50,000 acre-feet will be available for the beneficial use of Humboldt County and other downstream users." Condition 9

[16] The 1959 water delivery contract between Reclamation and Humboldt County includes the following:
"The United States agrees to release sufficient water from Trinity and/or Lewiston Reservoirs into the Trinity River so that not less than an annual quantity of 50,000 acre-feet will be available for the beneficial use of Humboldt County and other downstream users."
Contract, Article 8.

[17] The water year types included in the Trinity ROD are probability-based and classified by ranges of annual upper Trinity River Basin water year runoff. This classification is different from the water year types presented in all other tables in Appendix 6B of the DEIR/S, which are based on the historical record of WY1922 through WY2003 and defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 2000).

to both the Trinity and Sacramento Rivers. Therefore, the DEIR/S should be considered incomplete in the analysis of the effects of the Site Project operations on the Trinity River.

Table 6-2
Trinity River Record of Decision
Annual Flow Volumes and Peak Flows

Water Year Type	Volume (AF)	Peak Flow (cfs)	Peak Flow Duration (days)
Extremely Wet	815,000	11,000	5
Wet	701,000	8,500	5
Normal	647,000	6,000	5
Dry	453,000	4,500	5
Critically Dry	369,000	1,500	36

Notes:
cfs = cubic feet per second
Source: DOI, 2000.

4. Incomplete Cumulative Impact Assessment

In addition to the omission of the Humboldt County 50 TAF water delivery contract on the Trinity River, the Sites Project DEIR/S fails to consider and incorporate the Lower Klamath LTP operations into the water resources system modeling analyses. Under CEQA, a cumulative impact assessment must consider development projects within the cumulative study area, which includes past projects, projects under construction and approved, and pending projects that are anticipated to be either under construction or operational by the time of the completion of the proposed project. The Sites DEIR/S states the following (pg. 6A-2, Appendix 6A).

> *The Existing Conditions/No Project/No Action Condition simulation was developed assuming Year 2030 level of development and regulatory conditions. The Existing Conditions/No Project/No Action Condition assumptions include existing facilities and ongoing programs that existed as of March 2017 (publication of the Notice of Preparation) that could affect or could be affected by implementation of the alternatives. The Existing Conditions/No Project/No Action Condition assumptions and the models do not include any restoration actions or additional conveyance over the current conditions.*

Although the ROD for the Lower Klamath LTP[18] wasn't signed until April 2017, it was certainly a well-known and defined pending project and should have been incorporated into the baseline condition of the water resource system modeling analysis. Tables 6 through 8 provide average monthly storage and flow values for the TRD under the Lower Klamath LTP. Comparison of the Lower Klamath LTP Alternative 1 conditions presented in Table 6 through 8 to the Sites Project No Action Alternative conditions presented in Tables 1 through 3 indicate significant differences in project operations and hydrologic conditions when including the Lower Klamath LTP in the water resource impact assessment. For example, under the Lower Klamath LTP, diversions to

[18] U.S. Department of the Interior, Bureau of Reclamation, 2017, Record of Decision for the Long Term Plan to Protect Adult Salmon in the Lower Klamath River, April, Accessed at https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=28314

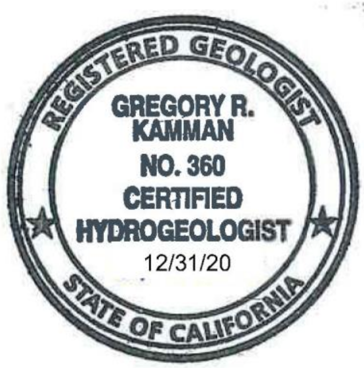
the Sacramento River are reduced by an average of 13 TAF per year, while Sites DEIR has diversions increasing, on average, by 4 TAF per year. The main reason for this difference is the August and September Trinity River release rates: as a result of flow augmentations, the Lower Klamath LTP increases average releases to Trinity River by 20% and 42% (presumably using the Humboldt County 50TAF water) above No Action flows, respectively (see Table 7). Alternative D of the Sites Project maintains a constant 450 cfs baseline ROD flow during these months for all water year types. The Lower Klamath LTP introduces significant project operations, not included in the Sites Project DEIR/S analyses, which could have significant effects on the anticipated water supply available to the project as well as impacts to temperature on the Sacramento River. Because of this omission in the impact analysis, the Sites Project DEIR/S should be considered incomplete.

Another cumulative impact that is not evaluated in the Sites Project DEIR/S is the influence of climate change on the meteorology and hydrology of northern California rivers. The water temperature modeling of Alternatives completed as part of DEIR/S analyses uses historic meteorologic and hydrologic data and do not consider the predicted warmer future temperatures in the Trinity and Klamath River basins under climate change (USBR, 2011)[19]. Warmer air temperatures under climate change will result in warmer reservoir and river water temperatures. Anticipated changes to the timing and magnitude of spring snowmelt hydrograph and associated tributary accretion (flow and water temperature) are likely to increase river water temperatures, which will reduce the attainment of water temperature objectives on the Trinity River, especially those established for outmigrant juvenile salmonids. Thus, the DEIR/S fails to evaluate the cumulative impact of climate change conditions.

Please feel free to contact me with any questions regarding the material and conclusions contained in this letter.

Sincerely,

Greg Kamman, PG, CHG
Principal Hydrologist



[19] U.S. Department of the Interior, Policy and Administration, Bureau of Reclamation, 2011, SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water. April, 226p.

TABLE 1: Trinity Lake end of month storage. Source: Table SW-01-9a, Appendix 6B of Sites Project DEIR/S.

Table SW-02-9a
Trinity Lake, End of Month Elevation
Long-term Average and Average by Water Year Type

Analysis Period	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Elevation (FEET)											
Long-term												
Full Simulation Period[1]												
No Action Alternative	2,278	2,280	2,285	2,292	2,302	2,313	2,325	2,324	2,321	2,310	2,297	2,286
Alternative D	2,281	2,283	2,288	2,294	2,304	2,314	2,325	2,325	2,322	2,310	2,298	2,287
Difference	2	3	3	2	2	1	1	1	1	1	1	1
Percent Difference[3]	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Water Year Types[2]												
Wet (32%)												
No Action Alternative	2,322	2,323	2,325	2,324	2,337	2,347	2,357	2,359	2,358	2,350	2,342	2,332
Alternative D	2,322	2,323	2,324	2,325	2,338	2,348	2,358	2,360	2,358	2,350	2,341	2,331
Difference	-1	0	0	1	1	1	0	0	0	0	-1	-1
Percent Difference	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Above Normal (15%)												
No Action Alternative	2,305	2,305	2,307	2,298	2,313	2,329	2,341	2,342	2,340	2,331	2,321	2,309
Alternative D	2,307	2,307	2,309	2,305	2,319	2,334	2,345	2,346	2,344	2,335	2,323	2,311
Difference	2	2	2	7	6	5	4	4	4	4	2	2
Percent Difference	0.1%	0.1%	0.1%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Below Normal (17%)												
No Action Alternative	2,275	2,278	2,285	2,281	2,289	2,298	2,313	2,313	2,310	2,298	2,287	2,277
Alternative D	2,275	2,278	2,286	2,281	2,289	2,298	2,314	2,313	2,310	2,298	2,286	2,277
Difference	0	1	0	0	0	0	0	0	0	0	0	0
Percent Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dry (22%)												
No Action Alternative	2,260	2,261	2,270	2,283	2,291	2,304	2,316	2,312	2,307	2,293	2,277	2,266
Alternative D	2,261	2,263	2,273	2,284	2,292	2,304	2,316	2,312	2,306	2,291	2,277	2,266
Difference	2	2	2	1	1	0	0	-1	-1	-1	0	0
Percent Difference	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%
Critical (15%)												
No Action Alternative	2,189	2,190	2,198	2,240	2,246	2,255	2,263	2,260	2,258	2,239	2,218	2,203
Alternative D	2,203	2,206	2,211	2,242	2,248	2,257	2,265	2,262	2,260	2,242	2,224	2,208
Difference	14	16	13	2	2	2	2	2	2	2	6	5
Percent Difference	0.6%	0.7%	0.6%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.3%	0.2%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 2: Monthly flow on Trinity River below Lewiston Reservoir. Source: Table SW-04-9a, Appendix 6B of Sites Project DEIR/S.

Table SW-04-9a
Trinity River below Lewiston Reservoir, Monthly Flow
Long-term Average and Average by Water Year Type

Analysis Period	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
						Monthly Flow (CFS)						
					Long-term							
Full Simulation Period[1]												
No Action Alternative	368	360	522	655	645	575	554	3,779	2,091	923	450	450
Alternative D	373	360	498	638	621	570	561	3,779	2,091	923	450	450
Difference	5	-1	-24	-17	-24	-5	6	0	0	0	0	0
Percent Difference[3]	1.2%	-0.2%	-4.6%	-2.6%	-3.7%	-0.9%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%
					Water Year Types[2]							
Wet (32%)												
No Action Alternative	373	300	852	1,412	1,026	1,096	627	4,636	3,318	1,289	450	450
Alternative D	373	300	775	1,351	1,052	1,143	647	4,636	3,318	1,289	450	450
Difference	0	0	-76	-61	26	47	20	0	0	0	0	0
Percent Difference	0.0%	0.0%	-8.9%	-4.3%	2.5%	4.3%	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Above Normal (15%)												
No Action Alternative	373	713	621	316	831	436	469	4,462	2,488	1,048	450	450
Alternative D	373	709	621	332	760	300	469	4,462	2,488	1,048	450	450
Difference	0	-5	0	16	-72	-136	0	0	0	0	0	0
Percent Difference	0.0%	-0.7%	0.0%	5.1%	-8.6%	-31.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Below Normal (17%)												
No Action Alternative	373	300	300	300	517	319	507	3,774	1,672	869	450	450
Alternative D	373	300	300	300	392	319	507	3,774	1,672	869	450	450
Difference	0	0	0	0	-125	0	0	0	0	0	0	0
Percent Difference	0.0%	0.0%	0.0%	0.0%	-24.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dry (22%)												
No Action Alternative	373	300	300	300	300	300	529	3,216	1,251	667	450	450
Alternative D	373	300	300	300	300	300	529	3,216	1,251	667	450	450
Difference	0	0	0	0	0	0	0	0	0	0	0	0
Percent Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Critical (15%)												
No Action Alternative	342	300	300	300	300	300	575	2,092	783	450	450	450
Alternative D	373	300	300	300	300	300	575	2,092	783	450	450	450
Difference	31	0	0	0	0	0	0	0	0	0	0	0
Percent Difference	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 3: Monthly flow through Clear Creek Tunnel. Source: Table SW-05-9a, Appendix 6B of Sites Project DEIR/S.

Table SW-05-9a
Clear Creek Tunnel, Monthly Flow
Long-term Average and Average by Water Year Type

Analysis Period	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Long-term												
Full Simulation Period[1]												
No Action Alternative	1,033	344	257	420	95	269	389	168	551	1,812	1,926	1,666
Alternative D	900	261	269	460	155	341	373	163	576	1,862	1,957	1,675
Difference	-133	-83	12	40	61	71	-16	-5	25	50	30	9
Percent Difference[3]	-12.9%	-24.2%	4.7%	9.4%	64.2%	26.4%	-4.2%	-3.2%	4.6%	2.8%	1.6%	0.5%
Water Year Types[2]												
Wet (32%)												
No Action Alternative	1,593	481	536	430	81	344	483	278	421	1,742	1,678	2,135
Alternative D	1,571	448	585	437	118	355	493	268	439	1,765	1,882	2,142
Difference	-22	-32	49	7	36	12	10	-10	18	23	204	6
Percent Difference	-1.4%	-6.7%	9.1%	1.6%		3.4%	2.0%	-3.5%	4.3%	1.3%	12.1%	0.3%
Above Normal (15%)												
No Action Alternative	964	437	304	269	58	302	588	0	167	1,417	1,875	1,958
Alternative D	1,088	340	237	269	71	468	564	21	166	1,500	2,313	1,875
Difference	124	-98	-67	0	12	166	-24	21	-1	83	438	-83
Percent Difference	12.9%	-22.4%	-22.1%	0.0%		54.9%	-4.1%		-0.5%	5.9%	23.3%	-4.3%
Below Normal (17%)												
No Action Alternative	429	186	65	295	80	384	265	61	660	1,538	1,796	1,361
Alternative D	433	68	96	334	212	406	171	61	660	1,698	1,714	1,342
Difference	4	-118	32	39	132	22	-94	0	0	161	-82	-18
Percent Difference	1.0%	-63.5%	48.6%	13.4%		5.8%	-35.3%	0.0%	0.0%	10.5%	-4.6%	-1.4%
Dry (22%)												
No Action Alternative	884	333	100	408	166	141	222	221	905	2,100	2,322	1,468
Alternative D	676	205	81	551	265	295	252	200	978	2,147	2,119	1,420
Difference	-209	-128	-20	143	99	154	29	-22	73	47	-203	-48
Percent Difference	-23.6%	-38.4%	-19.7%	35.2%	59.9%	109.4%	13.1%	-9.8%	8.1%	2.2%	-8.7%	-3.3%
Critical (15%)												
No Action Alternative	818	156	62	715	70	135	385	147	561	2,245	2,075	1,012
Alternative D	142	84	99	710	90	174	342	143	585	2,200	1,802	1,235
Difference	-676	-72	37	-5	21	39	-43	-4	25	-45	-272	222
Percent Difference	-82.6%	-46.2%		-0.8%		28.5%	-11.2%	-2.5%	4.4%	-2.0%	-13.1%	22.0%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 4: Estimated Monthly flow through Lewiston Reservoir.

Flow through Lewiston Lake (cfs)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Full Simulation Period1												
No Action Alternative	1401	704	779	1075	740	844	943	3947	2642	2735	2376	2116
Alternative D	1273	621	767	1098	776	911	934	3942	2667	2785	2407	2125
Difference	(128)	(83)	(12)	23	36	67	(9)	(5)	25	50	31	9
Percent Difference	-9.1%	-11.8%	-1.5%	2.1%	4.9%	7.9%	-1.0%	-0.1%	0.9%	1.8%	1.3%	0.4%
Wet (32%)												
No Action Alternative	1966	781	1388	1842	1107	1440	1110	4914	3739	3031	2128	2585
Alternative D	1944	748	1360	1788	1170	1498	1140	4904	3757	3054	2332	2592
Difference	(22)	(33)	(28)	(54)	63	58	30	(10)	18	23	204	7
Percent Difference	-1.1%	-4.2%	-2.0%	-2.9%	5.7%	4.0%	2.7%	-0.2%	0.5%	0.8%	9.6%	0.3%
Above Normal (15%)												
No Action Alternative	1337	1150	925	585	889	738	1057	4462	2655	2465	2325	2408
Alternative D	1461	1049	858	601	831	768	1033	4483	2654	2548	2763	2325
Difference	124	(101)	(67)	16	(58)	30	(24)	21	(1)	83	438	(83)
Percent Difference	9.3%	-8.8%	-7.2%	2.7%	-6.5%	4.1%	-2.3%	0.5%	0.0%	3.4%	18.8%	-3.4%
Below Normal (17%)												
No Action Alternative	802	486	365	595	597	703	772	3835	2332	2407	2246	1811
Alternative D	806	368	396	634	604	725	678	3835	2332	2567	2164	1792
Difference	4	(118)	31	39	7	22	(94)	0	0	160	(82)	(19)
Percent Difference	0.5%	-24.3%	8.5%	6.6%	1.2%	3.1%	-12.2%	0.0%	0.0%	6.6%	-3.7%	-1.0%
Dry (22%)												
No Action Alternative	1257	633	400	708	466	441	751	3437	2156	2767	2772	1918
Alternative D	1049	505	381	851	565	595	781	3416	2229	2814	2569	1870
Difference	(208)	(128)	(19)	143	99	154	30	(21)	73	47	(203)	(48)
Percent Difference	-16.5%	-20.2%	-4.8%	20.2%	21.2%	34.9%	4.0%	-0.6%	3.4%	1.7%	-7.3%	-2.5%
Critical (15%)												
No Action Alternative	1160	456	362	1015	370	435	960	2239	1344	2695	2525	1462
Alternative D	515	384	399	1010	390	474	917	2235	1368	2650	2252	1685
Difference	(645)	(72)	37	(5)	20	39	(43)	(4)	24	(45)	(273)	223
Percent Difference	-55.6%	-15.8%	10.2%	-0.5%	5.4%	9.0%	-4.5%	-0.2%	1.8%	-1.7%	-10.8%	15.3%

TABLE 5: Monthly temperatures of Trinity River below Lewiston Dam. Source: Table SQ-33-9a, Appendix 7E of Sites Project DEIR/S.

Table SQ-33-9a
Trinity River below Lewiston Dam, Monthly Temperature
Long-term Average and Average by Water Year Type

Analysis Period	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Temperature (DEG-F)											
Long-term												
Full Simulation Period[1]												
No Action Alternative	49.4	44.7	40.0	39.4	42.7	47.0	50.2	46.6	50.9	51.3	51.7	50.7
Alternative D	49.3	44.6	39.9	39.5	42.7	46.9	50.3	46.6	50.8	51.1	51.3	50.7
Difference	-0.1	-0.1	-0.1	0.2	0.0	-0.2	0.1	0.0	-0.1	-0.2	-0.4	0.1
Percent Difference[3]	-0.2%	-0.2%	-0.2%	0.4%	0.0%	-0.4%	0.2%	-0.1%	-0.2%	-0.4%	-0.7%	0.1%
Water Year Types[2]												
Wet (32%)												
No Action Alternative	47.0	44.6	41.5	40.6	43.0	45.9	49.1	45.8	48.3	50.8	51.6	48.6
Alternative D	47.0	44.6	41.3	40.5	43.0	45.8	49.1	45.8	48.3	50.7	50.9	48.8
Difference	0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.2	-0.7	0.2
Percent Difference	0.1%	0.1%	-0.3%	-0.2%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	-0.3%	-1.4%	0.4%
Above Normal (15%)												
No Action Alternative	48.2	43.3	40.2	38.6	42.6	47.3	49.9	45.9	50.6	51.6	50.9	48.8
Alternative D	47.7	43.2	39.8	38.8	42.6	47.2	50.0	45.9	50.5	51.2	49.6	49.4
Difference	-0.5	-0.1	-0.4	0.1	0.0	-0.1	0.1	-0.1	-0.1	-0.4	-1.3	0.6
Percent Difference	-1.1%	-0.2%	-1.1%	0.3%	0.0%	-0.2%	0.2%	-0.2%	-0.2%	-0.8%	-2.5%	1.3%
Below Normal (17%)												
No Action Alternative	50.2	44.7	39.0	38.7	41.9	46.8	51.1	46.4	51.3	52.0	52.0	51.3
Alternative D	50.2	44.7	39.1	38.8	41.9	46.7	51.6	46.5	51.3	51.6	52.2	51.5
Difference	0.0	0.0	0.2	0.1	0.0	-0.2	0.5	0.0	0.0	-0.3	0.1	0.2
Percent Difference	-0.1%	0.1%	0.4%	0.3%	0.0%	-0.4%	1.0%	0.1%	0.0%	-0.6%	0.3%	0.4%
Dry (22%)												
No Action Alternative	49.5	45.0	39.6	38.4	42.4	47.9	51.4	46.7	51.9	50.7	50.1	50.3
Alternative D	49.7	44.7	39.4	39.0	42.4	47.6	51.1	46.6	51.7	50.5	50.5	50.4
Difference	0.2	-0.2	-0.2	0.6	0.0	-0.4	-0.2	-0.1	-0.2	-0.3	0.4	0.1
Percent Difference	0.4%	-0.5%	-0.4%	1.5%	0.1%	-0.8%	-0.4%	-0.2%	-0.5%	-0.5%	0.8%	0.2%
Critical (15%)												
No Action Alternative	54.5	45.7	38.2	39.4	43.1	48.0	50.2	49.3	55.5	52.5	54.4	56.6
Alternative D	53.8	45.5	38.4	39.7	43.2	47.8	50.4	49.2	55.3	52.6	53.9	55.6
Difference	-0.7	-0.2	0.1	0.2	0.1	-0.2	0.2	-0.1	-0.2	0.1	-0.5	-1.0
Percent Difference	-1.3%	-0.5%	0.3%	0.6%	0.2%	-0.3%	0.4%	-0.2%	-0.3%	0.2%	-0.9%	-1.8%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 6: Monthly Trinity Lake Storage. Source: Table 4-1, Lower Klamath LTP DEIS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action (TAF)												
Extremely Wet	1,197	1,258	1,399	1,618	1,839	1,998	2,208	2,300	2,236	2,105	1,993	1,850
Wet	1,373	1,393	1,507	1,621	1,806	1,952	2,114	2,090	2,018	1,896	1,752	1,606
Normal	1,322	1,324	1,346	1,415	1,529	1,669	1,843	1,773	1,689	1,534	1,386	1,276
Dry	1,096	1,089	1,113	1,127	1,189	1,292	1,403	1,361	1,302	1,159	1,005	901
Critically Dry	1,051	1,016	1,014	988	1,012	1,068	1,087	1,048	985	836	676	598
Average All Years	1,233	1,242	1,306	1,385	1,511	1,637	1,779	1,755	1,686	1,548	1,403	1,283
Alternative 1 (TAF)												
Extremely Wet	1,170	1,236	1,377	1,597	1,821	1,981	2,191	2,285	2,221	2,090	1,979	1,839
Wet	1,362	1,382	1,497	1,613	1,798	1,946	2,107	2,083	2,011	1,890	1,743	1,595
Normal	1,319	1,321	1,343	1,415	1,528	1,669	1,842	1,772	1,689	1,536	1,387	1,266
Dry	1,092	1,085	1,109	1,123	1,184	1,288	1,399	1,357	1,298	1,148	992	881
Critically Dry	1,044	1,007	1,005	979	1,004	1,058	1,078	1,039	976	848	677	576
Average All Years	1,224	1,233	1,298	1,377	1,504	1,631	1,772	1,749	1,680	1,544	1,396	1,269
No Action compared to Alternative 1 (TAF)												
Extremely Wet	-27	-22	-22	-21	-17	-17	-17	-15	-15	-15	-15	-11
Wet	-11	-11	-10	-9	-8	-7	-7	-7	-6	-6	-8	-11
Normal	-3	-2	-3	0	0	0	0	0	0	3	1	-10
Dry	-4	-4	-4	-4	-4	-4	-4	-4	-4	-11	-13	-20
Critically Dry	-7	-9	-9	-9	-8	-9	-9	-9	-9	11	1	-22
Average All Years	-9	-9	-9	-8	-7	-6	-6	-6	-6	-5	-8	-14
No Action compared to Alternative 1 (%)												
Extremely Wet	-2%	-2%	-2%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Wet	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	-1%
Normal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
Dry	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	-2%
Critically Dry	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	1%	0%	-4%
Average All Years	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	-1%	-1%

Key:
TAF = thousand acre-feet

TABLE 7: Monthly flow on Trinity River below Lewiston Reservoir. Source: Table 4-3, Lower Klamath LTP DEIS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action (cfs)												
Extremely Wet	373	796	930	1,264	1,525	2,458	1,042	4,570	4,626	1,241	450	450
Wet	373	300	1,023	1,175	915	510	481	4,687	2,862	1,102	450	450
Normal	373	300	300	300	385	302	477	4,189	2,120	1,102	450	450
Dry	337	286	300	300	300	300	543	2,848	847	481	450	450
Critically Dry	368	267	300	300	300	300	600	1,498	783	450	450	400
Average All Years	363	359	605	696	668	654	584	3,753	2,210	890	450	445
Alternative 1 (cfs)												
Extremely Wet	373	719	930	1,248	1,455	2,458	1,042	4,570	4,626	1,241	460	477
Wet	373	300	1,024	1,151	910	505	481	4,687	2,862	1,102	503	533
Normal	373	300	300	300	358	302	477	4,189	2,120	1,102	508	632
Dry	337	286	300	300	300	300	543	2,848	847	481	574	725
Critically Dry	332	267	300	300	300	300	600	1,498	783	450	699	861
Average All Years	359	349	605	687	652	652	584	3,753	2,210	890	538	630
No Action compared to Alternative 1 (cfs)												
Extremely Wet	0	-77	0	-16	-69	0	0	0	0	0	10	27
Wet	0	0	1	-24	-5	-5	0	0	0	0	53	83
Normal	0	0	0	0	-27	0	0	0	0	0	58	182
Dry	0	0	0	0	0	0	0	0	0	0	124	275
Critically Dry	-37	0	0	0	0	0	0	0	0	0	249	461
Average All Years	-4	-10	0	-9	-16	-2	0	0	0	0	88	185
No Action compared to Alternative 1 (%)												
Extremely Wet	0%	-10%	0%	-1%	-5%	0%	0%	0%	0%	0%	2%	6%
Wet	0%	0%	0%	-2%	-1%	-1%	0%	0%	0%	0%	12%	18%
Normal	0%	0%	0%	0%	-7%	0%	0%	0%	0%	0%	13%	40%
Dry	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	28%	61%
Critically Dry	-10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	55%	115%
Average All Years	-1%	-3%	0%	-1%	-2%	0%	0%	0%	0%	0%	20%	42%

Key:
% = percent
cfs = cubic feet per second

TABLE 8: Monthly flow on Trinity River Diversion to Sacramento River at Lewiston Reservoir. Source: Table 4-3, Lower Klamath LTP DEIS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action (cfs)												
Extremely Wet	827	233	235	410	7	329	278	498	407	1,836	1,526	2,079
Wet	945	541	376	482	97	322	591	0	290	1,190	1,952	2,065
Normal	792	355	193	418	243	396	228	0	472	1,553	1,991	1,471
Dry	712	418	166	385	134	153	229	247	1,011	1,973	2,098	1,358
Critically Dry	598	609	132	748	168	157	426	378	736	2,028	2,178	949
Average All Years	802	439	241	464	131	276	367	172	575	1,640	1,965	1,648
Alternative 1 (cfs)												
Extremely Wet	766	234	233	410	7	329	278	465	407	1,836	1,513	1,984
Wet	904	551	355	482	100	303	586	0	290	1,181	1,937	2,025
Normal	767	344	196	378	270	396	228	0	469	1,510	1,957	1,471
Dry	636	415	162	387	134	152	229	247	1,008	2,092	2,009	1,196
Critically Dry	521	642	132	753	143	177	426	373	736	1,701	2,092	880
Average All Years	748	443	234	457	134	272	366	167	573	1,623	1,920	1,573
No Action compared to Alternative 1 (cfs)												
Extremely Wet	-61	1	-2	0	0	0	0	-33	0	0	-13	-95
Wet	-42	10	-21	0	3	-20	-5	0	0	-9	-14	-41
Normal	-25	-10	4	-40	27	0	0	0	-3	-43	-34	0
Dry	-75	-3	-4	2	0	-1	0	0	-3	119	-89	-163
Critically Dry	-77	32	0	5	-25	20	0	-4	0	-327	-86	-69
Average All Years	-53	4	-7	-7	3	-4	-2	-5	-2	-16	-45	-74
No Action compared to Alternative 1 (%)												
Extremely Wet	-7%	0%	-1%	0%	0%	0%	0%	-7%	0%	0%	-1%	-5%
Wet	-4%	2%	-6%	0%	3%	-6%	-1%	0%	0%	-1%	-1%	-2%
Normal	-3%	-3%	2%	-10%	11%	0%	0%	0%	-1%	-3%	-2%	0%
Dry	-11%	-1%	-3%	1%	0%	0%	0%	0%	0%	6%	-4%	-12%
Critically Dry	-13%	5%	0%	1%	-15%	13%	0%	-1%	0%	-16%	-4%	-7%
Average All Years	-7%	1%	-3%	-1%	3%	-1%	0%	-3%	0%	-1%	-2%	-5%

Key:
% = percent
cfs = cubic feet per second

Greg Kamman, PG, CHG

Principal Hydrologist

EDUCATION	1989	M.S. Geology - Sedimentology and Hydrogeology Miami University, Oxford, OH
	1985	A.B. Geology Miami University, Oxford, OH
REGISTRATION	No. 360 No. 5737	Certified Hydrogeologist (CHG.), CA Professional Geologist (PG), CA
PROFESSIONAL HISTORY	1997 - Present	Principal Hydrologist/Vice President Kamman Hydrology & Engineering, Inc. San Rafael, CA
	1994 - 1997	Senior Hydrologist/Vice President Balance Hydrologics, Inc., Berkeley, CA
	1991 - 1994	Project Geologist/Hydrogeologist Geomatrix Consultants, Inc., San Francisco, CA
	1989 - 1991	Senior Staff Geologist/Hydrogeologist Environ International Corporation, Princeton, NJ
	1986 - 1989	Instructor and Research/Teaching Assistant Miami University, Oxford, OH

SKILLS AND EXPERIENCE

As a Principal Hydrologist with over 25 of technical and consulting experience in the fields of geology, hydrology, and hydrogeology, Mr. Kamman routinely manages projects in the areas of surface- and ground-water hydrology, stream and wetland habitat restoration, water supply, water quality assessments, water resources management, and geomorphology. Areas of expertise include: stream and wetland habitat restoration; characterizing and modeling basin-scale hydrologic and geologic processes; assessing hydraulic and geomorphic responses to land-use changes in watersheds and causes of stream channel instability; evaluating surface- and ground-water resources and their interaction; and designing and implementing field investigations characterizing surface and subsurface conditions; and stream and wetland habitat restoration feasibility assessments and design. In addition, Mr. Kamman commonly works on projects that revolve around sensitive fishery, wetland, wildlife and/or riparian habitat enhancement. Thus, Mr. Kamman is accustomed to working within a multi-disciplined team and maintains close collaborative relationships with biologists, engineers, planners, architects, lawyers, and resource and regulatory agency staff. Mr. Kamman is a prime or contributing author to over 80 technical publications and reports in the discipline of hydrology – the majority pertaining to ecological restoration. Mr. Kamman routinely teaches courses on stream and wetland restoration through U.C. Berkeley Extension and San Francisco State University's Romberg Tiburon Center.

PROFESSIONAL SOCIETIES & AFFILIATIONS	American Geological Institute Society for Ecological Restoration International California Native Plant Society

7 Mt. Lassen Drive, Suite C122, San Rafael, CA 94903
Telephone: (415) 491-9600 Fax: (415) 680-1538 Email: Greg@KHE-Inc.com

1.0 TECHNICAL REPORTS

Kamman, G.K., Fiori, R., and Kamman, R.Z., 2017, Lagunitas Creek Salmonid Habitat Enhancement Project, anchoring and bank stabilization concerns at LDRJ Sites #4 and #5. Prepared for: Marin Municipal Water District, September 25, 23p.

Kamman G.R. and Hayes, C., 2017, Annual geomorphic monitoring (WY2017) rock cascade-pool structure, Green Gulch landslide repair project, Marin County. Prepared for: Green Gulch Farm/San Francisco Zen Center, August 31, 57 p.

Kamman, G.R., 2017, Results of Flood Assessment for Proposed Mason Street Culverts, Quartermaster Reach Wetland Restoration Project, The Presidio of San Francisco, California. Prepared for: The Presidio Trust, May, 37p.

Kamman, G.R., 2017, Mountain Lake Water Budget, The Presidio of San Francisco. Prepared for: The Presidio Trust, May, 56p.

Kamman, G.R., 2017, Preliminary Flood Inundation Analysis and Restoration Opportunities, Butte Creek Site, Colusa County, CA. Prepared for: WRA, February 17, 10p.

Kamman G.R. and Hayes, C., 2016, Annual geomorphic monitoring (WY2016) rock cascade-pool structure, Green Gulch landslide repair project, Marin County. Prepared for: Green Gulch Farm/San Francisco Zen Center, July 1, 53 p.

Kamman, G.R., 2016, Novato Creek Hydrologic Monitoring, Water Year 2016 Summary. Prepared for: Marin County Department of Public Works, June 7, 19p.

Kamman, G.R., 2016, Hydraulic Design and Feasibility Assessment Report: Eel River Estuary and Centerville Slough Enhancement Project, Humboldt County, CA. Prepared for: California Trout and California Department of Fish and Wildlife, June, 277p.

Kamman, G.R., 2016, Hydrologic Analysis Results: Proposal to Change Operations of the Crane Prairie, Wickiup, and Crescent Lake Dams and Reservoirs as related to harm to Oregon spotted frog. Prepared for: Earthjustice Northwest Office, Seattle, February 5, 18p.

Kamman, G.R., 2015, Characterization of Groundwater Conditions, Stanislaus County, California. Prepared for: Law Offices of Thomas N. Lippe APC, San Francisco, CA, November, 67p.

Kamman, G.R., 2015, Assessment of Groundwater Conditions, 2031 North Avenue Residence, Napa, California. Prepared for: Michael Lee, Napa, CA, November, 9, 7p.

Kamman, R.Z., Hayes, C., Kamman, G.R., Avocet Research Associates, Carbiener, M., Holland, E., and Baye, P., 2015, Draft McInnis Marsh Restoration Project: Feasibility Study and Alternatives Analysis McInnis Marsh, Marin County, CA. Prepared for: Marin County Parks and The California Coastal Conservancy, September 5, 66p.

Kamman, G.R., 2015, Draft Eel River Coastal Plain Dunes Assessment and Restoration Feasibility Analysis, Humboldt County, CA. Prepared for: GHD, June, 124p.

Kamman, G.R., 2015, Draft Basis of Design Report for Southern Eel River Delta Wetland Restoration and Enhancement Project. Prepared for: Trout Unlimited and California Coastal Conservancy, May, 66p.

Kamman, R.Z., Hayes, C. and Kamman G.K., 2015, Draft Hydrologic Assessment: Lawson's Land, Dillon Beach, CA. Prepared for: Lawson's Landing Inc. pursuant to The California Coastal Commission Coastal Development Permit, Special Condition 4.1.2.d, January, May, 38p.

Kamman G.R. and Hayes, C., 2015, Annual geomorphic monitoring (WY2015) rock cascade-pool structure, Green Gulch landslide repair project, Marin County. Prepared for: Green Gulch Farm/San Francisco Zen Center, March 2, 45 p.

Kamman, G.R., 2014, Groundwater assessment, Page Mill Road Office Complex, 1450/1454 Page Mill Road, Palo Alto, CA. Prepared for Stanford University Real Estate Operations, November 3, 8p.

Kamman, G.R., 2014, 100% Basis of design report, Lagunitas Creek salmonid winter habitat enhancement project. Prepared in association with: Fiori Geosciences, Prepared for: Marin Municipal Water District, September, 212p.

Kamman, G.R., 2014, Draft Lower Miller Creek channel maintenance and flood study: pre-design report. Prepared in association with: Demgen Aquatic Biology and Miller Pacific Engineering Group, Prepared for: Las Gallinas Valley Sanitary District, July, 142p.

Kamman, R.Z, WRECO, Kamman, G.R., 2014, Hydraulic assessment of existing conditions, Novato Creek Watershed Project. Prepared in association with: WRECO, Prepared for: County of Marin, Department of Public Works, June, 198p.

Kamman, R.Z. and Kamman G.K., 2013, Annual geomorphic monitoring report for Water Year 2013, Vineyard Creek Channel Enhancement Project. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District, May, 69p.

Kamman, G.R., 2014, Groundwater assessment, Upper California Avenue Site, 1451, 1501 and 1601 S. California Avenue, Palo Alto, CA. Prepared for Stanford University Real Estate Operations, April 10, 5p.

Kamman, G.R. and Lapine, S.L., 2014, Hydrologic sufficiency analysis, Rheem Creek Mitigation Bank, Richmond, CA. Prepared for: Olberding Environmental, Inc., on behalf of: Contra Costa Water District, April, 19p.

Kamman, G.R., 2013, Groundwater assessment, 1400 Page Mill Road, Palo Alto, CA. Prepared for Stanford University Real Estate Operations, September 3, 6p.

Kamman, G.R., 2013, Lagunitas Creek salmonid winter habitat enhancement assessment report. Prepared in association with: Fiori Geosciences and Dr. Bill Trush, Prepared for: Marin Municipal Water District, June, 124p.

Kamman, R.Z. and Kamman G.K., 2013, Annual geomorphic monitoring report for Water Year 2012, Vineyard Creek Channel Enhancement Project. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District, February, 83p.

Kamman, G.R. and Lapine, S.L., 2013, Hydrologic sufficiency analysis, Suisun Creek Preserve, Solano County, CA. Prepared for: Grizzly Bay, LLC, April, 12p.

Kamman, G.R. and Lapine, S.L., 2013, Hydrologic feasibility assessment, Suisun Creek Preserve, Solano County, CA. Prepared for: Grizzly Bay, LLC, March, 12p.

Kamman, G.R., 2012, Basis of design report, Home and G Ranch wetlands, Point Reyes National Seashore, Marin County, CA. Prepared for: Architectural Resources Group, Inc., on behalf of Point Reyes National Seashore, December, 136p.

Kamman, G.R., 2012, Groundwater assessment, 1701 Page Mill Road, Palo Alto, CA. Prepared for Stanford University Real Estate Operations, August 16, 5p.

Kamman, G.R. and Lapine, S.L., 2012, Hydrologic sufficiency analysis, Collier Creek Mitigation Bank, Livermore Area of Alameda and Contra Costa Counties, CA. Prepared for: Olberding Environmental, Inc., August, 28p.

Kamman, R.Z. and Kamman G.K., 2012, Annual geomorphic monitoring report for Water Year 2011, Vineyard Creek Channel Enhancement Project. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District, February, 46p.

Kamman, G.R. and Lapine, S., 2012, Erosion control assessment in support of trail planning at Mori Point, Pacifica, CA. Prepared for Golden Gate Parks Conservancy, February, 57p.

Kamman, G.R., 2011, Mana Plain Wetland Area Hydraulic Model Report, Kauai, Hawaii. Prepared for: Mana Plain Wetland Restoration Partnership, September 10, 87p.

Kamman, G.R., Kamman, R.Z., Lapine, S., and Higgins, S., 2011, Draft Basis of Design Report, Volume I, Salt River Ecosystem Restoration Project, Riverside Ranch Tidal Marsh Restoration and Preliminary Salt River Channel Design. Prepared for: Humboldt County RCD, June.

Kamman, G.R., 2011, Chapter 3.1: Hydrology and Water Quality and Chapter 3.2: Geology and Soils, in: Grassetti Environmental Consulting, California State Coastal Conservancy, and Kamman Hydrology & Engineering, Inc., 2011, Final Environmental Impact Report: Salt River Ecosystem Restoration Project (SCH# SD2007-05-6). Prepared for Humboldt County RCD, February, 744p.

Kamman, G.R., Higgins, S. and Lapine, S., 2011, 2nd DRAFT Restoration Feasibility and Conceptual Design Report, Third Valley Creek and Chicken Ranch Beach, Inverness, California. Prepared for: Tomales Bay Watershed Council, with contributions from May & Associates, Inc., Avocet Research Associates, and Anthropological Studies Center of Sonoma State University, April 20, 199p.

Kamman, R.Z., Kamman G.K., and Higgins, S., 2011, Annual geomorphic monitoring report for Water Year 2010, Vineyard Creek Channel Enhancement Project. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District, February, 47p.

Kamman, G.R. and Lapine, S., 2010, Nyhan Creek Trail Segment Assessment, Southern Marin County, California. Prepared for Golden Gate National Parks Conservancy, December 31, 23p.

Kamman, G.R., 2010, Chapter 3.1: Water Resources. In: The Presidio Trust (eds.), 2010. *The Quartermaster Reach Environmental Assessment, September 21, pp. 11-25.*

Kamman, G.R. and Higgins, S., 2010, Hydrologic and Water Quality Investigation, Lower Pitkin Marsh, Sonoma County, California. Prepared for Sonoma Land Trust, August 25, 69p.

Kamman, G.R., 2010. Subsurface Investigation & Conceptual Wetland Enhancement at North fort Scott Wetland Mitigation Site, The Presidio of San Francisco, California. Prepared for The Presidio Trust, August 6, 43p.

Kamman, G.R. and Lapine, S., 2010, Yreka Creek Hydrologic and Hydraulic Analysis Report, Siskiyou County, California. Prepared for WRA, Inc. and the City of Yreka, Department of Public Works, July 29, 32p.

Kamman, G.R. and Higgins, S., 2010, Western Stege Marsh Restoration Project, Year 5 Hydrologic Monitoring Report. Prepared for Tetra Tech EM Inc. and University of California, Berkeley, July 14, 76p.

Higgins, S. and Kamman, G.R., 2010, Watershed-based assessment of hydrologic and geomorphic conditions in Cache Creek through Capay Valley, Yolo County, CA. Prepared for Yolo County RCD, May 19, 85p.

Kamman, G.R. and Lapine, S., 2010, Seasonal Crossing Structure Concept Design. Prepared for: George Salvaggio (WRA, Inc.) and Jeannette Hook (City of Yreka), May 4, 7p.

Kamman, G.R., 2010, Banducci Reservoir Disposal Site Design, Muir Beach Project. Prepared for Carolyn Shoulders (GGNRA, NPS) and Sharon Farrell (GGNPC), April 5, 4p.

Kamman, G.R., 2010, Letter Report Regarding Feasibility to Divert Water from Arroyo Valle Seasonal Wetland Enhancement Design Concepts Shadow Cliffs Regional Recreation Area, Livermore, CA. Prepared for Anne Rivoire, Park Planner, East Bay Regional Park District. January 14, 13p.

Kamman, G.R., 2010, Hydrology Report, Temescal Creek Bridge Crossing, St. John’s Episcopal Church, Oakland, CA. Prepared for: Wolfe Mason Associates/Design Community & Environment, January, 53p.

Kamman, R.Z., Kamman G.K., and Higgins, S., 2009, Annual geomorphic monitoring report for Water Year 2009, Vineyard Creek Channel Enhancement Project. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District, December 18, 33p.

Kamman, G.R. and Lapine, S., 2009, Break-Away Bridge Options and Limitations. Prepared for George Salvaggio (WRA, Inc.) and Jeannette Hook (City of Yreka), December 7, 7p.

Higgins, S. and Kamman, G.R., 2009, Annual geomorphic monitoring of San Francisquito Creek channel, Sand Hill Road Bridge and former golf cart crossing, Stanford University, Santa Clara County, CA. Prepared for Stanford University, Facilities Operations - Utilities Division, December 1, 13p.

Kamman, G.R., (ed.), 2009, Phase 2 Technical Report, Sycamore Grove Recovery Program, Sycamore Grove Park, Livermore, CA. Prepared for Livermore Area Recreation and Park District and Zone 7 Water Agency, Contributing Authors: HortScience, Inc., Kamman Hydrology & Engineering, Inc., Lone Pine Research and National Forest Genetic Electrophoresis Laboratory, December, 129p.

Kamman, G.R., 2009, Sharp Park Conceptual Restoration Alternatives Report Review. Prepared for: Sharon Farrell (Golden Gate Parks Conservancy), Daphne Hatch (Golden Gate National Recreation Area), Phil Ginsburg (S.F. Recreation Park Commission), November 18, 3p.

Kamman, G.R. and Higgins, S., 2009. Fitzgerald Marine Reserve Trail Improvement: Hydrologic and Hydraulic Analysis, San Mateo County, California. Prepared for WRA, Inc., November, 22p.

Kamman, G.R., 2009, Opportunities and Constraints for Ecological Restoration Shadow Cliffs Regional Recreation Area. Prepared for: George Salvaggio (WRA) to Anne Rivoire, EBRPD, September 23, 13p.

Higgins, S. and Kamman, G.R., 2009, Preliminary Hydrologic Assessment Report for the Borba Dairy Farms Conservation and Wetland Mitigation Bank Merced County, California. Prepared for WRA, Inc., September 14, 40p.

Kamman, R.Z., Higgins, S. and Kamman, G., 2009, Olema Marsh Restoration: Salinity Impact Assessment Report. Prepared for: Point Reyes National Seashore Association and National Park Service, September, 58p.

Kamman, G.R. and Higgins, S., 2009, Western Stege Marsh Restoration Project, Year 4 Hydrologic Monitoring Report. Prepared for Tetra Tech EM Inc. and University of California, Berkeley, June 30, 37p.

Kamman, G.R. and Williams, T., 2009, Hydrologic monitoring results and implication on modification to Middle Pond, Mori Point. Prepared for Golden Gate Parks Conservancy, May 28, 8p.

Kamman, G.R. and Lapine, S., 2009, Yreka Creek Floodplain Enhancement Assessment. Prepared for: George Salvaggio (WRA, Inc.) and Jeannette Hook (City of Yreka), May 27, 10p.

Kamman, G.R. and Higgins, S., 2009. Preliminary Findings of a Geomorphic Assessment in Support of Erosion Control Planning and Design; Phleger Estate, San Mateo County, California. Prepared for Golden Gate National Parks Conservancy and Golden Gate National Recreation Area, NPS, April 28, 6p.

Kamman, G.R. and Higgins, S., 2009, Report for the Hydrologic Assessment and Ecological Enhancement Feasibility Study, Laguna Salada Wetland System, Pacifica, California. Prepared for: Tetra Tech Inc., San Francisco, March 30, 45p.

Kamman, G.R., 2009, Annual geomorphic monitoring of San Francisquito Creek channel, Sand Hill Road Bridge and former golf cart crossing, Stanford University, Santa Clara County, CA. Prepared for Stanford University, Facilities Operations - Utilities Division, February 18, 62p.

Kamman, G.K. and Higgins, S., 2008, Annual hydrologic/geomorphic monitoring, Vaquero Farms wetlands mitigation, Vineyards at Marsh Creek (Blackhawk 4)/EDAW Project No. 07015005.01. Prepared for EDAW Natural Resources (Sacramento), December 19, 20p.

Lapine, S. and Kamman, G.R., 2008. Hydrologic and Hydraulic Analysis, Saenger Property. Prepared for Paul Saenger, December 7, 5p.

Lapine, S. and Kamman, G.R., 2008, Lower West Creek drainage improvement assessment. Prepared for Marin County Department of Public Works, Flood Control, November 5, 4p.

Kamman, G.R., 2008. Memorandum from KHE to Mark Frey; Subject: NIKE Swale/Landfill 8 Shallow Subsurface Investigation. November 3.

Kamman, G.R., 2008, Reduced Flooding Pressure Resulting from Proposed Greenway Project. Prepared for Jeannette Hook (City of Yreka), August 26, 11p.

Kamman, G.R., 2008, Technical Assistance in Development of Year 3 Monitoring Report. Prepared for: Jason Brodersen, P.G., Program Manager, Tetra Tech EM Inc., August 20, 11p.

Kamman, R., Kamman, G.R., Higgins, S., and May, L, 2008, Summary of Headland Institute (HI) Stream Corridor Enhancement Design Components. Prepared for: The Headlands Institute Restoration Design Team, May 28, 36p.

Kamman, R., Kamman, G.R., Higgins, S., and May, L, 2008, Summary of Site Conditions for the Headland Institute (HI) Stream Corridor and Watershed. Prepared for: The Headlands Institute Restoration Design Team, May 5, 37p.

Kamman, G.R., 2008, Annual geomorphic monitoring of San Francisquito Creek channel, Sand Hill Road Bridge and former golf cart crossing, Stanford University, Santa Clara County, CA. Prepared for Olberding Environmental Inc., January 30, 37p.

Kamman, G.K. and Higgins, S., 2007, Annual hydrologic/geomorphic monitoring, Vaquero Farms wetlands mitigation, Vineyards at Marsh Creek (Blackhawk 4)/EDAW Project No. 07015005.01. Prepared for EDAW Natural Resources (Sacramento), December 17, 17p.

Kamman, G.R., 2007, Independent Model Review for Klamath Settlement Negotiations Klamath Independent Review Project (KIRP). Prepared for Erica Terrence and Anna Schulz, Northcoast Environmental Center, November 9, 19p.

Kamman, G.R., and Higgins, S., 2007, Results of subsurface investigation: Dragon Fly Creek. Prepared for The Presidio Trust, November 9, 12p.

Kamman, G.R., 2007, Chapter 3: Alternatives and Chapter 4.3: Water Resources, in: The Presidio Trust, 2007, Environmental Assessment for Tennessee Hollow Upper Watershed Revitalization Project, August, 149p.

Kamman, G.R., 2007, Mori Point trail planning and restoration project, wetland pond final designs. Prepared for Golden Gate Parks Conservancy, July 23, 34p.

Kamman, G.R., 2007, Chapter 2: Hydrological Considerations in: Nautilus Environmental (eds.), Brown & Caldwell, Foothill Associates, KHE, and Stoecker Ecological, 2007, Feasibility Study on the Reuse of Ojai Valley Sanitary District Effluent - DRAFT Final Facilities Planning Report, prepared for City of Buenaventura, Public Works Department, July 10, 148p.

Kamman, G.R., 2007, Mori Point wetland ponds - preliminary designs. Prepared for Golden Gate Parks Conservancy, June 19, 6p.

Kamman, G.R., and Higgins, S., 2007. Santa Clara River Estuary water budget and salinity assessment. Prepared for Nautilus Environmental LLC and The City of Buenaventura, April 30, 11p.

Kamman, G.R. and Kamman R.Z., 2007, Feasibility and design report of Bear Valley Creek watershed enhancement and fishery restoration project. Prepared for Point Reyes National Seashore Association and National Park Service, March, 325p.

Kamman, G.R., Kamman R.Z., and Beahan, C., 2007, Design report for lower Redwood Creek floodplain and salmonid habitat restoration at the Banducci site, Golden Gate National Recreation Area, Marin County, CA. Prepared for Golden Gate Parks Conservancy and National Park Service, February 28, 105p.

Kamman, G.R., 2007, Pilarcitos Creek Bank Stabilization Project, Pilarcitos Creek, San Mateo County, California. Prepared for TRC-Essex, January 22, 8p.

Kamman, G.R., 2007, Annual geomorphic monitoring of San Francisquito Creek channel, Sand Hill Road Bridge and former golf cart crossing, Stanford University, Santa Clara County, CA. Prepared for Olberding Environmental Inc., January 2, 29p.

Kamman, G.R. and Beahan, C., 2006, Annual geomorphic monitoring of Arroyo Mocho channel - WY2006, Wente Street Bridge, Livermore, CA. Prepared for Sycamore Associates, LLC, December 14, 13p.

Kamman, G.K. and Higgins, S., 2007, Hydraulic analysis for final design, Vaquero Farms Wetland Mitigation Project. Prepared for Sycamore Associates, LLC, July 11, 8p.

Kamman, G.R. and Lapine, S., 2006, West Creek drainage improvement assessment, Tiburon, CA. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District, July, 44p.

Kamman G.K. and Kamman, R.Z., 2006, Larkspur Creek bank stabilization, floodplain expansion and riparian revegetation project, Schaefer Parcel (Lark Creek Inn - parcel no. 021-104-34. Prepared for Department of Public Works, City of Larkspur, CA, June 1, 11p.

Kamman, G.R., 2006. Hydrologic Feasibility Assessment Report for the Tennessee Hollow Watershed Project, The Presidio of San Francisco. Prepared for: The Presidio Trust, with assistance from Colby Groundwater Consulting, May, 52p.

Kamman, G.R., 2006. Piezometer installation and monitoring Fill Site 6A, The Presidio of San Francisco. Prepared for The Presidio Trust, April 14, 20p.

Kamman, G.R., and Kamman, R.Z., 2006, Data Synthesis and Hydrodynamic Model Development Feasibility Report, Pescadero Lagoon, San Mateo County, California. Technical letter report prepared for California Coastal Commission, April 13, 18p.

Kamman, G.R., 2006, Leona Mines Closure - Conceptual Creek Design. Prepared for Peters & Ross, February 5, 15p.

Kamman, G.R. and Rios, T., 2005, Annual geomorphic monitoring of San Francisquito Creek channel, Sand Hill Road Bridge and former golf cart crossing, Stanford University, Santa Clara County, CA. Prepared for Olberding Environmental Inc., December 12, 20p.

Kamman, G.R., 2005, Preliminary hydrologic assessment, Mori Point Trail Planning and Restoration Project. Prepared for Golden Gate Parks Conservancy, October 14, 8p.

Kamman, G.R. and Rios, T., 2005, Annual geomorphic monitoring of Arroyo Mocho channel, Wente Street Bridge, Livermore, CA. Prepared for Sycamore Associates, LLC, November 11, 11p.

Kamman, G.R., 2005, Hydrology and water quality assessment report, Coastal Trail planning at Land's End, San Francisco, CA. Prepared for Golden Gate Parks Conservancy, August, 24p.

Kamman, G.R., 2005, Technical letter report - groundwater impact assessment, January 2005 Settlement Agreement, Lundy Hydroelectric Project (FERC No. 1390). Prepared for Lundy Mutual Water Company, May 6, 9p.

Kamman, G.R., Gragg, J., and Kamman R.Z., 2005. Hydrology & Coastal Lagoon Assessment: Environmental Study of the Santa Clara River Estuary. Prepared for Nautilus Environmental LLC and The City of Buenaventura, March, 52p.

Kamman, G.R. and Rios, T., 2005. Fiscalini Bank Stabilization Hydraulic Analysis and Preliminary Design Evaluation Report. Prepared for The California Coastal Conservancy and Greenspace-The Cambria Land Trust, February, 27p.

Kamman, G.R. and Rios, T., 2004, Survey and Hydraulic Analysis of St. Johns Property Project, Temescal Creek, Oakland, CA. Prepared for: Wolfe Mason Associates/Design Community & Environment, December 27, 13p.

Kamman, G.R. and Kamman R.Z., 2004, Gallinas Creek Restoration Feasibility Study and Conceptual Design Report, Marin County, California. Prepared for: San Pablo Bay Watershed Restoration Program Partners (US Army Corps of Engineers, San Francisco District and California Coastal Conservancy), in cooperation with: The Friends of Gallinas Creek., The Bay Institute, and Marin County Stormwater Pollution Prevention Program, December, 47p.

Kamman, G.R. and Rios, T., 2004. Hydrologic Feasibility Analysis for the Tolay Lake Ranch Property, Sonoma County, California. Prepared for: Sonoma County Agricultural Preservation & Open Space District, December, 96p.

Kamman, G.R. and Rios, T., 2004, Annual geomorphic monitoring of Arroyo Mocho channel, Wente Street Bridge, Livermore, CA. Prepared for Sycamore Associates, LLC, November 17, 10p.

Ecorp Consulting, Inc. and Kamman Hydrology & Engineering, Inc., 2004, Draft Gualala Estuary and Lower River Enhancement Plan: Results of 2002 and 2003 Physical and Biological Surveys. Prepared for: Sotoyome Resource Conservation District and California Coastal Conservancy, June 10.

Kamman, G.R., 2003, Annual geomorphic monitoring of Arroyo Mocho channel, Wente Street Bridge, Livermore, CA. Prepared for Sycamore Associates, LLC, December 23, 10p.

Kamman, G.R., 2003, Hydrologic Analyses - Technical Letter Report, Reach B-2 Pond, Sycamore Grove Park, Livermore, CA. Prepared for Livermore Area Recreation and Parks Department, December 4, 13p.

Kamman, G.R., 2003, Hydrologic assessment of wetland mitigation and monitoring plan, Metcalf Road Property, San Jose, CA. Prepared for: Sycamore Associates, LLC, November 21, 21p.

Kamman R.Z. and Kamman, G.R., 2003, Review of flood hazard analysis for Easkoot Creek Project, Stinson Beach, CA. Prepared for Golden Gate National Recreation Area, National Park Service, September 10, 1p.

Kamman, G.R., 2003, Redwood Creek levee analysis, Lower Redwood Creek, Orick, CA. Prepared for Humboldt County Department of Public Works, July 28, 15p.

Kamman, G.R., 2003. 3rd iteration of preliminary grading plan for Fill Site 6, Tennessee Hollow Riparian Corridor Restoration Project, The Presidio of San Francisco. Prepared for The Presidio Trust, March 25, 10p.

Kamman, G.R., 2003. Draft Interim Hydrologic Monitoring Report for the Tennessee Hollow Riparian Corridor Restoration Project, the Presidio of San Francisco. Prepared for The Presidio Trust, March, 110p.

Kamman, G.R. and McBain & Trush, Inc., 2002, Chapter 4: Shallow Groundwater Hydrology. In: McBain & Trush, Inc. (eds.), 2002. *San Joaquin River Restoration Study Background Report*, prepared for Friant Water Users Authority, Lindsay, CA, and Natural Resources Defense Council, San Francisco, CA, December,

Kamman, G.R., 2002. Conceptual Watershed Model and proposed surface- and ground-water monitoring program for the Tennessee Hollow Riparian Corridor Restoration Project, The Presidio of San Francisco. Prepared for The Presidio Trust, July, 77p.

Kamman, G.R., 2002. Hydraulic Assessment of Proposed Channel Modifications: Iron Horse Trail Concord, CA. Prepared for: The East Bay Regional Park District, January 2002, 12p.

Kamman, G.R. and Kamman, R.Z., 2001, Final revised tidal marsh designs, Cargill-Eden Landing Ecological Preserve, Hayward, CA. Prepared for: East Bay Regional Park District, September 7, 4p., with plates.

Kamman, G.R., Kamman, R.Z., and Granholm, S., 2001, Final conceptual seasonal wetland design, Damon Slough Mitigation Site, Oakland, CA. Prepared for: Port of Oakland, June 14, 37p.

Kamman, G.K., 2001, Salt Panne/Snowy Plover Management Area, Eden Landing Ecological Reserve Restoration and Management Plan, Hayward, CA. Prepared for: East Bay Regional Park District, April 18, 5p.

Kamman, G.R. and Kamman, R.Z., 2001, Hydrologic evaluation of final design for the Bay Point Regional Shoreline wetland restoration plan, Bay Point, CA. Prepared for: LSA and East Bay Regional Park District, April, 33p.

Kamman, G.R., 2001. Draft Comments: 100-year flood estimate on Upper Trinity River. Prepared for Trinity County Planning Department, February 9, 8p.

Kamman, R.Z. and Kamman, G.K., 2000, Tidal exchange analysis of tidal channel geometry, Cargill-Eden Landing Ecological Preserve, Hayward, CA. Prepared for: East Bay Regional Park District and Far West Restoration Engineering, November 1, 11p.

Kamman, G.R., 2000, Preliminary hydrologic sufficiency analysis for proposed California tiger salamander (CTS) pond, Bosley Property, Livermore, CA. Prepared for: Sycamore Associates, LLC, May 24, 7p.

Kamman, G.R. and Kamman, R.Z., 2000, Hydrologic analysis for the Bay Point Regional Shoreline wetland restoration plan, Bay Point, CA. Prepared for: LSA and East Bay Regional Park District, March, 47p.

Kamman, G.R., 2000, Hydrologic analyses for creek restoration design: Heather Farms Project Site, Walnut Creek, CA. Prepared for: Sycamore Associates, LLC, January, 33p.

Kamman, G.R., 2000, Hydrologic Analysis, Conway Ranch Water Rights, Mill Creek, Mono County, CA. Prepared for: Don Mooney Esq., January 28, 21p.

Kamman, G.R., 1999, Flood damage assessment of proposed Trinity River fish and wildlife restoration flow alternatives. Prepared for: Trinity County Planning Department, September, 19p.

Kamman, G.R., and Stokely, T., 1999, Trinity Dam auxiliary oputlet releases. Prepared for: Trinity County Planning Department, Agreement No. TFG 94-04, September 24, 4p.

Kamman, G.R., 1999, Addendum to Temperature analysis of proposed Trinity River fish and wildlife restoration flow alternatives using the BETTER model: cumulative effects analyses. Prepared for: Trinity County Planning Department, Agreement No. TFG 94-04, September, 7p.

Kamman, G.R., 1999, Temperature analysis of proposed Trinity River fish and wildlife restoration flow alternatives using the BETTER model. Prepared for: Trinity County Planning Department, Agreement No. TFG 94-04, June, 31p.

Kamman, G.R., 1999, Stormwater runoff hydrology and channel stability report: The Ranch on Silver Creek Project, San Jose, CA. Prepared for: Sycamore Associates, LLC, May, 21p + appendices.

Kamman, G.R., 1999, Baseline water quality and hydrology investigation: The Ranch on Silver Creek Project, San Jose, CA. Prepared for: Sycamore Associates, LLC, May, 28p.

Kamman, G.R., 1999, Slope stabilization at Wallabi Ct., Las Trampas Creek, Lafayette, CA. Prepared for: Sycamore Associates, LLC, April 5, 8p.

Kamman, G.R., 1999, Draft report on causation 1997 West Walker River flood damage to Mt. Gate Lodge, Mono County, CA. Prepared for: Lou deBottari, January 18, 16p.

Kamman, G.R., 1998, Hydrologic and hydraulic review of Temescal Creek Bridge repairs, 145 Duncan Way, Oakland, CA. Prepared for: Vince Aitro, December 31, 10p.

Kamman, G.R., 1998, Final summary of site visits and recommendations for bank stabilization, San Ramon Creek, South San Ramon Creek and associated tributaries, San Ramon, CA. Prepared for: City of San Ramon, Engineering, September 23, 12p.

Kamman, G.R., 1998, Hydrologic sufficiency and design considerations for proposed mitigation wetlands, Crystyl Ranch Drive, Contra Costa County, CA. Prepared for: Sycamore Associates, LLC, June, 19p.

Kamman, G.R., 1998, Carryover storage analysis, simulated (1928-1934) drought period. Prepared for Trinity County Planning Department, Agreement No. TFG 97-04, May 22, 1p.

Kamman, G.R., 1998, Draft carryover storage analysis results, maximized auxiliary bypass releases. Prepared for Trinity County Planning Department, Agreement No. TFG 97-04, May 21, 1p.

Kamman, G.R., 1998, Carryover storage analysis results, Maximum Flow, Flo Study, and No Action Alternatives. Prepared for Trinity County Planning Department, Agreement No. TFG 97-04, May 19, 3p.

Kamman, G.R., 1998, Carryover storage analysis results, Flow Study and No Action Alternatives. Prepared for Trinity County Planning Department, Agreement No. TFG 97-04, May 14, 3p.

Kamman, G.R., 1998, Carryover storage analysis results, Flow Study and No Action Alternatives. Prepared for Trinity County Planning Department, Agreement No. TFG 97-04, May 14, 3p.

Kamman, G.R. and Kamman, R.Z., 1997, Hamilton Base Realignment and Closure Wetland Conversion Alternative: Landfill 26 Groundwater Assessment. Prepared on behalf of PWA, Ltd. for IT Corporation and San Francisco District Corps of Engineers, October, 16p.

Kamman, G.R., 1997, Small community flood information study report for five Salinas River communities, Tembladero Slough study area. Prepared for: Phillip Williams & Associates, Ltd., on behalf of San Francisco District Corps of Engineers, September 30, 51p.

Kamman, G.R., 1997, Hydraulic estimates for San Ramon Creek bank stabilization, Crow Canyon Gardens, San Ramon. Prepared for: ENGEO and Sycamore Associates, LLC, September, 5p.

Kamman, G.R., 1997, Natural vs. regulated flow and temperature conditions on the Upper Eel River, California – Lake Pillsbury to Outlet Creek. Prepared for: California Trout, August 23, 103p.

Kamman, G.R., 1997, Theoretical temperature modeling – Upper Klamath Lake Area, Oregon. Prepared for: Phillip Williams & Associates, Ltd., March 10, 18p.

Kamman, G.R. and Hecht, B., 1997, Hydrology and Water Supplies at the Marin Coast Ranch, Marin County, California. Prepared for The Brenner Group, San Rafael, CA, March, 33p.

Kamman, G.R., 1996, Flow of the Mojave River for Water Year 1995, Victorville Narrows, California. Prepared for James C. Hanson Engineers, Sacramento, California, June, 9p.

Hanson, K.L., Coopersmith, K.J., Angell, M.M., Crampton, T.A., Wood, T.F., Kamman, G.R., Baldwin, F., Peregoy, W., and McVicar, T., 1996, Evaluation of the Capability of Inferred Faults in the Vicinity of Building 371, Rocky Flats Environmental Technology Site, Colorado.

Kamman, G.R., 1996, Progress Report: Flow of the Mojave River for Water Year 1995, Victorville Narrows, California. Prepared for: James C. Hanson Engineers, Sacramento, California, June.

Kamman, G.R., Hecht, B., and Owens, J., 1996, Hydrologic Assessment: Seminary Creek Restoration Project - 1996. Prepared for East Bay Asian Local Development Corporation, Oakland, California, June, 5p.

Kamman, G.R. and Hecht, B., 1996, Assessment of Fishway Effects on Water Production from the Los

Trancos Diversion, Stanford University, California. Prepared for Stanford University, May, 21p.

Kamman, G.R. and Hecht, B., 1996, Results of Baseline Hydrologic Investigation and Modifications to Recharge Mitigation Measures, Proposed Harbor View Development, Bodega Bay, California. Prepared for Redwood Development, Santa Rosa, California, May, 19p.

Kamman, G.R., Hecht, B., and Owens, J., 1996. Webb Ranch Bridge Hydrology Assessment. Prepared for Stanford Land Company, Menlo Park, California, April, 13p.

Hecht, B. and Kamman, G.R., 1996, Initial Assessment of Pre- and Post-Klamath Project Hydrology of the Klamath River and Impacts of the Project on In-stream Flows and Fishery Habitat. Prepared on behalf of The Yurok Tribe, March, 39p.

Kamman, G.R. and Hecht, B., 1996, Report of Hydrologic Investigation Results, Proposed Veterans Home Golf Course, Yountville, California. Prepared for Reynolds and Brown, Concord, California, January, 11p.

Kamman, G.R., 1995, Changes in Surface Water Salinity as a Function of Natural Wet and Dry Cycles - Santa Ynez River Basin. Prepared for the City of Santa Barbara, Santa Barbara, California, December, 8p.

Kamman, G.R. and Hecht, B., 1995, Daily and Peak Flow Records Measured at the San Geronimo Creek Gage during WY 1995. Prepared for: Marin Municipal Water District, Corte Madera, California, October.

Kamman, G.R., 1995, Daily and Peak Flow Records Measured at the San Geronimo Creek Gage during WY 1994. Prepared for: Marin Municipal Water District, Corte Madera, California, September.

Kamman, G.R. and Hecht, B., 1995, Interim Ground Water Monitoring Program: Sisquoc Plant and Vicinity, Santa Barbara County, California. Prepared for: SP Milling Company, Oxnard, California, July.

Kamman, G.R. and Hecht, B., 1995, Results of Hydrologic Investigation, Highland Ranch, Sonoma County, California. Prepared for: Robert Yahng, Baker and McKenzie, San Francisco, California, June, 8p.

Kamman, G.R., and Ramirez, T., 1994, Evaluation of Gravel Retainment Structures and Placement of Salmon Spawning Gravel in the Merced River below the Crocker-Huffman Dam. Prepared for Center for Environmental Design Research, University of California, Berkeley, California, May, 14p.

Kamman, G.R. and Hecht, B., 1995, Assessment of Fishway Effects on Water Production from the Los Trancos Diversion, Stanford University, California. Prepared for: Stanford University, May.

Kamman, G.R. and Johnson, K.A., 1994, Phase II Site Investigation Results, 1515 Industrial Way, Belmont, California. Prepared for: General Instrument Corporation, Parsippany, New Jersey, November.

Kamman, G.R. and Zemo, D.A., 1994, Ground Water Investigation Work Plan, Clark's Home and Garden, Hayward, California," prepared for: Mr. Chester Clark, Grants Pass, Oregon, April.

Kamman, G.R. and Graf, T., 1994, Results of Site Investigation, Quan's Automotive Service, Oakland, California. Prepared for: Alameda County Health Care Services Agency, Oakland, California, March.

Kamman, G.R., Rowles, L.D. and Bice, N.T., 1994, Addendum to Phase V Investigation Report, 234 East Main Street and Vicinity, Ontario, California. Prepared for: General Electric Company, San Francisco, California, February.

Kamman, G.R. and Goodin, S.E., 1994, Proposal for Underground Tank Site Remediation Testing and Management Services. Prepared for: California Fairs Financing Authority, Sacramento, California.

Kamman, G.R., Zemo, D.T., Bice, N.T., and Rafferty, M.T., 1993, Results of Phase I Activities and Phase II Work Plan for On-Site Soil Remediation, Former McKesson Facility, Santa Fe Springs, California. Prepared for: McKesson Corporation, San Francisco, California, November.

Kamman, G.R. and Goodin, S.E., 1993, Soil Investigation for Proposed Freeway Alignment, Parcels A, B, and C, Oakland Post Office, Oakland, California. Prepared for: California Department of Transportation, Oakland, California, September.

Kamman, G.R., Zemo, D.T., and Bice, N.T., 1993, Phase I On-Site Soil Remediation Work Plan, Former McKesson Facility, Santa Fe Springs, California. Prepared for: McKesson Corporation, San Francisco, California, June 1993 (with D.A. Zemo and N.T. Bice).

Kamman, G.R. and Rowles, L.D., 1994, Quarterly Ground Water Monitoring Reports, 234 East Main Street and Vicinity, Ontario, California. Prepared for: General Electric Company, San Francisco, California, March.

Kamman, G.R., Rowles, L.D., Foote, G.R., and Bice, N.T., 1993, Phase V Investigation Report, 234 East Main Street and Vicinity, Ontario, California. Prepared for: General Electric Company, San Francisco, California, January.

Kamman, G.R., Warner, S.D., and Goodin, S.E., 1992, Environmental Site Assessment Report, 215 Leo Avenue, San Jose, California. Prepared for: Redtree Properties, San Francisco, California, December.

Kamman, G.R. and Hall, N.T., 1992, Paleoseismic Investigations of the San Andreas Fault on the San Francisco Peninsula," NEHRP proposal to US Geological Survey, May.

Kamman, G.R., McDonald, S. and North, R., 1990, Presentation of Phase III Sampling Results and Partial Soil Cleanup Plan and Additional Ground Water Investigation for Paulsboro Packaging, Inc., ECRA Case No. 86826. Prepared for: Paulsboro Packaging, Inc., Paulsboro, New Jersey, December.

Kamman, G.R. and Fusillo, T., 1990, Addendum Report on the Results of Environmental Sampling at Tax Blocks S-6: Lots 90, 92, and 93, West Windsor, New Jersey, Prepared for: Matrix Development Group, Inc., Cranbury, New Jersey, June.

Kamman, G.R. and Stone, B., 1990, Results Report and Phase II Sampling Plan for the Courier-News, Bridgewater, New Jersey, ECRA Case No. 90029. Prepared for: The Courier News, Bridgewater, New Jersey, May.

Kamman, G.R. and Fusillo, T., 1990, Results of Soil, Sediment, and Ground Water Sampling at Tax Block S-6: Lots 90, 92, and 93 in West Windsor, New Jersey. Prepared for: Matrix Development Group, Inc., Cranbury, New Jersey, April.

Kamman, G.R. and Fusillo, T. 1989, Proposed Sampling Plan for University Square Associates Property, West Windsor Township, Mercer County. Prepared for: Matrix Development Group, Inc., Cranbury, New Jersey, December.

Kamman, G.R., 1989, Clay diagenesis of the Monterey Formation and relationship to burial history: Point Arena and Salinas Basins, California. M.S. thesis, Miami University, Oxford, OH, April, 147p.

2.0 DECLARATIONS, DEPOSITIONS & CEQA REVIEW COMMENTS

Kamman, G.R., 2017, Review of Sonoma Agenda Item Summary Report for Appeal Hearing, Knights Bridge Winery, PRMD file #: UPE 13-0046, 17134 Spencer Lane, Calistoga, CA. Prepared for: Maacama Watershed Alliance (MWA) and Friends of Spencer Lane, August 21, 30p.

Kamman, G.R., 2017, Review Comments: PAD and SD1, FERC Relicensing of Potter Valley Project (PVP). Professional declaration prepared for: Friends of Eel River, July 31, 8p.

Kamman, G.R., 2017, Review of Revised Draft EIR (RDEIR) Davidon/Scott Ranch GPA, Rezoning, and Vesting Tentative Map Project, Petaluma, California. Prepared for: Shute, Mihaly & Weinberger LLP, June 12, 11p.

Kamman, G.R., 2017, Review Comments, Draft Environmental Impact Report, Fish Habitat Flow and Water Rights Project. Professional declaration prepared for: Friends of Eel River, March 8, 18p.

Kamman, G.R., 2016, Review of Draft General Waste Discharge Requirements for Vineyard Dischargers in the Napa River and Sonoma Creek Watersheds. Prepared for: Law Offices of Thomas N. Lippe APC, December 12, 4p.

Kamman, G.R., 2016, Review of County Appeal Hearing Video from November 22, 2016, Walt Ranch Erosion Control Plan (P11-00205-ECPA), Walt Ranch Project, Napa, CA. Professional Declaration Prepared for: Law Offices of Thomas N. Lippe APC, November 28, 3 p.

Kamman, G.R., 2016, Review of Final EIR, Walt Ranch Erosion Control Plan (P11-00205-ECPA), Walt Ranch Project, Napa, CA. Professional Declaration Prepared for: Law Offices of Thomas N. Lippe APC, November 20, 15 p.

Kamman, G.R., 2016, Effect of Vineyard Drainage Elements on Modeled Peak Runoff, Walt Ranch Erosion Control Plan (P11-00205-ECPA), Walt Ranch Project, Napa, CA. Professional Declaration Prepared for: Law Offices of Thomas N. Lippe APC, November 17, 8 p.

Kamman, G.R., 2016, Review of Revised Mitigated Negative Declaration Knights Bridge Winery, PRMD file #: UPE 13-0046, 17134 Spencer Lane, Calistoga, CA. Prepared for: Maacama Watershed Alliance (MWA) and Friends of Spencer Lane, October 27, 50p.

Kamman, G.R., 2016, Review of Middle Green Valley Specific Plan Project, Second Revised Recirculated Draft Environmental Impact Report, Solano County, CA, Sch# 2009062048. Professional Declaration Prepared for: Law Offices of Amber Kemble, October 25, 3p.

Kamman, G.R., 2016, Review of Initial Study and Negative Declaration Mountain Peak Winery: Use Permit #P13-00320-UP, 3265 Soda Canyon Road, Napa, CA 94558 (APN: 032-500-033). Prepared for: The Soda Canyon Group, October 11, 15p.

Kamman, G.R., 2016, Hydrologic and Water Quality Issues Associated with Proposed Golden Bridges School Project at 203 Cotter Street, San Francisco, CA. Prepared for: Neighbors of Cotter Street, September 19, 15p.

Kamman, G.R., 2016, Review of Mitigated Negative Declaration Knights Bridge Winery, PRMD file #: UPE 13-0046, 17134 Spencer Lane, Calistoga, CA. Prepared for: Maacama Watershed Alliance (MWA) and Friends of Spencer Lane, September 16, 6p.

Kamman, G.R., 2016, Review of Draft EIR for General Waste Discharge Requirements for Vineyard Dischargers in the Napa River and Sonoma Creek Watersheds. Prepared for: Law Offices of Thomas N. Lippe APC, September 14, 81p.

Kamman, G.R., 2016, Landslide Hazard Assessment, Walt Ranch Erosion Control Plan (P11-00205-ECPA), Walt Ranch Project, Napa, CA. Professional Declaration Prepared for: Law Offices of Thomas N. Lippe APC, August 26, 45 p.

Kamman, G.R., 2016, Review of Approved Erosion Control Plan (P14-00069-ECPA), Kongsgaard Wine LLC – Atlas Peak Vineyard Conversion, Napa, CA. Professional Declaration Prepared for: Law Offices of Thomas N. Lippe APC, March 14, 8p.

Kamman, G.R., 2016, Second Declaration of Greg Kamman Plaintiff's Joint Motion for Preliminary Injunction, Prepared for Center for Biological Diversity (Plaintiff) v. U.S. Bureau of Reclamation, Case No. 6:16-cv-00035-TC (Recovery for Oregon Spotted Frog, Upper Deschutes Basin, Oregon) , March 11, 11p.

Kamman, G.R., 2016, Declaration of Greg Kamman Plaintiff's Joint Motion for Preliminary Injunction, Prepared for Center for Biological Diversity (Plaintiff) v. U.S. Bureau of Reclamation, Case No. 6:16-cv-00035-TC (Recovery for Oregon Spotted Frog, Upper Deschutes Basin, Oregon) , February 4, 8p.

Kamman, G.R., 2016, Review of Final, Recirculated and Draft Environmental Impact Reports, Corte Madera Inn Rebuild Project, Marin County, California. Prepared for: Community Venture Partners, February 4, 9p.

Kamman, G.R., 2016, Review of Response to Public Comments by Richard C. Slade & Associates LLC, Mountain Peak Winery: Use Permit #P13-00320, 3265 Soda Canyon Road, Napa, CA 94558 (APN: 032-500-033). Prepared for: The Soda Canyon Group, January 30, 298p.

Kamman, G.R., 2015, Review of Timber Harvest Plan (THP) 1-15-042 SON (Gualala Redwoods Inc. "Dogwood" THP). Professional Declaration Prepared for: Law Offices of Paul Carrol and Friends of the Gualala River, December 24, 4p.

Kamman, G.R., 2015, Declaration of Greg Kamman in Opposition to Affirmative Defense Regarding Mootness, Prepared for Paul Carroll, Attorney at Law and Center for Biological Diversity (Petitioners) v. County of Sonoma, Agricultural Commissioner of Sonoma County and (Respondents) Ohlson Ranch, September 9, 10p.

Kamman, G.R., 2015, Review of Timber Harvest Plan (THP) 1-15-042 SON (Gualala Redwoods Inc. "Dogwood" THP) and THP 1-15-033 SON (Gualala Redwoods Inc. "Apple" THP). Professional Declaration Prepared for: Law Offices of Paul Carrol and Friends of the Gualala River, August 6, 8p.

Kamman, G.R., 2015, Sharp Park Project Impacts to Laguna Salada. Prepared for National Parks Conservation Association and Wild Equity Institute, April 14, 1p.

Kamman, G.R., 2014, Review of Draft EIR, Walt Ranch Project, Napa, CA. Professional Declaration Prepared for: Lippe Gaffney Wagner LLP, November 20, 15 p.

Kamman, G.R., 2014, Review of Technical Reports Sonoma County Discretionary Development Permit Application #UPE 13-00046, Proposed Knights Bridge Winery, 18260 Hwy 128, Calistoga, CA 94515. Professional Declaration Prepared for: Maacama Watershed Alliance, October 27, 4p.

Kamman, G.R., 2014, Review of Middle Green Valley Specific Plan Project, Revised Recirculated Draft Environmental Impact Report, Solano County, CA, Sch# 2009062048. Professional Declaration Prepared for: Law Offices of Amber Kemble, August 11, 11p.

Kamman, G.R., 2014, Top of Bank Review, Finger Avenue Planned Development Project, Redwood City, CA. Professional Declaration Prepared for: Friends of Cordilleras Creek, July 14, 10 p.

Kamman, G.R., 2014, Hydrologic Technical Review of 1360 Big Rock Road Project St. Helena, California. Professional Declaration Prepared for: Lippe, Gaffney Wagner LLP, June 14, 5p.

Kamman, G.R., 2014, Review of IS/MND Kongsgaard Wine LLC – Atlas Peak Vineyard Conversion Agricultural Erosion Control Plan #P14-00069. Professional Declaration Prepared for: Law Offices of Thomas N. Lippe, APC, May 14, 9 p.

Kamman, G.R., 2013, Review of Middle Green Valley Specific Plan Project, Solano County, CA, Recirculated Draft EIR, Sch.# 2009062048. Professional Declaration Prepared for: Law Offices of Amber Kemble, October 10, 6p.

Kamman, G.R., 2013, Flow trend analysis, Williamson and Sprague River Basins. Prepared for: Yurok Tribe, July 22, 8p.

Kamman, G.R., 2014, Addendum to Hydrologic Technical Review of 1360 Big Rock Project, St. Helena, California.. Professional Declaration Prepared for: Lippe Gaffney Wagner, LLP, June 17, 2p.

Kamman, G.R., 2014, Hydrologic Technical Review of 1360 Big Rock Project, St. Helena, California. Professional Declaration Prepared for: Lippe Gaffney Wagner, LLP, June 14, 5 p.

Kamman, G.R., 2013, Proposed hydraulic analysis and design recommendations – landslide stabilization – creek cascade design element, Green Gulch Zen Center, Muir Beach, CA. Prepared for Green Gulch Zen Center, April 25, 4p.

Kamman, G.R., 2012, Deposition of Gregory Richard Kamman, R.G., C.H.G., Schaefer vs. City of Larkspur, CA, Superior Court of the State on California, County of Marin. August 23, 2012.

Kamman, G.R., 2012, Technical review comments to Biological Assessment, Sharp Park Safety, Infrastructure Improvement and Habitat Enhancement Project. Prepared for Wild Equity Institute, August 3, 11p.

Kamman, G.R., 2012, Proposed Hardy-based Environmental Water Allocation (EWA) Input for WRIMS Model Simulation, Klamath River Basin. Prepared for: Yurok Tribe, July 20, 5p.

Kamman, G.R., 2012, Review of Draft EIR, Hunter Subdivision Project, St. Helena, CA. Professional Declaration Prepared for: Law Offices of Thomas Lippe, July 10, 11p.

Kamman, G.R., 2012, Review of groundwater conditions and modeling report by S.S. Papadopulos & Associates, Inc., Scott Valley, California. Prepared for: Yurok Tribe, 4p.

Kamman, G.R., 2012, Review of Mitigated Negative Declaration, Ratna Ling Buddhist Retreat Master Plan, File No. PLP08-0021. Professional Declaration Prepared for: Law Offices of Paul Carrol and Friends of the Gualala River, April 4, 5p.

Kamman, G.R., 2011, Supplemental Declaration of Greg Kamman regarding Laguna Salada, Wild Equity Institute v. City and County of San Francisco, et al., Case No.: 3:11-CV-00958 SI, United States District Court, Northern District of California, San Francisco Division. Prepared for Wild Equity Institute, November 4, 50p.

Kamman, G.R., 2011, Declaration of Greg Kamman regarding Laguna Salada, Wild Equity Institute v. City and County of San Francisco, et al., Case No.: 3:11-CV-00958 SI, United States District Court, Northern District of California, San Francisco Division. Prepared for Wild Equity Institute, September 23, 7p.

Kamman, G.R., 2011, Preliminary Review of BBPUD Bay Flat Road Well Installation Project. Prepared for: Law Offices of Rose Zoia, July 10, 16p.

Kamman, G.R., 2010, Review of Sonoma County Water Agency NOP (issued 9/29/10) Fish Habitat Flow and Water Rights Project. Professional declaration prepared for: Friends of Eel River, November 8, 7p.

Kamman, G.R., 2009, Finger Avenue Nine-Lot Planned Development. Professional declaration prepared for Friends of Cordilleras Creek, October 26, 2p.

Kamman, G.R., 2009, Supplemental Technical Review of Henry Cornell Winery, 245 Wappo Road, Santa Rosa, CA APN 028-260-041. Prepared for Ms. Kimberly Burr, Esquire, June 1, 3p.

Kamman, G.R., 2009, San Rafael Airport Recreation Facility DEIR. Profession declaration prepared for Friends of Gallinas Creek, May 12, 3p.

Kamman, G.R., 2008, Technical Review of Henry Cornell Winery, 245 Wappo Road, Santa Rosa, CA APN 028-260-041. Prepared for Ms. Kimberly Burr, Esquire, November 12, 8p.

Kamman, G.R., 2007, Independent Model Review for Klamath Settlement Negotiations, Klamath Independent Review Project (KIRP). Prepared for Northcoast Environmental Center, November 9, 19p.

Kamman, G.R., 2007, Negative Declaration for File No. UPE04-0040, Gualala Instream. Professional declaration prepared for Friends of the Gualala River, October 21, 2p.

Kamman, G.R., 2007, Second Declaration on WRA and Balance Hydrologics, Inc. technical studies pertaining to wetland conditions at the Harbor View Development site, Bodega Bay, CA. September 20, 3p.

Kamman, G.R., 2007, Fairfax Conversion Project Environmental Impact Report (SCH# 2004082094). Professional declaration prepared for Friends of the Gualala River, July 27, 15p.

Kamman, G.R., 2007, Comments on WRA and Balance Hydrologics, Inc. technical studies pertaining to wetland conditions at the Harbor View Development site, Bodega Bay, CA. February 13, 4p.

Kamman, G.R., 2004, Evaluation of potential impacts on hydrology and water supply, THP No. 1-04-055 SON and Proposed Mitigated Negative Declaration TCP No. 04-533, Roessler/Zapar Inc. THP/Conversion, Annapolis, CA. Professional declaration prepared for Friends of the Gualala River, August 13, 11p.

Kamman, G.R., 2004, Evaluation of potential hydrologic effects, THP No. 1-04-059 SON and Proposed Mitigated Negative Declaration TCP No. 04-531, Sleepy Hollow (Martin) THP/Conversion, Annapolis, CA. Professional declaration prepared for Friends of the Gualala River, July 17, 9p.

Kamman, G.R., 2004, Robert Mondavi Properties Vineyard (Erosion Control Plan Application #99323). Professional declaration prepared for the Law Offices of Thomas N. Lippe, July 1, 5p.

Kamman, G.R., 2004, Pocket Canyon THP No. 1-020216 SON. Professional declaration prepared for Pocket Canyon Protection Group, March 8, 2p.

Kamman, G.R., 2003, Evaluation of potential hydrologic effects, Negative Declaration for THP/Vineyard Conversion, No. 1-01-171 SON, Artesa Vineyards, Annapolis, CA. Professional declaration prepared for Friends of the Gualala River, May 19, 9p.

Kamman, G.R., 1999, Review of Final Supplemental Environmental Assessment, Cirby-Linda-Dry Creek Flood Control Project. Professional declaration prepared for: Monty Hornbeck, Sunrise Office Park Owners Association; Bill Kopper/John Gabrielli, Attorneys at Law; and Sharon Cavello/Cathie Tritel, Placer Group Sierra Club, May 24, 10p.

Kamman, G.R., 1997, Review comments, Deer Creek Hills Draft EIR. Professional declaration prepared for: The Nature Conservancy, August 4, 6p.

Kamman, G.R., 1995, Variable Water Resources Available in the Area of Salinas, California. Declaration prepared for Price, Postal, and Parma, Santa Barbara, California, May, 6p.

3.0 PUBLICATIONS AND PRESENTATIONS

Kamman, G.R. and Kamman, R.Z., 2015, Landscape Scale Urban Creek Restoration in Marin County, CA - Urban Creek Restoration: Interfacing with the Community. 33rd Annual Salmonid Restoration Conference, March 11-14, Santa Rosa, CA.

Kamman, G.R., R.Z., 2015, Enhancing Channel and Floodplain Connectivity: Improving Salmonid Winter Habitat on Lagunitas Creek, Marin County, CA - Beyond the Thin Blue Line: Floodplain Processes, Habitat, and Importance to Salmonids. 33rd Annual Salmonid Restoration Conference, March 11-14, Santa Rosa, CA.

Kamman, G.R., 2012, The role of physical sciences in restoring ecosystems. November 7, Marin Science Seminar, San Rafael, CA.

King, N. and Kamman, G.R., 2012, Preferred Alternative for the Chicken Ranch Beach/Third Valley Creek Restoration Project. State of the Bay Conference 2012, Building Local Collaboration & Stewardship of the Tomales Bay Watershed. October 26, Presented by: Tomales Bay Watershed Council, Inverness Yacht Club, Inverness, CA.

King, N. and Kamman, G.R., 2010, Chicken Ranch Beach Restoration Planning by TBWC. State of the Bay Conference 2010, A Conference about Tomales Bay ant its Watershed. October 23, Presented by: Tomales Bay Watershed Council, Inverness Yacht Club, Inverness, CA.

Higgins, S. and Kamman, G.R., 2009, Historical changes in Creek, Capay Valley, CA. Poster presented at American Geophysical Union Fall Meeting 2009, Presentation No. EP21B-0602, December.

Kamman, G.R. and Higgins, S., 2009, Use of water-salinity budget models to estimate groundwater fluxes and assess future ecological conditions in hydrologically altered coastal lagoons. Coastal and Estuarine Research Federation 20th Biennial Conference, 1-5 November, Portland, OR

Bowen, M., Kamman, G.R., Kaye, R. and Keegan, T., 2007, Gualala River Estuary assessment and enhancement plan. Estuarine Research Federation, California Estuarine Research Society (CAERS) 2007 Annual Meeting, 18-20 March, Bodega Marine Lab (UC Davis), Bodega Bay, CA

Bowen, M. and Kamman, G.R., M., 2007, Salt River Estuary enhancement: enhancing the Eel River Estuary by restoring habitat and hydraulic connectivity to the Salt River. Salmonid Restoration Federation's 25th Salmonid Restoration Conference, 7-10 March, Santa Rosa, CA.

Magier, S., Baily, H., Kamman, G., and Pfeifer, D, 2005, Evaluation of ecological and hydrological conditions in the Santa Clara River Estuary with respect to discharge of treated effluent. In: Abstracts with Programs, The Society of Environmental Toxicology and Chemistry North America 26th Annual Meeting, 13-17 November, Baltimore Convention Center, Baltimore, Maryland.

Baily, H., Magier, S., Kamman, G., and Pfeifer, D, 2005, Evaluation of impacts and benefits associated with discharge of treated effluent to the Santa Clara River Estuary. In: Abstracts with Programs, The Society of Environmental Toxicology and Chemistry North America 26th Annual Meeting, 13-17 November, Baltimore Convention Center, Baltimore, Maryland.

Kamman, G.R., Kamman, R.Z., and Parsons, L., 2005, Hydrologic and Hydraulic Feasibility Assessments for Ecological Restoration: The Giacomini Wetland Restoration Project, Point Reyes National Seashore, CA. *In:* Abstracts with Programs, The Geological Society of America, 101st Annual

Cordilleran Section Meeting, Vol.37, No. 4, p. 104, Fairmont Hotel, April 29-May1, 2005, San Jose, CA.

Kamman, G.R., 2001. Modeling and its Role in the Klamath Basin – Lewiston Reservoir Modeling. Klamath Basin Fish & Water Management Symposium, Humboldt State University, Arcata, CA, May 22-25.

Kamman, G.R., 1998, Surface and ground water hydrology of the Salmon Creek watershed, Sonoma County, CA. Salmon Creek Watershed Day, May 30, Occidental, CA.

Kamman, G.R., 1998. The Use of Temperature Models in the Evaluation and Refinement of Proposed Trinity River Restoration Act Flow Alternatives. ASCE Wetlands Engineering and River Restoration Conference Proceedings, Denver, Colorado (March 22-23, 1998).

Hecht, B., and Kamman, G.R., 1997, Historical Changes in Seasonal Flows of the Klamath River Affecting Anadromous Fish Habitat. In: Abstracts with Programs Klamath Basin Restoration and Management Conference, March 1997, Yreka, California.

Hanson, K.L, Coppersmith, K.J., Angell, M., Crampton, T.A., Wood, T.F., Kamman, G., Badwan, F., Peregoy, W., and McVicar,T., 1995, Evaluation of the capability of inferred faults in the vicinity of Building 371, Rocky Flats Environmental Technology Site, Colorado, in Proceedings of the 5th DOE Phenomena Hazards Mitigation Conference, p. 185-194, 1995.

Kamman, G.R. and Mertz, K.A., 1989, Clay Diagenesis of the Monterey Formation: Point Arena and Salinas Basins, California. *In:* Abstracts with Programs, The Geological Society of America, 85th Annual Cordilleran Section Meeting, Spokane Convention Center, May 1989, Spokane, Washington, pp.99-100.

4.0 ENGINEERING DESIGNS AND SPECIFICATIONS

Kamman G.R., Kamman R.Z., Hayes, C., Lapine, S.L. and Fiori Geoscience, 2017, Lagunitas Creek Salmonid Winter Habitat Enhancement Plans, Marin County, CA., Project Sites 1-9: – Issued for Bid. Prepared for: Marin Municipal Water District, April 17, 25 sheets.

Kamman G.R., Kamman R.Z., Hayes, C., 2017, Mana Plain Wetland Restoration Plan, Mana, Kauai, Hawaii. Prepared for: State of Hawaii, Board of Land and Natural Resources, April 15, 18 sheets.

Kamman G.R., Kamman R.Z., and Hayes, C., 2017, Home Ranch Pond #2 and #9 Design, Point Reyes National Seashore. Prepared for: Jacobs Engineering, February 3, 5 sheets.

Kamman G.R. and Kamman R.Z., 2015, Plans for Construction of Conlon Avenue Parking Lot – 90% Design. Prepared for: Golden Gate National Recreation Area, Muir Woods National Monument, December 3, 10 sheets.

Kamman G.R. and Kamman R.Z., 2015, Plans for Construction of Conlon Avenue Parking Lot – 90% Design. Prepared for: Golden Gate National Recreation Area, Muir Woods National Monument, December 3, 10 sheets.

Kamman G.R. and Kamman R.Z., 2014, Plans for construction of Lower Miller Creek Channel Maintenance Project – 30% Design. Prepared for: Las Gallinas Valley Sanitary District, November, 11 sheets.

Kamman G.R., Lapine, S.L., and Hayes, C., 2014, Rheem Creek Wetland Restoration Design. Prepared for: Olberding Environmental, Inc., October 22, 1 sheet.

Kamman G.R., Kamman R.Z. and Lapine, S.L., 2014, East Arm Mountain Lake Wetland Restoration Plan, The Presidio of San Francisco, CA. Prepared for: The Presidio Trust, June 30, 11 sheets.

Kamman, G.R., 2014, John West Fork Fish Passage Repair Project. Prepared for: Point Reyes National Seashore, June, 6p.

Kamman G.R., Kamman R.Z., Lapine, S.L. and Oberkamper Associates Civil Engineers, Inc., 2014, YMCA Reach of Tennessee Hollow Creek Wetland Restoration Construction Documents, The Presidio of San Francisco, CA. Prepared for: The Presidio Trust, April, 15 sheets.

Kamman G.R., Kamman R.Z., and Oberkamper Associates Civil Engineers, Inc., 2014, Technical Specifications for YMCA Reach of Tennessee Hollow Creek Wetland Restoration, The Presidio of San Francisco, CA. Prepared for: The Presidio Trust, April, 133p.

Kamman G.R., and Kamman R.Z., 2014, Technical Specifications for East Arm Mountain Lake Wetland Restoration, The Presidio of San Francisco, CA. Prepared for: The Presidio Trust, March, 127p.

Kamman G.R., Kamman R.Z., Lapine, S.L., Oberkamper Associates Civil Engineers, Inc., and Roth LaMotte Landscape Architecture, 2014, MacArthur Meadow Wetland Restoration Plan, The Presidio of San Francisco, CA – 30% Design. Prepared for: The Presidio Trust, March 10, 12 sheets.

Kamman G.R., 2013, Suisun Creek Preserved Mitigation Wetland, Solano County, CA. Prepared for: Las Gallinas Valley Sanitary District, November, 11 sheets.

Kamman G.R., Kamman R.Z. and Lapine, S.L., 2013, Cayatano Creek Preserve Mitigation Wetland, Livermore Area, Alameda and Contra Costa Counties, CA – 50% Design. Prepared for: Grizzly Bay LLC., July 16, 2 sheets.

Miller Pacific Engineering Group and Kamman, G.R., 2013, Landslide stabilization retaining wall and rip-rap cascade, Green Gulch Zen Center, Muir Beach, CA. Prepared for: Green Gulch Zen Center, July, 8 sheets.

Kamman G.R., Kamman R.Z. and Lapine, S.L., 2013, Kellogg Creek and Deer Valley East Restoration Project, Contra Costa County, CA. Prepared for: Contra Costa Water District, June, 15 sheets.

Kamman G.R. and Kamman R.Z., 2013, Technical Specifications for Kellogg Creek and Deer Valley East Restoration Project, Contra Costa County, CA. Prepared for: Contra Costa Water District, June, 91p.

Kamman, G.R., 2012, John West Fork Repair Project, Point Reyes National Seashore, CA. Prepared for: National Park Service, December, 5 sheets.

Kamman G.R. and Lapine, S.L., 2012, Home Ranch Pond #9 Design, Point Reyes National Seashore, CA. Prepared for: Point Reyes National Seashore., October 24, 3 sheets.

Kamman G.R. and Lapine, S.L., 2012, G Ranch Wetland Swale near Abbott's Lagoon, Point Reyes National Seashore, CA. Prepared for: Point Reyes National Seashore., October 3, 3 sheets.

Kamman G.R. and Lapine, S.L., 2012, Eagle Ridge Preserve Property Wetland Design, Livermore Area, Contra Costa and Alameda Counties, CA. Prepared for: Olberding Environmental, Inc., August 31, 2 sheets.

Kamman G.R., 2012, Bear Valley Trail Upper Culvert Replacement and Bank Repair, Point Reyes National Seashore, CA. Prepared for: Point Reyes National Seashore, April, 8 sheets.

Kamman R.Z., Kamman G.R., and Lapine, S., 2012, Salt River Ecosystem Restoration Project, Riverside Ranch Tidal Marsh Restoration Plans, Phase 1 Construction. Prepared for Humboldt County RCD, April, 24 sheets.

Kamman R.Z., Kamman G.R., and Lapine, S., 2012, Technical Specifications for the Salt River Ecosystem Restoration Project, Phase 1 Construction, Riverside Ranch and Salt River Restoration Plans. Prepared for Humboldt County RCD, February, 163p.

Kamman, G.R., Kamman, R.Z., Higgins, S. and Lapine, S., 2010, Las Gallinas Valley Sanitary District (LGVSD) - Miller Creek Sanitary Sewer Easement Restoration (100% construction drawings), San Rafael, California. Prepared for LGVSD, September 1, 8 sheets.

Kamman, G.R., Kamman, R.Z., Higgins, S. and Lapine, S., 2010, Technical Specifications for Las Gallinas Valley Sanitary District (LGVSD) - Miller Creek Sanitary Sewer Easement Restoration, San Rafael, California. Prepared for LGVSD, September 1, 70p.

Kamman, G.R., Kamman, R.Z. and Lapine, S., 2010. Point Reyes National Seashore, Restore Critical Dune Habitat to Protect Threatened and Endangered Species, 100% construction drawings. Prepared for: Point Reyes National Seashore Association and National Park Service, June 1, 13 sheets.

Kamman, G.R. and Lapine, S., 2010. Former Reservoir Fill Site, Restoration at Muir Beach, Golden Gate National Recreation Area (100% Construction drawings). Prepared for Golden Gate National Parks Conservancy, May 12, 2 sheets.

Kamman, G.R. and Lapine, S., 2010. Alluvial Fan Fill Site, Restoration at Muir Beach, Golden Gate National Recreation Area (100% Construction drawings). Prepared for Golden Gate National Parks Conservancy, May 12, 2 sheets.

Kamman, G.R., Kamman, R.Z. and Lapine, S., 2010. Technical Specifications, Point Reyes National Seashore, Restore Critical Dune Habitat to Protect Threatened and Endangered Species, 100% plan set. Prepared for: Point Reyes National Seashore Association and National Park Service, June 1, 132p.

Kamman G.K. and Lapine, S., 2010, Dragonfly Creek Restoration Design, in: State of California, Department of Transportation, Project plans for construction on adjacent to State Highway in the City and County of San Francisco 0.3 mile south of Route 1/101 separation, March 25, 30 sheets.

Kamman G.R. and Lapine, S.L., 2009, Project Plans for Construction on Eastern Tributary of Tennessee Hollow Creek, The Presidio of San Francisco, CA. Prepared for: The Presidio Trust, on behalf of State of California, Department of Transportation., September 23,10 sheets.

Kamman, R.Z., Kamman G.K., and Beahan, C., 2008, 100% Design Drawings, Plans for construction of Vineyard Creek Channel Enhancement Project, from end of Arbor Circle to McClay Road, Project No. 2008-006. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District Zone 1 and City of Novato, CA, June, 28 sheets.

Kamman G.K., Kamman, R.Z., and Beahan, C., 2008, Contract documents including: notice to contractors, proposals, special provisions and contract documents for Vineyard Creek Channel Enhancement Project, from end of Arbor Circle to McClay Road, Novato California. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District Zone 1, June, 144p.

Kamman G.K. and Kamman, R.Z., 2008, Giacomini Wetland Restoration Project, Phase 2 (2008) Construction Drawings. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, May, 33 sheets.

Kamman G.K., Kamman, R.Z., and Beahan, C., 2007, Giacomini Wetland Restoration Project, Phase I (2007) Construction Drawings. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, August, 23 sheets.

Kamman G.K., Kamman, R.Z., and Beahan, C., 2007, Technical Specifications for Giacomini Wetland Restoration Project, Phase I (2007) Construction. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, with contributions from Winzler & Kelly, August, 185p.

Kamman G.K. and Kamman, R.Z., 2008, Technical Specifications for Giacomini Wetland Restoration Project, Phase 2 (2008) Construction. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, May, 243p.

Kamman, G.R., Kamman R.Z., and Beahan, C., 2007, 100% Specifications, Lower Redwood Creek floodplain and salmonid habitat restoration at the Banducci site, Golden Gate National Recreation

Area, Marin County, CA. Prepared for Golden Gate Parks Conservancy and National Park Service, June 8, 46p.

Kamman, R.Z., Kamman G.K., and Beahan, C., 2007, 100% Design Drawings, Lower Redwood Creek Restoration, The Banducci Site, Golden Gate National Recreation Area, Marin County, CA. Prepared for Golden Gate Parks Conservancy and National Park Service, February 28, 7 sheets.

Kamman G.K. and Kamman, R.Z., 2006, Feasibility Study and Construction Drawings for Freshwater Marsh and High Water Wildlife Refugia on the West Pasture of the Giacomini Dairy. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, September.

Kamman, G.R., 2002, Haypress Pond Restoration Grading Plan, Tennessee Valley, Sausalito, CA. Prepared for Golden Gate National Recreation Area, National Park Service, January 10, 15p.

5.0 ACADEMIC APPOINTMENTS

San Francisco State University, 2012 through 2014, Wetland hydrology. SFSU College of Extended Learning, Romberg Tiburon Center, CA, 2-day course, 1.6 CEU.

San Francisco State University, 2011, Introduction to wetland hydrology. Basic Wetland Delineation Training, SFSU College of Extended Learning, Romberg Tiburon Center, CA, March 28-April 1.

University of California, Berkeley Extension, 2001 through 2008, Hydrologic and geomorphic processes in stream restoration. Civil and Environmental Engineering, Certificate Program in California Water Management and Ecosystem Restoration, Berkeley, CA, 2-day course, 1.0 CEU.

San Francisco State University, 2007, Introduction to tidal wetland hydrology. SFSU College of Extended Learning, Romberg Tiburon Center, CA, May 11-12, 1.6 CEU.

City of San Jose, 2005, Hydrologic and geomorphic processes in stream restoration. City of San Jose's Environmental Services Department, Watershed Protection Division, San Jose, CA, January 26.

Miami University Geology Field Station, Dubois, WY, 1989, Instructor, Summer Session, May-July.

Miami University, Oxford, Ohio, 1985-89, Instructor and Research/Teaching Assistant (MS candidate).

Save California Salmon

California Sportfishing Protection Alliance
CSPA
Since 1983

Pacific Coast Federation of Fishermen's Associations
PCFFA
Stewards of the Fisheries

Environmental Water Caucus

california water impact network

Planning and Conservation League

Institute for Fisheries Resources

CRAB BOAT OWNERS ASSOCIATION, Inc.
2907 Jones Street
San Francisco, California 94133-1115
415-885-1180

Since 1971
the Northcoast Environmental Center
www.yournec.org

S.A.F.E.
Alternatives for our Forest Environment

Southern California Watershed Alliance

California Native Plant Society
Sacramento Valley Chapter

EJCW
Water Justice for All

PARC
protect american river canyons

Butte Environmental Council
Protecting Butte County's Land, Air & Water Since 1975

Fly Fishers
Davis, California

Friends of the River
since 1973

Sacramento River Council

California Wilderness Coalition

GoldenGate
Salmon Association

FLY FISHERS INTERNATIONAL
NORTHERN CALIFORNIA COUNCIL

The Bay Institute

Winnemem Wintu Tribe
Middle River People

Coast Action Group

Water Climate Trust CHICO 350 WILPF Earth Democracy

California Water Commission
P.O. Box 942836
Sacramento, CA 94236-0001

March 17, 2019

Subject: Need for Recirculated DEIS/EIR for Proposed Sites Reservoir

Dear Mr. Yun and Members of the California Water Commission;

We write to you under your role as a responsible agency under the California Environmental Quality Act[1] regarding the environmental documentation for the proposed Sites Reservoir Project. While the CWC is not the CEQA lead agency for Sites, you will be required to use the EIR prepared by the Sites Project Authority. In order to ensure timely awarding of construction funds, you have a vested interest to ensure that a legally adequate EIR is prepared.

Attached is a letter we sent to the Sites Project Authority documenting the multiple inadequacies in the Draft EIS/EIR for the project. Most importantly, the project as described to date does not resolve the fundamental issue of what will be the minimum bypass flows for the Sacramento River. This is a key issue that underlies the basic water yield and economic feasibility of this project.

The California Department of Fish and Wildlife has recommended a much higher minimum bypass flow in the Sacramento River than is being proposed by the (13,000 cfs compared to 3,250 cfs at Red Bluff, 4,000 cfs at Hamilton City and 5,000 cfs at Wilkins Slough).[2] The impacts to the Sacramento River fishery have not been adequately described in the DEIS/EIR, nor is there an alternative analyzed in the DEIS/EIR that would provide the flow recommendations by CDFW.

---

[1] See PowerPoint Presentation on CWC's role under CEQA for the WSIP at https://cwc.ca.gov/-/media/CWC-Website/Files/Documents/2015/06_June/June2015_Agenda_Item_11_Attach_2_Powerpoint_King.pdf
It should be noted that slide 12 says that CWC as a responsible agency should provide comments on the public review draft EIR, but according to the Sites Project Authority, the CWC did not provide comments.

[2] See CDFG letter of 1/12/18, page 9 "*CDFW recommends the Project proponents revise the bypass flow requirement to maintain at least 13,000 cfs past all diversion facilities prior to the diversion of water to reduce impacts on out-migrating juvenile salmonids.*" Accessed at https://www.friendsoftheriver.org/wp-content/uploads/2018/09/1-12-2018-CDFW-Sites-Project-Letter.pdf

It is impossible for anybody to know if this project is cost effective and promised environmental public benefits can be delivered until the Sacramento River minimum bypass flow issue is resolved. The Sites Project Authority's recommendation for Sacramento River minimum bypass flows appears to justify a finding of financial feasibility, but how feasible will the project be if CDFW's minimum bypass flows are legally required?

We believe this issue must be fully and adequately analyzed in the DEIS/EIR, prior to any water rights hearing or other permitting process that will rely on the information in the DEIS/EIR.

Based on the inadequacies identified in the attached letter, we encourage you to strongly recommend that the Sites Project Authority prepare a recirculated Draft EIS/EIR.

Sincerely,

Tom Stokely, Director
Save California Salmon
tstokely@att.net

Bill Jennings, Executive Director
California Sportfishing Protection Alliance
deltakeep@me.com

Carolee Krieger, Executive Director
California Water Impact Network
Caroleekrieger7@gmail.com

Conner Everts
Facilitator: Environmental Water Caucus
Executive Director: Southern California Watershed Alliance
connere@gmail.com

Ron Stork
Senior Policy Advocate
Friends of the River
RStork@friendsoftheriver.org

Noah Oppenheim, Executive Director
Pacific Coast Federation of Fishermen's Associations &
Institute for Fisheries Resources
noah@ifrfish.org

Larry Glass, Executive Director
Northcoast Environmental Center
Safe Alternatives for our Forest Environment
Larryglass71@gmail.com

Natalie Carter
Executive Director
Butte Environmental Council
natalie.carter@becnet.org

Dr. Glen Holstein
Chapter Botanist
Sacramento Valley Chapter of the
California Native Plant Society
holstein@cal.net

Gary Estes
Board Member
Protect American River Canyons (PARC)
gary.estes@wdlikenoname.net

Lowell Ashbaugh
Conservation Chair
Fly Fishers of Davis
ashbaugh.lowell@gmail.com

Alan Levine, Director
Coast Action Group
alevine@mcn.org

Rebecca Wu
Volunteer for Friends of the River
rebeccadawnwu@yahoo.com

Tryg Sletteland
Founder and former Executive Director
Sacramento River Council
tbsletteland@gmail.com

Jonas Minton
Senior Water Policy Advisor
Planning and Conservation League
jminton@pcl.org

Colin Bailey, Executive Director & Managing Attorney
The Environmental Justice Coalition for Water
colin@ejcw.org

John McManus
President
Golden Gate Salmon Association
john@goldengatesalmon.org

Mark Rockwell
Vice President for Conservation
Fly Fishers International
Northern California Council
mrockwell1945@gmail.com

Greg Reis, Scientist
The Bay Institute
greg@bayecotarium.org

Caleen Sisk, Chief
Winnemem Wintu Tribe
caleenwintu@gmail.com

Konrad Fisher, Director
Water Climate Trust
k@omrl.org

Mary Kay Benson
Steering Committee Manager
Chico 350
mkbe.sparkles3@gmail.com

Jean Hays, ED Leadership Team
Women's International League for Peace
And Freedom Earth Democracy
Skyhorse3593@sbcglobal.net

Attachments: Coalition Letter to Sites Project Authority
Kamman Hydrology Analysis of Sites DEIS/EIR on Trinity River

cc: California Water Commission Members
Representative Jared Huffman
Karuk Tribe
Hoopa Valley Tribe

Yurok Tribe
Humboldt County Board of Supervisors
Trinity County Board of Supervisors
Eileen Sobeck, Executive Officer SWRCB
Charlton Bonham, Director CDFW

Alicia Forsythe

From: Obegi, Doug <dobegi@nrdc.org>
Sent: Wednesday, September 30, 2020 1:23 PM
To: Alicia Forsythe
Subject: RE: CEQA range of alternatives for Sites Project being considered at Authority BOD meeting tomorrow

Thanks Ali. I think it'd be great to include them in the meeting (both of them were involved in developing the attachment to your email this am).

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, September 30, 2020 1:21 PM
To: Obegi, Doug <dobegi@nrdc.org>
Subject: RE: CEQA range of alternatives for Sites Project being considered at Authority BOD meeting tomorrow

Doug – Rachel Zwillinger asked if it would be okay to add in Gary Bobker and Grey Reis from TBI to the doodle poll and meeting. They were not on the email trail and thus, I haven't sent them the doodle poll. Let me know your preference. I am comfortable either way -- just wanted to check with you first.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Obegi, Doug <dobegi@nrdc.org>
Sent: Wednesday, September 30, 2020 9:27 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>; Ron Stork (RStork@friendsoftheriver.org) <RStork@friendsoftheriver.org>; Zwillinger, Rachel (Mail Contact) <rzwillinger@defenders.org>; Barry Nelson (barry@westernwaterstrategies.com) <barry@westernwaterstrategies.com>; Glen Spain <fish1ifr@aol.com>; jon@baykeeper.org; brandon.dawson@sierraclub.org; John Spranza (john.spranza@hdrinc.com) <john.spranza@hdrinc.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: RE: CEQA range of alternatives for Sites Project being considered at Authority BOD meeting tomorrow

Thanks Ali. I'll fill out the Doodle poll.

Best,
Doug

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, September 30, 2020 8:57 AM
To: Obegi, Doug <dobegi@nrdc.org>; Jerry Brown <jbrown@sitesproject.org>; Ron Stork (RStork@friendsoftheriver.org) <RStork@friendsoftheriver.org>; Zwillinger, Rachel (Mail Contact) <rzwillinger@defenders.org>; Barry Nelson (barry@westernwaterstrategies.com) <barry@westernwaterstrategies.com>; Glen Spain <fish1ifr@aol.com>;

jon@baykeeper.org; brandon.dawson@sierraclub.org; John Spranza (john.spranza@hdrinc.com) <john.spranza@hdrinc.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: RE: CEQA range of alternatives for Sites Project being considered at Authority BOD meeting tomorrow

Doug and all – I'd like to schedule some time to discuss and confirm the operational criteria that you all would like to see modelled. Please complete the doodle poll below so I can get a meeting for us on the calendar.

https://www.doodle.com/poll/cpnk5pqs82d48vga

Also, I believe the attached document is the most recent / up to date that we have in our files on the groups thoughts. I was thinking we can start our discussion with this document and go from there. Please let me know if there is something more recent we should be reviewing.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Alicia Forsythe
Sent: Monday, September 21, 2020 6:32 PM
To: 'Obegi, Doug' <dobegi@nrdc.org>; Jerry Brown <jbrown@sitesproject.org>
Cc: Ron Stork (RStork@friendsoftheriver.org) <RStork@friendsoftheriver.org>; Zwillinger, Rachel (Mail Contact) <rzwillinger@defenders.org>; Barry Nelson (barry@westernwaterstrategies.com) <barry@westernwaterstrategies.com>; Glen Spain <fish1ifr@aol.com>; jon@baykeeper.org; brandon.dawson@sierraclub.org
Subject: RE: CEQA range of alternatives for Sites Project being considered at Authority BOD meeting tomorrow

Doug – Thanks for your email and for watching our agendas / keeping up to date with the project.

I want to assure you that we have not changed our position from my June email. We will have Jacobs evaluate at least one set of operational criteria that are similar to (or the same as) what you have proposed. We will work with you, TBI, and others to confirm these criteria before we model them. This analysis will be in the Revised Draft EIR/EIS. Jacobs is working on a number of revisions to the Sites Calsim model, including modifications to the baseline , which we expect to be completed in the coming weeks. We will reach out to you soon for a meeting in October to discuss where we are on operational criteria along with confirming the criteria that you would like to see modelled.

Once we have the modifications to the Calsim model completed, we will run a series of analyses using the results of Calsim to test the operational criteria and resulting effects to juvenile salmon. These include follow on modeling (that uses the output of the Calsim modeling), such as DSM2 and OBAN, along with spreadsheet analyses based on recent scientific papers – many of which you cite below.

We truly appreciate your input and I will be reaching out in a few weeks to schedule some time to chat in October.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 |
aforsythe@sitesproject.org | www.SitesProject.org

From: Obegi, Doug <dobegi@nrdc.org>
Sent: Wednesday, September 16, 2020 9:28 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>
Cc: Ron Stork (RStork@friendsoftheriver.org) <RStork@friendsoftheriver.org>; Zwillinger, Rachel (Mail Contact) <rzwillinger@defenders.org>; Barry Nelson (barry@westernwaterstrategies.com) <barry@westernwaterstrategies.com>; Glen Spain <fish1ifr@aol.com>; jon@baykeeper.org; brandon.dawson@sierraclub.org
Subject: CEQA range of alternatives for Sites Project being considered at Authority BOD meeting tomorrow

Dear Ali and Jerry,

I hope you're both hanging in there these days, and that you and your families are all safe and sound between fires, hazardous air quality, COVID, and everything else that is making 2020 suck.

I'm writing about the proposal to select a preferred alternative for the Sites Project at tomorrow's meeting of the Authority's Board of Directors (https://3hm5en24txyp2e4cxyxaklbs-wpengine.netdna-ssl.com/wp-content/uploads/2019/11/02-03-EIR_EIS-Selection-of-Preferred-Project-for-Purposes-of-CEQA.pdf). It appears from the memo to the Board of Directors that the CEQA document will only consider 2 alternatives, with identical operational parameters for those alternatives (meaning that there are no operational alternatives being considered). The memo further states that the preferred alternative will be the basis for the application for a biological opinion and a CESA incidental take permit. I strongly urge the Board and staff at the Authority to take a different approach.

First, considering only a single operational scenario would violate CEQA's mandate to consider a reasonable range of alternatives, a point that state agencies have also made previously with respect to the environmental review for this project. So I hope that I'm misunderstanding the memo to the Board in concluding that this is the only operational alternative that is being considered. In addition, that approach is inconsistent with our last email exchange in June, where you stated that:

"We will have Jacobs conduct an analysis of at least one set of operational criteria that are similar to (or the same as) what you have proposed. We will work with you, TBI, and others to confirm these criteria before we model them. This analysis will be in the Revised Draft EIR/EIS. However, based on analyses we completed last summer / fall, we expect these criteria to result in a project that's not affordable and provides very little water to accomplish the project objectives. Thus, we don't anticipate that this will result in an alternative that we would carry forward for detailed analysis in the Revised EIR as we don't anticipate it to result in a feasible project."

I'm unaware of any such discussions to refine one or more operational alternatives since our email exchange in June. Has the Authority decided not to model any such alternatives? In addition, is the Authority not planning to model an alternative that is consistent with the SWRCB's 55% of unimpaired flow proposal from the July 2018 Framework (https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/sed/sac_delta_framework_070618%20.pdf)? In addition to violating CEQA, the failure to include analysis of these or similar alternatives should preclude state agencies from relying on the CEQA document for a water rights proceedings and for CESA permitting.

Second, as we have previously emphasized, the proposed operations being considered would significantly harm juvenile salmon migrating down the Sacramento River in the winter and spring months, as the best available science demonstrates a very strong flow:survival relationship for juvenile fall-run, spring-run, and winter-run Chinook salmon in the upper, middle, and lower Sacramento River and in the Delta (see citations below), and it would harm Longfin Smelt and other species downstream as a result of reducing Delta outflow during these months.

I strongly urge the Board to consider a reasonable range of alternatives that includes more protective operational parameters, including an alternative that is consistent with the SWRCB's 55% of unimpaired flow framework for the Sacramento River and an alternative similar to the operations that we have previously proposed. We remain willing to work with you to refine such an alternative.

Thank you for consideration of our views.

Sincerely,
Doug

Citations:

- Stuart Munch et al 2020. *Science for integrative management of a diadromous fish stock: interdependencies of fisheries, flow and habitat restoration*, Can. J. Fish. Aquat. Sci. 77: 1487–1504 (2020) dx.doi.org/10.1139/cjfas-2020-0075;
- Michel, Cyril 2019. *Decoupling outmigration from marine survival indicates outsized influence of streamflow on cohort success for California's Chinook salmon populations*, Can. J. Fish. Aquat. Sci.76: 1398–1410 (2019) dx.doi.org/10.1139/cjfas-2018-0140;
- Friedman, W. R. et al. 2019. *Modeling composite effects of marine and freshwater processes on migratory species*. Ecosphere 10(7):e02743. 10.1002/ecs2.2743;
- Mark Henderson et al, 2018. *Estimating spatial-temporal differences in Chinook salmon outmigration survival with habitat and predation related covariates*. Can. J. Fish. Aquat. Sci. 76(9): 1549-1561, https://doi.org/10.1139/cjfas-2018-0212;
- Notch, Jeremy et al 2020. *Outmigration survival of wild Chinook salmon smolts through the Sacramento River during historic drought and high water conditions*. Environ Biol Fish, https://doi.org/10.1007/s10641-020-00952-1
- Russell Perry et al 2018. Flow-mediated effects on travel time, routing, and survival of juvenile Chinook salmon in a spatially complex, tidally forced river delta. Can. J. Fish. Aquat. Sci. 75(11): 1886-1901, https://doi.org/10.1139/cjfas-2017-0310.

DOUG OBEGI
*Senior Attorney**
Water Program

NATURAL RESOURCES DEFENSE COUNCIL

111 SUTTER ST., 21ST FLOOR
SAN FRANCISCO, CA 94104
T 415.875.6100
DOBEGI@NRDC.ORG
NRDC.ORG

** Admitted to practice in California*

PRELIMINARY - NOT FOR DISTRIBUTION

Deliveries Table

Deliveries (TAF/year) (above No Project Alternative conditions)[a]	ALT A1 092220 rev03 NRDC1		ALT A1 092220 rev03 Scn B		ALT A1 092220 rev03 PEA	
	Average	Dry and Critical	Average	Dry and Critical	Average	Dry and Critical
Alternative Facilities	1.5-MAF Reservoir Dunnigan Pipeline (outlet only)		1.5-MAF Reservoir Dunnigan Pipeline (outlet only)		1.5-MAF Reservoir Dunnigan Pipeline (outlet only)	
Authority Deliveries in SWP Service Area	**76**	**171**	**84**	**201**	**95**	**234**
SOD Ag	0	0	0	0	0	0
SOD M&I	10	20	4	12	2	12
SOD WTS	65	151	80	188	93	222
Authority Deliveries in CVP Service Area	**17**	**35**	**21**	**43**	**24**	**48**
NOD Ag	17	35	21	43	24	48
Reclamation Deliveries from CVP Operational Flexibility	**-9**	**-6**	**-3**	**2**	**-3**	**-4**
NOD Ag	-3	-3	-3	-2	-4	-4
NOD M&I	-1	0	0	0	0	0
SOD Ag	-5	-4	1	4	1	1
SOD M&I	0	0	0	0	0	0
Sub-Total Supplemental Deliveries for Water Supply	**84**	**199**	**102**	**246**	**115**	**278**
Refuge Water Supply	**12**	**21**	**18**	**32**	**22**	**39**
NOD	3	4	4	6	5	7
SOD	9	18	14	26	17	32
Yolo Bypass Habitat Water Supply	**18**	**5**	**30**	**9**	**36**	**16**
Total Deliveries	**114**	**226**	**150**	**287**	**173**	**333**

Storage Increases (TAF) (above No Project Alternative conditions)[a]	ALT A1 092220 rev03 NRDC1		ALT A1 092220 rev03 Scn B		ALT A1 092220 rev03 Scn B	
	Average	Dry and Critical	Average	Dry and Critical	Average	Dry and Critical
Additional end-of-September storage	**34**	**41**	**60**	**79**	**68**	**91**
Trinity	1	2	1	2	1	2
Shasta	-15	-17	-8	-9	-10	-17
Oroville	47	57	70	93	81	115
Folsom	1	-1	-2	-7	-4	-10

Authority Deliveries in SWP Service Area	66%	76%	56%	70%	55%	70%
Authority Deliveries in CVP Service Area	15%	15%	14%	15%	14%	14%
Reclamation Deliveries from CVP Operational Flexibility	-8%	-3%	-2%	1%	-2%	-1%
Refuge Water Supply	11%	9%	12%	11%	13%	12%
Yolo Bypass Habitat Water Supply	16%	2%	20%	3%	21%	5%
	100%	100%	100%	100%	100%	100%

Portion of total additional end-of-September storage						
Trinity	2%	5%	1%	3%	1%	2%
Shasta	-42%	-40%	-13%	-12%	-15%	-18%
Oroville	137%	137%	116%	118%	120%	127%
Folsom	4%	-3%	-4%	-9%	-6%	-11%
	100%	100%	100%	100%	100%	100%

Notes:

[a] *Values shown are the net change between the Project Alternative and No Project Alternative*

Results are dependent on storage allocations (see storage allocation table)

PRELIMINARY - NOT FOR DISTRIBUTION

Sites Fills Table

Fills (TAF/year)	ALT A1 092220 rev03 NRDC1		ALT A1 092220 rev03 Scn B		ALT A1 092220 rev03 PEA	
	Average	**Dry and Critical**	**Average**	**Dry and Critical**	**Average**	**Dry and Critical**
Alternative Facilities	1.5-MAF Reservoir Dunnigan Pipeline (outlet only)		1.5-MAF Reservoir Dunnigan Pipeline (outlet only)		1.5-MAF Reservoir Dunnigan Pipeline (outlet only)	
Fills to Authority Deliveries in SWP Service Area	94	7	117	35	130	57
Fills to Authority Deliveries in CVP Service Area	22	4	26	8	31	13
Fills to Reclamation Deliveries from CVP Operational Flexibility	0	0	0	0	0	0
Fills to Refuge Water Supply	15	1	22	6	26	11
Fills to Yolo Bypass Habitat Water Supply	21	1	35	7	44	17
Total Fill	**152**	**12**	**200**	**56**	**230**	**99**

Fills to Authority Deliveries in SWP Service Area	62%	55%	59%	62%	57%	58%
Fills to Authority Deliveries in CVP Service Area	15%	31%	13%	13%	13%	13%
Fills to Reclamation Deliveries from CVP Operational Flexibility	0%	0%	0%	0%	0%	0%
Fills to Refuge Water Supply	10%	8%	11%	11%	11%	11%
Fills to Yolo Bypass Habitat Water Supply	14%	6%	18%	13%	19%	17%
	100%	100%	100%	100%	100%	100%

Notes:

Results are dependent on storage allocations (see storage allocation table)

PRELIMINARY - NOT FOR DISTRIBUTION

Sites Releases Table

Releases (TAF/year)	ALT A1 092220 rev03 NRDC1		ALT A1 092220 rev03 Scn B		ALT A1 092220 rev03 PEA	
	Average	Dry and Critical	Average	Dry and Critical	Average	Dry and Critical
Alternative Facilities	1.5-MAF Reservoir Dunnigan Pipeline (outlet only)		1.5-MAF Reservoir Dunnigan Pipeline (outlet only)		1.5-MAF Reservoir Dunnigan Pipeline (outlet only)	
Releases for Authority Deliveries in SWP Service Area	0	0	0	0	0	0
Releases for Authority Deliveries in SWP Service Areas through WTS	79	155	97	193	110	226
Releases for Authority Deliveries in CVP Service Area	17	35	21	43	24	48
Releases for Reclamation Deliveries from CVP Operational Flexibility	0	0	0	1	0	0
Releases for Refuge Water Supply	14	23	20	32	24	40
Releases for Yolo Bypass Habitat Water Supply	21	6	34	11	42	18
Total Releases	**131**	**219**	**172**	**279**	**200**	**331**

Releases for Authority Deliveries in SWP Service Area	0%	0%	0%	0%	0%	0%
Releases for Authority Deliveries in SWP Service Areas through WTS	60%	71%	56%	69%	55%	68%
Releases for Authority Deliveries in CVP Service Area	13%	16%	12%	15%	12%	14%
Releases for Reclamation Deliveries from CVP Operational Flexibility	0%	0%	0%	0%	0%	0%
Releases for Refuge Water Supply	11%	10%	12%	11%	12%	12%
Releases for Yolo Bypass Habitat Water Supply	16%	3%	20%	4%	21%	6%
	100%	100%			100%	100%

Notes:

Results are dependent on storage allocations (see storage allocation table)

PRELIMINARY - NOT FOR DISTRIBUTION

Sites Storage Allocation Table

Storage Volumes (TAF)	ALT A1 092220 rev03 NRDC1	ALT A1 092220 rev03 Scn B	ALT A1 092220 rev03 PEA
Alternative Facilities	1.5-MAF Reservoir Dunnigan Pipeline (outlet only)	1.5-MAF Reservoir Dunnigan Pipeline (outlet only)	1.5-MAF Reservoir Dunnigan Pipeline (outlet only)
Authority Deliveries in SWP Service Area	946	946	946
Authority Deliveries in CVP Service Area	190	190	190
Reclamation Deliveries from CVP Operational Flexibility	0	0	0
Refuge Water Supply	124	124	124
Yolo Bypass Habitat Water Supply	120	120	120
Dead Pool Storage	120	120	120
Total Storage	**1500**	**1500**	**1500**

Authority Deliveries in SWP Service Area	63%	63%	63%
Authority Deliveries in CVP Service Area	13%	13%	13%
Reclamation Deliveries from CVP Operational Flexibility	0%	0%	0%
Refuge Water Supply	8%	8%	8%
Yolo Bypass Habitat Water Supply	8%	8%	8%
Dead Pool Storage	8%	8%	8%

Notes:

Results are dependent on storage allocations

Alicia Forsythe

From: Obegi, Doug <dobegi@nrdc.org>
Sent: Wednesday, October 28, 2020 8:42 AM
To: Alicia Forsythe; Jerry Brown; Ron Stork (RStork@friendsoftheriver.org); Zwillinger, Rachel (Mail Contact); Barry Nelson (barry@westernwaterstrategies.com); Glen Spain; jon@baykeeper.org; brandon.dawson@sierraclub.org; John Spranza (john.spranza@hdrinc.com); Heydinger, Erin; bobker@bay.org; Greg Reis
Subject: RE: Sites - Operational Criteria for Modeling Efforts
Attachments: Sites_Environmental minimums_8.6.18.pdf

Hi Ali,

Sorry for the delay in responding, and thank you for following up. Given your answers about the modeling capabilities w/r/t floodplain inundation and Delta outflow, it appears that the Sites team can model the operational criteria in the attached document. It didn't sound like you had any questions about the Sacramento River bypass flow criteria (Freeport and at points of diversion) in the attachment, which should be pretty straightforward to model. And with respect to floodplain inundation and Delta outflow specifically:

1) Floodplain inundation: Model operations to ensure no changes to the frequency and duration of flood flows into the Yolo Bypass and Sutter Bypass (per our criteria on page 1). We recognize this will be an approximation, which I assume involves some post-processing analysis of the CALSIM results; and,
2) Delta outflow: use the criteria from pages 2 and 3 (including both the minimum Delta outflow requirements on page 3 and the maximum diversion rate as a percentage of NDOI on page 2).

Does that make sense? Please let us know if you have questions. And we appreciate you following up on the other questions as well.

Thanks,
Doug

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, October 20, 2020 12:02 PM
To: Obegi, Doug <dobegi@nrdc.org>; Jerry Brown <jbrown@sitesproject.org>; Ron Stork (RStork@friendsoftheriver.org) <RStork@friendsoftheriver.org>; Zwillinger, Rachel (Mail Contact) <rzwillinger@defenders.org>; Barry Nelson (barry@westernwaterstrategies.com) <barry@westernwaterstrategies.com>; Glen Spain <fish1ifr@aol.com>; jon@baykeeper.org; brandon.dawson@sierraclub.org; John Spranza (john.spranza@hdrinc.com) <john.spranza@hdrinc.com>; Heydinger, Erin <erin.heydinger@hdrinc.com>; bobker@bay.org; Greg Reis <greg@bayecotarium.org>
Subject: RE: Sites - Operational Criteria for Modeling Efforts

All – Thanks for the good discussion on the status of the Sites modeling effort and operational criteria that you would like to see modeled. Below are the responses to the two questions that I had as near-term action items for the Sites team.

1. Is there a way to tie Sites diversion criteria to changes in frequency and duration of flows into the bypass system? What "knobs" do we have to turn with regard to flows into the bypass system in the model? – Yes, but this is an approximation using the Calsim model. Calsim can tell us the months and amounts of flows in the bypasses and we can assess those changes. But as Calsim is a monthly timestep, it will spread these changes over the month.

2. Can Sites diversion be ramped based on Delta outflow? Meaning, can we have a "diversion table" ramping that is tied to Delta outflow? Yes, we can do this with the Sites Calsim model.

We are ready to run your proposed criteria through the Sites Calsim model. Please let us know what you would like to see modeled. If we could have your criteria by October 27, that would be helpful.

Also, I had the additional following action items, that we will continue to follow up on:

1. What is Sites' FERC exemption approach?
2. What would be the changes / effects on temperatures as a result of Sites releases into the Sacramento River and Yolo Bypass?
3. The group would like a better sense of the ecosystem benefits and how those benefits would be realized.
4. Will Sites be running an operational scenario assuming the State Board's proposed 55% unimpaired outflow?
5. Schedule a future meeting focused on terrestrial species impacts and mitigation measures.

We continue to follow up on these items and will circle back on them. Let me know if there are any other action items I missed.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 |
aforsythe@sitesproject.org | www.SitesProject.org

-----Original Appointment-----
From: Alicia Forsythe
Sent: Friday, October 2, 2020 10:57 AM
To: Alicia Forsythe; Obegi, Doug; Jerry Brown; Ron Stork (RStork@friendsoftheriver.org); Zwillinger, Rachel (Mail Contact); Barry Nelson (barry@westernwaterstrategies.com); Glen Spain; jon@baykeeper.org; brandon.dawson@sierraclub.org; John Spranza (john.spranza@hdrinc.com); Heydinger, Erin; bobker@bay.org; Greg Reis
Subject: Sites - Operational Criteria for Modeling Efforts
When: Thursday, October 8, 2020 1:00 PM-2:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Update on 10/8 – Added Agenda

Discuss and confirm the operational criteria that you all would like to see modelled. We can use the attached as a basis for our discussion if that works for the group.

Join Microsoft Teams Meeting

+1 916-538-7066 United States, Sacramento (Toll)

Conference ID: 947 762 130#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

SITES RESERVOIR:
CRITERIA FOR AN ENVIRONMENTALLY RESPONSIBLE PROJECT

- Upper Sacramento River bypass flows: Flows of at least 15,000 cfs past all Sacramento River points of diversion for Sites Reservoir are required prior to the diversion of water into the reservoir during the months of October to June to protect out-migrating juvenile salmonids. (*See* Table A)

- Lower Sacramento River flows: Diversions of water into the reservoir should not occur from October to June unless flows at Freeport are greater than 35,000 cfs. Lower Sacramento River bypass flows in October and June shall be based on real time monitoring for salmonids. (*See* Table A)

- Flows for the San Francisco Bay-Delta Estuary: Per Table B, diversions of water into the reservoir should occur only when sufficient Delta inflows and outflows are available to meet the needs of Delta smelt, longfin smelt, migrating Chinook salmon, and other flow-dependent species.

- Floodplain inundation: Diversions must not reduce the frequency or duration of inundation of the Yolo Bypass and the Sutter Bypass, as floodplain inundation is beneficial for rearing salmon, migratory birds, and other wildlife.

- Overhead powerlines: Any new overhead powerlines associated with the project should be sited along exiting transmission corridors and not run along the Delevan National Wildlife Refuge. The power lines should also conform to current Avian Power Line Interaction Committee guidelines.

- Refuge water supplies: Water supply availability for federal, state, and private wildlife refuges must not be negatively affected, and a detailed description of conveyance methods should be provided for any publicly funded Level 4 refuges water supplies.

- Mitigation for construction impacts: Detailed plans must be developed showing how all temporary and permanent impacts of the project on golden eagles, giant garter snakes, vernal pools, and other species and habitats will be mitigated according to law, including appropriate assurances and performance standards.

- Releases of water from Sites Reservoir to the Sacramento River: Additional analysis of the water quality impacts of reservoir releases is necessary, given concerns regarding water temperature, algal blooms, and other water quality parameters.

Table A: Sites Reservoir bypass flows triggered by Sacramento River fish and wildlife protections

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Notes
Sacramento River at Freeport	real time	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	real time				Based on NGO proposed WaterFix minimum bypass flow of 35,000 cfs at Freeport Nov-May. The 35,000 cfs bypass flow is also in effect in Oct and Jun if real time observations show salmon are present.
Sacramento River at all Points of Diversion for	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs				Minimum bypass flow. Based on CDFW 2016 recommendation.
Max diversion rate	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%				When Net Delta Outflow Index (NDOI) is above minimum flows identified in Table A and Table B but below 60,000 cfs, diversions to Sites limited to a maximum of 2% of the river flow. When NDOI exceeds 60,000 cfs, diversions to Sites limited to 5% of Sacramento River flow.

Table B: Sites Reservoir bypass flows triggered by downstream water quality protections

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Notes
Delta Outflow				42,800 cfs		44,500 cfs			42,800 cfs				Bypass flow, based on longfin smelt flow need but will benefit salmon and other species as well (SWRCB 2017)
	11,400 cfs in W and AN years, 7,400 cfs all other yr types	11,400 cfs in W and AN years, 7,400 cfs all other yr types								7,100 cfs	7,100 cfs	11,400 cfs in W and AN years, 7,400 cfs all other yr types	Bypass flow, consistent with proposed NGO terms and conditions for California Water Fix regarding Delta Smelt
X2	74 km (W) or 81 km (AN)	No diversions in AN or W years	No diversions of X2-related releases in AN or W years									74 km (W) or 81 km (AN)	No diversions when diversions would result in noncompliance with current Delta smelt RPA requirements to maintain Fall X2 position in Sept-Dec period following a W or AN year
OMR, E:I, etc.	Water supply releases, water transfers, and refuge releases for SOD delivery are subject to all water quality and endangered species protections in the Delta.												

Alicia Forsythe

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 12:13 PM
To: Alicia Forsythe
Subject: RE: Financial Analysis for NRDC Criteria

Haha it's been a crazy week!

I looked back at my notes and CH didn't include from NRDC the X2 or delta outflow requirements included in the letter. That said, I think Rob said they took the criteria they thought would be fairly easy to incorporate in the model. So we could take those numbers and run them through the financial model with the understanding that incorporating those criteria would only add to the cost per acre foot. It would give us a sense without having CH add a lot more to the model. What do you think?

Erin Heydinger PE, PMP
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Friday, October 30, 2020 11:49 AM
To: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: RE: Financial Analysis for NRDC Criteria

You're right. Thank you for always having things under control! I honestly have been so busy that I hadn't read Doug's email. But now that I read it, you are totally correct.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 |
aforsythe@sitesproject.org | www.SitesProject.org

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 11:44 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: RE: Financial Analysis for NRDC Criteria

Hi Ali,

Maybe I am mixed up on this… the way I read Doug's email was that they were not going to add or adjust any criteria beyond the 2018 letter. That letter is what we sent to CH when we asked them to do the NRDC analysis. Were you thinking we would add more of the detailed criteria and re-run before we met again with NRDC? Sorry if I jumped the gun on this or misunderstood what was needed!

Erin

Erin Heydinger PE, PMP
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Friday, October 30, 2020 11:03 AM
To: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: RE: Financial Analysis for NRDC Criteria

Hey Erin – before we do this, were there any major changes in the info that Doug sent on Wednesday? Do we need to re-run Calsim with what Doug sent on Wednesday? I just want to make sure that if we run the financial model, we run it on what Doug asked us to as this was our commitment to NRDC.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 9:32 AM
To: Leaf, Rob/SAC <Rob.Leaf@jacobs.com>; Micko, Steve/SAC <Steve.Micko@jacobs.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Financial Analysis for NRDC Criteria

Hi Rob and Steve,

We discussed having MDA provide a $/acre foot cost with the NRDC diversion criteria. I believe all Brian needs to do this analysis is the LTA releases and the project capital cost (which I have from value planning). Can you send over the number you were showing yesterday for the long term average?

Thanks!
Erin

Erin Heydinger, PE, PMP
Asst. Project Manager
Water/Wastewater

HDR

2379 Gateway Oaks Dr, #200
Sacramento, CA 95833
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

Alicia Forsythe

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 2:38 PM
To: Alicia Forsythe
Subject: FW: Cost per Acre-Foot under NRDC Criteria

Hi Ali,

See below from Brian. Note that this assumes 20 TAF for the State, because Brian assumed that the reduction in releases would also equate to reduction in water available for the State. He said he could also run the analysis keeping the State at 40 TAF, but thought it might get a bit confusing when comparing to other scenarios. I am thinking we would have to keep the State participation at 40 TAF to ensure we were providing adequate benefits to the State, but I get where he's coming from.

Do you think we should have him run this at 40 TAF State participation as well?

Erin

PS – good to know this is a super quick analysis for him! Took him ~30 minutes.

Erin Heydinger PE, PMP
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

From: Brian Grubbs <grubbs@montaguederose.com>
Sent: Friday, October 30, 2020 2:14 PM
To: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Cc: JP Robinette <JRobinette@brwncald.com>; Doug Montague <montague@montaguederose.com>
Subject: RE: Cost per Acre-Foot under NRDC Criteria

Erin,
Since the cost hasn't changed and the funding hasn't changed the breakout by state and local should be the same. So for 131TAF, 109.5 TAF for participants, and 21.5 TAF for the state. I provided the comparison with the last VP7 case so you can verify I'm providing the right value. This is all-in total cost (debt service + O&M&R – revenue)

VP 7: $3.037B, 1,000cfs, 1.5 MAF			
release amount	243 TAF	131 TAF	difference
w/o WIFIA			
$/AF (2020$)	661	1,185	524
with WIFIA			
$/AF (2020$)	611	1,093	482

Does this answer the question?

Brian Grubbs | Managing Director
Montague DeRose and Associates
916-712-1747

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 1:47 PM
To: Brian Grubbs <grubbs@montaguederose.com>
Cc: JP Robinette <JRobinette@brwncald.com>
Subject: RE: Cost per Acre-Foot under NRDC Criteria

Hi Brian,

Yes, this would be VP7 we're looking at. And yes again, 131 TAF/year total for both. Do you need the breakdown by state/local participant?

Erin

Erin Heydinger PE, PMP
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

From: Brian Grubbs <grubbs@montaguederose.com>
Sent: Friday, October 30, 2020 1:45 PM
To: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Cc: JP Robinette <JRobinette@brwncald.com>
Subject: RE: Cost per Acre-Foot under NRDC Criteria

CAUTION: [EXTERNAL] This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Erin,
I didn't rack the 1,000 cfs criteria, is that VP7 which was a 1.5MAF reservoir costing $3.037B.
And is that 131 TAF/year total release for the state and participants?

Brian Grubbs | Managing Director
Montague DeRose and Associates
916-712-1747

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 1:26 PM
To: grubbs@montaguederose.com
Cc: JP Robinette (JRobinette@BrwnCald.com) <JRobinette@BrwnCald.com>
Subject: Cost per Acre-Foot under NRDC Criteria

Hi Brian,

It was nice to see you today at the CWC meeting! Hope your fall is going well. I am working with the modeling team on assessing some modeling criteria we were sent by the NRDC. I am hoping you can do a quick run with the Value Planning financial spreadsheet to give us a sense of the cost per acre-foot for water based on the NRDC criteria. This would be using the cost estimate for the 1.5 MAF reservoir with 1,000 cfs conveyance (~3.037B project). The long-term average deliveries under the requested criteria are 131 TAF/year.

I'm thinking this is a pretty quick analysis for you, but let me know if not, or if you need any more information from me.

Thanks!
Erin

Erin Heydinger, PE, PMP
Asst. Project Manager
Water/Wastewater

HDR
2379 Gateway Oaks Dr, #200
Sacramento, CA 95833
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

Alicia Forsythe

From: Thayer, Reed/SAC <Reed.Thayer@jacobs.com>
Sent: Monday, November 2, 2020 5:25 PM
To: Heydinger, Erin; Leaf, Rob/SAC; Micko, Steve/SAC
Cc: Alicia Forsythe
Subject: RE: Financial Analysis for NRDC Criteria

Erin,
Under the NRDC1 scenario, the release from Sites would be, on average, 14 TAF for refuge water supply and 21 TAF for Yolo Bypass habitat.
-Reed

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Monday, November 2, 2020 1:10 PM
To: Leaf, Rob/SAC <Rob.Leaf@jacobs.com>; Micko, Steve/SAC <Steve.Micko@jacobs.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>; Thayer, Reed/SAC <Reed.Thayer@jacobs.com>
Subject: [EXTERNAL] RE: Financial Analysis for NRDC Criteria

Thanks, Rob. Can you let me know how of that water would go to the State for ecosystem benefits under this scenario?

Erin

Erin Heydinger PE, PMP
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

From: Leaf, Rob/SAC <Rob.Leaf@jacobs.com>
Sent: Friday, October 30, 2020 12:01 PM
To: Heydinger, Erin <Erin.Heydinger@hdrinc.com>; Micko, Steve/SAC <Steve.Micko@jacobs.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>; Thayer, Reed/SAC <Reed.Thayer@jacobs.com>
Subject: RE: Financial Analysis for NRDC Criteria

Erin,

The long term average Sites releases from the run with the NRDC criteria (scenario A1 NRDC1) is 131 TAF/year. The facilities assumed are consistent with VP7. This value is based on the September 22nd model that we have been using for current discussions.

Rob

From: Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Sent: Friday, October 30, 2020 9:32 AM
To: Leaf, Rob/SAC <Rob.Leaf@jacobs.com>; Micko, Steve/SAC <Steve.Micko@jacobs.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: [EXTERNAL] Financial Analysis for NRDC Criteria

Hi Rob and Steve,

We discussed having MDA provide a $/acre foot cost with the NRDC diversion criteria. I believe all Brian needs to do this analysis is the LTA releases and the project capital cost (which I have from value planning). Can you send over the number you were showing yesterday for the long term average?

Thanks!
Erin

Erin Heydinger, PE, PMP
Asst. Project Manager
Water/Wastewater

HDR
2379 Gateway Oaks Dr, #200
Sacramento, CA 95833
D 916.679.8863 **M** 651.307.9758

hdrinc.com/follow-us

NOTICE - This communication may contain confidential and privileged information that is for the sole use of the intended recipient. Any viewing, copying or distribution of, or reliance on this message by unintended recipients is strictly prohibited. If you have received this message in error, please notify us immediately by replying to the message and deleting it from your computer.

Alicia Forsythe

Subject: Sites - 2021 Water Estimate
Location: Microsoft Teams Meeting

Start: Fri 5/28/2021 1:00 PM
End: Fri 5/28/2021 2:30 PM

Recurrence: (none)

Meeting Status: Meeting organizer

Organizer: Alicia Forsythe
Required Attendees Alicia Forsythe; dobegi@nrdc.org; Ron Stork; Greg Reis; brandon.dawson@sierraclub.org; Chris Shutes; jon@baykeeper.org; bobker@bay.org; bobker@sbcglobal.net; barry@westernwaterstrategies.com; john@goldengatesalmon.org; rzwillinger@defenders.org; Jerry Brown; Heydinger, Erin; Leaf, Rob/SAC; Steve Micko (Steve.Micko@jacobs.com)
Optional Attendees: Deirdre Des Jardins

Based on the doodle poll, this date works for the majority of the group.

Agenda to follow.

Ali

____

Microsoft Teams meeting

Join on your computer or mobile app
Click here to join the meeting

Or call in (audio only)
+1 916-538-7066,,339027022# United States, Sacramento
Phone Conference ID: 339 027 022#
Find a local number | Reset PIN

Learn More | Meeting options

____

North American Journal of Fisheries Management

ISSN: 0275-5947 print / 1548-8675 online
DOI: 10.1002/nafm.10748

ARTICLE

Factors Affecting Spatiotemporal Variation in Survival of Endangered Winter-Run Chinook Salmon Out-migrating from the Sacramento River

Jason L. Hassrick*
ICF, 201 Mission Street, Suite 1500, San Francisco, California 94105, USA

Arnold J. Ammann
National Marine Fisheries Service, Southwest Fisheries Science Center, 110 McAllister Way, Santa Cruz, California 95060, USA

Russell W. Perry
U.S. Geological Survey, Western Fisheries Research Center, 5501A Cook-Underwood Road, Cook, Washington 98605, USA

Sara N. John and Miles E. Daniels
National Marine Fisheries Service, Southwest Fisheries Science Center, 110 McAllister Way, Santa Cruz, California 95060, USA; and Institute of Marine Sciences, University of California, Santa Cruz, 1156 High Street, Santa Cruz, California 95060, USA

Abstract
Among four extant and declining runs of Chinook Salmon *Oncorhynchus tshawytscha* in California's Central Valley, none has declined as precipitously as the Sacramento River winter run. Migratory winter-run Chinook Salmon employ a life history strategy to reside and feed in stopover habitats on their way from freshwaters to the ocean. Migratory winter run, on their way from freshwaters to the ocean, employ a life history strategy to reside and feed in stopover habitats that have been affected by anthropogenic disturbance. Using acoustic telemetry, we examined conditions that influenced reach-specific movement and survival of out-migrating juveniles during a prolonged, multi-year drought from 2013 to 2016, followed by one of the wettest years on record (2017). We modeled how time-varying individual riverine covariates and reach-specific habitat features influenced smolt survival. Model selection favored a model with mean annual flow, intra-annual deviations from the mean flow at the reach scale, reach-specific channel characteristics, and travel time. Mean annual flow had the strongest positive effect on survival. A negative interaction between mean annual flow and intra-annual reach flow indicated that within-year deviations at the reach scale from annual mean flow had larger effects on survival in low-flow years. These factors resulted in higher survival during years with pulse flows or high flows. Changes in movement behavior in response to small-scale changes in velocity were negatively associated with survival. Covariates of revetment and wooded bank habitat were positively associated with survival, but the effect of these fixed habitat features changed depending on whether they were situated in the upper or lower part of the river. Fish exhibited density-dependent stopover behavior, with slowed downstream migration in the upper river in the wet years and extending to the lower river in the most critically dry year. This paper contributes two key findings for natural resource managers interested in flow management and targeted habitat restoration. The first is new insight into how the magnitude of pulse flows in dry and wet years affects survival of winter-run fish. The second is that density dependence influences where stopover habitat is used. Despite this, we identified an area of the river where fish consistently exhibited stopover behavior in all years.

*Corresponding author: jason.hassrick@icf.com
Received August 3, 2021; accepted January 19, 2022

Migration is a fundamentally important ecological process for animals that reproduce and forage in different places. Environmental decision making is challenging in application to migrating species because management approaches must span a vast range of distant and distinct habitats (Runge et al. 2014). Stopover behavior is an important component of migration for animals that must refuel along the migration path before continuing toward their ultimate destination. Studies of birds have found that migrants will select stopover habitats that allow refueling with maximum efficiency to remain on schedule (Alerstam and Lindström 1992). Loss of even a small amount of stopover habitat can have disproportionately large impacts on migratory populations (Iwamura et al. 2014). Effective management of migratory species therefore depends on accurate characterization of habitat use.

In diadromous fishes, migration can be long and complex (Thorstad et al. 2012), but little is known about how stopover habitats vary in quality and how they are used. The Chinook Salmon *Oncorhynchus tshawytscha* is a suitable species in which to examine this behavior because the juveniles migrate through entire watersheds from inland freshwater streams where they are born to productive coastal estuaries (Moore et al. 2016). Accordingly, rivers function as a migratory corridor during the smolt migration phase, which is considered one of the most vulnerable periods in their anadromous life history (Quinn 2005). Alternatively, juvenile salmon may stop over during transit to capitalize on foraging opportunities, seek refuge from predators, or simply rest. Quantifying how juvenile salmon allocate their time across the riverscape is foundational to understanding the relative importance of different riverine habitats (Thorpe 1994; Moore et al. 2016).

California's Central Valley represents the southern extent of the range for Chinook Salmon, where they are confronted with a number of stressors (Fisher 1994; Yoshiyama et al. 1998). Mild winters with a receding snowpack and dry summers frequently result in a hydrologic system where water availability and demand are mismatched (Berg and Hall 2017). Dams on the major rivers block access to historical habitat, and water storage and managed releases to meet human demands throughout the year result in a flattened hydrograph relative to natural flows (Kondolf and Batalla 2005). Muted peak flows in winter and increased summer flows can mask cues that salmon use to initiate migration (Bunn and Arthington 2002). Finally, climate change projections of rising temperatures in the Sacramento River (Cloern et al. 2011) show an increased likelihood and duration of drought conditions, which have been occurring in California with increasing frequency over the past two decades (Diffenbaugh et al. 2015).

All four populations of extant Chinook Salmon races in California's Central Valley have declined over the past decades and have experienced precipitous declines since the onset of the latest megadrought in the early 2000s (Johnson and Lindley 2016), which was the second-driest 20-year period since 800 CE (Williams et al. 2020). Sacramento River winter-run Chinook Salmon (hereafter, "winter run") are the most critically endangered of the four Chinook Salmon runs in the Central Valley. The spawning population crashed from 87,000 in the late 1960s to fewer than 200 in the early 1990s (Fisher 1994) and remains at risk of extinction (Lindley et al. 2009; Poytress et al. 2014).

Historically, the winter run adapted to California's dry and variable climate by holding in the coldest upper reaches of headwater tributaries of the Sacramento River during summer months, when temperatures in the Central Valley were unsuitable for spawning and rearing (Yoshiyama et al. 1998). Fry reared in thermal refuges of these tributaries throughout summer (5–10 months) and migrated as smolts during the first freshets of the following autumn (Williams 2006). For the past 75 years, access to historic spawning tributaries has been eliminated by construction of Shasta and Keswick dams, forcing three populations to mix and spawn as one in the main stem of the Sacramento River downstream of Keswick Dam (Williams 2006). In the post-dam era, otolith geochemistry provides some evidence that winter-run fish continue to rear in nonnatal tributaries extending as far downstream as the San Francisco estuary (Phillis et al. 2018).

Hatchery releases of juvenile winter-run "pre-smolts" into the river are timed to maximize survival and occur during storm events when high instream flows can facilitate rapid emigration. However, the mechanism for how survival per unit time is related to flows is not well understood. On one hand, high flows could move fish rapidly through hazardous habitat. Alternatively, if fish move in response to density-dependent habitat availability, high flows could reduce pressure to move by creating more stopover habitat. Furthermore, it is unknown whether flows affect survival the same way across all reaches. Understanding which mechanisms most influence survival and identifying the reaches in which juvenile salmon experience particularly high or low mortality can therefore help managers find ways to focus on specific, targeted actions to improve survival.

Without this information, the National Marine Fisheries Service has had to rely on out-migration information from larger, yearling hatchery late-fall-run fish as surrogates to fill data gaps in their winter-run recovery plans (Johnson and Lindley 2016; Johnson et al. 2017). However, a growing body of scientific literature cautions against inferring too much from surrogates because they often do not respond in the same way as the targeted taxa to similar environmental conditions (Caro and O'Doherty 1999; Andelman and Fagan 2000). Even within a Chinook

Salmon run, the responses of hatchery and wild fish to environmental conditions may differ, resulting in differences in mortality during out-migration (Buchanan et al. 2010).

Nevertheless, research using acoustic telemetry primarily on late-fall Chinook Salmon has yielded some important insights into some of the immediate challenges confronted by migrating salmon smolts in general, such as disorienting structures with magnetic fields that influence seaward orientation (Klimley et al. 2017), predation dynamics (Sabal et al. 2016, 2021), entrainment into the south Sacramento–San Joaquin Delta (hereafter, "Delta"; Perry et al. 2015), and loss of habitat and limited food resources (Donaldson et al. 2014). This study builds upon earlier work on flow-mediated survival relationships that are gaining prominence in the field. Flow-mediated survival during the out-migration phase of the life cycle has been shown to have a greater effect on smolt-to-adult returns than marine survival (Michel 2019). The magnitude of bidirectional, tidally influenced flows has also been recognized as an important determinant of migration routing and survival in the Delta (Perry et al. 2018; Singer et al. 2020), and intra- and interannual reach flow has a greater impact on late-fall-run survival than other riverine and predation-related covariates (Henderson et al. 2019).

This study was designed to evaluate the effects of flow on winter-run survival at multiple scales and in the presence of other habitat covariates by directly evaluating the survival of hatchery-origin winter-run out-migrants using the Juvenile Salmon Acoustic Telemetry System (JSATS). Due to their scarcity, it was not feasible to obtain natural-origin winter-run fish (i.e., offspring of adults spawned in the river); therefore, extrapolation of our findings to natural-origin fish should be considered with caution (Buchanan et al. 2010). Furthermore, because our study used smolt-sized fish released in the upper river, our understanding of movement rates will be skewed to fish that would have reared in natal habitat and then initiated their smolt out-migration rather than rearing downstream. Evidence of downstream rearing is therefore likely to be conservative.

Within this framework, we developed a suite of mark–recapture models following the approach developed for the late-fall run by Henderson et al. (2019). We examined how individual features of the fish themselves (i.e., fish size); temporal, reach-constant riparian habitat features; and spatial, time-varying hydrologic conditions affected survival of out-migrating, hatchery-origin, winter-run juveniles. The study was carried out during a 5-year period under extremely variable climate conditions: a prolonged, multi-year drought (2013–2016) followed by one of the wettest years on record (2017). Although only one wet year was represented in our study, it allowed us to contrast movement behavior and survival outside of the drought conditions that characterized all other years in this study. To quantify relationships between covariates and survival, we used mark–recapture models and information-theoretic model selection criteria to rank alternative models. Our goals were to (1) examine spatial and temporal patterns in out-migration movement and survival in the river and (2) identify which combination of environmental covariates had the greatest influence on survival.

METHODS

Study site.— The Sacramento River is the largest river in California, flowing south from Mount Shasta for 410 km before reaching the Delta. Mean daily discharge from the Sacramento River in 1955–2019 was 656 m^3/s (California Department of Water Resources, Dayflow database), draining about 68,635 km^2 of the Central Valley. Keswick Dam (river kilometer [rkm] 557 from the Golden Gate Bridge [rkm 0]) is the upper limit to anadromy on the Sacramento River. For this study, we focused on movement and survival in the Sacramento River, ending 387 rkm downstream at the city of Sacramento, prior to entering the branching Delta and tidal estuary (Figure 1).

Acoustic-tagged fish.— The acoustic tags used with the JSATS in this study were manufactured by Advanced Telemetry Systems (ATS, Isanti, Minnesota). The model used in 2013 weighed 430 mg, with dimensions of $11.9 \times 5.3 \times 3.8$ mm and a pulse rate interval (PRI) of 7 s, while the model used in 2014–2017 weighed 310 mg, with dimensions of $10.8 \times 5.3 \times 3.0$ mm and a PRI of 10 s. Each year, 5% of tags were randomly sampled and used to verify tag life, which ranged from 43 to 90 d, with an average of 70 d. This satisfied the assumption of closure in the mark–recapture models because the longest duration travel times occurred early in the upper to middle river and did not exceed this value over the course of migrating through the study area.

At Livingston Stone National Fish Hatchery (U.S. Fish and Wildlife Service, Shasta Lake, California), fish that were selected for acoustic tagging were taken from tanks that contained the largest fish (one to eight tanks depending on the year) to keep individual tag burden below 5.9% (Brown et al. 2010). Prior to tag implantation, each fish was anesthetized to stage IV (i.e., fish were observed to have lost equilibrium and exhibited minimal response to touch; average time to stage IV was 141 s). Anesthetized fish were weighed to the nearest 0.1 g, and FL was measured to the nearest millimeter. Fish were placed ventral side up on a V-shaped, foam surgery cradle. Anesthesia was maintained during surgery with dilute anesthetic solution pumped through a small plastic tube leading into the mouth. An incision about 7 mm long was made between

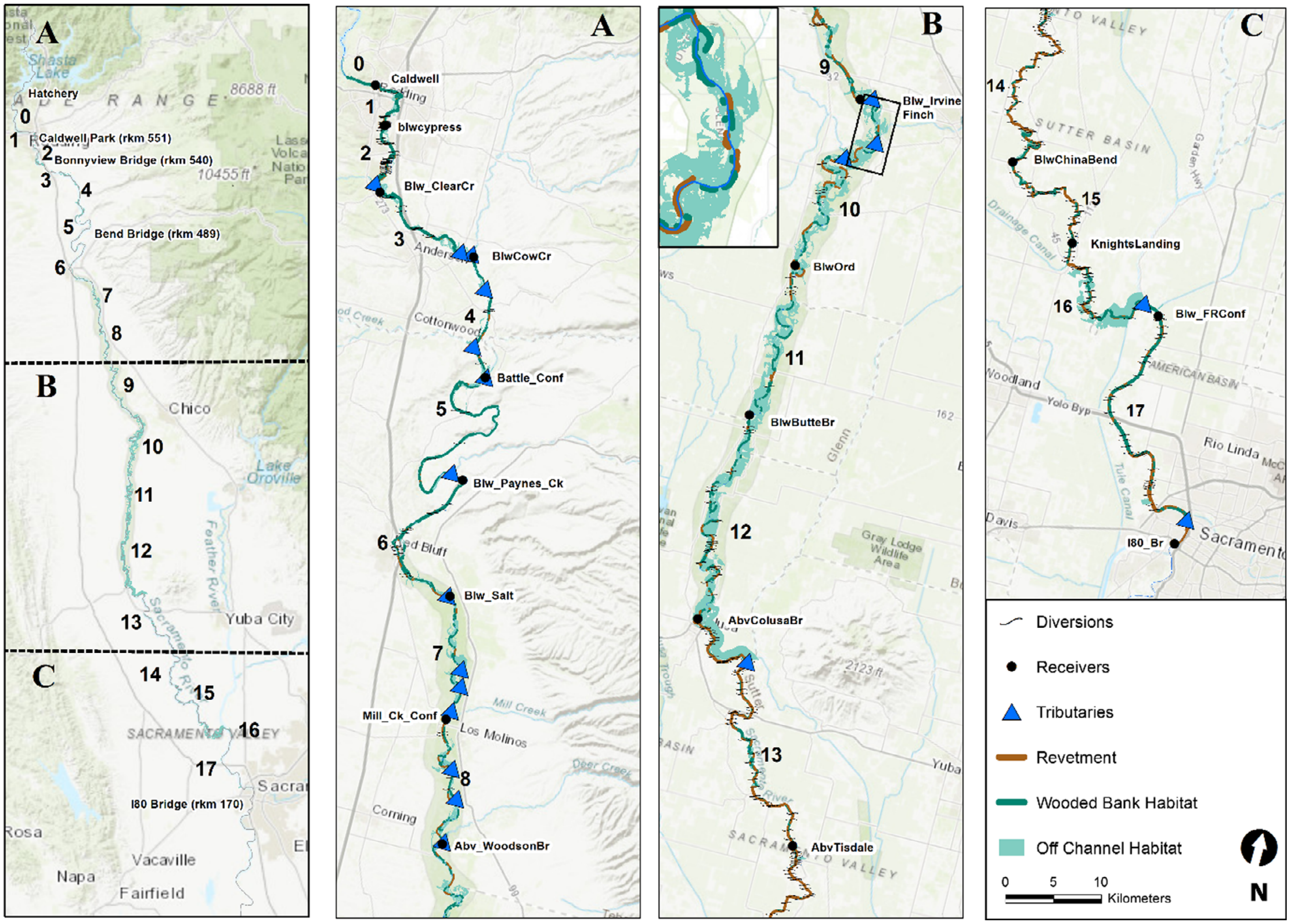


FIGURE 1. Extent of the study area from Redding to Sacramento (left panel). River reaches are numbered between acoustic receiver sites. Time-constant habitat features are mapped over the study area for the (**A**) upper, (**B**) middle, and (**C**) lower sections of the river. The inset map magnifies wooded bank habitat, revetment, and off-channel habitat that was connected within 1 km of the main-stem Sacramento River in the wet year. World topographic base map source: Esri, DeLorme, TomTom, Intermap, GeoTechnologies, General Bathymetric Chart of the Oceans, U.S. Geological Survey, Food and Agriculture Organization of the United Nations, National Park Service, Natural Resources Canada, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, Ministry of Economy, Trade and Industry (Japan), Esri China (Hong Kong), swisstopo, MapmyIndia, and the GIS User Community.

the pelvic and pectoral fins approximately 3 mm off the ventral midline using a 3-mm scalpel (Sharpoint 15° stab knife). A disinfected acoustic tag was inserted battery first into the coelom through the incision, and the incision was closed with one or two sutures of absorbable monofilament (6/0 Monoswift). Surgery time averaged 142 s. Fish were observed to resume normal swimming behavior after an average of 236 s. Mean tag burden (tag weight expressed as a percentage of fish weight) by year ranged from 3.2% to 4.3%.

Following surgery, tagged fish were returned to tanks and held for 1–3 d until the hatchery production fish were loaded into transport trucks. Acoustic-tagged fish were transferred into portable PVC/mesh holding pens and placed within the tank of a transport truck. Transport time from the hatchery to release into the Sacramento River at Caldwell Park (Redding) was approximately 45 min; in 2016, fish were released at Bonnyview Bridge (Redding), and transport time for those fish was approximately 60 min. Acoustic-tagged fish were released simultaneously with the other hatchery-origin fish, which were released after sunset. In 2015, when hatchery fish were released over three consecutive days, acoustic-tagged fish were released on the first and third days. The number of acoustic-tagged individuals and the number of hatchery fish released varied substantially among the 5 years of this study; in particular, hatchery releases were much higher in 2014 and 2015 to compensate for anticipated severe losses of naturally produced fish due to drought, with elevated river temperatures and associated critically dry conditions (Table 1).

Acoustic receivers.— As part of the California Fish Tracking Consortium, we tracked fish by using an array of acoustic receivers beginning 3 km below the release location in Redding; extending down the Sacramento River, Delta, and San Francisco Bay; and ending at a dual line of receivers at the Golden Gate Bridge. However, for this study we were interested in examining riverine survival using outputs from the River Assessment for Forecasting Temperature (RAFT) model, which terminates at the tidal Delta, so we restricted this analysis to only receiver locations in the Sacramento River, ending at the city of Sacramento, to estimate survival and movement over 379 km (Figure 1). Receivers positioned downstream in the Delta to the point of ocean entry at the Golden Gate Bridge were therefore pooled into a single site and used to improve estimates of detection probability and survival for all reaches upstream of the final line.

Three different types of JSATS receivers were used in this study: ATS Model SR3000; Lotek Wireless (Newmarket, Ontario, Canada) Model WHS4000; and Teknologic Engineering (Edmonds, Washington) Model LER. Detection range varied from 50 to 300 m depending on river conditions (A. J. Ammann, unpublished data), with an 85% probability of recording at least four valid transmissions from a distance of 135 m (Ammann 2020). We deployed 40 receivers at 18 locations demarcating 17 river reaches (Figure 1). At most of the receiver locations, two receivers were deployed across the river to improve cross-sectional detection coverage. Receivers were held in position with a bottom anchor that was either attached to a shore cable or suspended from a bridge structure.

Postprocessing.— All receiver files contain some amount of invalid or false positive detections. These must be distinguished from true detections and removed to prevent biased interpretation of fish movement and survival (Beeman and Perry 2012). Therefore, each raw receiver file was processed using a set of algorithms to remove false detections (Deng et al. 2017) and to add location information and a unique fish identifier. The filtering algorithm was customized for each of the three receiver models. Briefly, the filtering algorithm used criteria that included the following constraints: (1) the detection code had to match that of a released fish; (2) detection time had to occur after the release time and before the tag was expected to expire; (3) detections that occurred less than 0.3 s after the previous detection (multipath) were removed; and (4) detections had to have occurred within a time window and within the tag's PRI that was specified depending on receiver make. Lotek receivers required a minimum of four detections within 16.6 times the PRI, and the observed PRIs among these detections had to be within 20% of the nominal PRI. Additionally, the SD of these PRIs had to be less than 0.025. Teknologic receivers required at least two detections within four times the PRI, the observed PRI had to be within 10% of the nominal PRI, and the difference in frequency of the two detections had to be less than 55 kHz. The ATS receivers required at least two detections within four times the PRI, the observed PRI had to be within 10% of the nominal PRI, frequencies of the two detections had to be between 416.30 and 418.75 kHz, and the difference in frequency of the two detections had to be less than 0.505 kHz. Separate receiver files were then compiled into a single table. Plots of the time of detection versus rkm were created for each fish and visually inspected for detections that were not spatially and temporally congruent with the remaining detections. We considered any upstream movements as those of predators having ingested a tagged fish. Where predation was inferred, we ended the fish's detection history at the furthest downstream detection.

Mark–recapture analysis.— We used a Cormack–Jolly–Seber survival model (Cormack 1964; Jolly 1965; Seber 1965) to analyze capture histories and estimate the effects of covariates on survival (ϕ) and detection (p). The

TABLE 1. Number and size (mean ± SD) of acoustic-tagged winter-run Chinook Salmon juveniles released each year. Fish were reared at Livingston Stone National Fish Hatchery and released at Caldwell Park (Redding, California; rkm 551) except in 2016, when the release location was Bonnyview Bridge (Redding; rkm 540). Tag burden was calculated as 100 × (tag weight/fish weight). Flow at Bend Bridge was calculated from the date of release to the date on which the last fish was detected at Tower Bridge in Sacramento.

Release date	Number of fish acoustic tagged	Weight (g)	FL (mm)	Tag burden (%; mean, range)	Hatchery winter-run fish released	Flow (m^3/s) at Bend Bridge[a] (mean, range)
Feb 7, 2013	148	10.3 ± 1.7	98 ± 5.0	4.3 (2.5–5.4)	166,967	168 (127–289)
Feb 14, 2014	358	9.4 ± 2.4	95 ± 7.7	3.9 (2.0–5.8)	190,905	187 (108–790)
Feb 4 and 6, 2015	249; 318	10.5 ± 2.0	100 ± 6.1	3.2 (2.0–5.9)	590,623	197 (105–1,453)
Feb 17 and 18, 2016	285; 285	9.3 ± 1.6	96 ± 5.1	3.6 (2.3–5.3)	415,865	432 (151–1,603)
Feb 2, 2017	569	9.1 ± 2.4	93 ± 7.5	3.7 (1.7–5.7)	141,388	1,315 (385–2,832)

[a]U.S. Geological Survey/U.S. Bureau of Reclamation (Bend Bridge hydrologic station [40.28849°, –122.186661°; rkm 489.4]; https://dashboard.waterdata.usgs.gov/api/gwis/2.0/service/site?agencyCode=USGS&siteNumber=11377100&open=15630).

Cormack–Jolly–Seber model was adapted from its original intended function to estimate survival over time into a spatial form of the model that could be used for animals that migrate unidirectionally (Burham et al. 1987) and could be “recaptured” in the form of acoustic detections along the migratory corridor. River reaches were bounded by receivers positioned at approximately 7–38-km intervals along the Sacramento River to the beginning of the Delta at the I-80/I-50 Bridge. In three locations where receiver positions were adjusted slightly among years (Butte City, Knights Landing, and Tower Bridge), the receivers were moved 6, 2, and 2 rkm from their original locations, respectively. For this analysis, these sites were assigned the rkm of the upstream-most receiver at each location. A capture history for each fish was created by assigning a “1” (detected) or a “0” (not detected) at each receiver location.

Survival was modeled in program MARK (White and Burnham 1999) through the RMark package (Laake 2013) within R (R Core Team 2020). By substituting space for time, we modeled reach-specific survival (S) as a logistic function using a linear structure,

$$\text{logit}\left(S_{i,j}\right) = \sum_{k=0}^{K} \beta_{j,k} x_{i,j,k}, \quad (1)$$

where logit() is the logit link function, $S_{i,j}$ is the survival probability for the ith individual in the jth reach, and $\beta_{j,k}$ is the slope coefficient of the kth covariate, $x_{i,j,k}$.

This model structure allowed for a mixture of spatially and time-varying covariates (e.g., water temperature), spatially and time-constant individual covariates (e.g., FL), spatially varying but time-constant covariates (e.g., reach length), and time-varying but spatially constant covariates (e.g., mean annual river flow). Each of the covariates we included in the analysis had an a priori hypothesized effect on smolt survival (Table 2). Fish size, as measured by FL, was the only covariate that was unique to each individual but constant across reaches and time. The time-varying, reach-constant covariate was annual mean flow at Bend Bridge, confined to the period spanning from the date of fish release to the date on which the last fish was detected in the river. Bend Bridge was chosen because it was upstream of major tributaries and diversions and therefore representative of flow in the Sacramento River watershed.

For each of the reaches, we derived spatially varying, time-constant covariates to define habitat features, many of which did not change between years and represented the best available approximation of reach-specific physical habitat for the Sacramento River (Figure 1). Each of the habitat features was mapped using ArcGIS version 10.4.1 (Esri, Redlands, California). River area and off-channel habitat were calculated as area per reach. Off-channel habitat was summarized as an annual mean from Landsat scenes corresponding to January–April, when fish were in the river. Median travel time was calculated from all observed travel times on a per-reach basis for each year. All other habitat features did not vary temporally across the study period. Shaded riverine aquatic cover (wooded bank) was defined as the nearshore aquatic area at the interface of the river and adjacent woody riparian habitat. This measure does not quantify instream cover. Specifically, to be designated as shaded riverine cover, the adjacent bank had to be composed of natural, eroding substrates supporting riparian vegetation that overhung or protruded into the water, with the water containing variable amounts of woody debris, such as leaves, logs, branches, and roots. Wooded bank and revetment were summarized as percentages of the length of the riverbank per reach. Remaining riverbank that was not classified as revetment or shaded was designated as bare bank. Other reach-specific covariates included the number of diversions, number of tributaries, and river sinuosity (Table 2).

A time-varying individual covariate was defined as the mean of the daily covariate (e.g., water flow, velocity, or temperature) over an individual’s travel time through a reach. For the purposes of defining covariate values for each fish, individuals that were undetected at a given receiver location but subsequently detected at a location further downstream had that missing arrival time imputed by using the observed arrival time at the upstream location, the observed arrival time at the next downstream location, the distance between these two locations, and the reach length between the upstream location and the missed location,

$$A_{(missed)} = A_{(upstream)} + \frac{\text{RL}_{(upstream \rightarrow missed)} \times \left[A_{(downstream)} - A_{(upstream)}\right]}{\text{RL}_{(upstream \rightarrow downstream)}}, \quad (2)$$

where A is arrival time and RL is reach length (km) between locations.

There were many more reaches defined by acoustic receivers than there were flow stations in the river. Therefore, to more closely match fish presence with environmental covariates, we used the RAFT model (Pike et al. 2013), which is a one-dimensional physical hydrodynamic model that estimates laterally and vertically averaged channel water temperature, flow, depth, and velocity every 10 min at a 2-km spatial resolution. We included temperature because metabolic rates and predation rates increase at higher temperatures (Vigg et al. 1991; Killen et al. 2010).

We considered flow at the reach scale and at the watershed scale because flow dynamics have been shown to be important for survival (Michel 2018; Perry et al. 2018;

TABLE 2. Hypothesized effects of covariates on winter-run Chinook Salmon survival for covariates included in the top mark–recapture survival model.

Category	Covariate	Definition	Prediction	Hypothesis
Individual	Length[a]	FL	Positive	Larger fish have higher survival due to improved predator avoidance and gape limitation
Temporal	Annual flow[b]	Mean flow at Bend Bridge (Jan–Apr)	Positive	Higher flows produce more habitat, facilitate downstream migration, and increase turbidity, which reduces predator exposure
Spatial	Reach length	Distance between upstream and downstream receivers	Negative	Longer migration distance increases exposure to predators
	Off-channel habitat[c]	Connected wetted area per reach within 1 km of river edge	Positive	Increased off-channel habitat produces more refuge and forage habitat
	Travel time	Median travel time	Negative	Longer travel time will decrease survival because of increased exposure to predators
	Sinuosity[d]	Deviation of reach length from shortest path	Positive	Increased sinuosity creates more instream habitat
	Revetment[e]	Percent revetment	Negative	Increased revetment reduces habitat refugia
	Diversions[f]	Number of diversions per kilometer for each reach	Negative	Increased habitat structure for predators
	Tributaries[g]	Number of tributaries per kilometer exceeding a Strahler stream order of 3	Positive	Increased access to nonnatal habitat
	Wooded bank habitat[h]	Percentage of nonriprapped bank with adjacent woody vegetation	Positive	Increased cover produces more refuge habitat
	Width : depth ratio[i]	Mean ratio of wetted channel width to depth	Positive	Wider, shallow channels increase refuge habitat
	Slope[i]	Mean elevation gradient of a reach	Positive	Steeper gradients will decrease travel time

TABLE 2. Continued.

Category	Covariate	Definition	Prediction	Hypothesis
Time-varying individual[i]	Temperature	Mean river temperature per reach	Negative	Increased temperature increases predator activity and reduces aerobic scope, potentially impacting locomotion
	Depth	Mean river depth per reach	Positive	Favors avoidance of bottom-oriented predators (catfish) and surface-oriented predators (birds)
	Interannual reach flow	Mean river flow per reach	Positive	Higher flows within a reach produce more habitat in that reach
	Intra-annual reach flow	Mean river flow per reach and year	Positive	Higher flows will be associated with increased turbidity and refugia
	Reach velocity	Mean river velocity per reach	Positive	Higher velocities will shorten travel time and reduce predator exposure

[a]Measured at tagging.

[b]U.S. Geological Survey data inventory page for site 11377100–Sacramento River above Bend Bridge, near Red Bluff, California: U.S. Geological Survey Web page, accessed January 20, 2022, at https://dashboard.waterdata.usgs.gov/api/gwis/2.0/service/site?agencyCode=USGS&siteNumber=11377100&open=15630.

[c]Normalized difference water index using 2-week conglomerates in Landsat (https://landsatlook.usgs.gov; April 9–23, 2013; February 21–March 18, 2014; February 24–March 5, 2015; March 23–30, 2016; and February 22–March 1, 2017).

[d]Sinuosity toolbox in ArcGIS.

[e]California Department of Water Resources.

[f]California Department of Fish and Wildlife (Passage Assessment Database) and the National Oceanic and Atmospheric Administration Southwest Fisheries Science Center.

[g]National Hydrography Dataset Plus (U.S. Environmental Protection Agency) with a Strahler stream order of 3.

[h]California Department of Water Resources and Google Earth imagery.

[i]Produced by the authors using the River Assessment for Forecasting Temperature (RAFT) model (Pike et al. 2013).

Henderson et al. 2019). In addition to mean annual flow at Bend Bridge, we included flow variables that measured variation from each reach's mean flow and variation relative to the mean flow in each year. We refer to these covariates as "interannual reach flow" and "intra-annual reach flow," respectively, following the methods of Henderson et al. (2019). Interannual reach flow was calculated by standardizing flow to each reach's mean flow:

$$z_{\text{inter},d,y,k} = \frac{Q_{d,y,k} - \mu_k}{\sigma_k}, \quad (3)$$

whereas intra-annual flow was calculated by standardizing daily flow within each reach and year:

$$z_{\text{intra},d,y,k} = \frac{Q_{d,y,k} - \mu_{y,k}}{\sigma_{y,k}}, \quad (4)$$

where $z_{\text{inter},d,y,k}$ and $z_{\text{intra},d,y,k}$ are the inter- and intra-annual reach flows on day d in year y and reach k; $Q_{d,y,k}$ is discharge; μ_k and $\mu_{y,k}$ are the means of $Q_{d,y,k}$ for each reach and each reach and year, respectively; and σ_k and $\sigma_{y,k}$ are the SDs of $Q_{d,y,k}$ for each reach and each reach and year. Including intra-annual reach flow allowed us to examine whether large freshet events within a reach would increase survival relative to the mean flow for that year (Cavallo et al. 2013; Courter et al. 2016). We included intra-annual reach flow in models with mean annual flow at Bend Bridge because scaling intra-annual flow by both year and reach removes the effect of annual differences in intra-annual reach flow, thus eliminating correlation between these variables. We also included an interaction term between mean annual flow and intra-annual reach flow, which tests whether within-year deviations from the mean annual flow had a different effect in high- and low-flow years.

Before fitting mark–recapture models, we conducted pairwise comparisons of all covariates to evaluate collinearity. If the correlation coefficients between any two variables exceeded 0.70 (Dormann et al. 2012) or if the variance inflation factor exceeded 10 (Kutner et al. 2004), we retained only the covariate with a greater hypothesized effect on survival (Supplementary Material available in the online version of this article). All continuous variables were standardized to zero mean and unit SD so that changes in survival could be predicted by a 1-SD change in each covariate value.

Model selection.— We used Akaike's information criterion (AIC) to rank alternative models based on the best trade-off between improved fit and model complexity (Burnham and Anderson 2002). Models with lower AIC values are considered better-fitting models in the model set. Our model selection process consisted of first identifying the best-fitting model for detection probability, then assessing goodness of fit, and finally fitting alternative survival models using the best-fitting detection model. We evaluated goodness of fit by estimating the degree of overdispersion using two different parameters in program MARK: the median-$\hat{c}$ procedure and the bootstrap goodness-of-fit procedure. Goodness of fit was evaluated using a model that allowed both survival and detection to vary independently among reaches and years (i.e., a reach × year interaction). Estimates of $\hat{c}$ less than or equal to 4 indicate that variability in the data was greater than expected given the multinomial likelihood structure of the mark–recapture model. Values of $\hat{c}$ greater than 1 indicate overdispersion, with more variability in the data than expected given the multinomial structure of the mark–recapture model, while values much greater than 1 (e.g., $\hat{c} > 4$) indicate a fundamental lack of fit, whereby the model structure poorly describes variation in the data (Burnham and Anderson 2002). We estimated $\hat{c}$ to be 1.54, indicating that our model structure was appropriate but that our data were slightly overdispersed. We therefore used the quasi-AIC (QAIC_c), which adjusts the AIC value based on $\hat{c}$, to select the model that was most supported by the data and ranked with the lowest QAIC_c score. In addition, $\hat{c}$ was used to inflate the SEs of parameter estimates in the model selected for inference.

The relative importance of covariates in the selected model (lowest QAIC_c score) was evaluated graphically and by examining point estimates of β coefficients with 95% CIs. Covariates having β coefficients with large absolute values were interpreted to have a larger effect on survival. Covariates having β coefficients with 95% CIs that overlapped zero were interpreted as not being significantly different from zero (i.e., no detectable effect). Covariates that did not contribute significantly to explaining the data were still retained in the selected model because they were chosen a priori to be important for their potential effect on survival (Burnham et al. 2011).

To identify the most parsimonious detection model, we fitted a series of models with increasing complexity while holding the survival model structure fixed using the reach × year interaction model. Like survival, we modeled the effect of covariates on detection as linear on the logit scale (equation 1). The simplest model included only sampling occasion (i.e., receiver site) as a main effect on detection probability (Supplementary Material). Next, we added year as a categorical factor to the reach model. The third model added an interaction between year and receiver site because the number of receivers and/or receiver model used at each location varied among years. Finally, the mean reach-specific velocity for each individual was added to each of the three models above for a total of six models in the model set. We hypothesized that river velocity and the ambient noise associated with velocity impact the attenuation of acoustic signals in water, thereby affecting detection probability. For all models, detection probabilities were set to zero when receivers were not deployed below Paynes Creek (location 6) and at the Mill Creek confluence (location 8) in 2013, below Cypress (location 2) when fish were released downstream of this location in 2016, and below China Bend (location 15) in 2017. We found that the model with water velocity and a site × year interaction had the lowest $QAIC_c$, which was considerably lower than that of the second-best model, which included only a site × year interaction ($\Delta QAIC_c = 2{,}069$; Supplementary Material). Therefore, the model including water velocity and the site × year interaction was used for all survival models.

Using an approach similar to that described above for the detection models, we fitted a set of eight survival models (Table 3) of increasing complexity and we used the $QAIC_c$ model selection criterion to rank each model. Subsets of the more parameterized models were evaluated using the same model selection criteria. As a basis of comparison with more parameterized covariate models, the models with the fewest variables only estimated survival separately for each reach or for each reach and year. From there, we included a model to test the effect of reach length (i.e., travel distance) and travel time on survival, with an intercept offset for each year. This model tested whether reaches with longer travel times and reach lengths, which increase exposure to predators (Anderson et al. 2005), could better explain variation in survival among reaches and years. Third, we added the RAFT model's flow variables (e.g., flow and velocity) to models that included reach length and travel time to test whether river flows affected survival after accounting for effects of travel time and reach length. Fourth, we evaluated models that only included time-constant habitat covariates (e.g., wooded bank habitat, number of tributaries, etc.; see Table 2 for the full list) or time-varying covariates (e.g., temperature and depth) that excluded flow variables. Finally, the most complex models combined all covariates from the preceding models, fitting one full model with interannual reach flow and another with intra-annual reach flow.

RESULTS

Spatiotemporal Conditions

Water temperatures ranged from 8°C to 16°C throughout the study period and varied among years but always had an increasing trend from February to April, as measured at Bend Bridge (Figure 2). Drought years 2014 and 2015 had the warmest mean February–March whole-river temperatures (12.2°C and 13.6°C, respectively). Peak flows in the Sacramento River varied temporally between years in response to storm events: no pulses in 2013, a few weak pulses in 2014, a single large pulse in 2015, two moderate pulses in 2016, and many large pulses on top of extremely high sustained flows in 2017 (Figure 2).

Riparian channel features varied spatially across the study area, with a greater number of tributaries upstream and greater percentage of revetment, greater number of diversions, and a smaller width : depth ratio downstream (Figure 1). Bank type characteristics were distributed in distinct sections of the Sacramento River (Figure 3). The upper section (reaches 1–6) contained mostly wooded bank, with some bare bank and lesser amounts of revetment. The middle section (reaches 7–12) was predominantly bare bank, with some wooded bank and lesser amounts of revetment. The area with the highest proportion of bare bank was associated with off-channel habitat (Figure 1) in drought years ($r = 0.80$). The lower river section (reaches 13–17) was predominantly revetment, with some wooded bank and a lesser amount of bare bank.

Travel Time

The time it took fish to travel downstream varied by reach and across years with different flow, velocity, and temperature profiles (Figure 4). Fish slowed down through the upper and middle reaches of the river during the high-flow year, through the middle reaches during all years, and in the lower reaches during the most critically dry year (2013; Figure 5). Travel times were the longest in the wettest and driest years. In the wettest year (2017), median travel time in the upper Sacramento River (Figure 1) was 24 d, ranging up to 70 d, while in the critically dry year (2013), median travel time in the middle Sacramento River was 33 d, ranging up to 54 d (Table 4). The most consistent slow travel times occurred in the middle Sacramento River, within a 55-km stretch of the river between Woodson Bridge and Tisdale (reaches 9–13; Figures 1, 5). This part of the river coincides with the greatest extent of connected off-channel habitat that was visible during the wet year between Red Bluff and Colusa (Figure 1).

Reach-Specific Patterns in Survival

Reach-specific survival scaled by distance and time (per 10 km per day) was consistently high (98–100%) in the upper reaches (1–4) and lower reaches (13–17) of the Sacramento River (Figure 6A). Reach-specific survival was lowest (96%) at reach 7 and intermediate (97–98%) through reaches 8–12 between Red Bluff and Colusa.

Factors that Affect Survival

Survival models with flow and habitat covariates received more support than the models that included only reach or reach and year, indicating that we had identified features that were important for juvenile salmon survival. The top-ranked survival model based on $QAIC_c$ was the full intra-

TABLE 3. Covariates included in each of the candidate mark–recapture survival models.

Covariate name	Reach	Distance–travel time	Interannual flow	Habitat	Intra-annual flow	Reach and year	Full interannual	Full intra-annual
Reach distance		x	x	x	x		x	x
Fish FL				x			x	x
Proportion of revetment				x			x	x
River sinuosity				x			x	x
Diversions per kilometer				x			x	x
Proportion of shaded riparian area				x			x	x
Tributaries per kilometer				x			x	x
Channel width : depth ratio				x			x	x
Mean slope of reach				x			x	x
Median travel time per reach		x	x	x	x		x	x
Reach	x					x		
Calendar year		x	x		x	x		
Reach × year interaction						x		
Flow standardized by reach			x				x	
Mean water temperature per reach							x	x
Mean water depth per reach							x	x
Mean water velocity per reach							x	x
Off-channel habitat per kilometer							x	x
Flow standardized by reach and year					x			x
Annual flow at Bend Bridge					x			x
Yearly reach flow × annual flow interaction								x

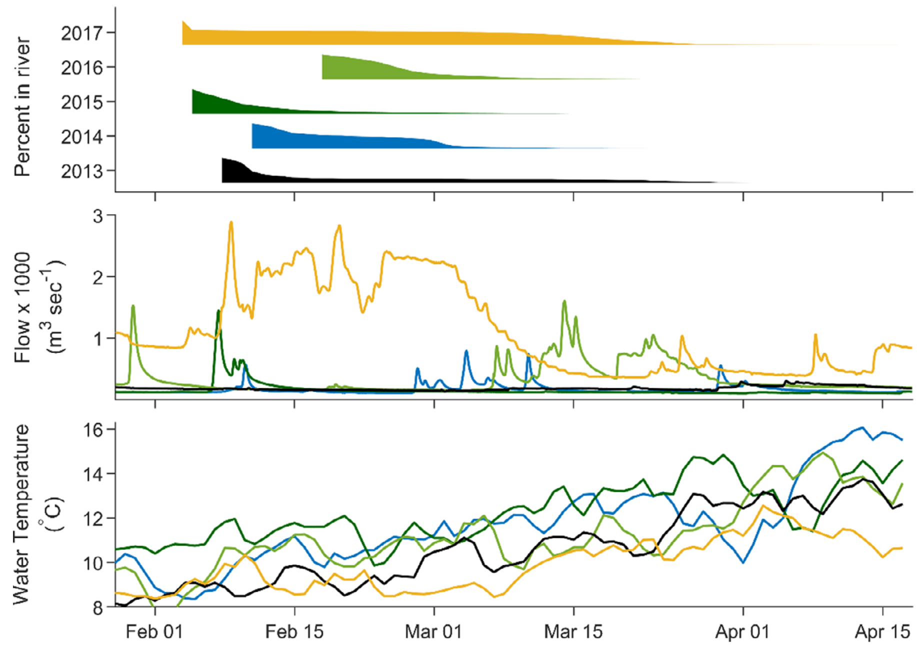


FIGURE 2. Percentage of acoustic-tagged winter-run Chinook Salmon juveniles in the Sacramento River from the date of release to the date on which the last fish was detected at Tower Bridge in the city of Sacramento for each year (upper panel). Flow (middle panel) and water temperature (lower panel) at Bend Bridge are also presented for each year (U.S. Geological Survey/U.S. Bureau of Reclamation hydrologic station [40.28849°, −122.186661°; rkm 489.4]; https://dashboard.waterdata.usgs.gov/api/gwis/2.0/service/site?agencyCode=USGS&siteNumber=11377100&open=15630).

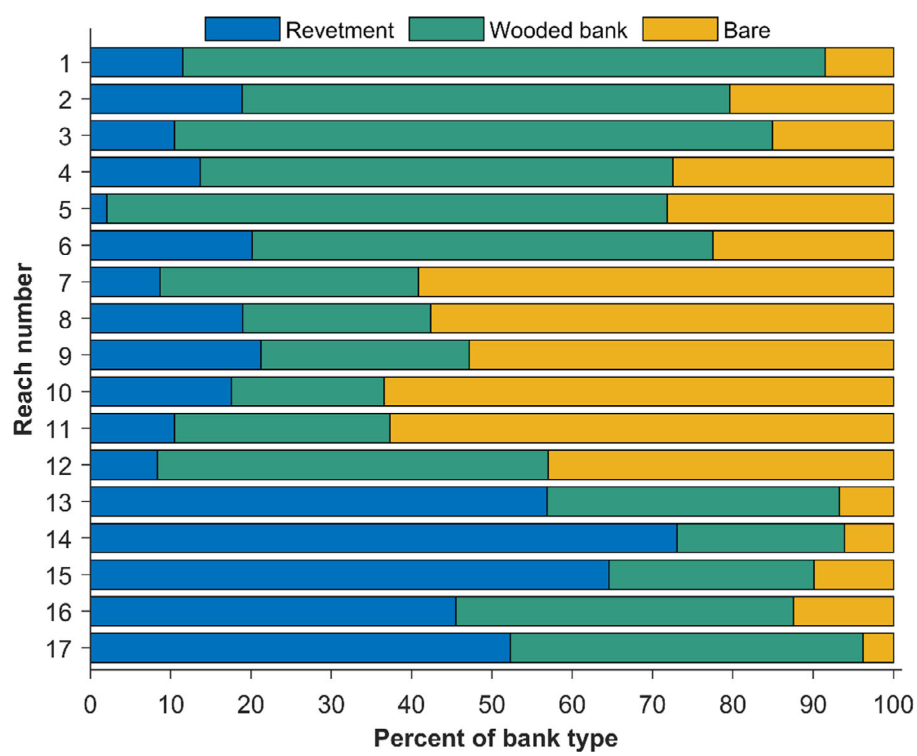


FIGURE 3. Percentages of revetment, wooded bank, and bare bank shoreline habitat types from upstream (reach 1) to downstream (reach 17) reaches of the Sacramento River. The area with the highest proportion of bare bank is associated with off-channel habitat (Figure 1) during drought years ($r = 0.80$).

annual reach flow and habitat model (Tables 3, 5), characterized by an interaction between mean annual flow and intra-annual reach flow and a combination of time-constant, reach-specific habitat features, reach water velocity, travel time, and fish length (Table 3). Among covariates with significant coefficients, as judged by 95% CIs that did not overlap zero, variation in annual flow had the strongest positive association with survival. These findings indicate that a 1-SD change in annual flow had a stronger effect on survival than a 1-SD change in any of the other covariates in the top-ranked model. However, the effect of annual flow was dampened by the negative effect of an intra-annual reach

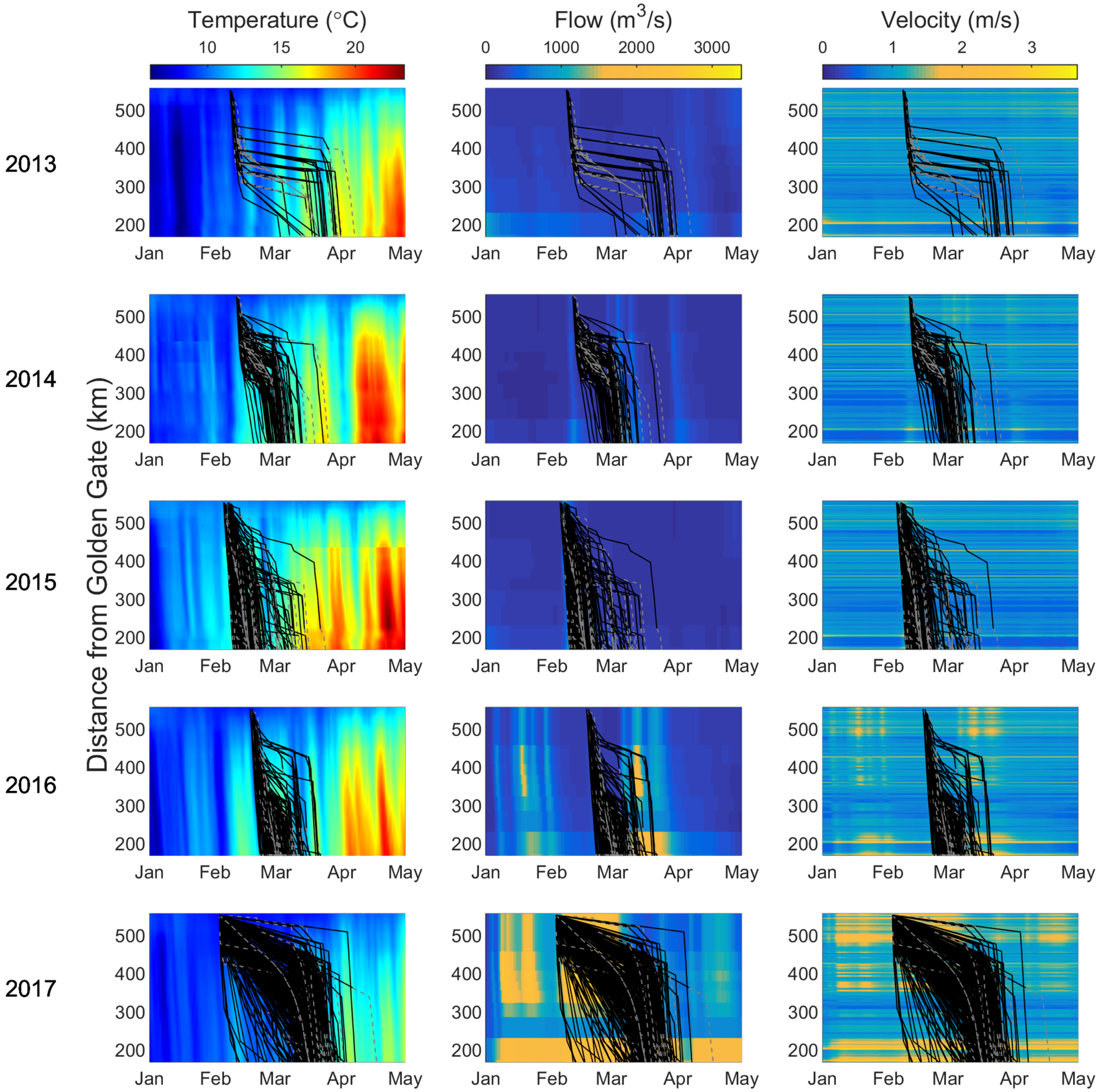


FIGURE 4. Downstream detections of juvenile winter-run Chinook Salmon (black lines) and interpolated tracks (gray dashed lines) in the Sacramento River from Redding to Sacramento, California. Detections overlay River Assessment for Forecasting Temperature (RAFT) model outputs for temperature (left column), flow (middle column), and velocity (right column) in water years 2013 (top row) to 2017 (bottom row).

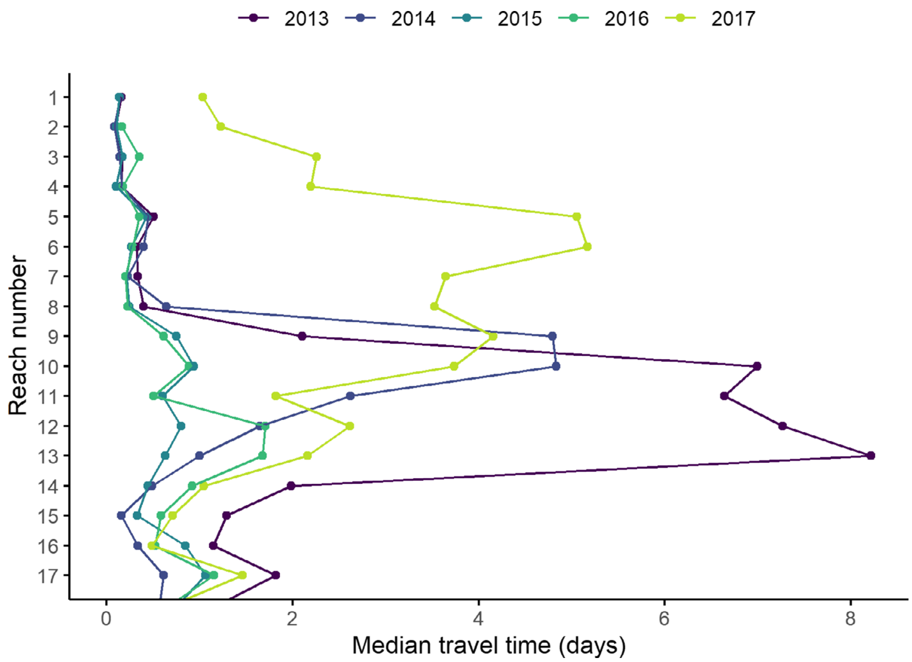


FIGURE 5. Travel time (d) by reach for juvenile winter-run Chinook Salmon migrating down the Sacramento River in each year. Each point represents the median number of days it took tagged fish to transit through a reach bounded upstream and downstream by acoustic receivers.

TABLE 4. Yearly variation in median travel time (d) of juvenile winter-run Chinook Salmon (Count) moving down the Sacramento River, with minimum (Min) and maximum (Max) values for the upper, middle, and lower sections (Figure 1) of the river.

Year	Section	Count	Median	Min	Max
2013	Upper	118	3	1	44
	Middle	23	33	4	54
	Lower	22	14	2	35
2014	Upper	288	3	1	36
	Middle	146	17	2	36
	Lower	135	3	2	13
2015	Upper	446	2	1	31
	Middle	310	5	1	36
	Lower	233	3	1	32
2016	Upper	531	2	1	28
	Middle	362	6	2	28
	Lower	285	5	1	28
2017	Upper	335	24	1	70
	Middle	293	18	2	44
	Lower	234	6	2	39

flow × annual flow interaction term. Other covariates with a significant positive effect on survival (i.e., 95% CIs that did not overlap zero) included percentages of revetment and wooded bank, fish length, and reach-specific intra-annual flow (Figure 7). Channel width : depth ratio, reach-specific velocity, depth, and reach length all had negative associations with survival, along with travel time, river temperature, and the intra-annual reach flow × annual flow interaction term. River sinuosity, diversion density, off-channel habitat, slope, and number of tributaries had negligible effects on survival, indicating that the covariates included in the selected model sufficiently explained differences in survival among years and reaches. Time-constant covariates, including river sinuosity, slope, and percent wooded bank, acted to increase estimates of survival in the upper reaches but decreased estimates of survival in the lower reaches relative to mean covariate values (Figure 6B). In contrast, the width : depth ratio decreased estimates of survival through the middle river (reaches 7 and 8) and increased estimates of survival relative to mean covariate values from reach 13 downstream, where the river becomes more channelized with revetment along the bank.

Mean annual flow, intra-annual reach flow, and their interaction had contrasting effects on predicted survival (Figure 8). Predicted survival per 10 km per day increased as a function of mean annual flow, with intra-annual reach flow and all other covariates set to mean values (Figure 8A). Due to the negative interaction between annual and intra-annual reach flow, the slope coefficient for intra-annual reach flow declined with annual flow such that reach effects were more positively associated with survival in low-flow years (Figure 8B). The combined effect of mean annual flow and intra-annual reach flow led to a positive relationship in low-flow years but a flat relationship in the high-flow year (Figure 8C). These findings

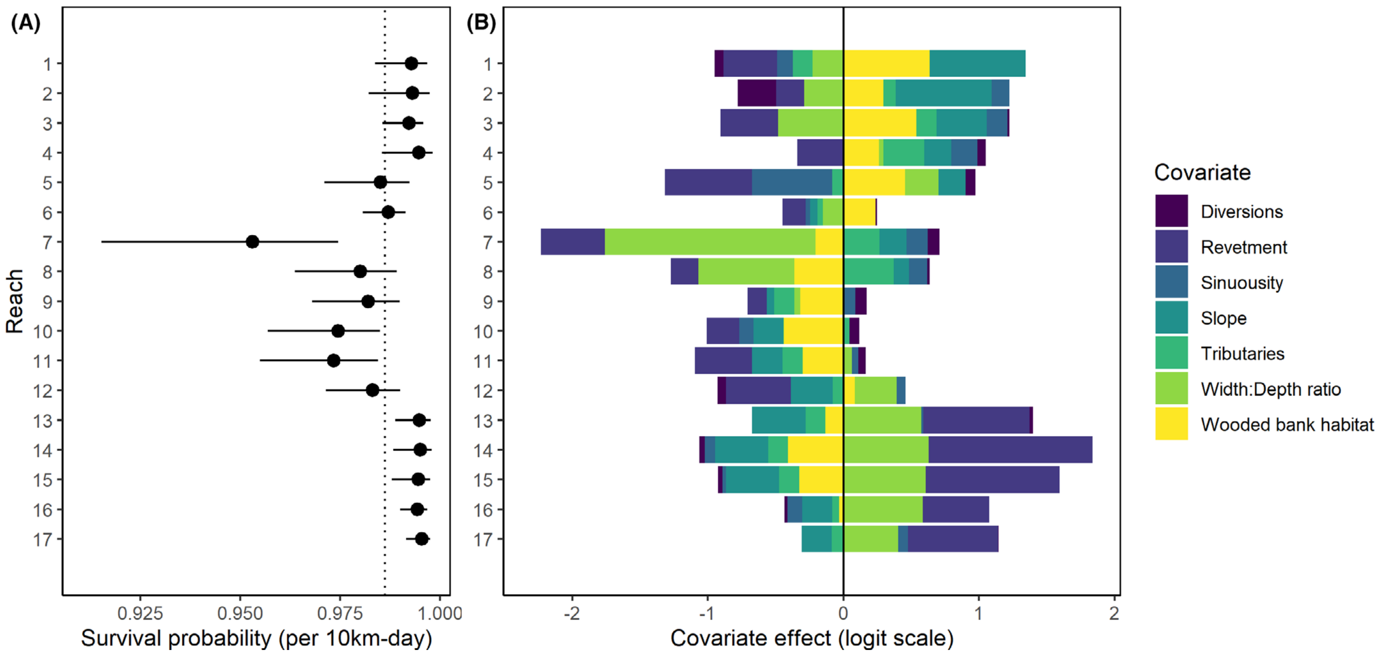


FIGURE 6. Effect of time-constant, reach-specific covariates on survival of juvenile winter-run Chinook Salmon: **(A)** predicted survival per 10 km per day (with 95% CIs) when all covariates are set to mean values except the reach-specific covariates shown in panel B (dashed line shows the mean survival over all reaches); and **(B)** the effect of each reach-specific covariate on the linear predictor (see equation 1). Covariate effects (represented as stacked bars) were calculated as the product of the standardized covariate and its corresponding slope coefficient (i.e., β). Habitat features associated with the riverbank also varied across the migration corridor (see Figure 3).

suggest that variation in daily reach-specific flows affect survival more in years when mean annual flow is low than in high-flow years.

DISCUSSION

The Sacramento River is the main source of California's water conveyance system and acts as a key migration corridor for anadromous fish moving from freshwater to ocean environments. Therefore, the management of reservoir releases directly affects the conditions encountered by juvenile salmon as they migrate to the ocean as smolts. Because of their small size, smolts are vulnerable to how these conditions affect exposure to predators during the downstream emigration phase of their life history (Sabal et al. 2021). Additionally, they may be vulnerable to delayed mortality in the ocean from associated migration duress (Michel 2018).

The decline of the winter run, as the most critically imperiled Chinook Salmon run, remains one of the most important issues confronting water management in the Sacramento River. In this study, we observed that mean annual flow over the time during which fish were in the river had the most positive effect on their survival out of all the modeled covariates. Moreover, we observed that higher flow at the reach scale had a more positive effect on survival in dry years with low flow than it did in wet years with high flow. Although the interaction between annual flow and intra-annual reach flow occurs with one high-flow year observed in 2017 (Figure 5), similar observations have been made in previous work on late-fall-run Chinook Salmon (Courter et al. 2016; Perry et al. 2018; Henderson et al. 2019). Anomalous wet years like 2017 are important to consider because California remains in a state of extended drought, and obtaining data for years like this is likely to be difficult given their importance for fish survival. It has long been known that freshwater flow is connected to variation in survival of juvenile salmon migrating to the sea (Kjelson and Brandes 1989; Newman and Rice 2002; Michel 2018; Notch et al. 2020); however, our findings suggest that although it may not be possible to create wet-year flow conditions like those in 2017, increasing flow through managed flow pulses can benefit salmon survival. Our results also improve current understanding of how annual changes in flow can affect survival rates and spatially varying changes in habitat features known to be important for rearing (Zeug et al. 2019; Zeug and Winemiller 2008) with time-varying features of the river (i.e., reach flow, temperature, and depth; Henderson et al. 2019). Considering these factors together in a novel framework that scales survival by the amount of time fish are spending in a given part of the river provides a clearer way to examine spatial variation in migration survival.

TABLE 5. Survival (ϕ) model selection based on quasi-Akaike's information criterion ($QAIC_c$) ranks with a $\hat{c}$ of 1.54. Models are shown with the number of parameters (npar), the calculated value of $QAIC_c$, the difference in $QAIC_c$ value between the given model and the top model ($\Delta QAIC_c$), and the deviance value (QDeviance).

Survival model	npar	$QAIC_c$	$\Delta QAIC_c$	QDeviance
Full intra-annual	108	13,320.53	0.00	13,103.37
Full interannual	106	13,415.67	95.15	13,202.56
Separate survival for reach and year	175	13,438.75	118.23	13,085.71
Intra-annual reach flow	100	13,488.73	168.20	13,287.73
Habitat	102	13,508.79	188.26	13,303.76
Interannual reach flow	98	13,544.11	223.58	13,347.15
Distance–travel time model	97	13,547.31	226.78	13,352.37
Reach	107	13,576.39	255.86	13,361.25

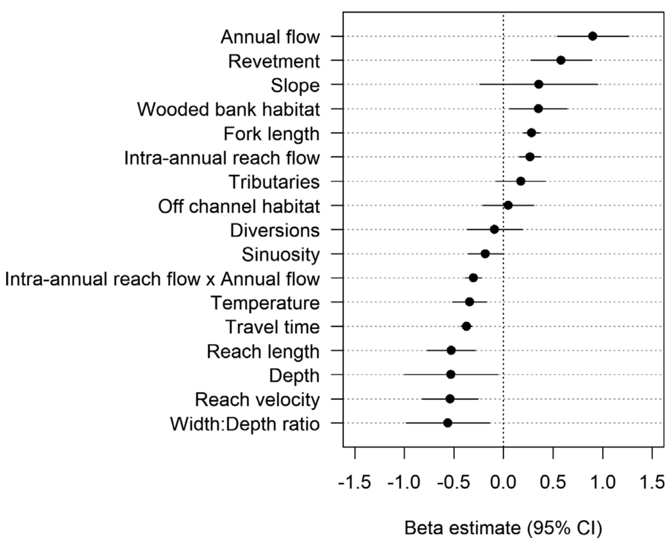


FIGURE 7. Parameter estimates (±95% CI) of slope coefficients (i.e., β estimates) for each covariate in the selected model. The CIs that overlap zero indicate no significant effect.

In some ways, our results differed from those of previous studies on the late-fall run (Perry et al. 2010; Michel et al. 2015; Henderson et al. 2019) and spring run (Cordoleani et al. 2018; Notch et al. 2020) of Chinook Salmon. We observed stopover behavior in all years, but the region of the river in which stopover behavior occurred appeared to depend on density-dependent habitat availability, with fish exhibiting stopover behavior higher in the river during the wettest year and lower in the river during the driest year (Figure 5). During dry years with lower flow, salmon

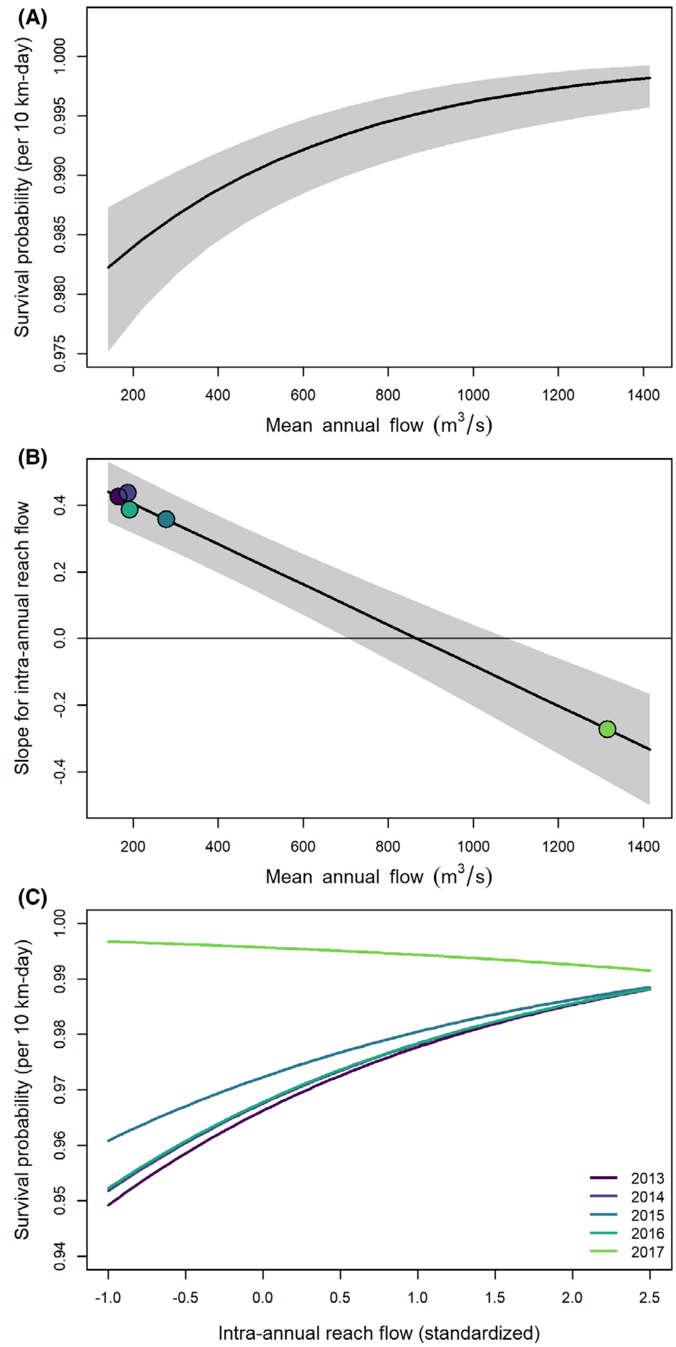


FIGURE 8. Effects of mean annual flow, interannual reach flow, and their interaction on predicted survival of juvenile winter-run Chinook Salmon: **(A)** predicted survival per 10 km per day as a function of mean annual flow, with intra-annual reach flow and the other covariates set to mean values, except for travel time (set to 1 d) and reach length (set to 10 km); **(B)** effect of the interaction between mean annual flow and intra-annual reach flow, showing the slope coefficient for intra-annual reach flow as a function of mean annual flow (symbols represent the slope for intra-annual reach flow for each value of mean annual flow; symbols are slightly jittered vertically to reduce overlap); and **(C)** combined effect of mean annual flow and interannual reach flow on predicted survival per 10 km per day. Shaded regions in panels A and B show the 95% CIs.

that delay migration tend to experience higher mortality (Sturrock et al. 2020). In 2013, a year that was characterized by low flows and a nearly flat hydrograph (Figure 2), the stopover behavior low in the river and the corresponding low survival suggest that fish may not initiate downstream migration without an appropriate migration cue, which usually arrives as a pulse in flow (del Rosario et al. 2013) or, ultimately, as warming temperatures (Figure 4). Salmon are known to avoid high temperatures by timing their migration to occur before or after peak river temperatures (Hodgson and Quinn 2002). Therefore, we might expect that fish migrating in response to high temperatures could suffer indirect effects, such as a reduction in aerobic scope (Eliason and Farrell 2016).

The trade-off between increased exposure to predators and access to good foraging habitat is indirectly supported with a positive association between annual flow and survival (Michel et al. 2015; Perry et al. 2018; Henderson et al. 2019; Zeug et al. 2020). High flows can benefit survival by increasing water turbidity, thus providing cover for juveniles to evade predators (Gregory and Levings 1998), and by offering access to a greater diversity of foraging and refuge habitat that allows fish to slow down higher in the watershed. A positive association of body size with survival is consistent with previous work on other runs (Cordoleani et al. 2018; Henderson et al. 2019; Notch et al. 2020), which suggests that a fish's size can reduce predation as individuals grow beyond the gape limitation of some predators (Nowlin et al. 2006). A caveat is that the increased tag burden of fish in the smaller size range could disproportionately affect the survival of acoustic-tagged fish (Brown et al. 2010; Liss et al. 2016). Although we did not detect a fish size effect for tag shedding or survival rates in the portion of tagged fish that were held and monitored for 60 d, tag burden will disproportionally affect the performance of smaller fish and may contribute to the observed higher survival for larger fish.

Some relationships between other covariates and survival ran counter to our working hypotheses and revealed interesting patterns upon further investigation. First, increased survival was associated with a higher proportion of revetment along the riverbank (Figure 7). However, the positive effect of revetment was only observed where it was predominant along the riverbank in the last five reaches (Figure 6B, reaches 13–17), which had similar habitat and morphology (e.g., deep, narrow, low-gradient channels; Supplementary Material) and downstream of reaches where fish were observed exhibiting slow travel. Fish surviving to these lower reaches are likely larger because of longer feeding durations or upstream size-selective mortality that removed smaller fish. Moreover, fish holding upstream that survived to these lower reaches are more likely to be actively out-migrating, which decreases travel time (Figure 5) and exposure to predators. Future work that compares the spatial survival of other runs that emigrate at other times may shed some light on the role of revetment, predation, and survival in this part of the river.

Second, while more rapid downstream movement may appear to result in better in-river survival for out-migrating smolts, the negative association between reach velocity and survival suggests that volitional downstream movement may be compromised. Inflection points that indicate a change to downstream migration behavior appear to correspond to sudden changes in the velocity profile of the river (Figure 4). As instream rearing is known to occur for winter-run fish in the main-stem Sacramento River (Freeman et al. 2001) and tributaries (Phillis et al. 2018), we may be observing a switch from resting and feeding to migration behavior in which vulnerability to mortality is higher, at least initially. During the wet year of 2017, when water velocities were high throughout the main channel, better access to low-velocity off-channel and ephemeral tributary habitat throughout the upper and middle Sacramento River may have been key for fish to improve foraging opportunities on prey (e.g., drift) that would otherwise have been advected in the main stem throughout the largest pulse flow periods.

Limitations of observational studies on hatchery-raised salmon in the field can make it difficult to infer how variables might affect wild fish, which initiate their smolt migration earlier in the fall. Natural-origin winter-run fish initiate their downstream migration beginning in July and into autumn, around the time when the first storms of the year arrive in California, following several months of summer conditions characterized by low flows and warm temperatures. These early storms create unique conditions, known colloquially as a "first flush," when accumulated debris and sediment are carried downstream, creating turbid conditions and cover that wild fish could use as refugia from predators. In contrast, our study fish were released during the peak of winter in a single synchronized event with the entire hatchery production of winter run to provide a swamping effect and improve survival. A study on Sockeye Salmon *O. nerka* using a combination of PIT and acoustic tags demonstrated that the estimated survival probability for smolts increased from 50% when migrating with 2,000 conspecifics to 95% when migrating with 350,000 conspecifics (Furey et al. 2016). Because density dependence spreads fish out as they migrate downriver through rearing habitat along channel margins, a predator swamping effect will attenuate at an unknown rate and will likely have different characteristics than natural-origin fish experience. In addition, if density-dependent habitat availability is indeed the primary mechanism that predicts where fish will slow down, natural-origin fish that are not confronted with as many conspecifics at a given time are more likely to exhibit slower travel times in the upper reaches of the river than that of our study fish. Future studies that release similar numbers of fish at different locations along the river may be able to control for a swamping effect and more closely approximate how natural-origin fish behave.

Management Implications

Flow management is often used as a primary tool for mitigating impacts to fish. When high flows are not available, maintaining functional flows through flow pulses offers managers another way to improve survival under low-flow conditions (Michel et al. 2021). Figure 8B describes how the slope of the intra-annual reach flow–survival relationship changes with mean annual flow. This relationship can be used by managers to determine, at a given level of annual flow, whether a flow pulse is likely to produce a measurable effect on survival. For example, when flow is less than about 700 m^3/s, given the confidence interval, pulse flows will have a high probability of having a positive effect on survival. The relationship also indicates what the magnitude of the effect may be. For example, when mean annual flow is 600 m^3/s, a pulse flow is going to have half the effect of a pulse event than when mean annual flow is 200 m^3/s. Of course, there are no observations between 300 and 1,300 m^3/s, and collecting these data in a targeted way is recommended to determine whether the relationship at higher flows is nonlinear.

As climate change induces more variability and a higher frequency of hot and dry conditions, facilitating migration with pulse flows is likely to become harder to achieve due to water scarcity and a lack of habitat diversity throughout the watershed (Lindley et al. 2007). This means that the resilience of declining salmon populations will increasingly depend on habitat restoration (Herbold et al. 2018). While habitat restoration can take months or years to achieve, depending on the scale of the activity, more information is needed to understand which characteristics of holding habitat cause fish to alter emigration. Some of the ways that winter-run fish interacted with spatial covariates appeared to change as they moved downstream, possibly because of selection, given that hatcheries release naïve juveniles into the upper river, or because of switching from holding to out-migration behavior. It is therefore important for resource managers to consider that how fish perceive the value of habitat variables can change in response to density-dependent effects and as the fish develop and mature, exhibiting behavioral and physiological plasticity as they undergo smoltification.

In this study, off-channel habitat was inaccessible during all years except 2017, which is likely why we were unable to detect an effect of access to off-channel habitat on survival. Natural-origin winter-run fish, which begin to rear and out-migrate during late fall and winter, when natural flows are more variable, may have better access to ephemeral off-channel habitat (Bellido-Leiva et al. 2021). We detected low survival and slow travel times in a middle section of the river with a large extent of potential off-channel habitat (Figure 1) where bare banks predominated (Figure 3), suggesting a location where juveniles may be responsive to targeted restoration efforts (around reaches 7–12), such as connecting off-channel habitat at lower flow thresholds.

The positive effect of wooded bank habitat on survival throughout the study area suggests that restoration activities that increase cover and bank complexity along the shoreline of the main-stem river could improve foraging and resting habitat (Zajanc et al. 2013). Indeed, vegetation has been shown to have the largest effect on smolt movement rates in the Sacramento River, with fish slowing down in areas having increased cover (Zajanc et al. 2013; McNair 2015). Wooded bank habitat on the Sacramento River has been lost over the past 50 years, primarily due to bank protection projects like the Sacramento Riverbank Protection Project. Since 1961, over 225 km (140 mi) of revetment (riprap) have been constructed on the riverbank, with only 7% of shaded riparian cover remaining in the lower Sacramento River (USFWS 2004). In our study, fish moved quickly through areas with heavy revetment and they exhibited slower movement in areas with wooded habitat. Moving slowly allows the fish time to rest and feed on their journey to sea.

In conclusion, out-migration survival of winter-run juveniles on the Sacramento River was best described by an intra-annual flow model with a mix of time-varying spatial covariates, reach-specific habitat features, and individual effects. Years with higher flow showed a strong association with increased survival, and years with lower flow showed a more positive flow–survival relationship at the reach scale. Wooded bank habitat had a positive association with survival, despite having been replaced by revetment along more than 90% of the riverbank in the Sacramento River. Evidence for instream holding behavior, which is known to be an important life history trait in juvenile winter-run fish, was indicated by slow travel times that appeared to respond to density-dependent habitat availability. Consistent slow travel times were observed in a section of the river between Red Bluff and Colusa, which coincided with the greatest extent of potential off-channel habitat that was connected during the high flows of 2017. Other habitat features did not have a consistent effect on survival across the migration corridor, as they displayed either a positive association with survival in the upper river and a negative association with survival in the lower part of the river or vice versa, indicating a dynamic relationship between the fish's physiological/behavioral developmental characteristics and their environment. With increased variability in drought and flood severity associated with climate change, it will become more important to disentangle the behavioral factors that affect out-migration timing (Munsch et al. 2019) and survival (Johnson et al. 2017), particularly as demands for freshwater put additional pressure on native fishes like Central Valley Chinook Salmon at the southern extent of their range.

ACKNOWLEDGMENTS

Funding for this study was provided by the State and Federal Contractors Water Agency, the Sites Authority, an Ecosystem Restoration Grant from the California Department of Fish and Wildlife, and the U.S. Bureau of Reclamation. J.L.H. was supported by a postdoctoral fellowship provided by the Delta Science Program to initiate the study. We are grateful to many field biologists at the National Oceanic and Atmospheric Administration's Southwest Fisheries Science Center for helping to collect the data upon which our analysis was based. Special thanks to Bob Null, Kevin Niemela, and John Rueth (U.S. Fish and Wildlife Service and Livingston Stone National Fish Hatchery) for tagging and logistical support. All experiments were performed upon approval by the Institutional Animal Care and Use Committee at the University of California at Santa Cruz. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government. There is no conflict of interest declared in this article.

ORCID

Jason L. Hassrick https://orcid.org/0000-0003-2650-3901
Arnold J. Ammann https://orcid.org/0000-0002-9349-1798

REFERENCES

Alerstam, T., and Å. Lindström. 1992. Optimal fat loads in migrating birds: a test of the time-minimizing hypothesis. American Naturalist 140:477–491.

Ammann, A. J. 2020. Factors affecting detection probability and range of transmitters and receivers designed for the Juvenile Salmon Acoustic Telemetry System. Environmental Biology of Fishes 103:625–634.

Andelman, S. J., and W. F. Fagan. 2000. Umbrellas and flagships: efficient conservation surrogates or expensive mistakes? Proceedings of the National Academy of Sciences of the United States of America 97:5954–5959.

Anderson, J. J., E. Gurarie, and R. W. Zabel. 2005. Mean free-path length theory of predator–prey interactions: application to juvenile salmon migration. Ecological Modelling 186:196–211.

Beeman, J. W., and R. W. Perry. 2012. Bias from false-positive detections and strategies for their removal in studies using telemetry. Pages 505–518 *in* N. S. Adams, J. W. Beeman, and J. H. Eiler, editors. Telemetry techniques: a user guide for fisheries research. American Fisheries Society, Bethesda, Maryland.

Bellido-Leiva, F., R. A. Lusardi, and J. R. Lund. 2021. Modeling the effect of habitat availability and quality on endangered winter-run Chinook Salmon (*Oncorhynchus tshawytscha*) production in the Sacramento Valley. Ecological Modelling 447:109511.

Berg, N., and A. Hall. 2017. Anthropogenic warming impacts on California snowpack during drought. Geophysical Research Letters 44:2511–2518.

Brown, R. S., R. A. Harnish, K. M. Carter, J. W. Boyd, K. A. Deters, and M. B. Eppard. 2010. An evaluation of the maximum tag burden for implantation of acoustic transmitters in juvenile Chinook Salmon. North American Journal of Fisheries Management 30:499–505.

Buchanan, R. A., J. R. Skalski, and A. E. Giorgi. 2010. Evaluating surrogacy of hatchery releases for the performance of wild yearling Chinook Salmon from the Snake River basin. North American Journal of Fisheries Management 30:1258–1269.

Bunn, S. E., and A. H. Arthington. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30:492–507.

Burnham, K., D. Anderson, G. White, C. Brownie, and K. Pollock. 1987. Design and analysis methods for fish survival experiments based on release–recapture. American Fisheries Society, Monograph 5, Bethesda, Maryland.

Burnham, K., and D. Anderson. 2002. Model selection and multi-model inference, 2nd edition. Springer, New York.

Burnham, K. P., D. R. Anderson, and K. P. Huyvaert. 2011. AIC model selection and multimodel inference in behavioral ecology: some background, observations, and comparisons. Behavioral Ecology and Sociobiology 65:23–35.

Caro, T., and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. Conservation Biology 13:805–814.

Cavallo, B., J. Merz, and J. Setka. 2013. Effects of predator and flow manipulation on Chinook Salmon (*Oncorhynchus tshawytscha*) survival in an imperiled estuary. Environmental Biology of Fishes 96:393–403.

Cloern, J. E., N. Knowles, L. R. Brown, D. Cayan, M. D. Dettinger, T. L. Morgan, D. H. Schoellhamer, M. T. Stacey, M. van der Wegen, R. W. Wagner, and A. D. Jassby. 2011. Projected evolution of California's San Francisco Bay-Delta-river system in a century of climate change. PLOS (Public Library of Science) ONE [online serial] 6(9): e24465.

Cordoleani, F., J. Notch, A. S. McHuron, A. J. Ammann, and C. J. Michel. 2018. Movement and survival of wild Chinook Salmon smolts from Butte Creek during their out-migration to the ocean: comparison of a dry year versus a wet year. Transactions of the American Fisheries Society 147:171–184.

Cormack, R. 1964. Estimates of survival from the sighting of marked animals. Biometrika 51:429–438.

Courter, I. I., T. M. Garrison, T. J. Kock, R. W. Perry, D. B. Child, and J. D. Hubble. 2016. Benefits of prescribed flows for salmon smolt survival enhancement vary longitudinally in a highly managed river system. River Research and Applications 32:1999–2008.

del Rosario, R. B., Y. J. Redler, K. Newman, P. L. Brandes, T. Sommer, K. Reece, and R. Vincik. 2013. Migration patterns of juvenile winter-run-sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta. San Francisco Estuary and Watershed Science [online serial] 11(1).

Deng, Z. D., J. J. Martinez, H. Li, R. A. Harnish, C. M. Woodley, J. A. Hughes, X. Li, T. Fu, J. Lu, G. A. McMichael, M. A. Weiland, M. B. Eppard, J. R. Skalski, and R. L. Townsend. 2017. Comparing the survival rate of juvenile Chinook Salmon migrating through hydropower systems using injectable and surgical acoustic transmitters. Scientific Reports 7:article 42999.

Diffenbaugh, N. S., D. L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. Proceedings of the National Academy of Sciences of the United States of America 112:3931–3936.

Donaldson, M. R., S. G. Hinch, C. D. Suski, A. T. Fisk, M. R. Heupel, and S. J. Cooke. 2014. Making connections in aquatic ecosystems with acoustic telemetry monitoring. Frontiers in Ecology and the Environment 12:565–573.

Dormann, C. F., S. J. Schymanski, J. Cabral, I. Chuine, C. Graham, F. Hartig, M. Kearney, X. Morin, C. Römermann, B. Schröder, and A. Singer. 2012. Correlation and process in species distribution models: bridging a dichotomy. Journal of Biogeography 39:2119–2131.

Eliason, E., and A. Farrell. 2016. Oxygen uptake in Pacific salmon *Oncorhynchus* spp.: when ecology and physiology meet. Journal of Fish Biology 88:359–388.

Fisher, F. W. 1994. Past and present status of Central Valley Chinook Salmon. Conservation Biology 8:870–873.

Freeman, M. C., Z. H. Bowen, K. D. Bovee, and E. R. Irwin. 2001. Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes. Ecological Applications 11:179–190.

Furey, N. B., S. G. Hinch, A. L. Bass, C. T. Middleton, V. Minke-Martin, and A. G. Lotto. 2016. Predator swamping reduces predation risk during nocturnal migration of juvenile salmon in a high-mortality landscape. Journal of Animal Ecology 85:948–959.

Gregory, R. S., and C. D. Levings. 1998. Turbidity reduces predation on migrating juvenile Pacific salmon. Transactions of the American Fisheries Society 127:275–285.

Henderson, M. J., I. S. Iglesias, C. J. Michel, A. J. Ammann, and D. D. Huff. 2019. Estimating spatial–temporal differences in Chinook Salmon outmigration survival with habitat- and predation-related covariates. Canadian Journal of Fisheries and Aquatic Sciences 76:1549–1561.

Herbold, B., S. M. Carlson, and R. Henery. 2018. Managing for salmon resilience in California's variable and changing climate. San Francisco Estuary and Watershed Science [online serial] 16(2):article 3.

Hodgson, S., and T. P. Quinn. 2002. The timing of adult Sockeye Salmon migration into fresh water: adaptations by populations to prevailing thermal regimes. Canadian Journal of Zoology 80:542–555.

Iwamura, T., R. A. Fuller, and H. P. Possingham. 2014. Optimal management of a multispecies shorebird flyway under sea-level rise. Conservation Biology 28:1710–1720.

Johnson, R. C., and S. Lindley. 2016. Central Valley recovery domain. NOAA Technical Memorandum NMFS-SWFSC-564.

Johnson, R. C., S. Windell, P. L. Brandes, J. L. Conrad, J. Ferguson, P. A. L. Goertler, B. N. Harvey, J. Heublein, J. A. Israel, D. W. Kratville, J. E. Kirsch, R. W. Perry, J. Pisciotto, W. R. Poytress, K. Reece, and B. G. Swart. 2017. Science advancements key to increasing management value of life stage monitoring networks for endangered Sacramento River winter-run Chinook Salmon in California. San Francisco Estuary and Watershed Science [online serial] 15(3): article 1.

Jolly, G. M. 1965. Explicit estimates from capture–recapture data with both death and immigration-stochastic model. Biometrika 52:225–247.

Killen, S. S., D. Atkinson, and D. S. Glazier. 2010. The intraspecific scaling of metabolic rate with body mass in fishes depends on lifestyle and temperature. Ecology Letters 13:184–193.

Kjelson, M. A., and P. L. Brandes. 1989. The use of smolt survival estimates to quantify the effects of habitat changes on salmonid stocks in the Sacramento-San Joaquin rivers, California. Pages 100–115 *in* C. D. Levings, L. B. Holtby, and M. A. Henderson, editors. Proceedings of the national workshop on effects of habitat alteration on salmonid stocks. Canadian Special Publication of Fisheries and Aquatic Sciences 105.

Klimley, A. P., M. T. Wyman, and R. Kavet. 2017. Chinook Salmon and Green Sturgeon migrate through San Francisco Estuary despite large distortions in the local magnetic field produced by bridges. PLOS (Public Library of Science) ONE [online serial] 12(6):e0169031.

Kondolf, G. M., and R. J. Batalla. 2005. Hydrological effects of dams and water diversions on rivers of Mediterranean-climate regions: examples from California. Elsevier, Amsterdam.

Kutner, M., C. Nachtsheim, and J. Neter. 2004. Applied linear regression models. McGraw-Hill/Irwin, Boston.

Laake, J. L. 2013. RMark: an R interface for analysis of capture–recapture data with MARK. National Marine Fisheries Service, Alaska Fisheries Science Center, Processed Report 2013-1, Seattle.

Lindley, S. T., C. B. Grimes, M. S. Mohr, W. T. Peterson, J. E. Stein, J. J. Anderson, L. W. Botsford, D. L. Bottom, C. A. Busack, and T. K. Collier. 2009. What caused the Sacramento River fall Chinook stock collapse? NOAA Technical Memorandum NMFS-SWFSC-447.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook Salmon and steelhead in the Sacramento-San Joaquin basin. San Francisco Estuary and Watershed Science [online serial] 5(1):article 4.

Liss, S. A., R. S. Brown, K. A. Deters, R. W. Walker, Z. D. Deng, M. B. Eppard, R. L. Townsend, and A. G. Seaburg. 2016. Mortality, transmitter retention, growth, and wound healing in juvenile salmon injected with micro acoustic transmitters. Transactions of the American Fisheries Society 145:1047–1058.

McNair, N. N. 2015. An analysis of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) outmigration speed and survival in response to habitat features: Sacramento River from Knights Landing to Sacramento, California. Master's thesis. University of San Francisco, San Francisco, California.

Michel, C. J. 2018. Decoupling outmigration from marine survival indicates outsized influence of streamflow on cohort success for California's Chinook Salmon populations. Canadian Journal of Fisheries and Aquatic Sciences 76:1398–1410.

Michel, C. J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, M. J. Thomas, G. P. Singer, A. P. Klimley, and R. B. MacFarlane. 2015. Chinook Salmon outmigration survival in wet and dry years in California's Sacramento River. Canadian Journal of Fisheries and Aquatic Sciences 72:1749–1759.

Michel, C. J., J. Notch, F. Cordoleani, A. Ammann, and E. Danner. 2021. Nonlinear survival of imperiled fish informs managed flows in a highly modified river. Ecosphere 12(5):e03498.

Moore, J. W., J. Gordon, C. Carr-Harris, A. S. Gottesfeld, S. M. Wilson, and J. H. Russell. 2016. Assessing estuaries as stopover habitats for juvenile Pacific salmon. Marine Ecology Progress Series 559:201–215.

Munsch, S. H., C. M. Greene, R. C. Johnson, W. H. Satterthwaite, H. Imaki, and P. L. Brandes. 2019. Warm, dry winters truncate timing and size distribution of seaward-migrating salmon across a large, regulated watershed. Ecological Applications 29(4):e01880.

Newman, K. B., and J. Rice. 2002. Modeling the survival of Chinook Salmon smolts outmigrating through the lower Sacramento River system. Journal of the American Statistical Association 97:983–993.

Notch, J. J., A. S. McHuron, C. J. Michel, F. Cordoleani, M. Johnson, M. J. Henderson, and A. J. Ammann. 2020. Outmigration survival of wild Chinook Salmon smolts through the Sacramento River during historic drought and high water conditions. Environmental Biology of Fishes 103:561–576.

Nowlin, W. H., R. W. Drenner, K. R. Guckenberger, M. A. Lauden, G. T. Alonso, J. E. Fennell, and J. L. Smith. 2006. Gape limitation, prey size refuges and the top-down impacts of piscivorous Largemouth Bass in shallow pond ecosystems. Hydrobiologia 563:357–369.

Perry, R. W., P. L. Brandes, J. R. Burau, P. T. Sandstrom, and J. R. Skalski. 2015. Effect of tides, river flow, and gate operations on entrainment of juvenile salmon into the interior Sacramento–San

Joaquin River Delta. Transactions of the American Fisheries Society 144:445–455.

Perry, R. W., A. C. Pope, J. G. Romine, P. L. Brandes, J. R. Burau, A. R. Blake, A. J. Ammann, and C. J. Michel. 2018. Flow-mediated effects on travel time, routing, and survival of juvenile Chinook Salmon in a spatially complex, tidally forced river delta. Canadian Journal of Fisheries and Aquatic Sciences 75:1886–1901.

Perry, R. W., J. R. Skalski, P. L. Brandes, P. T. Sandstrom, A. P. Klimley, A. Ammann, and B. MacFarlane. 2010. Estimating survival and migration route probabilities of juvenile Chinook Salmon in the Sacramento–San Joaquin River Delta. North American Journal of Fisheries Management 30:142–156.

Phillis, C. C., A. M. Sturrock, R. C. Johnson, and P. K. Weber. 2018. Endangered winter-run Chinook Salmon rely on diverse rearing habitats in a highly altered landscape. Biological Conservation 217:358–362.

Pike, A., E. Danner, D. Boughton, F. Melton, R. Nemani, B. Rajagopalan, and S. Lindley. 2013. Forecasting river temperatures in real time using a stochastic dynamics approach. Water Resources Research 49:5168–5182.

Poytress, W. R., J. J. Gruber, F. D. Carrillo, and S. D. Voss. 2014. Compendium report of Red Bluff Diversion Dam rotary trap juvenile anadromous fish production indices for years 2002–2012. U.S. Fish and Wildlife Service, Red Bluff, California.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout, 1st edition. University of Washington Press, Seattle.

R Core Team. 2020. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna.

Runge, C. A., T. G. Martin, H. P. Possingham, S. G. Willis, and R. A. Fuller. 2014. Conserving mobile species. Frontiers in Ecology and the Environment 12:395–402.

Sabal, M. C., M. S. Boyce, C. L. Charpentier, N. B. Furey, T. M. Luhring, H. W. Martin, M. C. Melnychuk, R. B. Srygley, C. M. Wagner, A. J. Wirsing, R. C. Ydenberg, and E. P. Palkovacs. 2021. Predation landscapes influence migratory prey ecology and evolution. Trends in Ecology and Evolution 36:737–749.

Sabal, M., S. Hayes, J. Merz, and J. Setka. 2016. Habitat alterations and a nonnative predator, the Striped Bass, increase native Chinook Salmon mortality in the Central Valley, California. North American Journal of Fisheries Management 36:309–320.

Seber, G. A. 1965. A note on the multiple-recapture census. Biometrika 52:249–259.

Singer, G. P., E. D. Chapman, A. J. Ammann, A. P. Klimley, A. L. Rypel, and N. A. Fangue. 2020. Historic drought influences outmigration dynamics of juvenile fall and spring-run Chinook Salmon. Environmental Biology of Fishes 103:543–559.

Sturrock, A. M., S. M. Carlson, J. D. Wikert, T. Heyne, S. Nusslé, J. E. Merz, H. J. W. Sturrock, and R. C. Johnson. 2020. Unnatural selection of salmon life histories in a modified riverscape. Global Change Biology 26:1235–1247.

Thorpe, J. 1994. Reproductive strategies in Atlantic Salmon, *Salmo salar* L. Aquaculture Research 25:77–87.

Thorstad, E. B., F. Whoriskey, I. Uglem, A. Moore, A. H. Rikardsen, and B. Finstad. 2012. A critical life stage of the Atlantic Salmon *Salmo salar*: behaviour and survival during the smolt and initial post-smolt migration. Journal of Fish Biology 81:500–542.

USFWS (U.S. Fish and Wildlife Service). 2004. Impacts of riprapping to aquatic organisms and river functioning, lower Sacramento River. USFWS, Sacramento, California.

Vigg, S., T. P. Poe, L. A. Prendergast, and H. C. Hansel. 1991. Rates of consumption of juvenile salmonids and alternative prey fish by Northern Squawfish, Walleyes, Smallmouth Bass, and Channel Catfish in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:421–438.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46(Supplement 1):S120–S139.

Williams, A. P., E. R. Cook, J. E. Smerdon, B. I. Cook, J. T. Abatzoglou, K. Bolles, S. H. Baek, A. M. Badger, and B. Livneh. 2020. Large contribution from anthropogenic warming to an emerging North American megadrought. Science 368:314–318.

Williams, J. G. 2006. Central Valley salmon: a perspective on Chinook and steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science [online serial] 4(3):article 2.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook Salmon in the Central Valley region of California. North American Journal of Fisheries Management 18:487–521.

Zajanc, D., S. H. Kramer, N. Nur, and P. A. Nelson. 2013. Holding behavior of Chinook Salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) smolts, as influenced by habitat features of levee banks, in the highly modified lower Sacramento River, California. Environmental Biology of Fishes 96:245–256.

Zeug, S. C., K. Sellheim, J. Melgo, and J. E. Merz. 2020. Spatial variation of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) survival in a modified California river. Environmental Biology of Fishes 103:465–479.

Zeug, S. C., J. Wiesenfeld, K. Sellheim, A. Brodsky, and J. E. Merz. 2019. Assessment of juvenile Chinook Salmon rearing habitat potential prior to species reintroduction. North American Journal of Fisheries Management 39:762–777.

Zeug, S. C., and K. O. Winemiller. 2008. Relationships between hydrology, spatial heterogeneity, and fish recruitment dynamics in a temperate floodplain river. River Research and Applications 24:90–102.

SUPPORTING INFORMATION

Additional supplemental material may be found online in the Supporting Information section at the end of the article.

Alicia Forsythe

From: Alicia Forsythe
Sent: Friday, May 6, 2022 8:47 AM
To: Jerry Brown; Obegi, Doug
Subject: RE: New study concludes Sac River flows less than 21,000 cfs reduce winter-run survival
Attachments: Hassrick et al. 2022_NAJFM.pdf

Hi Doug – My apologies for taking so long to get back to you on the paper. The Sites Project Authority actually split the cost with ICF to make this paper open source as it has some key findings relative to our pulse flow protection measure. We wanted the agencies and others to be able to have easy access to it without copyright issues. The published version is attached and the on-line version is here: Factors Affecting Spatiotemporal Variation in Survival of Endangered Winter-Run Chinook Salmon Out-migrating from the Sacramento River - Hassrick - 2022 - North American Journal of Fisheries Management - Wiley Online Library.

Yesterday, I asked Jason to reach out to you to chat about the study. I've asked the Sites team to not participate in this as I want you to have a comfortable space to ask Jason questions to better understand what they looked at and the results. I expect you'll hear from Jason soon.

Again, my apologies for taking so long to get back to you on this paper. Hope you have a great weekend!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 |
aforsythe@sitesproject.org | www.SitesProject.org

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Thursday, April 14, 2022 4:36 PM
To: Obegi, Doug <dobegi@nrdc.org>; Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Re: New study concludes Sac River flows less than 21,000 cfs reduce winter-run survival

Doug – thanks for the message. Ali is out this week on vacation. Regarding the study, thank you for passing this along to us. I'm pretty sure the team is aware of the paper. Jason, the prime author, does work for ICF on the project. Ali will have more to say about it when she returns. Regarding the daily diversion tool, we'd be happy to get the right people together with your folks to work through any questions. Just let us know how we can help.

Jerry

From: Doug Obegi <dobegi@nrdc.org>
Date: Thursday, April 14, 2022 at 3:27 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>, Jerry Brown <jbrown@sitesproject.org>
Subject: FW: New study concludes Sac River flows less than 21,000 cfs reduce winter-run survival

Dear Jerry and Ali,

Thank you again for sending us the daily diversion tool, and to Jerry for coffee/tea the other morning. I wanted to follow up with two things for you:

First, I wanted to make sure that you were aware of this new peer reviewed scientific study which concludes that for juvenile winter-run Chinook salmon, migratory survival down the Sacramento River is reduced when flows are less than approximately 24,000 cfs (equivalent to 700 cubic meters per second). We've submitted this paper to CDFW (see below), and wanted to make sure that this was included in the JPA's administrative record for NEPA/CEQA since this was new information that was not available at the time of the public comment period on the EIS/EIR.

Second, we've been analyzing the potential changes in water diversions to storage using the daily diversion tool, and it appears that the proposed change to the bypass flow of 10,700 cfs from Oct to June results in an approximately 25% reduction in diversions to storage. It sounds like that is similar to what y'all are finding (our numbers are lower than what WRMWSD reported to their Board). In addition, as we have been exploring the model, we're not sure that the Delta outflow requirements in the model are actually working to limit water diversions to storage. It may be (probably is!) user error on our part, but if we're not able to get the model to work right in the next week or two we may want to check in to make sure the model is actually working correctly.

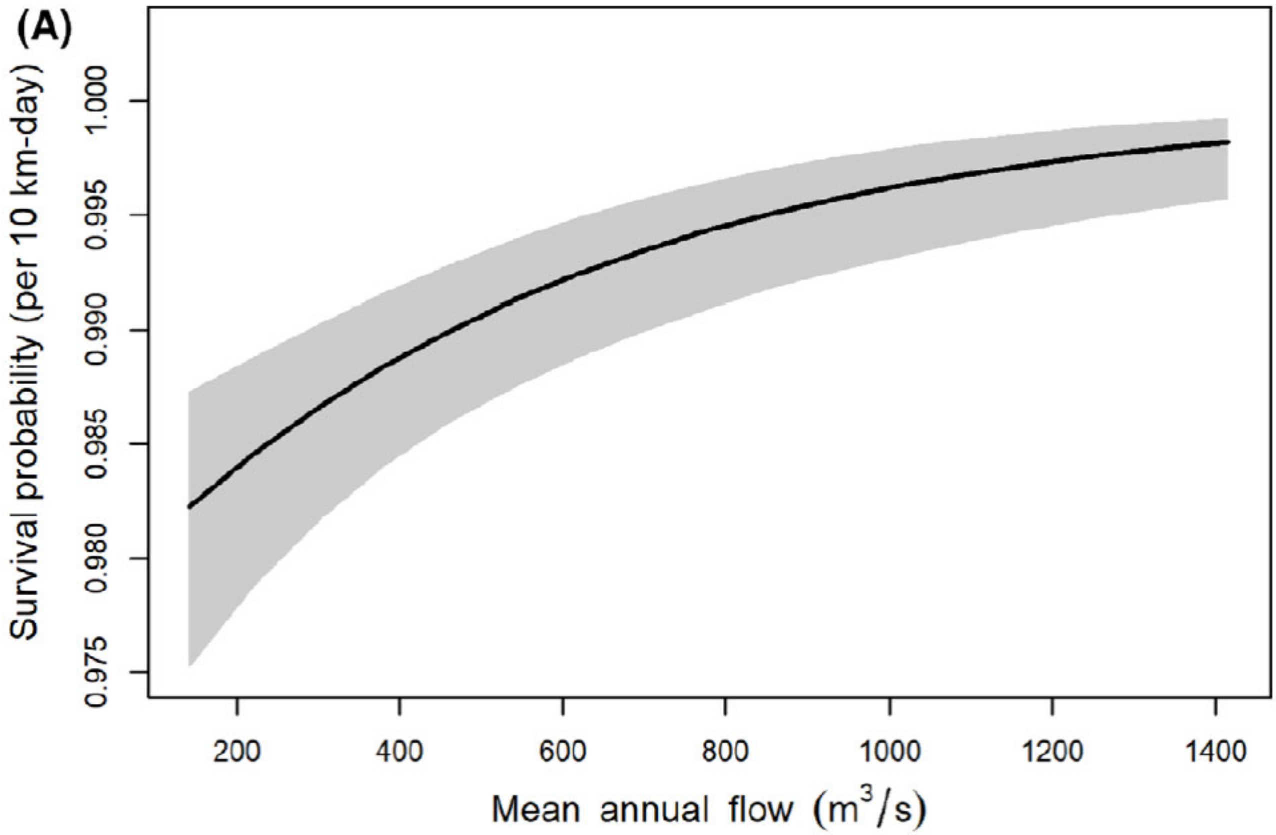
Thanks,
Doug

From: Obegi, Doug
Sent: Friday, March 25, 2022 10:52 AM
To: Kristal Davis-Fadtke <Kristal.Davis-Fadtke@wildlife.ca.gov>
Cc: jon@baykeeper.org
Subject: New study concludes Sac River flows less than 21,000 cfs reduce winter-run survival

Hi Kristal,

I wanted to make sure you were aware of this new paper, which finds that for winter-run Chinook salmon, juvenile migratory survival down the Sacramento River is reduced when flows are less than around 24,000 cfs / 700 cubic meters per second:

"For example, when flow is less than about 700 m3/s, given the confidence interval, pulse flows will have a high probability of having a positive effect on survival. The relationship also indicates what the magnitude of the effect may be. For example, when mean annual flow is 600 m3/s, a pulse flow is going to have half the effect of a pulse event than when mean annual flow is 200 m3/s."



This paper indicates that at least for hatchery winter-run Chinook salmon, higher bypass flow thresholds for Sites Reservoir than 10,700 cfs are necessary to fully mitigate impacts and avoid further reductions in juvenile survival of this endangered species.

Best,
Doug

From: Hassrick, Jason <Jason.Hassrick@icf.com>
Sent: Friday, March 25, 2022 9:23 AM
To: Obegi, Doug <dobegi@nrdc.org>
Subject: RE: FW: Request for pre-publication copy of your recent manuscript

Hi Doug,

Attached is the published paper. Thanks for your interest.

Jason

From: Obegi, Doug <dobegi@nrdc.org>
Sent: Tuesday, February 1, 2022 12:39 PM
To: Hassrick, Jason <Jason.Hassrick@icf.com>; arnold.ammann <arnold.ammann@noaa.gov>
Cc: miles.daniels@noaa.gov; Perry, Russell <rperry@usgs.gov>
Subject: RE: FW: Request for pre-publication copy of your recent manuscript

Aha – thanks!

From: Hassrick, Jason <Jason.Hassrick@icf.com>
Sent: Tuesday, February 1, 2022 12:38 PM
To: Obegi, Doug <dobegi@nrdc.org>; arnold.ammann <arnold.ammann@noaa.gov>
Cc: miles.daniels@noaa.gov; Perry, Russell <rperry@usgs.gov>
Subject: RE: FW: Request for pre-publication copy of your recent manuscript

Hi Doug,

We did not work up cumulative survival because that is something that Arnold is preparing for a separate paper. As I mentioned to you before, I'll send out the finalized paper to you after I go through the proofs. I should receive them from the journal this week.

Jason

From: Obegi, Doug <dobegi@nrdc.org>
Sent: Tuesday, February 1, 2022 12:17 PM
To: arnold.ammann <arnold.ammann@noaa.gov>
Cc: miles.daniels@noaa.gov; Hassrick, Jason <Jason.Hassrick@icf.com>; Perry, Russell <rperry@usgs.gov>
Subject: RE: FW: Request for pre-publication copy of your recent manuscript

Sorry, no, I was interested in whether y'all had calculated what the survival rate down the length of the Sacramento River would be at different flow levels, based on the survival rate per 10 km reach shown in the flow:survival curve in Figure 8A. In other words, converting the flow:survival graph in Figure 8A into survival down the entire river rather than per 10 km segment.

From: Arnold Ammann - NOAA Federal <arnold.ammann@noaa.gov>
Sent: Tuesday, February 1, 2022 12:09 PM
To: Obegi, Doug <dobegi@nrdc.org>
Cc: miles.daniels@noaa.gov; Hassrick, Jason <Jason.Hassrick@icf.com>; Perry, Russell <rperry@usgs.gov>
Subject: Re: FW: Request for pre-publication copy of your recent manuscript

Hi Doug,
We have overall river survival by year, and flow varies by year. Is that what you are looking for? I will pull up that data for you.
Arnold

On Tue, Feb 1, 2022 at 11:36 AM Obegi, Doug <dobegi@nrdc.org> wrote:

> While I have your ear… Did y'all calculate what the overall change in survival is in the Sacramento River at the different flow levels in Figure 8A (the cumulative change in survival over the entire river at the various flow levels on that curve, rather than the change per 10 km, assuming flows and other covariables held constant)?
>
> **From:** Arnold Ammann - NOAA Federal <arnold.ammann@noaa.gov>
> **Sent:** Tuesday, February 1, 2022 11:32 AM
> **To:** Obegi, Doug <dobegi@nrdc.org>
> **Cc:** miles.daniels@noaa.gov
> **Subject:** Re: FW: Request for pre-publication copy of your recent manuscript

Great!

On Tue, Feb 1, 2022 at 11:31 AM Obegi, Doug <dobegi@nrdc.org> wrote:

Yeah, it came through and I'm looking at it now.

From: Arnold Ammann - NOAA Federal <arnold.ammann@noaa.gov>
Sent: Tuesday, February 1, 2022 11:32 AM
To: Obegi, Doug <dobegi@nrdc.org>
Cc: miles.daniels@noaa.gov
Subject: Re: FW: Request for pre-publication copy of your recent manuscript

Were you able to download it? I got a system message saying it was too large.

On Tue, Feb 1, 2022 at 11:24 AM Obegi, Doug <dobegi@nrdc.org> wrote:

Thanks Arnold! Look forward to reading the paper.

Take care,

Doug

From: Arnold Ammann - NOAA Federal <arnold.ammann@noaa.gov>
Sent: Tuesday, February 1, 2022 10:57 AM
To: Obegi, Doug <dobegi@nrdc.org>
Cc: miles.daniels@noaa.gov
Subject: Re: FW: Request for pre-publication copy of your recent manuscript

Hello Doug,

Please find attached the early online version of the paper. Let me know if you have any questions about it.

Cheers,

Arnold

On Mon, Jan 31, 2022 at 1:49 PM Obegi, Doug <dobegi@nrdc.org> wrote:

Congratulations to you both on this new paper published in CJFAM! Very cool. Any chance that one of you has a pre-publication version that you could share with me?

From: Obegi, Doug
Sent: Monday, January 31, 2022 1:24 PM
To: jason.hassrick@icf.com
Subject: Request for pre-publication copy of your recent manuscript

Hi Jason,

I hope you're doing well these days. Congratulations on your new paper published in CJFAM! (https://afspubs.onlinelibrary.wiley.com/doi/abs/10.1002/nafm.10748)

Do you have a pre-publication version of the manuscript that you would be willing to share with me, since the paper is currently not open access?

Thanks,

Doug

DOUG OBEGI

*Senior Attorney**

Water Program

NATURAL RESOURCES

DEFENSE COUNCIL

111 SUTTER ST., 21ST FLOOR

SAN FRANCISCO, CA 94104

T 415.875.6100
DOBEGI@NRDC.ORG
NRDC.ORG

Please save paper.
Think before printing.

** Admitted to practice in California*

--

Arnold J. Ammann
National Marine Fisheries Service
Fisheries Ecology Division
110 McAllister Way
Santa Cruz, CA 95060
Tel: 831-331-9947
arnold.ammann@noaa.gov

--

Arnold J. Ammann
National Marine Fisheries Service
Fisheries Ecology Division
110 McAllister Way
Santa Cruz, CA 95060
Tel: 831-331-9947
arnold.ammann@noaa.gov

--

Arnold J. Ammann
National Marine Fisheries Service
Fisheries Ecology Division
110 McAllister Way
Santa Cruz, CA 95060

Tel: 831-331-9947
arnold.ammann@noaa.gov

--
Arnold J. Ammann
National Marine Fisheries Service
Fisheries Ecology Division
110 McAllister Way
Santa Cruz, CA 95060
Tel: 831-331-9947
arnold.ammann@noaa.gov

Water Right Application Update

January 31, 2023

Sites

1

Agenda

1. Introductions
2. Status of Water Right Application
3. Revised Water Availability Analysis
4. State Board's Water Availability Analysis Tool
5. Additional Topics from the Group
6. Action Items and Next Steps

 2

2

Status of Water Right Application

Sites

3

Application Status To Date

- Application submitted May 2022
- State Water Board's August 26, 2022 letter
  - Accepted the application!
  - Determined incomplete and requested additional information
    - Water Availability Analysis
      - Revise to include assessment of proposed, but not yet completed, Water Quality Control Plan Update and Voluntary Agreements
      - Changes and updates in the existing analysis methodologies
    - Missing information, revisions, and further explanation
      - 16 items in table attached to letter
      - Most are minor inconsistencies or information that would assist in the processing of the permit
- Supplemental information submitted on January 6, 2023

Draft - Predecisional Working Document - For Discussion Purposes Only 4

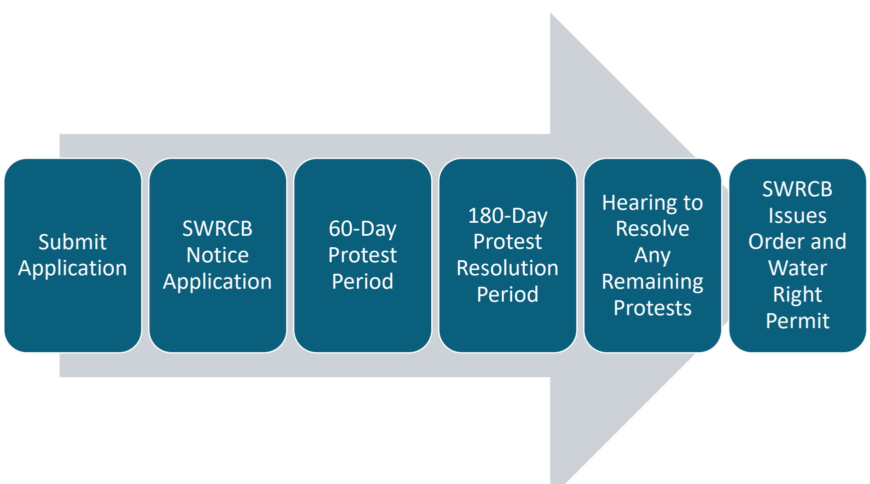
4

Key Near-term Next Steps

- Waiting to hear from the State Water Board
- Option 1 ~ maybe 45 to 90 days
  - State Water Board notifies Sites that Application is complete
  - Preparation for Noticing
  - Noticing of Application
- Option 2 ~ schedule unknown, but longer
  - State Water Board notifies Sites that additional information is needed
  - Sites prepares and submits information
  - Back to Option 1

5

Major Water Right Permit Process Steps



6

Revised Water Availability Analysis

Sites

7

Water Availability Analysis Revisions

- May 2022 approach included 3 methodologies with 4 different analyses
- January 2023 approach includes 3 methodologies with 6 different analyses
  - Expanded each to address SWRCB staff requests (to the best we can)
  - Now including:
    - 2070 CT Calsim II analysis – to address future climate change
    - ROC on LTO Alt 4 Calsim II analysis – to address possible 55% unimpaired inflow requirement in a future Water Quality Control Plan in an operational format
    - Each show reasonable likelihood of water available for the Project
  - Report was completely revised and resubmitted
- Numerous meetings with SWRCB staff to discuss approaches and work through items

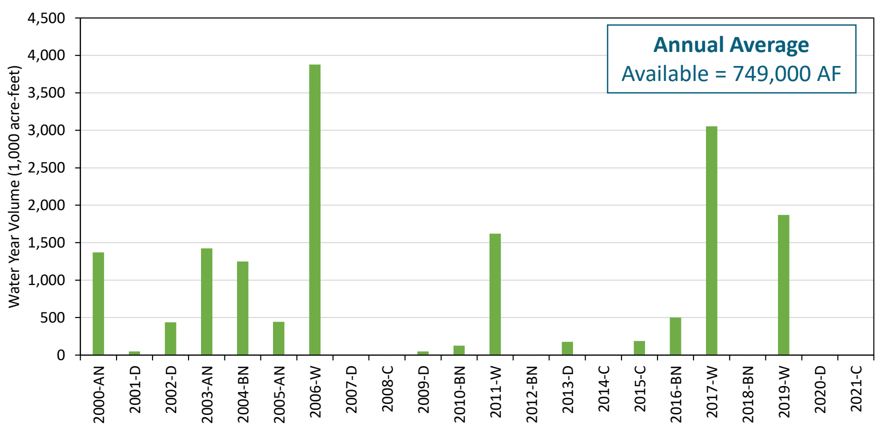
 8

8

Historical Approach – Approach and Assumptions

- Calculates availability along the "flowpath" from the Points of Diversion (Red Bluff/Hamilton City) through the Delta on a daily timestep
- Historical flow data and water right face values; includes Wilkins Slough Bypass, Bend Bridge Pulse Protection, Delta Water Quality requirements/Delta Excess
- Updates:
  - Minor correction to Bend Bridge logic (essentially no change to results)
  - Extension of analysis through the Delta (including D-1641 / BiOp requirements and export face value demands as limitations on volumes available)

Historical Approach – Available Volumes



Historical Approach – Conclusions

- Water available in 18 out of 22 years (~78%)
- Water available Dec – Jun
  - Sep-Nov availability affected mostly by water right demand assumptions
- Very conservative approach
  - Layers face value water right demands on top of observed flow conditions

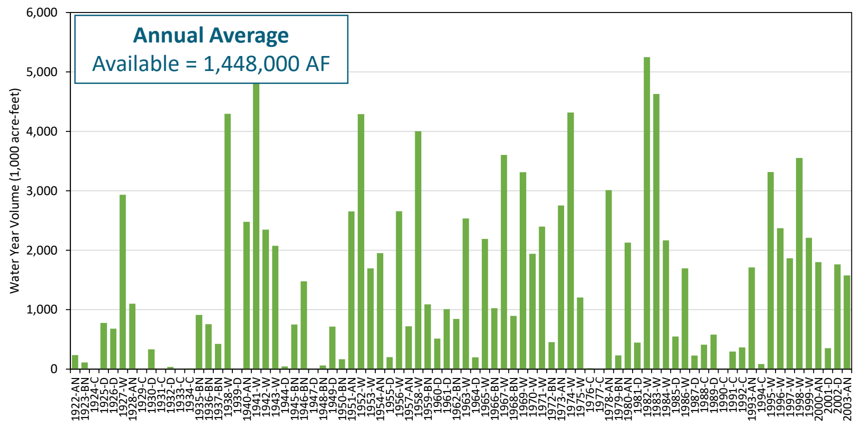
11

CalSim Approach – Approach and Assumptions

- Post-processed CalSim II model run for Alt 3 with modeling for Final EIR/EIS
  - Monthly timestep; historical hydrology, 2020 planning level demands
  - Allows for evaluation of other scenarios (such as climate change or changed regulatory requirements)
- Wilkins Slough Bypass, Bend Bridge Pulse Protection, Delta Conditions
- Updates:
  - Availability provided for both PODs
  - Refined Delta availability calculations
  - Corrected availability calculations at upstream POAs

12

CalSim Approach – Available Volumes



13

CalSim Approach – Conclusions

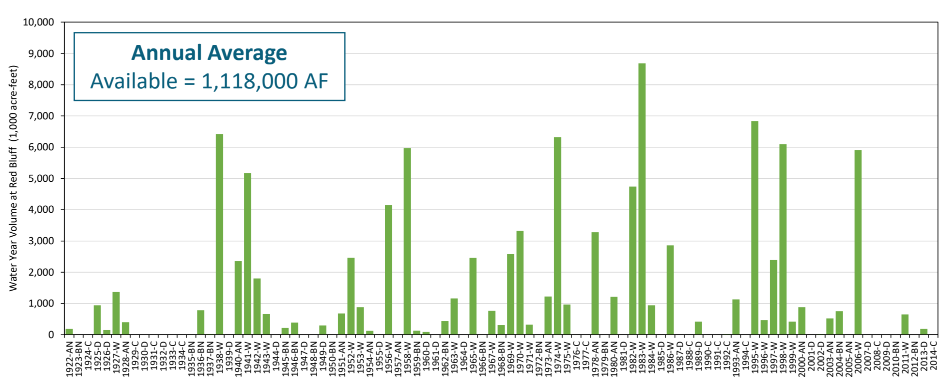
- Water available in 74 out of 82 years (~89%)
- Water available in all months of the Sites diversion season (Sept to June)
- Results provide a realistic, planning-level outlook of availability with current demands and regulatory requirements

14

Face Value Approach – Approach and Assumptions

- Theoretical approach performed at the request of SWRCB staff using unimpaired flow data and water right face values for the entire Sacramento watershed; completed on a monthly timestep
- Updates:
  - Availability at both PODs
  - Expand analysis through the Delta
  - Disaggregate Red Bluff subwatershed upstream of Shasta
  - Refined representation of face value storage demands
  - Minor corrections to select water right demands
  - Results provided at monthly timestep
  - Refined estimate of potential Sites diversions

Face Value Approach – Available Volumes



Face Value Approach – Conclusions

- Water available in 55 out of 93 years (~59%); mostly Wet and Above Normal years
- Availability typically controlled by Red Bluff or Delta
- Extremely conservative approach
  - Assumes each water right in watershed diverts full face value
  - Assumes full storage volume as demand every year
  - Includes minimal adjustments to overlapping rights/contracts

Water Availability Analysis – Summary Results

Analysis	Average (AF)	Frequency	Minimum (AF)	Maximum (AF)
Historical	749,000	18/22 (~78%)	2,000	3,878,000
CalSim II	1,448,000	74/82 (~89%)	15,000	5,249,000
Face Value	1,118,000	55/93 (~59%)	15,000	8,681,000
CalSim II with 2035 CT Climate Scenario	1,518,000	73/82 (~88%)	32,000	5,330,000
CalSim II with 2070 CT Climate Scenario	1,455,000	70/82 (~84%)	53,000	5,176,000
CalSim II ROC on LTO Alternative 4	658,000	51/82 (~61%)	10,000	4,046,000

Water Availability Analysis – Overall Conclusions

- Thorough analysis used three separate approaches with varying degree of conservatism
- All analyses indicate:
  - Reasonable likelihood of water available for Sites Project diversions
  - Additional water available beyond the Sites Project diversions
    - Sites is not taking ALL of the available water in the system
- By including FV demands (Historical/Face Value) and planning level demands (CalSim), Sites is consistent with VAs since Sites does not rely on VA flows to calculate water available for Sites
- Together, the refined WAA meets all requests in the SWRCB's August Letter

State Board's Water Availability Analysis Tool

Sites

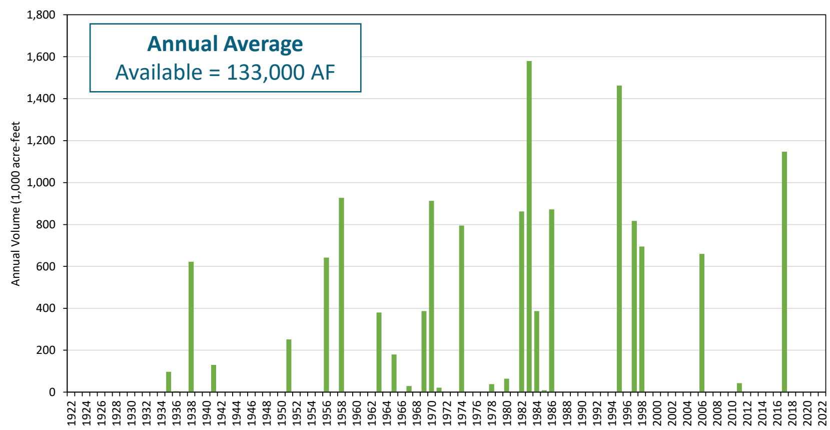
State Water Board WAA Tool

- SWRCB Staff developed **water availability tool** based off Water Unavailability Methodology spreadsheet
- Estimates water available for Sites Application No. A025517X01, priority date 9/30/1977
- Covers entire Bay-Delta watershed
- Relies upon DWR and CNRFC unimpaired flow data
- Developed their own face value demand dataset
- Completed on a monthly timestep for WY 1922 – 2022

Water Availability Tool from SWRCB Staff

- Potential regulatory requirement analyzed:
  - 55% of unimpaired flow in Sacramento Watershed (including Delta eastside tributaries) is bypassed year-round as Delta outflow
  - 40% of unimpaired flow from San Joaquin River tributaries is bypassed February through June
- Theoretical analysis (some similarities to our Face Value Approach)
  - Less water is shown available for diversion by Sites compared to other analyses
- SWRCB Staff requested evaluation of results with Bend Bridge Pulse Protection and Wilkins Slough Bypass requirement

State Water Board WAA Tool – Summary Results



Results with Bend Bridge Pulse Protection and Wilkins Slough Bypass requirement

State Water Board WAA Tool – Overall Conclusions

- Water available in 27 out of 101 years (~27%); mostly in Wet years
- Although Sites performed analysis using the State Board WAA Tool, does not approve or endorse the Tool or the results produced by the Tool
- Many outstanding questions/concerns regarding approach
  - Uncertain purpose
    - Inclusion of unimpaired flow requirement; inclusion of Bend Bridge Pulse Protection and Wilkins Slough Bypass
  - Concerns with development of demand dataset
  - Return flows
  - Theoretical approach, does not represent actual system operations

Additional Topics from the Group

25

Action Items and Next Steps

26

Questions?

27

28

Sites Project Operations and Water Right Overview

January 2023

Sites

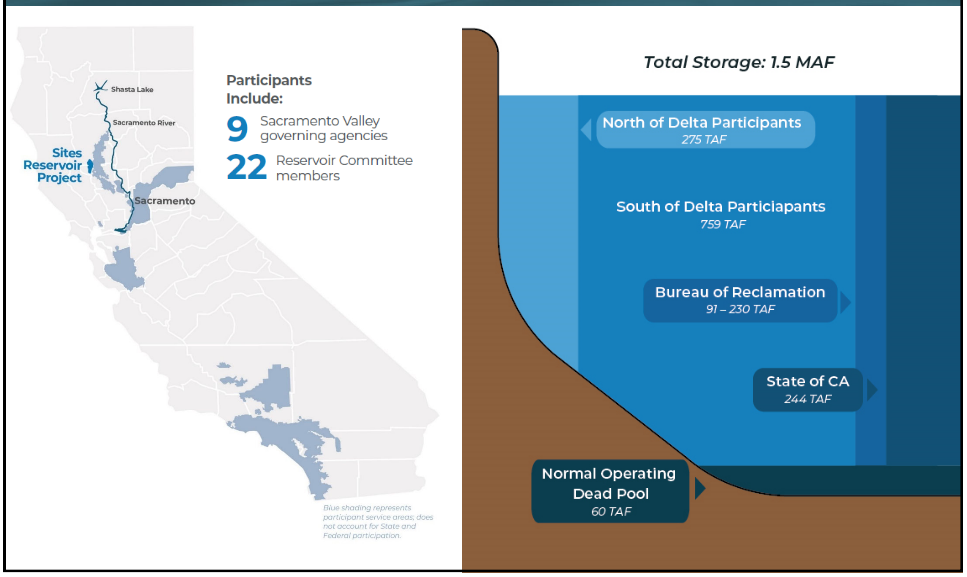
1

Project Overview

Sites

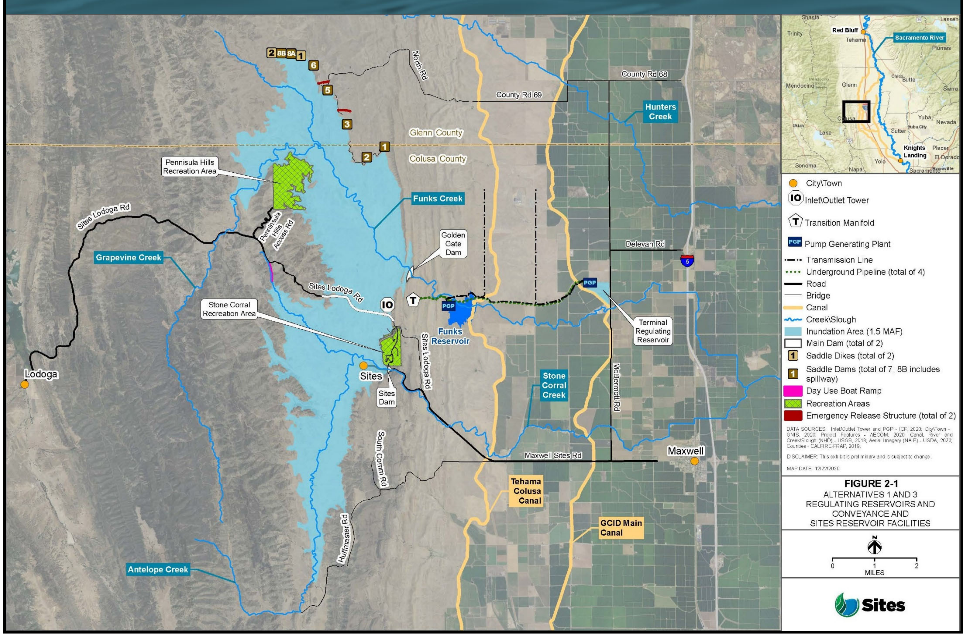
2

What is the Sites Project?



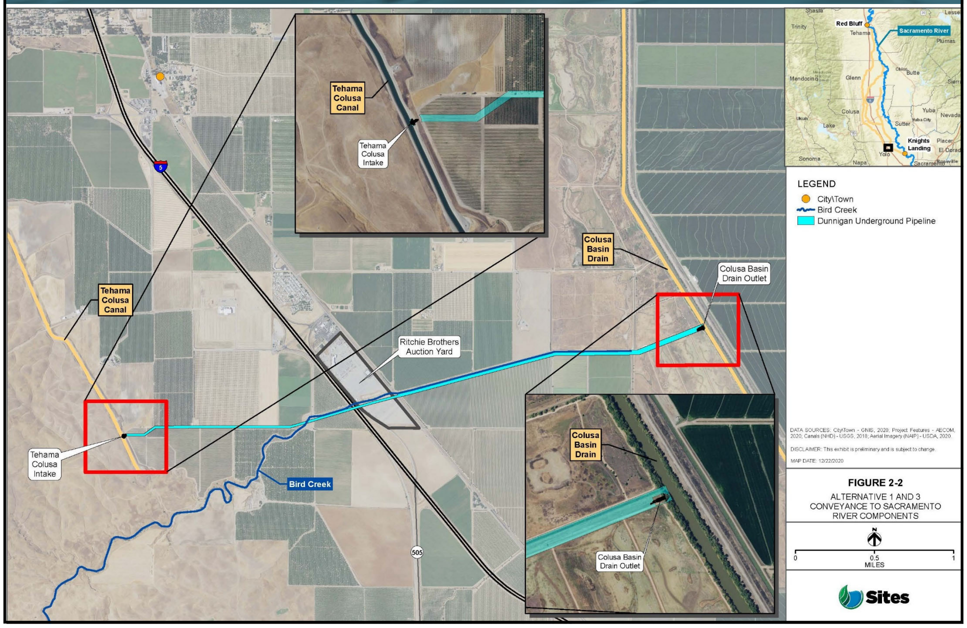
3

Alternative 1 and 3 Facilities



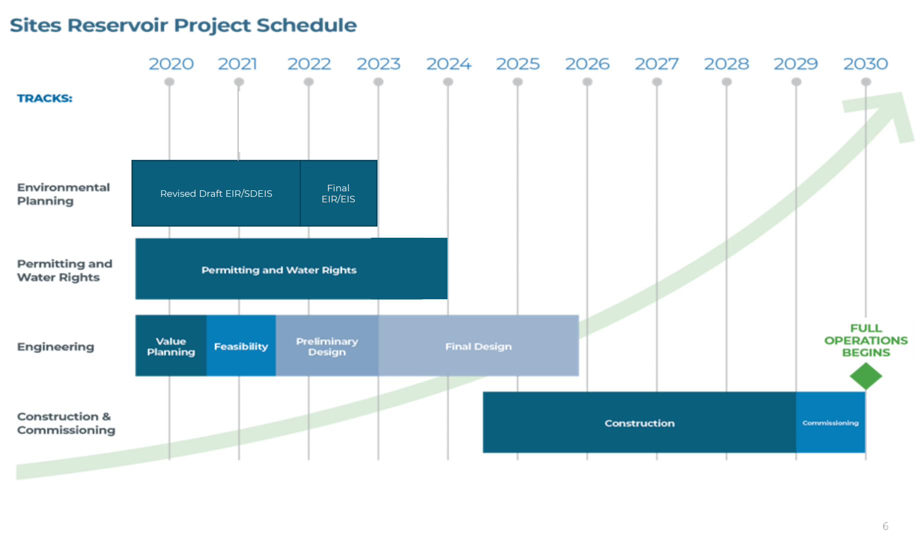
4

Alternative 1 and 3 Facilities



5

Project Schedule



6

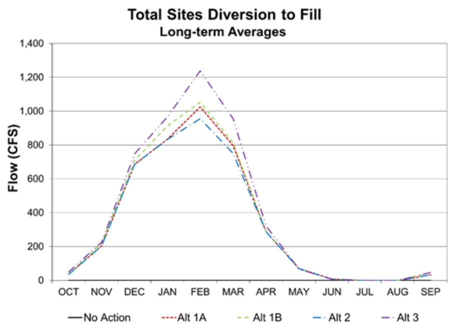
Operations Overview

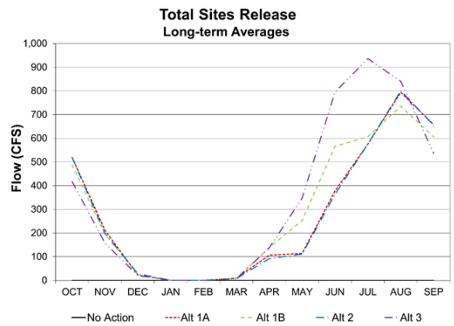
- Sites seeking to divert Sacramento River flows when all of the following conditions are met:
  - Flows exceed minimum project diversion criteria
  - Delta is in “excess” conditions as determined by Reclamation and DWR under the Coordinated Operations Agreement
  - Senior downstream water rights have been satisfied
  - Flows are available above those needed to meet all applicable laws, regulations, BiOps and court orders in place at the time of diversion
  - Season of diversion = Sept 1 to June 14; when Sacramento River is not fully appropriated
- Project-Specific Criteria:
  - Wilkins Slough Bypass flows
  - Pulse flow protection

Annual Operations

- Diversions
- Exchanges
  - Reclamation
  - DWR
- Releases
  - TC Canal
  - GCID Canal
  - North Delta (Yolo Bypass)
  - South of Delta
- Exports through the Delta

Diversions and Releases





9

Water Right Approach – Application #A025517X01

Sites

10

State Filing – Petition to Assign

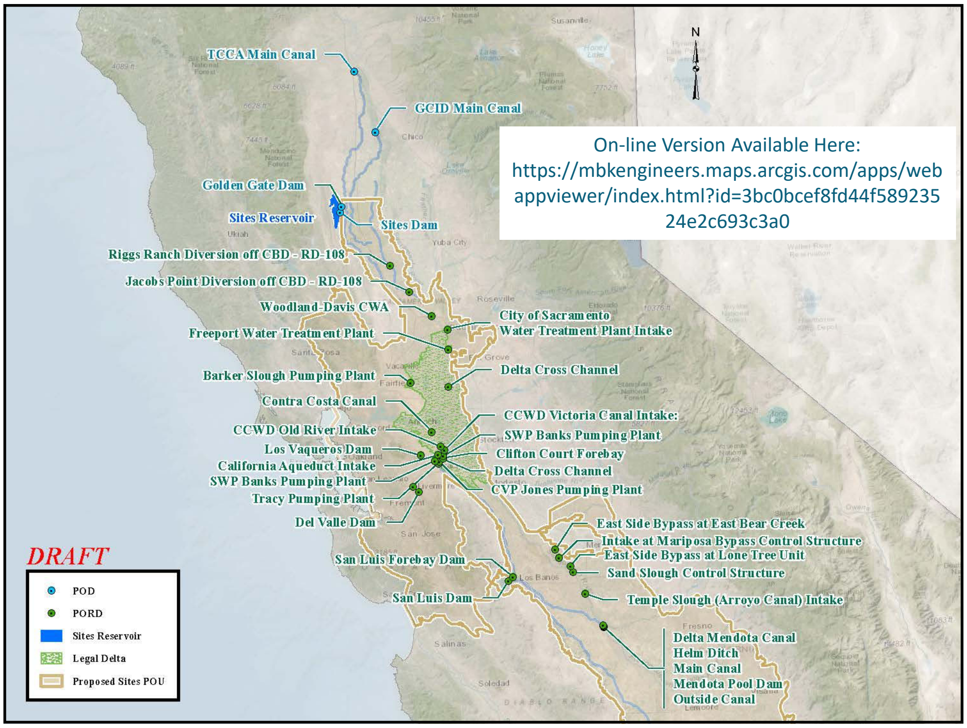
- Petition to amend and assign State Filing A025517 (Colusa Reservoir)
  - Priority date of 9/30/77
- Request release from priority
  - A025514 (Glenn Reservoir)
  - A025513 (Glenn Reservoir - power)
  - Among other State filings in the Sacramento River watershed
- Sites water right application is for diversion of Sites water only – no diversions of CVP or SWP water is included in water right
  - Some Sites water is provided to Reclamation as a participant
  - Sites is not applying for a water right to divert or redivert Trinity River water

11

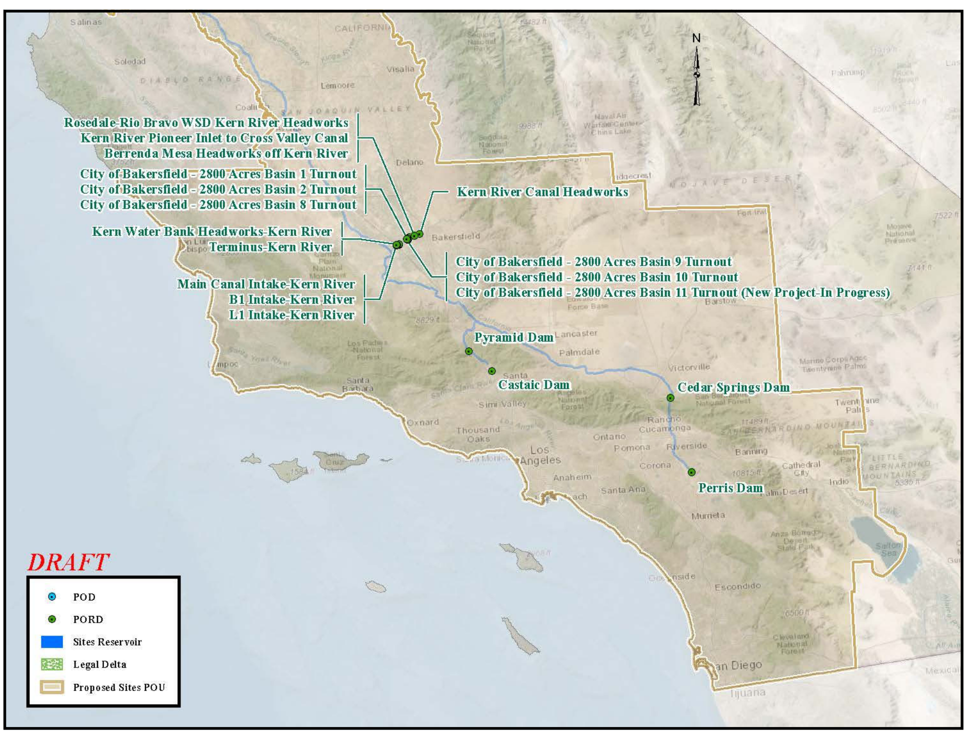
Key Water Right Parameters

- Sources
  - Sacramento River
  - Stone Corral and Funks creeks
- Points of Diversion
  - Tehama-Colusa Canal (existing, screened facility)
  - Glenn-Colusa Irrigation District's Main Canal (existing, screened facility)
  - Sites Dam and Golden Gate Dams
- Diversion to storage = 1,500,000 AF; no direct diversion
- Points of Rediversion and Place of Use on next slides

12


TCCA Main Canal
GCID Main Canal
On-line Version Available Here:
https://mbkengineers.maps.arcgis.com/apps/webappviewer/index.html?id=3bc0bcef8fd44f58923524e2c693c3a0
Golden Gate Dam
Sites Reservoir
Sites Dam
Riggs Ranch Diversion off CBD - RD-108
Jacobs Point Diversion off CBD - RD-108
Woodland-Davis CWA
City of Sacramento Water Treatment Plant Intake
Freeport Water Treatment Plant
Delta Cross Channel
Barker Slough Pumping Plant
Contra Costa Canal
CCWD Victoria Canal Intake:
CCWD Old River Intake
SWP Banks Pumping Plant
Los Vaqueros Dam
Clifton Court Forebay
California Aqueduct Intake
Delta Cross Channel
SWP Banks Pumping Plant
CVP Jones Pumping Plant
Tracy Pumping Plant
Del Valle Dam
East Side Bypass at East Bear Creek
Intake at Mariposa Bypass Control Structure
East Side Bypass at Lone Tree Unit
DRAFT
San Luis Forebay Dam
Sand Slough Control Structure
San Luis Dam
Temple Slough (Arroyo Canal) Intake
Delta Mendota Canal
Helm Ditch
Main Canal
Mendota Pool Dam
Outside Canal
POD
PORD
Sites Reservoir
Legal Delta
Proposed Sites POU

13


Rosedale-Rio Bravo WSD Kern River Headworks
Kern River Pioneer Inlet to Cross Valley Canal
Berrenda Mesa Headworks off Kern River
City of Bakersfield - 2800 Acres Basin 1 Turnout
City of Bakersfield - 2800 Acres Basin 2 Turnout
City of Bakersfield - 2800 Acres Basin 8 Turnout
Kern River Canal Headworks
Kern Water Bank Headworks-Kern River
Terminus-Kern River
City of Bakersfield - 2800 Acres Basin 9 Turnout
City of Bakersfield - 2800 Acres Basin 10 Turnout
City of Bakersfield - 2800 Acres Basin 11 Turnout (New Project-In Progress)
Main Canal Intake-Kern River
B1 Intake-Kern River
L1 Intake-Kern River
Pyramid Dam
Castaic Dam
Cedar Springs Dam
Perris Dam
DRAFT
POD
PORD
Sites Reservoir
Legal Delta
Proposed Sites POU

14

Water Right Terms

Sites

15

Special or Project-Specific Terms

- Right now, envisioning 5 for the Project
  1. Winter water rights
  2. Funks and Stone Corral Creeks Flows
  3. Diversion Criteria
  4. CVP and SWP
  5. Trinity River
- Items 1 to 3 were included in our May 2022 application
- Items 4 and 5 were included in our January 2023 supplemental information response
- Proactively addressing issues and concerns

16

Winter Water Right Term

- Diversions of water under the following listed water rights shall have priority over the right to divert water under this permit:
  1. AGENCY appropriative water right issued pursuant to Permit XXXXX (Application YYYYYY);

Priority Date	Application	Owner
12/22/1977	A025616	City Of West Sacramento
05/01/1978	A025727	Natomas Central Mutual Water Co
09/07/1984	A028238	Willow Creek Mutual Water Co
04/19/1994	A030358	Woodland-Davis Clean Water Agency
11/02/1994	A030410	Pelger Mutual Water Company
05/30/1995	A030445	Maxwell Irrigation District
06/13/1995	A030454	Sacramento County Water Agency
11/19/1998	A030812	Princeton-Codora-Glenn Irrigation District
11/19/1998	A030813	Provident Irrigation District
02/18/1999	A030838	Glenn-Colusa Irrigation District
05/13/2003	A031436	Reclamation District #108
01/20/2012	A031919	River Garden Farms

Funks and Stone Corral Creeks Flows Term

- Proposed Term summary
  - Within 1 year of permit issuance, prepare Technical Studies Plan to collect information necessary to address Fish and Game Code 5937
    - Develop in consultation with CDFW, USFWS, and Colusa County
    - Implement Study Plan
  - Within 5 years of permit issuance, develop Funks and Stone Corral Creek Operations Plan
    - Describe approach to addressing 5937 requirements, if any
    - Approach for releases
    - Monitoring plan
    - Develop in consultation with CDFW, USFWS, and Colusa County
    - Approved by Deputy Director for Water Rights
- Term mimics the text in the RDEIR/SDEIS

Diversion Criteria Term

- Diversions under this permit shall be subject to the Permittee complying with the California Endangered Species Act (Fish & G. Code, § 2050 et seq.), including any conditions of approval relative to Permittee's water operations in an Incidental Take Permit

CVP and SWP Term

- No diversion is authorized that would adversely affect the operation of the CVP or SWP under the Projects' existing water rights in effect on the date of this Order and as such existing water rights may be modified.
- An adverse effect shall be deemed to result from permittee's diversion at any time Reclamation and DWR have declared the Delta to be in balanced water conditions under the Coordinated Operation Agreement, unless otherwise agreed by Reclamation and DWR.
- An adverse effect shall also include any time that such diversion would directly or indirectly require the CVP or SWP to release water from storage or to reduce their diversion or rediversion of water from the Delta to provide or assure flow in the Delta required to meet any applicable provision of state or federal law.
- All Sites Project diversions shall comply with the provisions of any operations agreement among DWR, Reclamation, and the Sites Authority, as may be amended from time to time.

Trinity River Term

- The Sites Project's diversions to storage under this Permit shall not include the diversion or rediversion of Trinity River water (water diverted by Reclamation from the Trinity River watershed into the Sacramento River watershed pursuant to its water rights) unless the Trinity River water is abandoned in the Sacramento River and all other diversion criteria in this Permit are met.
- Furthermore, the Sites Project's diversions to storage under this Permit shall not negatively impact Trinity River obligations of Reclamation, including but not limited to those obligations specified in the 1959 Contract between the United States and Humboldt County, the Trinity River Mainstem Fishery Restoration Record of Decision, and the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River, and related obligations in the Bureau of Reclamation's water right permits 11966, 11967, 11968, 11969, 11970, 11971, 11972, and 11973.

Standard Terms

- Included these in our application
  - Term 90, Reduction of Diversion Season
    - Subject to prior rights; during some years, water will not be available for diversion during portions or all of the season authorized
  - Term 91, Inbasin Entitlements
    - No diversion authorized when satisfaction of inbasin entitlements requires supplemental releases by CVP and SWP
  - Term 96, Reserved Jurisdiction for Bay-Delta Plan Amendments
    - SWRCB reserves jurisdiction to amend water right to establish new and modified Bay-Delta Plan
  - Term 70, Compliance Plan (mandatory)
    - Compliance Plan required identifying how water right holder will comply with the terms and conditions of water right
- List is not exhaustive of what we expect in the permit. More will come during the protest resolution process and at final permit issuance

Water Availability Analysis

Sites

23

Requirements and Approach Overview

- Projects seeking to appropriate water must demonstrate a "Reasonable likelihood of water available for appropriation"
- Three approaches, 6 analyses
  - Historical
  - CalSim II
    - Historical hydrology
    - Climate change – 2035 Central Tendency
    - Climate change – 2070 Central Tendency
    - Unimpaired Flow – Based on Reclamation's Alternative 4 in their 2019 Reconsultation EIS
  - Face Value
- Voluntary Agreements addressed qualitatively

Draft - Predecisional Working Document - For Discussion Purposes Only 24

24

Summary of Approaches/Assumptions

Approach	Time Period	Supply	Demand
Historical	Daily data from January 2000 – September 2021	Historical flow data from 5 gages on Sacramento River from Red Bluff to Freeport	Face value of all water rights in Sacramento River reach and Delta Conditions
CalSim II			
Historical hydrology	Monthly analysis for water years 1922-2003	Historical hydrology	2030 planning level demands
Climate change – 2035 Central Tendency	Monthly analysis for water years 1922-2003	2035 central tendency	2030 planning level demands
Climate change – 2070 Central Tendency	Monthly analysis for water years 1922-2003	2070 central tendency developed for WSIP projects	2030 planning level demands
Unimpaired Flow – Based on Reclamation's Alternative 4 in their 2019 Reconsultation EIS	Monthly analysis for water years 1922-2003	Historical hydrology with modifications to account for a 55% unimpaired inflow requirement	2030 planning level demands
Face Value	Analyzed on a seasonal basis for water years 1922-2014	Monthly unimpaired flow data from DWR Natural Flow report	Water right face value throughout Sacramento Watershed (~8,500 water rights)

Summary of Results

Approach	Result Take-away	Annual Average Available (AFY)	Max Water Available (AF)
Historical	Water available in all year types* and 18 of 22 years	748,000	3,879,000
CalSim II			
Historical hydrology	Water available in all year types and 74 of 82 years	1,448,000	5,249,000
Climate change – 2035 Central Tendency	Water available in all year types and 73 of 82 years	1,518,000	5,330,000
Climate change – 2070 Central Tendency	Water available in all year types and 70 of 82 years	1,455,000	5,176,000
Unimpaired Flow – Based on Reclamation's Alternative 4 in their 2019 Reconsultation EIS	Water available in all year types and 73 of 82 years	1,518,000	5,330,000
Face Value	Water available mainly in wet and above normal years and 55 of 93 years	1,118,000	8,681,000

*Based on the Sacramento Valley Water Year Index (40-30-30 Index)

Water Availability Analysis – Overall Conclusions

- Thorough analysis used three separate approaches with six different analyses conducted with varying degree of conservatism
- All analyses indicate:
  - Reasonable likelihood of water available for Sites Project diversions
  - Additional water available beyond the Sites Project diversions
    - Sites is not taking ALL of the available water in the system

27

Water Right Schedule

Sites

28

Water Right Schedule

- May 2022 – Submitted Application
- August 2022 – State Water Board accepted application and requested additional information
- January 2023 – Sites submitted additional information
- Early Spring 2023 – State Board Notice
- Late Spring/Summer/Fall 2023 – Formal Protest Resolution Period
- Late Spring 2023 – Final EIR/EIS
- Winter 2023/early Summer 2024 – Hearing on remaining protests (mandatory hearing for State filing)
- Late Summer 2024 – State Board issues Order and water right

Draft - Predecisional Working Document - For Discussion Purposes Only 29

29

Ali Forsythe
916-880-0676
aforsythe@sitesproject.org

30

Sites

31

January 6, 2023

Erik Ekdahl, Deputy Director
Division of Water Rights
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814
Sent via electronic mail only

Subject: Application A025517X01 of Sites Project Authority, Response to the State Water Resources Control Board, Division of Water Rights Staff's August 26, 2022 Letter

Dear Mr. Ekdahl:

The Sites Project Authority submitted a water right application for the Sites Reservoir Project (Project) on May 11, 2022. The Authority received your letter dated August 26, 2022, accepting the Authority's application and assigning it Application number A025517X01. Your August 26, 2022 letter requested that the Authority submit additional information within 60 days to address what the State Water Resources Control Board (State Water Board), Division of Water Rights (Division) staff determined to be incomplete aspects of the application.

On October 24, the Authority requested, and Division staff approved a short time extension to October 28, 2022 to allow Authority staff to confer with the Authority's Board of Directors on a longer time extension request. On October 27, 2022, the Authority requested until January 6, 2023, to submit the additional information identified in the Division's August acceptance letter. On October 28, 2022, the Division approved this requested time extension.

This letter and its enclosures respond to all aspects of your August 26, 2022 letter and information request. All enclosures have been submitted electronically via the State Water Board's FTP sites, as arranged with Division staff. In addition to the electronic submittal, maps providing supplemental information regarding the place of use and hydropower facilities (one original and one copy) are hand-delivered with this letter. The Authority requests that the Notice of Application for the Sites water right be immediately issued.

The enclosed Memorandum details how the Authority has addressed each information request and identifies where to find the response in the following packet. In developing the enclosed materials, the Authority worked extensively with Division staff to better understand and completely address the individual information requests. Through this close coordination and the assistance of your staff, the Authority has responded to your letter and satisfied all of the information requests. We appreciate your commitment of staff resources to review this important Project and work directly with the Authority and its team in substantive dialogue.

As described in our May 2022 letter, the Authority's 2020 Strategic Plan identified the values of trust and integrity, environmental stewardship and proactive innovation. Based on these values, the Authority has continued to reach out to water agencies, regulatory agencies, and non-governmental organizations to understand and address their concerns. To this end, the enclosed materials include two additional project-specific terms. These terms address concerns expressed by the Bureau of Reclamation and Department of Water Resources and concerns expressed by Trinity River interests. By including these terms, the Authority requests that the State Water Board include these terms in the Authority's water right permit in addition to the three project-specific terms and four standard terms requested in our application. The Authority requests that the State Water Board notice the application with all five project-specific terms and four standard terms. The Authority will continue to proactively meet and confer with interested parties and attempt to collaboratively develop mutually agreeable solutions.

We appreciate State Water Board staff's continued efforts on this urgently needed Project as we work to develop this 21st Century, climate adapted, water storage system for the benefit of California's farms, cities, and environment for generations to come. If there are any questions on this submittal or its contents please contact me at jbrown@sitesproject.org or 925-260-7417 or Alicia Forsythe, Environmental Planning and Permitting Manager, at aforsythe@sitesproject.org or 916-880-0676. We look forward to expeditious processing and completion of the Authority's application in a collaborative manner.

Sincerely,

Jerry Brown
Executive Director

Enclosures

ec: Amanda Montgomery, Division of Water Rights
Amanda.montgomery@waterboards.ca.gov

Sites

Jelena Hartman, Division of Water Rights
Jelena.hartman@waterboards.ca.gov

Kristal Davis-Fadtke, California Department of Fish and Wildlife
kristal.davis-fadtke@wildlife.ca.gov

Joseph Yun, California Water Commission
joseph.yun@water.ca.gov

Anna Naimark, California Environmental Protection Agency
anna.naimark@calepa.ca.gov

Proposed Sites-Specific Water Right Terms

Since submitting its water right application on May 11, 2022, the Sites Project Authority (Authority) has continued to coordinate with the Department of Water Resources (DWR) and the Bureau of (Reclamation) to develop a mutually agreeable, Sites-specific term. In addition, the Authority has proactively reached out to water agencies, regulatory agencies, tribal entities, and non-governmental organizations to discuss the Project's water right application approach, identify concerns, and proactively address those concerns. As a result of this ongoing coordination, the Authority requests that the two additional terms below be included in the Project's water right permit.

Central Valley Project & State Water Project Term

No diversion is authorized that would adversely affect the operation of the Central Valley Project or State Water Project under the Projects' existing water rights in effect on the date of this Order and as such existing water rights may be modified. An adverse effect shall be deemed to result from permittee's diversion at any time the Bureau of Reclamation and the Department of Water Resources have declared the Delta to be in balanced water conditions under the Coordinated Operation Agreement, unless otherwise agreed by the Bureau of Reclamation and the Department of Water Resources. An adverse effect shall also include any time that such diversion would directly or indirectly require the Central Valley Project or the State Water Project to release water from storage or to reduce their diversion or rediversion of water from the Delta to provide or assure flow in the Delta required to meet any applicable provision of state or federal law. All Sites Project diversions shall comply with the provisions of any operations agreement among the Department of Water Resources of the State of California, the Bureau of Reclamation, and the Sites Reservoir Joint Powers Authority, as may be amended from time to time.

Trinity River Term

The Sites Project's diversions to storage under this Permit shall not include the diversion or rediversion of Trinity River water (water diverted by the Bureau of Reclamation from the Trinity River watershed into the Sacramento River watershed pursuant to its water rights) unless the Trinity River water is abandoned in the Sacramento River and all other diversion criteria in this Permit are met.

Furthermore, the Sites Project's diversions to storage under this Permit shall not negatively impact Trinity River obligations of the Bureau of Reclamation, including but not limited to those obligations specified in the 1959 Contract between the United States and Humboldt County, the Trinity River Mainstem Fishery Restoration Record of Decision, and the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River, and related obligations in the Bureau of Reclamation's water right permits 11966, 11967, 11968, 11969, 11970, 11971, 11972, and 11973.

Alicia Forsythe

From: Alicia Forsythe
Sent: Wednesday, February 1, 2023 5:14 PM
To: Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Tom Biglione; earth1stdoug@gmail.com; Jerry Brown; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber; Chris Shutes
Subject: RE: Sites Project - January 2023 Water Right Submittal for NGOs
Attachments: 202301_NGO Water Right Update_Final.pdf; 202301_Sites Water Right Presentation.pdf; 20230106 _Sites Response to Aug 26 SB Letter_Final Cover Letter.pdf; App H - Water Rights Terms.pdf

Categories: Needs to Get Done

Hi all - Thanks for your patience as I conferred with the Sites team on the action items from our call yesterday. Below are the action items that we noted. Please let me know if I missed anything or have missed characterized anything.

1. Send Presentation, Presentation slides on new terms, and new term language submitted – Attached
2. Send summary table of Water Availability Analysis diversion results
3. Send Reservoir elevation sequencing from the CALSIM II modeling analysis for the Final EIR/EIS
4. Confirm / identify inches per year reservoir losses
5. Confirm / identify seepage loss approach for Final EIR/EIS
6. Schedule follow on meeting to discuss how Sites was incorporated into the CALSIM modeling and Operations Plan
7. Schedule follow on meeting to discuss anticipated water temperatures, reservoir release temperatures, water temperatures into the Sacramento River, inlet/outlet tower characteristics, and reservoir stratification

Attached is the presentation from yesterday along with a general water right presentation that we use – this is where I pulled the 2 new special term slides from (see slide 20 for the CVP/SWP term and slide 21 for the Trinity River term). I've also attached our January 6 letter to the State Water Board and Appendix H of the January 6 submittal. The letter reflects our request to the Board to include these two terms in our permit and Appendix H is the same term language provided to the Board.

We'll get moving on our other action items and will circle back next week.

Thanks again for the great discussion yesterday!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

-----Original Appointment-----
From: Alicia Forsythe
Sent: Friday, January 20, 2023 10:07 AM
To: Alicia Forsythe; Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber
Cc: Tom Biglione; earth1stdoug@gmail.com; Jerry Brown
Subject: Sites Project - January 2023 Water Right Submittal for NGOs
When: Tuesday, January 31, 2023 1:00 PM-2:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Agenda to be provided a few days prior to the meeting.

____

Microsoft Teams meeting

Join on your computer, mobile app or room device
[Click here to join the meeting]

Meeting ID: 244 565 499 842
Passcode: spJB4G
Download Teams | Join on the web

Or call in (audio only)
+1 916-538-7066,,76319708# United States, Sacramento
Phone Conference ID: 763 197 08#
Find a local number | Reset PIN

Learn More | Meeting options

____

Sites Project Water Availability Analysis – Estimated Annual Diversions

Analysis	Average (AF)	Frequency	Minimum (AF)	Maximum (AF)	Report Location
Historical*	287,000	18/22 (~78%)	2,000	1,236,000	p. 153
CalSim II	276,000	73/82 (~88%)	7,000	1,055,000	p. 176
Face Value*	330,000	55/93 (~59%)	15,000	1,383,000	p. 196
CalSim II with 2035 CT Climate Scenario	303,000	73/82 (~88%)	2,000	967,000	p. 179
CalSim II with 2070 CT Climate Scenario	309,000	70/82 (~84%)	10,000	1,114,000	p. 182
CalSim II ROC on LTO Alternative 4*	327,000	51/82 (~61%)	10,000	1,763,000	p. 185
State Board WAA Tool*	57,000	27/101 (~27%)	4,000	565,000	App B; p. 15

*Estimates only consider diversion facility capacity and do not account for reservoir capacity or operations

Alicia Forsythe

From: Alicia Forsythe
Sent: Thursday, February 23, 2023 2:46 PM
To: Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Tom Biglione; earth1stdoug@gmail.com; Jerry Brown; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber; Chris Shutes

Subject: RE: Sites Project - January 2023 Water Right Submittal for NGOs
Attachments: SPJPA_Sites_SitesStorageAndWSE_ALT3_051722_20230220.xlsx; 20230204_Sites WAA Estimated Diversions.pptx

Categories: Needs to Get Done

Hello all – Thanks for your continued patience. The foot surgery was a little more than I was expecting so I've been working to catch up on a number of things. Below are the action items from our late January call and the status of each one.

1. Send Presentation, Presentation slides on new terms, and new term language submitted – Attached to Feb 1 email

2. Send summary table of Water Availability Analysis diversion results – Attached PowerPoint file titled "20230204_Sites WAA Estimated Diversions" with the diversion results.

3. Send Reservoir elevation sequencing from the CALSIM II modeling analysis for the Final EIR/EIS – Attached Excel file titled "SPJPA_Sites_SitesStorageAndWSE_ALT3_051722_20230220". This provides both the elevation and volume of storage for Alternative 3, the Authority's preferred project using the revised diversion criteria and modeling that will come out in the Final EIR/EIS.

4. Confirm / identify inches per year reservoir losses, estimated evaporative inches per year loss and what it was based upon., i.e. current dry pan tests, actual data from other reservoirs in the Sacramento Valley, or some other source – Below is some text that I've copied from our upcoming Final EIR/EIS, Master Response 3. I am still waiting for a little more information on this item that I will follow up with shortly as I realize that response below doesn't speak to how the CALSIM model calculates evaporation.

   Seepage, Evaporation and Conveyance Losses

   The CALSIM II model considers losses due to net evaporation at its reservoirs. For the Final EIR/EIS Alternative 3, the long-term average evaporative losses are 27 TAF per year. These evaporative losses are roughly 10% of the long-term average annual diversion volume. Seepage at Sites Reservoir is not considered in the CALSIM II model. However, local seepage is evaluated in Appendix 8B, *Groundwater Modeling*. According to Appendix 8B, seepage losses would be roughly 2,150 gallons per minute, or 3.5 TAF per year, under the larger (1.8 MAF) configurations of Sites Reservoir presented in the 2017 Draft EIR/EIS. Considering that seepage would decrease under the alternatives presented in the RDEIR/SDEIS, the volume of loss to seepage is within 1–2% of the long-term average annual diversions.

The CALSIM II model considers conveyance losses along the canals between diversion facilities at Red Bluff and Hamilton City and Sites Reservoir. The assumed conveyance losses are presented in Table MR3-1.

Table MR3-1. CALSIM II Conveyance Loss Assumptions

Diversion Facility	Season	Max Sites Fill (cfs)	Assumed Losses	Max Diversion from Sacramento River (cfs)
Red Bluff	Year-round	2,100	1%	2,121
Hamilton City	Nov–Mar	1,800	2%	1,837
	Apr–Oct	1,800	13%	2,069

cfs = cubic feet per second

5. Confirm / identify seepage loss approach for Final EIR/EIS – See above.

6. Schedule follow on meeting to discuss how Sites was incorporated into the CALSIM modeling and Operations Plan – See Doodle Poll below

7. Schedule follow on meeting to discuss anticipated water temperatures, reservoir release temperatures, water temperatures into the Sacramento River, inlet/outlet tower characteristics, and reservoir stratification – See Doodle Poll below, however, in the mean time, below is some information from the Revised Draft EIR/Supplemental Draft EIS.

   Water temperature is analyzed throughout Chapter 6, with tables identifying the mean and median changes in Sacramento River temperature when water is released into the Colusa Basin Drain at Dunnigan starting on page 6-67 (excerpt below). Reservoir temperatures, temperature variation at depth and Inlet/Outlet (I/O) characteristics are discussed starting on page 6-104. Stratification and then seasonal mixing in Sites Reservoir is assumed given the mean depth of the reservoir and that stratification is a norm in northern California reservoirs. The effects of this stratification on water quality is discussed throughout Chapter 6. More details regarding results of the monthly blending model are provided in Appendix 6D, Sites Reservoir Discharge Temperature Modeling.

   Estimated Change in Sacramento River Water Temperature (ºF) when Sites Reservoir Water is Released to the Dunnigan Pipeline under Alternative 3

Month	Mean Estimated Change in Water Temperature (ºF) from Sites Reservoir Releases in the Sacramento River	Median Estimated Change in Water Temperature (ºF) from Sites Reservoir Releases in the Sacramento River
January	--	–
February	--	–
March	--	–
April	-0.21	0
May	-0.26	-0.11
June	-0.12	-0.07
July	-0.12	-0.11
August	-0.28	-0.28
September	-0.12	-0.08
October	-0.15	0
November	-0.24	-0.08
December	-0.13	-0.12

We have 2 more meetings planned – one on CALSIM modeling and Operations Plan and one on all things water temperature. Below is a doodle poll to schedule these two meetings.

https://doodle.com/meeting/participate/id/egpOyBla

We look forward to the continued discussion.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

From: Alicia Forsythe
Sent: Wednesday, February 1, 2023 5:14 PM
To: Angela Bezzone <bezzone@mbkengineers.com>; Spranza, John <john.spranza@hdrinc.com>; Aaron Ferguson <aferguson@somachlaw.com>; Wesley Walker <walker@mbkengineers.com>; Jann Dorman <janndorman@friendsoftheriver.org>; David Zelinsky <zelinsky.david@gmail.com>; Tom Stokely <tgstoked@gmail.com>; Tom Biglione <tom@rvfis.com>; earth1stdoug@gmail.com; Jerry Brown <jbrown@sitesproject.org>; Regina Chichizola <regina@californiasalmon.org>; Kasil Willie <kasil@californiasalmon.org>; Glen Spain <FISH1IFR@aol.com>; Doug Obegi <dobegi@nrdc.org>; Chris Shutes <blancapaloma@msn.com>; Howard Penn <howard@pcl.org>; Erin Woolley <erin.woolley@sierraclub.org>; jimb <jimb@aqualliance.net>; Deirdre Des Jardins <ddj@cah2oresearch.com>; Lowell Ashbaugh <ashbaugh.lowell@gmail.com>; Ashley Overhouse <AOverhouse@defenders.org>; Tom Biglione <ftbiglione@gmail.com>; Meg <agmglwv@gmail.com>; Malissa A. Tayaba <matayaba@ssband.org>; Ron Stork <RStork@friendsoftheriver.org>; Keiko Mertz <keiko@friendsoftheriver.org>; Peter Burnes <ahugetrout-2@yahoo.com>; Vivian Helliwell <vhelliwell@mcn.org>; Konrad <k@omrl.org>; Andy Hitchings

<ahitchings@somachlaw.com>; Marc Van Camp <Vancamp@mbkengineers.com>; Konrad Fisher <k@waterclimate.org>; Kelley Taber <ktaber@somachlaw.com>; Chris Shutes <blancapaloma@msn.com>
Subject: RE: Sites Project - January 2023 Water Right Submittal for NGOs

Hi all - Thanks for your patience as I conferred with the Sites team on the action items from our call yesterday. Below are the action items that we noted. Please let me know if I missed anything or have missed characterized anything.

1. Send Presentation, Presentation slides on new terms, and new term language submitted – Attached
2. Send summary table of Water Availability Analysis diversion results
3. Send Reservoir elevation sequencing from the CALSIM II modeling analysis for the Final EIR/EIS
4. Confirm / identify inches per year reservoir losses
5. Confirm / identify seepage loss approach for Final EIR/EIS
6. Schedule follow on meeting to discuss how Sites was incorporated into the CALSIM modeling and Operations Plan
7. Schedule follow on meeting to discuss anticipated water temperatures, reservoir release temperatures, water temperatures into the Sacramento River, inlet/outlet tower characteristics, and reservoir stratification

Attached is the presentation from yesterday along with a general water right presentation that we use – this is where I pulled the 2 new special term slides from (see slide 20 for the CVP/SWP term and slide 21 for the Trinity River term). I've also attached our January 6 letter to the State Water Board and Appendix H of the January 6 submittal. The letter reflects our request to the Board to include these two terms in our permit and Appendix H is the same term language provided to the Board.

We'll get moving on our other action items and will circle back next week.

Thanks again for the great discussion yesterday!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

-----Original Appointment-----
From: Alicia Forsythe
Sent: Friday, January 20, 2023 10:07 AM
To: Alicia Forsythe; Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber
Cc: Tom Biglione; earth1stdoug@gmail.com; Jerry Brown
Subject: Sites Project - January 2023 Water Right Submittal for NGOs

When: Tuesday, January 31, 2023 1:00 PM-2:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Agenda to be provided a few days prior to the meeting.

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 244 565 499 842
Passcode: spJB4G
Download Teams | Join on the web

Or call in (audio only)
+1 916-538-7066,,76319708#   United States, Sacramento
Phone Conference ID: 763 197 08#
Find a local number | Reset PIN

Learn More | Meeting options

A		CALSIM	CALSIM
B		NODOS_STOR	NODOS_STOR
C		STORAGE	ELEVATION
E			
F		2020D09E	2020D09E
Units		TAF	FEET
Type		PER-AVER	INST-VAL
2	31Oct1921	964	453
3	30Nov1921	963	453
4	31Dec1921	967	453
5	31Jan1922	967	453
6	28Feb1922	1088	464
7	31Mar1922	1087	464
8	30Apr1922	1083	464
9	31May1922	1078	463
10	30Jun1922	1067	462
11	31Jul1922	959	452
12	31Aug1922	852	443
13	30Sep1922	813	439
14	31Oct1922	792	437
15	30Nov1922	792	437
16	31Dec1922	843	442
17	31Jan1923	844	442
18	28Feb1923	844	442
19	31Mar1923	841	442
20	30Apr1923	837	441
21	31May1923	832	441
22	30Jun1923	737	431
23	31Jul1923	677	425
24	31Aug1923	661	423
25	30Sep1923	654	422
26	31Oct1923	578	414
27	30Nov1923	511	406
28	31Dec1923	499	404
29	31Jan1924	500	404
30	29Feb1924	500	405
31	31Mar1924	494	404
32	30Apr1924	409	392
33	31May1924	353	384
34	30Jun1924	268	371
35	31Jul1924	145	347
36	31Aug1924	80	330
37	30Sep1924	76	328
38	31Oct1924	76	328
39	30Nov1924	76	328
40	31Dec1924	77	329
41	31Jan1925	77	329

42	28Feb1925	243	367
43	31Mar1925	243	367
44	30Apr1925	240	367
45	31May1925	239	366
46	30Jun1925	183	356
47	31Jul1925	114	340
48	31Aug1925	109	339
49	30Sep1925	100	336
50	31Oct1925	93	334
51	30Nov1925	93	334
52	31Dec1925	93	334
53	31Jan1926	94	334
54	28Feb1926	285	374
55	31Mar1926	283	374
56	30Apr1926	282	373
57	31May1926	217	363
58	30Jun1926	191	358
59	31Jul1926	115	341
60	31Aug1926	80	330
61	30Sep1926	69	326
62	31Oct1926	65	325
63	30Nov1926	64	325
64	31Dec1926	258	370
65	31Jan1927	463	400
66	28Feb1927	656	423
67	31Mar1927	818	439
68	30Apr1927	1012	457
69	31May1927	1007	457
70	30Jun1927	999	456
71	31Jul1927	987	455
72	31Aug1927	950	452
73	30Sep1927	916	449
74	31Oct1927	914	448
75	30Nov1927	915	448
76	31Dec1927	918	449
77	31Jan1928	919	449
78	29Feb1928	1046	460
79	31Mar1928	1230	476
80	30Apr1928	1225	476
81	31May1928	1218	475
82	30Jun1928	1117	466
83	31Jul1928	945	451
84	31Aug1928	792	437
85	30Sep1928	696	427
86	31Oct1928	688	426
87	30Nov1928	686	426
88	31Dec1928	686	426

89	31Jan1929	685	426
90	28Feb1929	686	426
91	31Mar1929	684	425
92	30Apr1929	601	416
93	31May1929	487	403
94	30Jun1929	344	383
95	31Jul1929	220	363
96	31Aug1929	187	357
97	30Sep1929	175	354
98	31Oct1929	145	347
99	30Nov1929	124	343
100	31Dec1929	120	342
101	31Jan1930	121	342
102	28Feb1930	162	351
103	31Mar1930	278	373
104	30Apr1930	272	372
105	31May1930	224	364
106	30Jun1930	207	361
107	31Jul1930	185	356
108	31Aug1930	106	338
109	30Sep1930	89	333
110	31Oct1930	86	331
111	30Nov1930	85	331
112	31Dec1930	85	331
113	31Jan1931	86	332
114	28Feb1931	86	332
115	31Mar1931	86	331
116	30Apr1931	80	329
117	31May1931	73	327
118	30Jun1931	69	326
119	31Jul1931	64	325
120	31Aug1931	62	324
121	30Sep1931	61	324
122	31Oct1931	60	323
123	30Nov1931	60	323
124	31Dec1931	62	324
125	31Jan1932	62	324
126	29Feb1932	62	324
127	31Mar1932	62	324
128	30Apr1932	61	323
129	31May1932	60	323
130	30Jun1932	58	323
131	31Jul1932	56	322
132	31Aug1932	54	321
133	30Sep1932	53	321
134	31Oct1932	52	321
135	30Nov1932	52	321

136	31Dec1932	52	321
137	31Jan1933	53	321
138	28Feb1933	53	321
139	31Mar1933	52	321
140	30Apr1933	52	320
141	31May1933	51	320
142	30Jun1933	49	319
143	31Jul1933	47	318
144	31Aug1933	46	317
145	30Sep1933	44	317
146	31Oct1933	44	316
147	30Nov1933	43	316
148	31Dec1933	45	317
149	31Jan1934	45	317
150	28Feb1934	47	318
151	31Mar1934	46	318
152	30Apr1934	46	317
153	31May1934	44	317
154	30Jun1934	43	316
155	31Jul1934	41	315
156	31Aug1934	40	314
157	30Sep1934	39	313
158	31Oct1934	38	313
159	30Nov1934	39	313
160	31Dec1934	39	313
161	31Jan1935	119	341
162	28Feb1935	119	342
163	31Mar1935	175	354
164	30Apr1935	374	388
165	31May1935	358	385
166	30Jun1935	248	368
167	31Jul1935	208	361
168	31Aug1935	202	360
169	30Sep1935	195	359
170	31Oct1935	117	341
171	30Nov1935	90	333
172	31Dec1935	88	332
173	31Jan1936	112	340
174	29Feb1936	262	370
175	31Mar1936	262	370
176	30Apr1936	257	369
177	31May1936	246	368
178	30Jun1936	239	366
179	31Jul1936	173	354
180	31Aug1936	138	346
181	30Sep1936	125	343
182	31Oct1936	121	342

183	30Nov1936	61	323
184	31Dec1936	61	324
185	31Jan1937	62	324
186	28Feb1937	100	336
187	31Mar1937	253	369
188	30Apr1937	247	368
189	31May1937	236	366
190	30Jun1937	169	353
191	31Jul1937	143	347
192	31Aug1937	89	333
193	30Sep1937	86	332
194	31Oct1937	83	330
195	30Nov1937	264	371
196	31Dec1937	401	391
197	31Jan1938	408	392
198	28Feb1938	602	416
199	31Mar1938	818	439
200	30Apr1938	1034	459
201	31May1938	1166	471
202	30Jun1938	1158	470
203	31Jul1938	1147	469
204	31Aug1938	1108	466
205	30Sep1938	1075	463
206	31Oct1938	1068	462
207	30Nov1938	1067	462
208	31Dec1938	1067	462
209	31Jan1939	1068	462
210	28Feb1939	1067	462
211	31Mar1939	1059	462
212	30Apr1939	1012	457
213	31May1939	909	448
214	30Jun1939	776	435
215	31Jul1939	610	417
216	31Aug1939	530	408
217	30Sep1939	446	398
218	31Oct1939	366	386
219	30Nov1939	297	376
220	31Dec1939	289	375
221	31Jan1940	414	393
222	29Feb1940	612	418
223	31Mar1940	826	440
224	30Apr1940	1033	459
225	31May1940	1027	459
226	30Jun1940	926	449
227	31Jul1940	818	439
228	31Aug1940	780	435
229	30Sep1940	746	432

230	31Oct1940	744	432
231	30Nov1940	727	430
232	31Dec1940	918	449
233	31Jan1941	1128	467
234	28Feb1941	1325	484
235	31Mar1941	1500	497
236	30Apr1941	1500	497
237	31May1941	1499	497
238	30Jun1941	1491	497
239	31Jul1941	1478	496
240	31Aug1941	1439	493
241	30Sep1941	1405	490
242	31Oct1941	1375	488
243	30Nov1941	1375	488
244	31Dec1941	1500	497
245	31Jan1942	1500	497
246	28Feb1942	1500	497
247	31Mar1942	1499	497
248	30Apr1942	1500	497
249	31May1942	1495	497
250	30Jun1942	1486	496
251	31Jul1942	1473	495
252	31Aug1942	1434	492
253	30Sep1942	1400	490
254	31Oct1942	1368	487
255	30Nov1942	1369	487
256	31Dec1942	1372	487
257	31Jan1943	1500	497
258	28Feb1943	1500	497
259	31Mar1943	1500	497
260	30Apr1943	1496	497
261	31May1943	1488	496
262	30Jun1943	1479	496
263	31Jul1943	1466	495
264	31Aug1943	1427	492
265	30Sep1943	1391	489
266	31Oct1943	1361	487
267	30Nov1943	1359	486
268	31Dec1943	1361	487
269	31Jan1944	1363	487
270	29Feb1944	1372	487
271	31Mar1944	1370	487
272	30Apr1944	1343	485
273	31May1944	1263	479
274	30Jun1944	1129	468
275	31Jul1944	972	454
276	31Aug1944	815	439

277	30Sep1944	724	430
278	31Oct1944	642	421
279	30Nov1944	642	421
280	31Dec1944	632	420
281	31Jan1945	632	420
282	28Feb1945	811	439
283	31Mar1945	812	439
284	30Apr1945	805	438
285	31May1945	801	438
286	30Jun1945	703	427
287	31Jul1945	673	424
288	31Aug1945	658	423
289	30Sep1945	629	420
290	31Oct1945	626	419
291	30Nov1945	595	416
292	31Dec1945	788	436
293	31Jan1946	992	456
294	28Feb1946	992	456
295	31Mar1946	991	455
296	30Apr1946	987	455
297	31May1946	982	455
298	30Jun1946	885	446
299	31Jul1946	863	444
300	31Aug1946	823	440
301	30Sep1946	786	436
302	31Oct1946	764	434
303	30Nov1946	750	432
304	31Dec1946	748	432
305	31Jan1947	748	432
306	28Feb1947	749	432
307	31Mar1947	749	432
308	30Apr1947	740	431
309	31May1947	729	430
310	30Jun1947	653	422
311	31Jul1947	561	412
312	31Aug1947	438	397
313	30Sep1947	356	385
314	31Oct1947	283	374
315	30Nov1947	262	370
316	31Dec1947	262	370
317	31Jan1948	262	370
318	29Feb1948	262	370
319	31Mar1948	259	370
320	30Apr1948	260	370
321	31May1948	258	370
322	30Jun1948	255	369
323	31Jul1948	222	364

324	31Aug1948	217	363
325	30Sep1948	305	377
326	31Oct1948	303	377
327	30Nov1948	226	364
328	31Dec1948	227	364
329	31Jan1949	227	364
330	28Feb1949	227	364
331	31Mar1949	414	393
332	30Apr1949	408	392
333	31May1949	334	382
334	30Jun1949	285	374
335	31Jul1949	159	351
336	31Aug1949	128	344
337	30Sep1949	118	341
338	31Oct1949	110	339
339	30Nov1949	109	339
340	31Dec1949	109	339
341	31Jan1950	111	339
342	28Feb1950	176	355
343	31Mar1950	176	354
344	30Apr1950	167	352
345	31May1950	162	351
346	30Jun1950	155	350
347	31Jul1950	125	343
348	31Aug1950	120	342
349	30Sep1950	115	341
350	31Oct1950	92	334
351	30Nov1950	176	354
352	31Dec1950	394	390
353	31Jan1951	600	416
354	28Feb1951	790	436
355	31Mar1951	803	438
356	30Apr1951	800	437
357	31May1951	795	437
358	30Jun1951	696	427
359	31Jul1951	588	415
360	31Aug1951	545	410
361	30Sep1951	510	406
362	31Oct1951	498	404
363	30Nov1951	497	404
364	31Dec1951	716	429
365	31Jan1952	925	449
366	29Feb1952	1119	467
367	31Mar1952	1334	484
368	30Apr1952	1499	497
369	31May1952	1494	497
370	30Jun1952	1486	496

371	31Jul1952	1473	495
372	31Aug1952	1434	492
373	30Sep1952	1398	489
374	31Oct1952	1366	487
375	30Nov1952	1367	487
376	31Dec1952	1500	497
377	31Jan1953	1500	497
378	28Feb1953	1498	497
379	31Mar1953	1497	497
380	30Apr1953	1494	497
381	31May1953	1490	497
382	30Jun1953	1480	496
383	31Jul1953	1464	495
384	31Aug1953	1425	492
385	30Sep1953	1382	488
386	31Oct1953	1351	486
387	30Nov1953	1353	486
388	31Dec1953	1352	486
389	31Jan1954	1500	497
390	28Feb1954	1500	497
391	31Mar1954	1500	497
392	30Apr1954	1496	497
393	31May1954	1489	497
394	30Jun1954	1389	489
395	31Jul1954	1275	480
396	31Aug1954	1154	470
397	30Sep1954	1091	464
398	31Oct1954	1057	461
399	30Nov1954	1058	462
400	31Dec1954	1138	468
401	31Jan1955	1139	468
402	28Feb1955	1138	468
403	31Mar1955	1135	468
404	30Apr1955	1128	467
405	31May1955	1091	464
406	30Jun1955	944	451
407	31Jul1955	817	439
408	31Aug1955	697	427
409	30Sep1955	621	419
410	31Oct1955	541	409
411	30Nov1955	503	405
412	31Dec1955	668	424
413	31Jan1956	877	445
414	29Feb1956	1072	463
415	31Mar1956	1175	471
416	30Apr1956	1173	471
417	31May1956	1167	471

418	30Jun1956	1157	470
419	31Jul1956	1146	469
420	31Aug1956	1108	466
421	30Sep1956	1101	465
422	31Oct1956	1098	465
423	30Nov1956	1097	465
424	31Dec1956	1096	465
425	31Jan1957	1099	465
426	28Feb1957	1119	467
427	31Mar1957	1332	484
428	30Apr1957	1325	484
429	31May1957	1320	483
430	30Jun1957	1217	475
431	31Jul1957	1107	466
432	31Aug1957	980	454
433	30Sep1957	947	451
434	31Oct1957	1007	457
435	30Nov1957	1004	457
436	31Dec1957	1179	472
437	31Jan1958	1387	489
438	28Feb1958	1500	497
439	31Mar1958	1500	497
440	30Apr1958	1500	497
441	31May1958	1500	497
442	30Jun1958	1492	497
443	31Jul1958	1479	496
444	31Aug1958	1439	493
445	30Sep1958	1404	490
446	31Oct1958	1372	487
447	30Nov1958	1370	487
448	31Dec1958	1370	487
449	31Jan1959	1500	497
450	28Feb1959	1500	497
451	31Mar1959	1497	497
452	30Apr1959	1436	492
453	31May1959	1342	485
454	30Jun1959	1241	477
455	31Jul1959	1093	464
456	31Aug1959	985	455
457	30Sep1959	951	452
458	31Oct1959	892	446
459	30Nov1959	870	444
460	31Dec1959	858	443
461	31Jan1960	861	443
462	29Feb1960	954	452
463	31Mar1960	1081	463
464	30Apr1960	1053	461

465	31May1960	1037	460
466	30Jun1960	899	447
467	31Jul1960	791	437
468	31Aug1960	657	423
469	30Sep1960	569	413
470	31Oct1960	509	406
471	30Nov1960	498	404
472	31Dec1960	584	414
473	31Jan1961	585	415
474	28Feb1961	744	432
475	31Mar1961	763	434
476	30Apr1961	711	428
477	31May1961	687	426
478	30Jun1961	613	418
479	31Jul1961	512	406
480	31Aug1961	394	390
481	30Sep1961	315	379
482	31Oct1961	235	366
483	30Nov1961	208	361
484	31Dec1961	209	361
485	31Jan1962	209	361
486	28Feb1962	362	386
487	31Mar1962	433	396
488	30Apr1962	429	395
489	31May1962	371	387
490	30Jun1962	360	386
491	31Jul1962	339	383
492	31Aug1962	303	377
493	30Sep1962	259	370
494	31Oct1962	412	393
495	30Nov1962	407	392
496	31Dec1962	537	409
497	31Jan1963	538	409
498	28Feb1963	729	430
499	31Mar1963	765	434
500	30Apr1963	990	455
501	31May1963	986	455
502	30Jun1963	979	454
503	31Jul1963	969	453
504	31Aug1963	932	450
505	30Sep1963	899	447
506	31Oct1963	898	447
507	30Nov1963	1005	457
508	31Dec1963	1005	457
509	31Jan1964	1006	457
510	29Feb1964	1003	457
511	31Mar1964	1000	456

512	30Apr1964	954	452
513	31May1964	862	443
514	30Jun1964	742	432
515	31Jul1964	650	422
516	31Aug1964	602	417
517	30Sep1964	516	406
518	31Oct1964	448	398
519	30Nov1964	443	397
520	31Dec1964	578	414
521	31Jan1965	785	436
522	28Feb1965	814	439
523	31Mar1965	812	439
524	30Apr1965	987	455
525	31May1965	981	454
526	30Jun1965	971	454
527	31Jul1965	961	453
528	31Aug1965	925	449
529	30Sep1965	891	446
530	31Oct1965	887	446
531	30Nov1965	967	453
532	31Dec1965	968	453
533	31Jan1966	1140	468
534	28Feb1966	1261	479
535	31Mar1966	1473	495
536	30Apr1966	1467	495
537	31May1966	1374	488
538	30Jun1966	1272	480
539	31Jul1966	1122	467
540	31Aug1966	986	455
541	30Sep1966	915	448
542	31Oct1966	842	442
543	30Nov1966	844	442
544	31Dec1966	1063	462
545	31Jan1967	1217	475
546	28Feb1967	1405	490
547	31Mar1967	1500	497
548	30Apr1967	1500	497
549	31May1967	1498	497
550	30Jun1967	1494	497
551	31Jul1967	1483	496
552	31Aug1967	1443	493
553	30Sep1967	1436	492
554	31Oct1967	1405	490
555	30Nov1967	1405	490
556	31Dec1967	1405	490
557	31Jan1968	1421	491
558	29Feb1968	1500	497

559	31Mar1968	1500	497
560	30Apr1968	1492	497
561	31May1968	1399	490
562	30Jun1968	1294	481
563	31Jul1968	1132	468
564	31Aug1968	1011	457
565	30Sep1968	1002	456
566	31Oct1968	968	453
567	30Nov1968	932	450
568	31Dec1968	1099	465
569	31Jan1969	1287	481
570	28Feb1969	1483	496
571	31Mar1969	1500	497
572	30Apr1969	1500	497
573	31May1969	1498	497
574	30Jun1969	1488	496
575	31Jul1969	1476	495
576	31Aug1969	1436	492
577	30Sep1969	1498	497
578	31Oct1969	1468	495
579	30Nov1969	1466	495
580	31Dec1969	1500	497
581	31Jan1970	1500	497
582	28Feb1970	1500	497
583	31Mar1970	1500	497
584	30Apr1970	1491	497
585	31May1970	1483	496
586	30Jun1970	1472	495
587	31Jul1970	1433	492
588	31Aug1970	1395	489
589	30Sep1970	1328	484
590	31Oct1970	1297	482
591	30Nov1970	1303	482
592	31Dec1970	1500	497
593	31Jan1971	1500	497
594	28Feb1971	1498	497
595	31Mar1971	1500	497
596	30Apr1971	1496	497
597	31May1971	1491	497
598	30Jun1971	1480	496
599	31Jul1971	1468	495
600	31Aug1971	1428	492
601	30Sep1971	1385	488
602	31Oct1971	1353	486
603	30Nov1971	1352	486
604	31Dec1971	1356	486
605	31Jan1972	1356	486

606	29Feb1972	1356	486
607	31Mar1972	1499	497
608	30Apr1972	1488	496
609	31May1972	1481	496
610	30Jun1972	1382	488
611	31Jul1972	1234	476
612	31Aug1972	1098	465
613	30Sep1972	1012	457
614	31Oct1972	947	451
615	30Nov1972	986	455
616	31Dec1972	1074	463
617	31Jan1973	1283	480
618	28Feb1973	1478	496
619	31Mar1973	1500	497
620	30Apr1973	1494	497
621	31May1973	1487	496
622	30Jun1973	1385	488
623	31Jul1973	1273	480
624	31Aug1973	1134	468
625	30Sep1973	1071	463
626	31Oct1973	1039	460
627	30Nov1973	1211	474
628	31Dec1973	1430	492
629	31Jan1974	1467	495
630	28Feb1974	1500	497
631	31Mar1974	1500	497
632	30Apr1974	1500	497
633	31May1974	1493	497
634	30Jun1974	1485	496
635	31Jul1974	1474	495
636	31Aug1974	1435	492
637	30Sep1974	1400	490
638	31Oct1974	1369	487
639	30Nov1974	1367	487
640	31Dec1974	1371	487
641	31Jan1975	1371	487
642	28Feb1975	1500	497
643	31Mar1975	1500	497
644	30Apr1975	1497	497
645	31May1975	1489	497
646	30Jun1975	1478	496
647	31Jul1975	1466	495
648	31Aug1975	1428	492
649	30Sep1975	1393	489
650	31Oct1975	1408	490
651	30Nov1975	1406	490
652	31Dec1975	1406	490

653	31Jan1976	1405	490
654	29Feb1976	1404	490
655	31Mar1976	1389	489
656	30Apr1976	1370	487
657	31May1976	1323	484
658	30Jun1976	1187	472
659	31Jul1976	1025	459
660	31Aug1976	913	448
661	30Sep1976	827	440
662	31Oct1976	745	432
663	30Nov1976	698	427
664	31Dec1976	683	425
665	31Jan1977	684	425
666	28Feb1977	683	425
667	31Mar1977	682	425
668	30Apr1977	602	417
669	31May1977	521	407
670	30Jun1977	396	391
671	31Jul1977	271	372
672	31Aug1977	157	350
673	30Sep1977	149	348
674	31Oct1977	136	345
675	30Nov1977	130	344
676	31Dec1977	131	344
677	31Jan1978	335	382
678	28Feb1978	527	408
679	31Mar1978	743	432
680	30Apr1978	742	432
681	31May1978	736	431
682	30Jun1978	730	430
683	31Jul1978	618	418
684	31Aug1978	580	414
685	30Sep1978	547	410
686	31Oct1978	524	407
687	30Nov1978	520	407
688	31Dec1978	516	406
689	31Jan1979	520	407
690	28Feb1979	584	414
691	31Mar1979	616	418
692	30Apr1979	612	418
693	31May1979	607	417
694	30Jun1979	526	408
695	31Jul1979	509	406
696	31Aug1979	501	405
697	30Sep1979	492	404
698	31Oct1979	447	398
699	30Nov1979	447	398

700	31Dec1979	449	398
701	31Jan1980	655	422
702	29Feb1980	854	443
703	31Mar1980	1035	460
704	30Apr1980	1031	459
705	31May1980	1026	459
706	30Jun1980	1018	458
707	31Jul1980	908	448
708	31Aug1980	827	440
709	30Sep1980	793	437
710	31Oct1980	787	436
711	30Nov1980	784	436
712	31Dec1980	784	436
713	31Jan1981	790	436
714	28Feb1981	808	438
715	31Mar1981	992	456
716	30Apr1981	988	455
717	31May1981	984	455
718	30Jun1981	895	447
719	31Jul1981	854	443
720	31Aug1981	838	441
721	30Sep1981	758	433
722	31Oct1981	694	427
723	30Nov1981	885	446
724	31Dec1981	1104	465
725	31Jan1982	1312	483
726	28Feb1982	1500	497
727	31Mar1982	1500	497
728	30Apr1982	1500	497
729	31May1982	1492	497
730	30Jun1982	1485	496
731	31Jul1982	1474	495
732	31Aug1982	1436	492
733	30Sep1982	1499	497
734	31Oct1982	1500	497
735	30Nov1982	1500	497
736	31Dec1982	1500	497
737	31Jan1983	1500	497
738	28Feb1983	1500	497
739	31Mar1983	1500	497
740	30Apr1983	1500	497
741	31May1983	1499	497
742	30Jun1983	1498	497
743	31Jul1983	1451	494
744	31Aug1983	1416	491
745	30Sep1983	1382	488
746	31Oct1983	1405	490

747	30Nov1983	1500	497
748	31Dec1983	1500	497
749	31Jan1984	1500	497
750	29Feb1984	1500	497
751	31Mar1984	1499	497
752	30Apr1984	1494	497
753	31May1984	1486	496
754	30Jun1984	1473	495
755	31Jul1984	1460	494
756	31Aug1984	1404	490
757	30Sep1984	1342	485
758	31Oct1984	1340	485
759	30Nov1984	1500	497
760	31Dec1984	1500	497
761	31Jan1985	1500	497
762	28Feb1985	1499	497
763	31Mar1985	1499	497
764	30Apr1985	1491	497
765	31May1985	1335	485
766	30Jun1985	1207	474
767	31Jul1985	1035	460
768	31Aug1985	926	449
769	30Sep1985	871	444
770	31Oct1985	790	436
771	30Nov1985	771	434
772	31Dec1985	760	433
773	31Jan1986	763	434
774	28Feb1986	941	451
775	31Mar1986	1157	470
776	30Apr1986	1151	469
777	31May1986	1135	468
778	30Jun1986	1111	466
779	31Jul1986	1084	464
780	31Aug1986	1033	459
781	30Sep1986	997	456
782	31Oct1986	978	454
783	30Nov1986	976	454
784	31Dec1986	976	454
785	31Jan1987	977	454
786	28Feb1987	978	454
787	31Mar1987	1070	463
788	30Apr1987	1038	460
789	31May1987	941	451
790	30Jun1987	781	436
791	31Jul1987	624	419
792	31Aug1987	504	405
793	30Sep1987	422	394

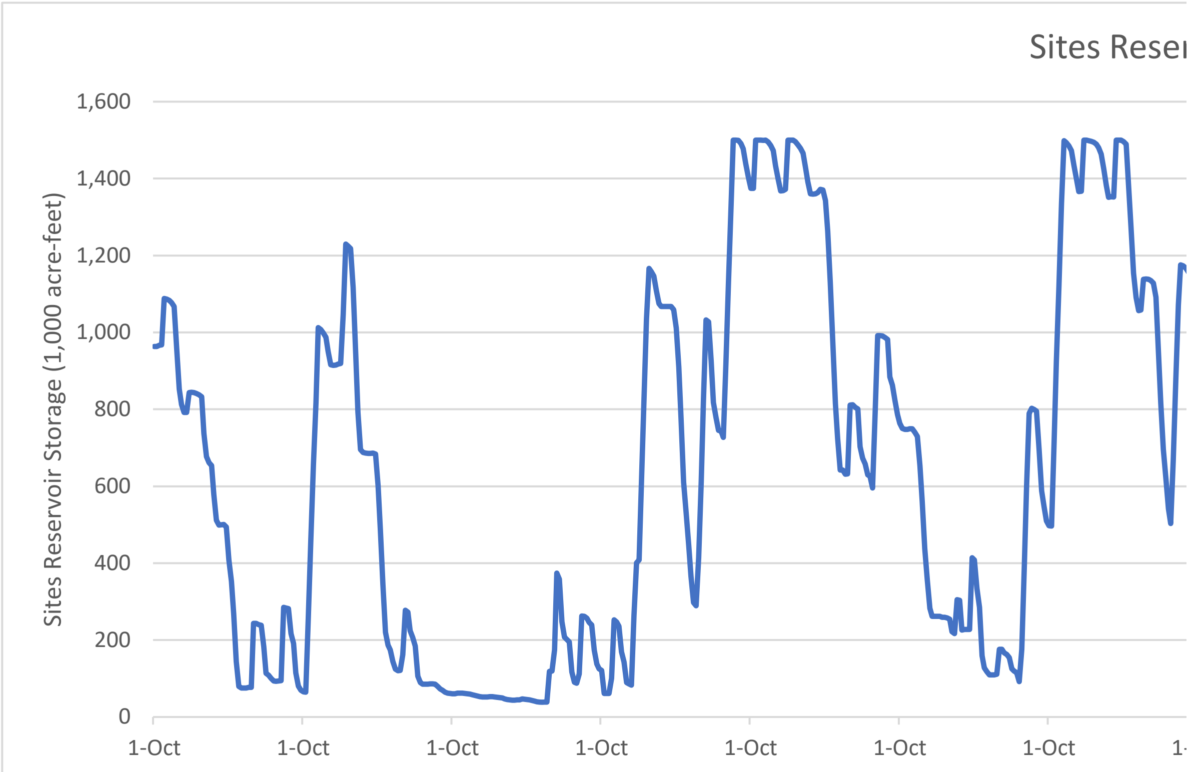
794	31Oct1987	372	387
795	30Nov1987	355	385
796	31Dec1987	357	385
797	31Jan1988	524	407
798	29Feb1988	522	407
799	31Mar1988	518	407
800	30Apr1988	505	405
801	31May1988	432	396
802	30Jun1988	332	382
803	31Jul1988	208	361
804	31Aug1988	152	349
805	30Sep1988	140	346
806	31Oct1988	131	344
807	30Nov1988	131	344
808	31Dec1988	131	344
809	31Jan1989	131	344
810	28Feb1989	131	344
811	31Mar1989	316	379
812	30Apr1989	307	378
813	31May1989	252	369
814	30Jun1989	233	365
815	31Jul1989	207	361
816	31Aug1989	132	344
817	30Sep1989	121	342
818	31Oct1989	104	337
819	30Nov1989	102	337
820	31Dec1989	101	336
821	31Jan1990	102	337
822	28Feb1990	102	337
823	31Mar1990	101	336
824	30Apr1990	100	336
825	31May1990	99	336
826	30Jun1990	87	332
827	31Jul1990	82	330
828	31Aug1990	77	329
829	30Sep1990	73	327
830	31Oct1990	72	327
831	30Nov1990	71	327
832	31Dec1990	71	327
833	31Jan1991	71	327
834	28Feb1991	71	327
835	31Mar1991	226	364
836	30Apr1991	213	362
837	31May1991	164	352
838	30Jun1991	121	342
839	31Jul1991	91	333
840	31Aug1991	88	332

841	30Sep1991	81	330
842	31Oct1991	74	328
843	30Nov1991	74	328
844	31Dec1991	74	328
845	31Jan1992	74	328
846	29Feb1992	204	361
847	31Mar1992	228	364
848	30Apr1992	215	362
849	31May1992	106	338
850	30Jun1992	98	335
851	31Jul1992	95	334
852	31Aug1992	92	334
853	30Sep1992	85	331
854	31Oct1992	79	329
855	30Nov1992	78	329
856	31Dec1992	79	329
857	31Jan1993	249	368
858	28Feb1993	397	391
859	31Mar1993	610	417
860	30Apr1993	608	417
861	31May1993	605	417
862	30Jun1993	627	419
863	31Jul1993	516	406
864	31Aug1993	447	398
865	30Sep1993	414	393
866	31Oct1993	399	391
867	30Nov1993	396	391
868	31Dec1993	395	391
869	31Jan1994	396	391
870	28Feb1994	439	397
871	31Mar1994	437	396
872	30Apr1994	417	394
873	31May1994	403	392
874	30Jun1994	344	383
875	31Jul1994	205	361
876	31Aug1994	110	339
877	30Sep1994	92	334
878	31Oct1994	75	328
879	30Nov1994	71	327
880	31Dec1994	72	327
881	31Jan1995	281	373
882	28Feb1995	470	401
883	31Mar1995	690	426
884	30Apr1995	849	442
885	31May1995	1014	458
886	30Jun1995	1009	457
887	31Jul1995	1001	456

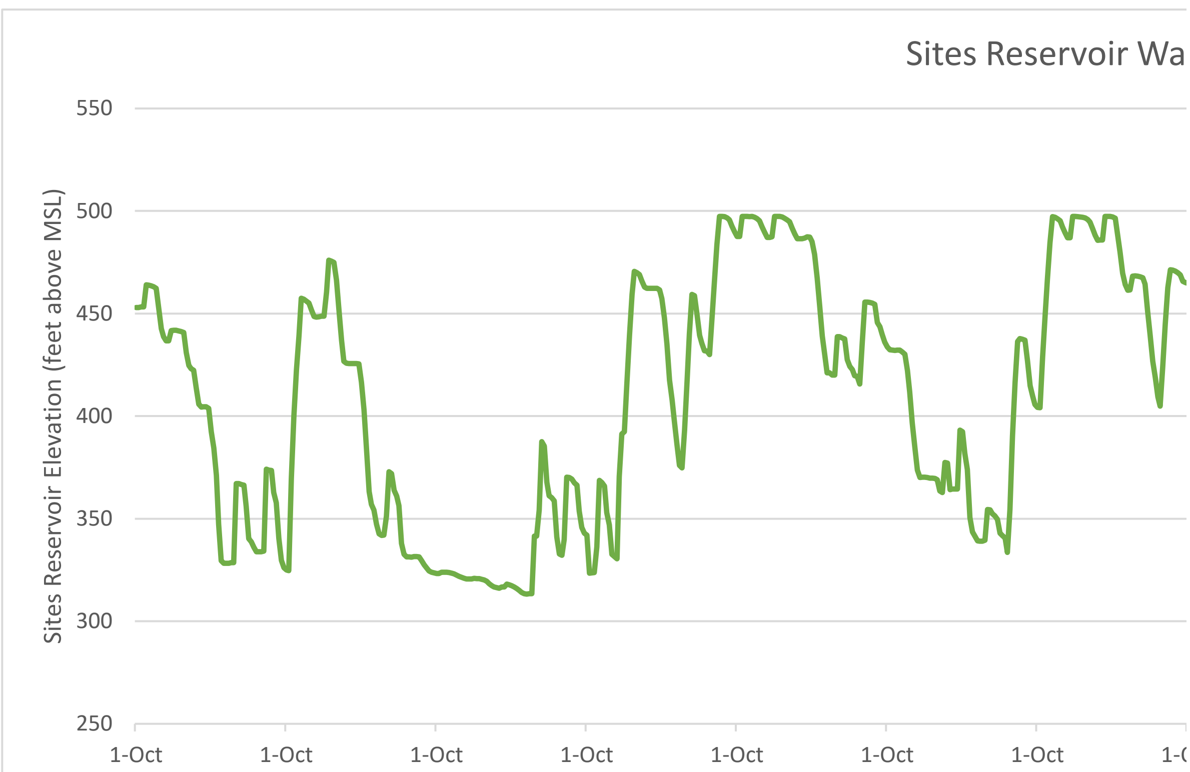
888	31Aug1995	993	456
889	30Sep1995	960	453
890	31Oct1995	928	450
891	30Nov1995	927	449
892	31Dec1995	932	450
893	31Jan1996	1103	465
894	29Feb1996	1302	482
895	31Mar1996	1500	497
896	30Apr1996	1498	497
897	31May1996	1500	497
898	30Jun1996	1492	497
899	31Jul1996	1479	496
900	31Aug1996	1468	495
901	30Sep1996	1434	492
902	31Oct1996	1404	490
903	30Nov1996	1404	490
904	31Dec1996	1500	497
905	31Jan1997	1500	497
906	28Feb1997	1500	497
907	31Mar1997	1498	497
908	30Apr1997	1491	497
909	31May1997	1484	496
910	30Jun1997	1474	495
911	31Jul1997	1462	494
912	31Aug1997	1424	491
913	30Sep1997	1368	487
914	31Oct1997	1337	485
915	30Nov1997	1342	485
916	31Dec1997	1401	490
917	31Jan1998	1500	497
918	28Feb1998	1500	497
919	31Mar1998	1500	497
920	30Apr1998	1500	497
921	31May1998	1500	497
922	30Jun1998	1499	497
923	31Jul1998	1490	497
924	31Aug1998	1481	496
925	30Sep1998	1447	493
926	31Oct1998	1416	491
927	30Nov1998	1449	493
928	31Dec1998	1500	497
929	31Jan1999	1500	497
930	28Feb1999	1500	497
931	31Mar1999	1500	497
932	30Apr1999	1497	497
933	31May1999	1490	497
934	30Jun1999	1480	496

935	31Jul1999	1469	495
936	31Aug1999	1432	492
937	30Sep1999	1392	489
938	31Oct1999	1360	486
939	30Nov1999	1362	487
940	31Dec1999	1361	487
941	31Jan2000	1433	492
942	29Feb2000	1500	497
943	31Mar2000	1500	497
944	30Apr2000	1498	497
945	31May2000	1493	497
946	30Jun2000	1336	485
947	31Jul2000	1219	475
948	31Aug2000	1074	463
949	30Sep2000	1026	459
950	31Oct2000	996	456
951	30Nov2000	993	456
952	31Dec2000	981	455
953	31Jan2001	985	455
954	28Feb2001	1031	459
955	31Mar2001	1147	469
956	30Apr2001	1137	468
957	31May2001	1044	460
958	30Jun2001	913	448
959	31Jul2001	775	435
960	31Aug2001	647	422
961	30Sep2001	564	412
962	31Oct2001	485	403
963	30Nov2001	413	393
964	31Dec2001	633	420
965	31Jan2002	839	441
966	28Feb2002	838	441
967	31Mar2002	836	441
968	30Apr2002	832	441
969	31May2002	827	440
970	30Jun2002	667	424
971	31Jul2002	567	412
972	31Aug2002	448	398
973	30Sep2002	366	386
974	31Oct2002	312	379
975	30Nov2002	292	375
976	31Dec2002	368	387
977	31Jan2003	574	413
978	28Feb2003	574	413
979	31Mar2003	617	418
980	30Apr2003	617	418
981	31May2003	615	418

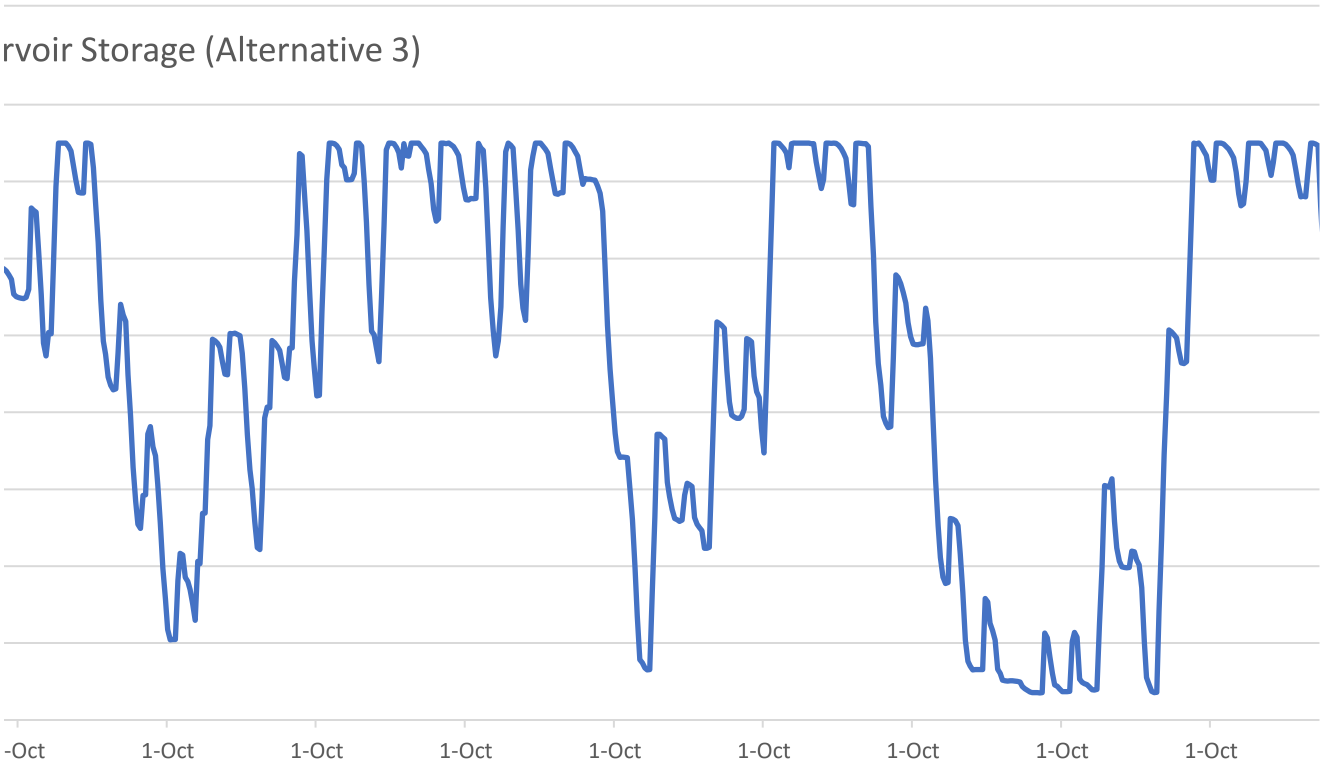
982	30Jun2003	609	417
983	31Jul2003	516	406
984	31Aug2003	480	402
985	30Sep2003	446	398

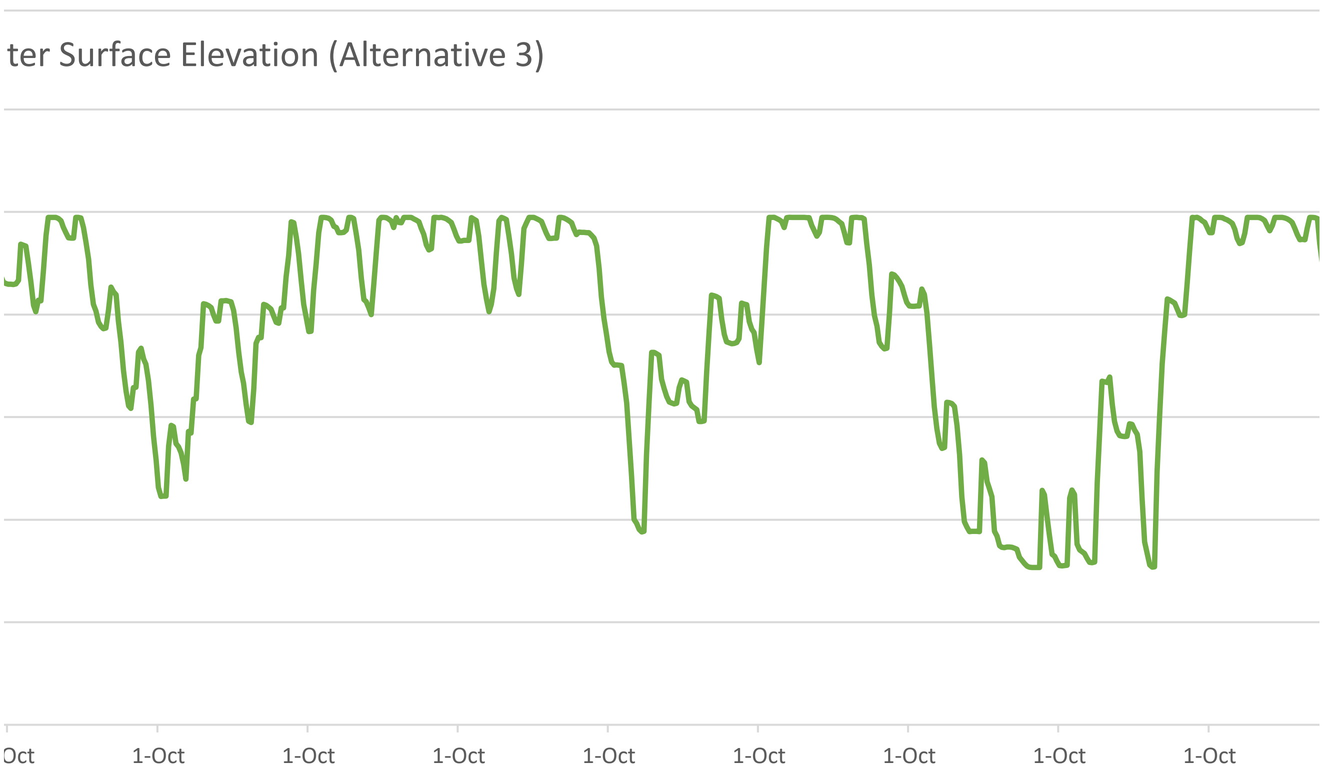


Sites Reser
1,600
1,400
1,200
1,000
800
600
400
200
0
Sites Reservoir Storage (1,000 acre-feet)
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct

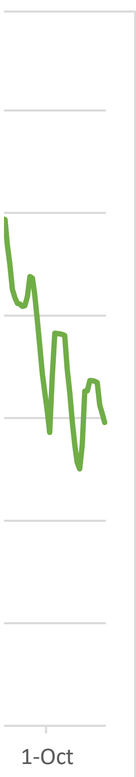


Sites Reservoir Wa
550
500
450
400
350
300
250
Sites Reservoir Elevation (feet above MSL)
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct


rvoir Storage (Alternative 3)
-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct


ter Surface Elevation (Alternative 3)
Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct
1-Oct


1-Oct


1-Oct

Alicia Forsythe

From: Alicia Forsythe
Sent: Tuesday, February 28, 2023 11:32 AM
To: Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Tom Biglione; earth1stdoug@gmail.com; Jerry Brown; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber; Chris Shutes
Subject: RE: Sites Project - January 2023 Water Right Submittal for NGOs

Categories: Needs to Get Done

Hi all – I hope everyone is doing well and staying safe with all this snow.

Two items – First, please respond to the doodle poll so I can get our next meetings scheduled:
https://doodle.com/meeting/participate/id/egpOyBla

Second, here's a little more information on #4 and how the CALSIM model calculates evaporation.

> The net evaporation rate at Sites Reservoir considers evaporative losses (primarily in the summer) and gains from precipitation (primarily in the winter). The evaporation rate timeseries data at Sites is an average of the CalSim II evaporation rate timeseries at three nearby Coastal Range reservoirs: East Park, Stony Gorge, and Black Butte. The CalSim II evaporation rates at East Park, Stony Gorge and Black Butte were developed by Reclamation (USBR, 2004) and are based on historical evaporation records. In addition to evaporation, Sites Reservoir assumes gains from precipitation. Precipitation rates are estimated with the CWC WSIP gridded VIC data set centered on 1995. For an additional description of these data, please review Appendix A of the WSIP Technical Reference Document (CWC, 2016).
>
> **References**
> U.S. Bureau of Reclamation. 2004. Stony Creek Model: CALSIM Application. March 2004
> California Water Commission (CWC). 2016. Water Storage Investment Program: Technical Reference. November 2016.

Thanks all!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

From: Alicia Forsythe
Sent: Thursday, February 23, 2023 2:46 PM
To: Angela Bezzone <bezzone@mbkengineers.com>; Spranza, John <john.spranza@hdrinc.com>; Aaron Ferguson <aferguson@somachlaw.com>; Wesley Walker <walker@mbkengineers.com>; Jann Dorman <janndorman@friendsoftheriver.org>; David Zelinsky <zelinsky.david@gmail.com>; Tom Stokely <tgstoked@gmail.com>; Tom Biglione <tom@rvfis.com>; earth1stdoug@gmail.com; Jerry Brown <jbrown@sitesproject.org>; Regina Chichizola <regina@californiasalmon.org>; Kasil Willie <kasil@californiasalmon.org>; Glen Spain <FISH1IFR@aol.com>; Doug Obegi <dobegi@nrdc.org>; Chris Shutes <blancapaloma@msn.com>; Howard Penn <howard@pcl.org>; Erin Woolley <erin.woolley@sierraclub.org>; jimb <jimb@aqualliance.net>; Deirdre Des Jardins <ddj@cah2oresearch.com>; Lowell Ashbaugh <ashbaugh.lowell@gmail.com>; Ashley Overhouse <AOverhouse@defenders.org>; Tom Biglione <ftbiglione@gmail.com>; Meg <agmglwv@gmail.com>; Malissa A. Tayaba <matayaba@ssband.org>; Ron Stork <RStork@friendsoftheriver.org>; Keiko Mertz <keiko@friendsoftheriver.org>; Peter Burnes <ahugetrout-2@yahoo.com>; Vivian Helliwell <vhelliwell@mcn.org>; Konrad <k@omrl.org>; Andy Hitchings <ahitchings@somachlaw.com>; Marc Van Camp <Vancamp@mbkengineers.com>; Konrad Fisher <k@waterclimate.org>; Kelley Taber <ktaber@somachlaw.com>; Chris Shutes <blancapaloma@msn.com>
Subject: RE: Sites Project - January 2023 Water Right Submittal for NGOs

Hello all – Thanks for your continued patience. The foot surgery was a little more than I was expecting so I've been working to catch up on a number of things. Below are the action items from our late January call and the status of each one.

1. Send Presentation, Presentation slides on new terms, and new term language submitted – Attached to Feb 1 email

2. Send summary table of Water Availability Analysis diversion results – Attached PowerPoint file titled "20230204_Sites WAA Estimated Diversions" with the diversion results.

3. Send Reservoir elevation sequencing from the CALSIM II modeling analysis for the Final EIR/EIS – Attached Excel file titled "SPJPA_Sites_SitesStorageAndWSE_ALT3_051722_20230220". This provides both the elevation and volume of storage for Alternative 3, the Authority's preferred project using the revised diversion criteria and modeling that will come out in the Final EIR/EIS.

4. Confirm / identify inches per year reservoir losses, estimated evaporative inches per year loss and what it was based upon., i.e. current dry pan tests, actual data from other reservoirs in the Sacramento Valley, or some other source – Below is some text that I've copied from our upcoming Final EIR/EIS, Master Response 3. I am still waiting for a little more information on this item that I will follow up with shortly as I realize that response below doesn't speak to how the CALSIM model calculates evaporation.

   Seepage, Evaporation and Conveyance Losses

   The CALSIM II model considers losses due to net evaporation at its reservoirs. For the Final EIR/EIS Alternative 3, the long-term average evaporative losses are 27 TAF per year. These evaporative losses are roughly 10% of the long-term average annual diversion volume. Seepage at Sites Reservoir is not considered in the CALSIM II model. However, local seepage is evaluated in Appendix 8B, *Groundwater Modeling*. According to Appendix 8B, seepage losses would be roughly 2,150 gallons per minute, or 3.5 TAF per year, under the larger (1.8 MAF) configurations of Sites Reservoir presented in the 2017 Draft EIR/EIS. Considering that seepage would decrease under the alternatives presented in the RDEIR/SDEIS, the volume of loss to seepage is within 1–2% of the long-term average annual diversions.

The CALSIM II model considers conveyance losses along the canals between diversion facilities at Red Bluff and Hamilton City and Sites Reservoir. The assumed conveyance losses are presented in Table MR3-1.

Table MR3-1. CALSIM II Conveyance Loss Assumptions

Diversion Facility	Season	Max Sites Fill (cfs)	Assumed Losses	Max Diversion from Sacramento River (cfs)
Red Bluff	Year-round	2,100	1%	2,121
Hamilton City	Nov–Mar	1,800	2%	1,837
	Apr–Oct	1,800	13%	2,069

cfs = cubic feet per second

5. Confirm / identify seepage loss approach for Final EIR/EIS – See above.

6. Schedule follow on meeting to discuss how Sites was incorporated into the CALSIM modeling and Operations Plan – See Doodle Poll below

7. Schedule follow on meeting to discuss anticipated water temperatures, reservoir release temperatures, water temperatures into the Sacramento River, inlet/outlet tower characteristics, and reservoir stratification – See Doodle Poll below, however, in the mean time, below is some information from the Revised Draft EIR/Supplemental Draft EIS.

   Water temperature is analyzed throughout Chapter 6, with tables identifying the mean and median changes in Sacramento River temperature when water is released into the Colusa Basin Drain at Dunnigan starting on page 6-67 (excerpt below). Reservoir temperatures, temperature variation at depth and Inlet/Outlet (I/O) characteristics are discussed starting on page 6-104. Stratification and then seasonal mixing in Sites Reservoir is assumed given the mean depth of the reservoir and that stratification is a norm in northern California reservoirs. The effects of this stratification on water quality is discussed throughout Chapter 6. More details regarding results of the monthly blending model are provided in Appendix 6D, Sites Reservoir Discharge Temperature Modeling.

   Estimated Change in Sacramento River Water Temperature (ºF) when Sites Reservoir Water is Released to the Dunnigan Pipeline under Alternative 3

Month	Mean Estimated Change in Water Temperature (ºF) from Sites Reservoir Releases in the Sacramento River	Median Estimated Change in Water Temperature (ºF) from Sites Reservoir Releases in the Sacramento River
January	--	–
February	--	–
March	--	–
April	-0.21	0
May	-0.26	-0.11
June	-0.12	-0.07
July	-0.12	-0.11
August	-0.28	-0.28
September	-0.12	-0.08
October	-0.15	0
November	-0.24	-0.08
December	-0.13	-0.12

We have 2 more meetings planned – one on CALSIM modeling and Operations Plan and one on all things water temperature. Below is a doodle poll to schedule these two meetings.

https://doodle.com/meeting/participate/id/egpOyBla

We look forward to the continued discussion.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Alicia Forsythe
Sent: Wednesday, February 1, 2023 5:14 PM
To: Angela Bezzone <bezzone@mbkengineers.com>; Spranza, John <john.spranza@hdrinc.com>; Aaron Ferguson <aferguson@somachlaw.com>; Wesley Walker <walker@mbkengineers.com>; Jann Dorman <janndorman@friendsoftheriver.org>; David Zelinsky <zelinsky.david@gmail.com>; Tom Stokely <tgstoked@gmail.com>; Tom Biglione <tom@rvfis.com>; earth1stdoug@gmail.com; Jerry Brown <jbrown@sitesproject.org>; Regina Chichizola <regina@californiasalmon.org>; Kasil Willie <kasil@californiasalmon.org>; Glen Spain <FISH1IFR@aol.com>; Doug Obegi <dobegi@nrdc.org>; Chris Shutes <blancapaloma@msn.com>; Howard Penn <howard@pcl.org>; Erin Woolley <erin.woolley@sierraclub.org>; jimb <jimb@aqualliance.net>; Deirdre Des Jardins <ddj@cah2oresearch.com>; Lowell Ashbaugh <ashbaugh.lowell@gmail.com>; Ashley Overhouse <AOverhouse@defenders.org>; Tom Biglione <ftbiglione@gmail.com>; Meg <agmglwv@gmail.com>; Malissa A. Tayaba <matayaba@ssband.org>; Ron Stork <RStork@friendsoftheriver.org>; Keiko Mertz <keiko@friendsoftheriver.org>; Peter Burnes <ahugetrout-2@yahoo.com>; Vivian Helliwell <vhelliwell@mcn.org>; Konrad <k@omrl.org>; Andy Hitchings

<ahitchings@somachlaw.com>; Marc Van Camp <Vancamp@mbkengineers.com>; Konrad Fisher <k@waterclimate.org>; Kelley Taber <ktaber@somachlaw.com>; Chris Shutes <blancapaloma@msn.com>
Subject: RE: Sites Project - January 2023 Water Right Submittal for NGOs

Hi all - Thanks for your patience as I conferred with the Sites team on the action items from our call yesterday. Below are the action items that we noted. Please let me know if I missed anything or have missed characterized anything.

1. Send Presentation, Presentation slides on new terms, and new term language submitted – Attached
2. Send summary table of Water Availability Analysis diversion results
3. Send Reservoir elevation sequencing from the CALSIM II modeling analysis for the Final EIR/EIS
4. Confirm / identify inches per year reservoir losses
5. Confirm / identify seepage loss approach for Final EIR/EIS
6. Schedule follow on meeting to discuss how Sites was incorporated into the CALSIM modeling and Operations Plan
7. Schedule follow on meeting to discuss anticipated water temperatures, reservoir release temperatures, water temperatures into the Sacramento River, inlet/outlet tower characteristics, and reservoir stratification

Attached is the presentation from yesterday along with a general water right presentation that we use – this is where I pulled the 2 new special term slides from (see slide 20 for the CVP/SWP term and slide 21 for the Trinity River term). I've also attached our January 6 letter to the State Water Board and Appendix H of the January 6 submittal. The letter reflects our request to the Board to include these two terms in our permit and Appendix H is the same term language provided to the Board.

We'll get moving on our other action items and will circle back next week.

Thanks again for the great discussion yesterday!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

-----Original Appointment-----
From: Alicia Forsythe
Sent: Friday, January 20, 2023 10:07 AM
To: Alicia Forsythe; Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber
Cc: Tom Biglione; earth1stdoug@gmail.com; Jerry Brown
Subject: Sites Project - January 2023 Water Right Submittal for NGOs

When: Tuesday, January 31, 2023 1:00 PM-2:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Agenda to be provided a few days prior to the meeting.

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 244 565 499 842
Passcode: spJB4G
Download Teams | Join on the web

Or call in (audio only)
+1 916-538-7066,,76319708# United States, Sacramento
Phone Conference ID: 763 197 08#
Find a local number | Reset PIN

Learn More | Meeting options

Alicia Forsythe

From: Alicia Forsythe
Sent: Wednesday, March 29, 2023 5:01 PM
To: Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Tom Biglione; earth1stdoug@gmail.com; Jerry Brown; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber; steve.micko@jacobs.com; Andycam436@gmail.com; Leaf, Rob
Subject: RE: Sites Project - CalSim Modeling Discussion
Attachments: RDEIR-SDEIS-App08B-Groundwater-Modeling.pdf; Sites_CalSimModeling_20230309.pdf

Hello NGO Group – I wanted to follow up from our March 9 CALSIM modeling meeting. Attached is the presentation from the meeting. We also had 2 action items/follow up items as noted below.

1. CALSIM II modeling doesn't preserve mass balance. It creates 200,000 af of water that isn't there in dry and critically dry years. –

   This was a comment in the chat that we talked a little bit about on the call, but committed to close the loop more on this. After the call, our modeling team let me know that we did look into this a number of years ago and ran some sensitivity runs to see how this might be affecting the Project's analysis. This was well over a decade ago and pre-2017 WSIP modeling and report. In these sensitivity runs, we didn't see a big change in the Project when lowering the hydrology in these dry and critically dry years. As we discussed on the call, we don't divert much in these years and are focused more on moving water out of the reservoir. These sensitivity runs were conducted using our old diversion criteria and the Project as it was envisioned in 2017. Although the Project has changed substantially since 2017, we've made it more protective of flows in the river (we now have high bypass flow criteria prior to diversions), so we would expect similar results to the prior sensitivity runs – meaning our more protective diversion criteria have us diverting little water in these drier years and thus, the overestimation of the CALSIM II model in dry and critically dry years isn't likely affecting our results. We realize this is a very nuanced modeling question and are happy to set up a small group call with the modeling team for anyone who would like to chat about this in more detail.

2. Do we know the reason the seepage loss estimate is so low? Soil/geo characteristics?

   Seepages losses from the reservoir were calculated as part of the 2017 Draft EIR/EIS. The alternatives considered in 2017 were generally bigger reservoir footprints (up to 1.8 MAF) and a larger Funks Reservoir (an existing reservoir that we would have enlarged in the 2017 alternatives and renamed Holthouse Reservoir). For the 2019 RDEIR/SDEIS, we used the same calculation and analysis as was done for these previous alternatives. The seepage values were low and fairly insignificant, so we did not recalculate those as the loss are expected to be minimal. The loss calculation is included in Appendix 8B of the Sites RDEIR/SDEIS (which is attached). The maximum seepage is estimated to be 2,150 gpm (or about 3.5 TAF/yr).

Hope this helps. We look forward to our next discussion.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

-----Original Appointment-----
From: Alicia Forsythe
Sent: Tuesday, March 7, 2023 11:34 AM
To: Alicia Forsythe; Angela Bezzone; Spranza, John; Aaron Ferguson; Wesley Walker; Jann Dorman; David Zelinsky; Tom Stokely; Tom Biglione; earth1stdoug@gmail.com; Jerry Brown; Regina Chichizola; Kasil Willie; Glen Spain; Doug Obegi; Chris Shutes; Howard Penn; Erin Woolley; jimb; Deirdre Des Jardins; Lowell Ashbaugh; Ashley Overhouse; Tom Biglione; Meg; Malissa A. Tayaba; Ron Stork; Keiko Mertz; Peter Burnes; Vivian Helliwell; Konrad; Andy Hitchings; Marc Van Camp; Konrad Fisher; Kelley Taber; steve.micko@jacobs.com; Andycam436@gmail.com
Cc: Leaf, Rob
Subject: Sites Project - CalSim Modeling Discussion
When: Thursday, March 9, 2023 2:30 PM-4:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Hi all – Please join us for a more detailed discussion of the Sites Project's Calsim modeling efforts.

____

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 272 105 741 068
Passcode: Bnm9dm
Download Teams | Join on the web

Or call in (audio only)
+1 916-538-7066,,982143483#   United States, Sacramento
Phone Conference ID: 982 143 483#
Find a local number | Reset PIN

Learn More | Meeting options

____

Appendix 8B Groundwater Modeling

Appendix 8B Introduction

The information contained in this appendix was originally produced in the 2017 Public Draft Environmental Impact Report/Environmental Impact Statement (2017 Draft EIR/EIS). This information is included so the reader can reference the groundwater modeling results that are applicable to Alternatives 1, 2 and 3 evaluated in Chapter 8, *Groundwater Resources*. Multiple project facilities evaluated in the 2017 Draft EIR/EIS are no longer part of the Project as described in this Revised Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement. These include the Delevan Pipeline, Delevan Intake, and Holthouse Reservoir. As such, these facilities are not discussed in Chapter 8, but appear in this appendix. Line items and numbers identified or noted as “No Action Alternative” represent the “Existing conditions/No Project/No Action Condition” as described in the 2017 Draft EIR/EIS. The figure numbering and page numbering in this appendix reflects the original numbering in the 2017 Draft EIR/EIS.

APPENDIX 10A
Groundwater Modeling

10A.1 Introduction

This technical appendix provides detailed descriptions of numerical groundwater modeling performed to support groundwater resources impacts analyses. Groundwater modeling simulations fell into two categories: (1) those performed to evaluate potential changes in groundwater elevations resulting from reservoir seepage and (2) those performed to evaluate potential changes in groundwater and stream stage elevations and groundwater/surface water interaction resulting from operation of Sites Reservoir Project (Project) diversions. The following sections provide the technical details associated with these analyses.

10A.2 Modeling to Evaluate Impacts of Reservoir Seepage on Groundwater Resources

The construction and operation the Sites and Holthouse Reservoirs would result in inundation of new land within the Primary Study Area. A portion of the water retained in these reservoirs will infiltrate into the underlying subsurface materials, acting as new sources of recharge to the underlying groundwater system. Additional recharge may result in increases in groundwater levels in the aquifer system within the Primary Study Area. Potential direct Project-related impacts resulting from reservoir operation on groundwater resources within the Primary Study Area were evaluated using a combination of analytical and numerical methods ($SACFEM_{2013}$ [CH2M HILL and MBK Engineers, 2014]). The following sections provide the details associated with these methods.

10A.2.1 Approach to Estimating Reservoir Seepage

Because the Sites Reservoir footprint and the majority of the Holthouse Reservoir footprint fall outside of the existing $SACFEM_{2013}$ model domain, potential seepage from these reservoirs was computed external to the numerical model using an analytical solution. This analytical solution assumes that the surface water and groundwater systems are coupled (that is, the groundwater elevation beneath the reservoir has increased over time due to seepage and is now in contact with the bottom of the surface water body). Reservoir seepage was computed as follows:

$$Q = Kh \times \frac{Hres - Haq}{L} \times A \tag{1}$$

Where:

Q	=	reservoir seepage (L^3/T)
K_h	=	horizontal hydraulic conductivity of aquifer (L/T)
H_{res}	=	maximum operating stage of the reservoir (L)
H_{aq}	=	groundwater elevation at the margin of the alluvial basin (L)
L	=	distance from reservoir to the margin of the alluvial basin (L)
A	=	cross-sectional area (L^2)

The following information/data sources were used as the equation input terms:

- The horizontal hydraulic conductivity (K_h) of the bedrock units underlying the reservoir was assumed to be 0.03 feet per day (10^{-5} centimeters per second). This value was considered reasonable for a bulk hydraulic conductivity (that is, based on the cumulative effect of lithology and structure [fractures]) based on literature values (Freeze and Cherry, 1979).
- The maximum reservoir stage (H_{res}) for the Holthouse Reservoir is 206 feet above the North American Vertical Datum of 1988 (NAVD88) for all alternatives. The maximum Sites Reservoir stage is 480 feet NAVD88 for Alternative A and 520 feet NAVD88 for Alternatives B, C, and D.
- The groundwater elevation at the western margin of the alluvial subbasin is approximately 130 feet NAVD88 (Figures 10-3 and 10-4 of Chapter 10 Groundwater Resources).
- The distance from points within the Sites and Holthouse Reservoirs to the western margin of the alluvial subbasin (L) were computed for 10-meter digital elevation model (DEM) grid cells within the reservoir footprints. The distances were computed based on the difference between the easting (x-coordinate) of each DEM cell center and the average easting (x-coordinate) at the alluvial subbasin margin. Because the Holthouse Reservoir is partially within the alluvial subbasin, a minimum distance of 750 feet was assumed for this evaluation.
- The area (a) term was equal to each DEM “cell”. It was assumed that each plan-view DEM cell area represents the cross-sectional area of the groundwater flow tube oriented vertically from the base of the reservoir and transitioning to horizontal as groundwater moves laterally through the groundwater system toward the Sacramento Valley aquifer.

Reservoir seepage was computed using Equation 1 for each DEM grid cell within the Sites Reservoir Alternative A; Sites Reservoir Alternatives B, C, and D; and Holthouse Reservoir inundation areas. The seepage values for each of the DEM grid cells were totaled for each of the reservoir inundation areas to yield the total reservoir seepage estimate of:

- Sites Reservoir, Alternative A: 1,500 gallons per minute (gpm) (2,420 acre-feet per year [ac-ft/yr])
- Sites Reservoir, Alternatives B, C, and D: 1,930 gpm 3,100 ac-ft/yr)
- Holthouse Reservoir: 220 gpm (350 ac-ft/yr)

10A.2.2 Numerical Model Simulations

$SACFEM_{2013}$ is a numerical tool composed of a groundwater model and a surface water budgeting module that computes the monthly agricultural pumping and groundwater recharge resulting from applied water and precipitation. The $SACFEM_{2013}$ model domain encompasses the entire Sacramento Valley Groundwater Basin with nodal spacing ranging from 410 feet (125 meters) to 3,280 feet (1,000 meters). The model is calibrated to groundwater levels measured in monitoring wells during a 40-year period (water years 1970 through 2010). Complete documentation of the construction and calibration of $SACFEM_{2013}$ is included in *Sacramento Valley Finite Element Groundwater Flow Model User’s Manual* (CH2M HILL and MBK Engineers, 2014). The baseline $SACFEM_{2013}$ simulations represents the Existing Conditions/No Project/No Action Condition to which model output which includes reservoir seepage were compared.

The potential effects of long-term reservoir operation on groundwater elevations within the Sacramento Valley Groundwater Basin (Colusa Subbasin) were evaluated for the combined seepage from the

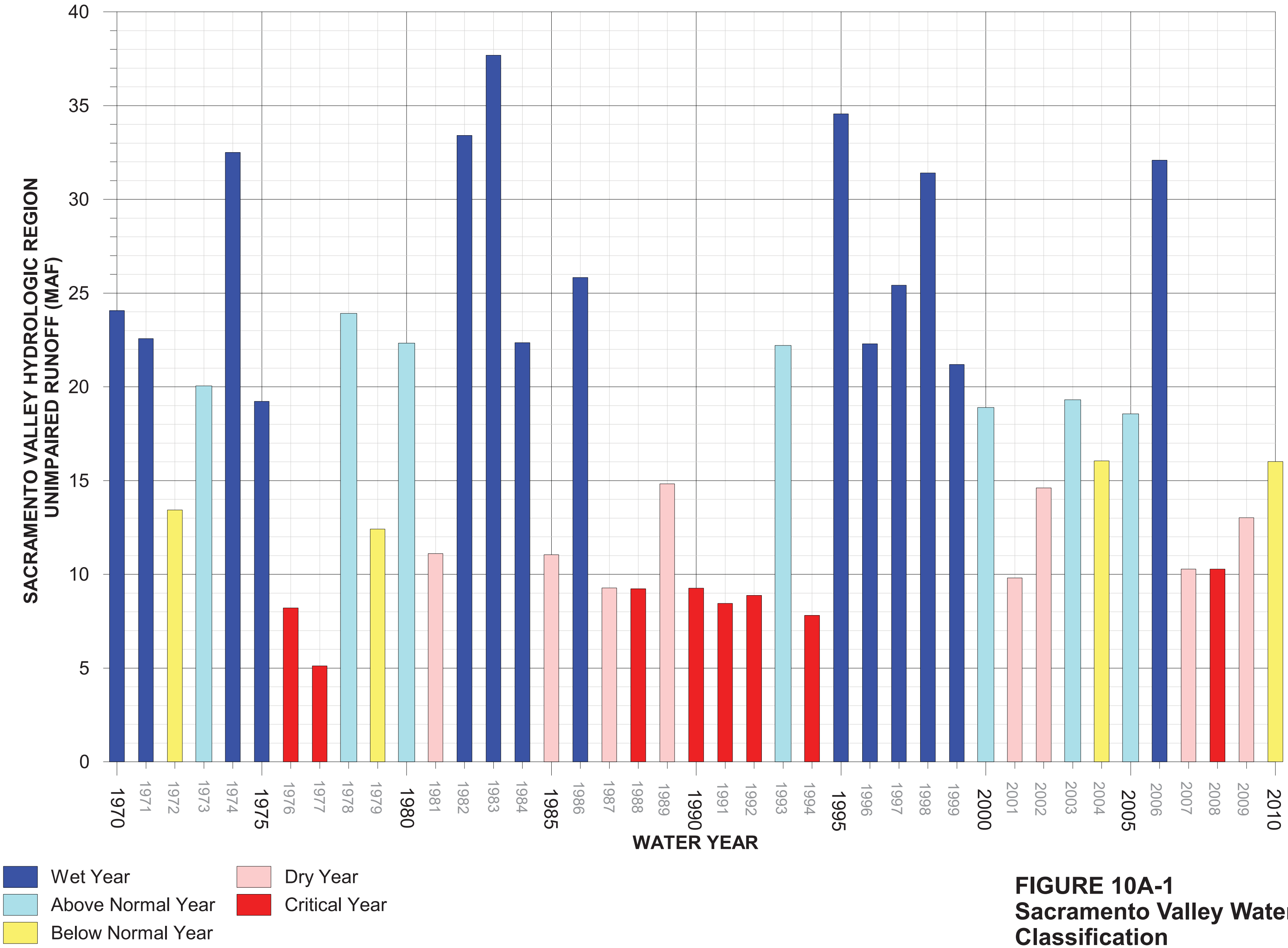
Holthouse and Sites Alternative B, C, D configurations. It was determined that because the estimated seepage under Alternative A was of smaller magnitude, if the impacts associated with the Alternatives B, C, and D configuration were less-than-significant, those for Alternative A would be as well. The estimated reservoir seepage values described above were used as input to $SACFEM_{2013}$ as specified flux boundary conditions. Seepage was assigned as inflow to model nodes along the western $SACFEM_{2013}$ model boundary immediately downgradient (east of) the Sites and Holthouse Reservoir footprints. The seepage inflow was apportioned to these nodes based on the upgradient reservoir widths. That is, nodes where the widths of the Sites and/or Holthouse reservoirs to the west were wider (such as the middle portion of the Sites Reservoir) were assigned relatively more seepage inflow than those nodes where the upgradient reservoirs were of lesser width (such as the northern and southern portions of Sites Reservoir). Seepage inflow was split among the seven model layers based on the relative transmissivity of the layers at each node (that is, layers with higher relative transmissivity were assigned a relatively higher portion of inflow for that node).

As described above, SACFEM2013 includes a 40-year transient simulation period with varying hydrologic conditions. For the purposes of this evaluation, estimated reservoir seepage was simulated in SACFEM2013 for the first 17 years of the simulation period (water year 1970 through water year 1985). This simulation period was considered appropriate for this evaluation because it included a critical drought (water years 1976 and 1977) and the wettest year in the simulation period (water year 1983) (Figure 10A-1). The baseline groundwater levels (the Existing Conditions/No Project/No Action Condition) were defined as the groundwater conditions resulting from the SACFEM2013 calibration simulation described and documented in CH2M HILL and MBK Engineers (2014). A second simulation was performed assigning additional inflow along the portion of the western model boundary as described above. The model forecast groundwater elevations from the Existing Conditions/No Project/No Action Condition and Alternatives B, C, D simulations were compared to evaluate the magnitude and distribution of potential increase in groundwater elevations in the Sacramento Valley Groundwater Basin (Colusa Subbasin) due to reservoir seepage. Increases in groundwater levels are presented/discussed for the shallow portions of the aquifer system as this represents zones where increases in groundwater levels could impact shallow root zones in agricultural areas or wetlands/wildlife areas. Spring 2016 depth to groundwater measurements, collected as part of the semi-annual DWR groundwater level monitoring program, are provided for context (DWR, 2017). Spring generally represents the period of seasonally high groundwater (that is, shallowest depth to water) in the Sacramento Valley Groundwater Basin.

10A.2.3 Results

Potential rates of seepage from the Sites and Holthouse Reservoirs under the maximum Alternative B through D reservoirs were estimated to be approximately 2,150 gpm. Figures 10A-2A and 10A-2A present simulated Existing Conditions/No Project/No Action Condition and Alternative B groundwater elevations in the vicinity of Funks Reservoir (the point with the largest increase in groundwater levels) and for a location within the orchards southeast of Funks Creek. Figures 10A-2A and 10A-2B also present bar charts representing the Sacramento Valley water year classification for the period simulated. These data show that following the onset of reservoir operation (simulated as beginning in water year 1971), simulated groundwater levels begin to increase as compared to the Existing Conditions/No Project/No Action Condition. The rate and magnitude of increase varies over time; however, in most years the inflow to the groundwater system from reservoir seepage provides a benefit in terms of an additional source of water to groundwater users in the valley. For example, as shown on Figure 10A-2A, groundwater levels are projected to be over 20-feet higher during critical drought years (1976-1977).

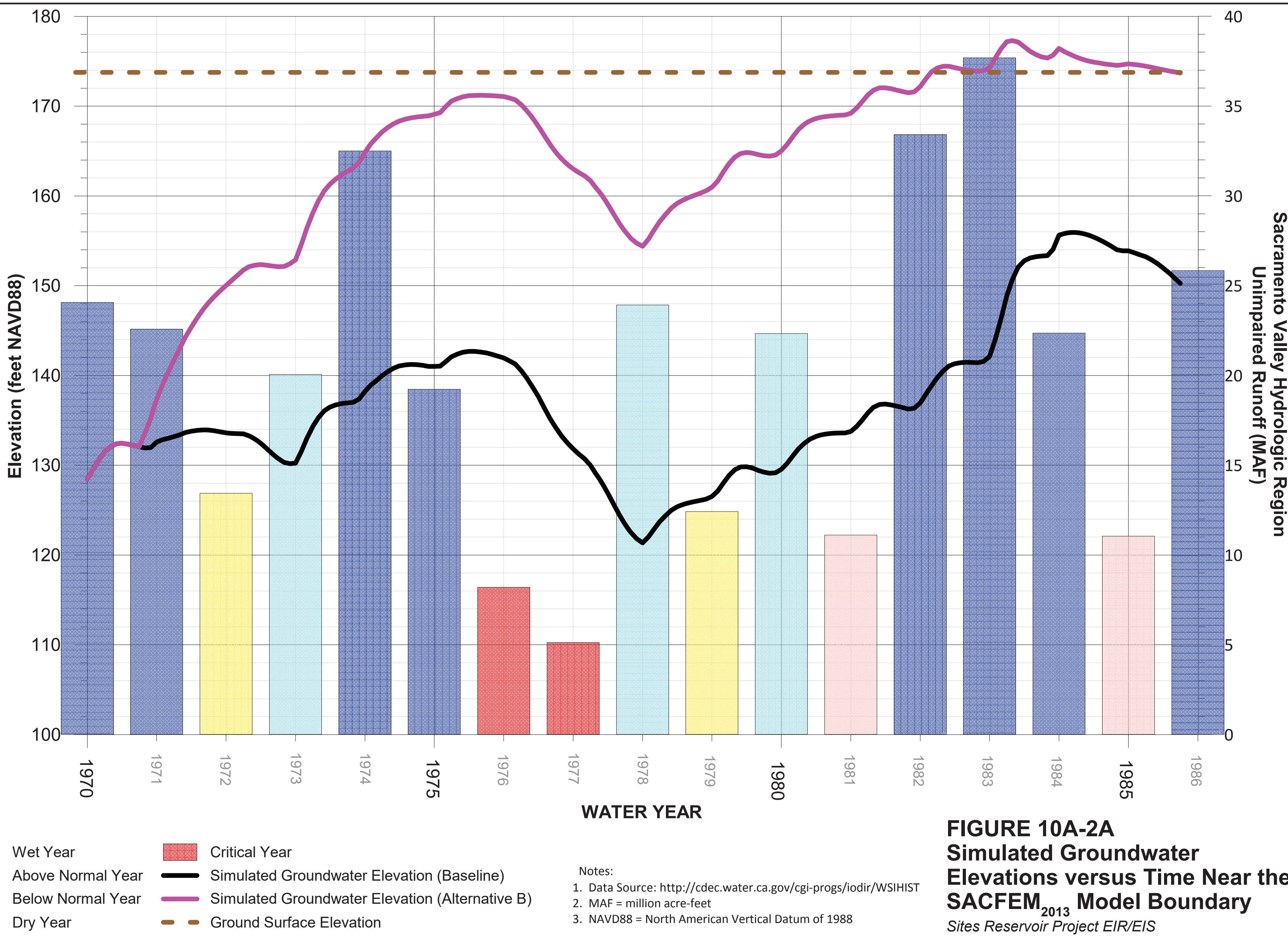
During extremely wet hydrologic conditions, such as water year 1983, the increased groundwater levels may result in additional discharge to streams and/or low lying areas. If groundwater levels rising to or near ground surface occur in agricultural areas, crops may be impacted. Figure 10A-2B presents hydrographs for a location within the orchards southeast of Funks creek where groundwater levels are projected to increase. These hydrographs indicate that even during extremely wet conditions, groundwater levels are forecast to be several feet below ground surface in these critical locations (at the highest simulated elevations).



Data Source: http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST

FIGURE 10A-1
Sacramento Valley Water Year Classification
Sites Reservoir Project EIR/EIS

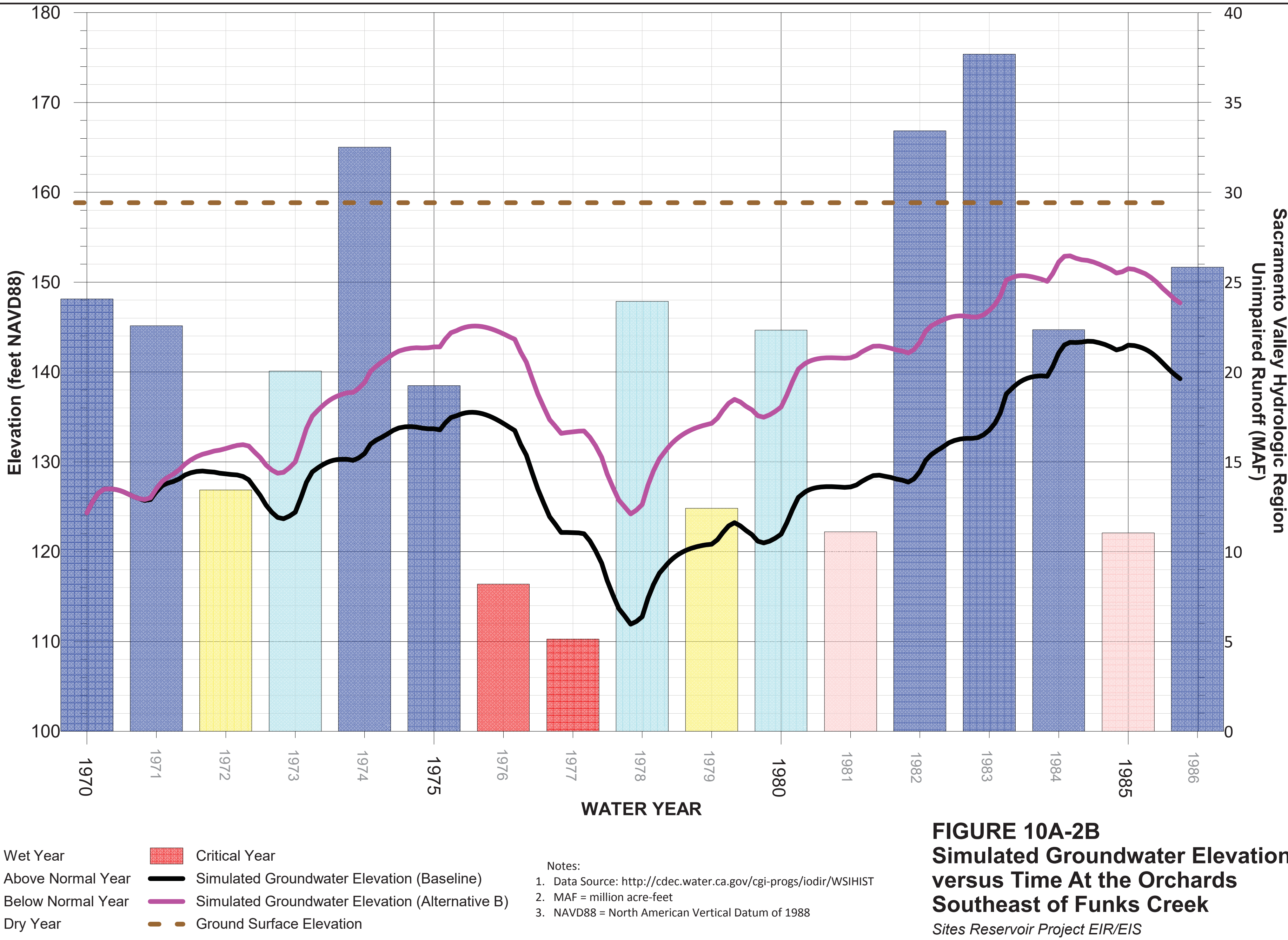
This page intentionally left blank.



Notes:
1. Data Source: http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST
2. MAF = million acre-feet
3. NAVD88 = North American Vertical Datum of 1988

FIGURE 10A-2A
Simulated Groundwater Elevations versus Time Near the $SACFEM_{2013}$ Model Boundary
Sites Reservoir Project EIR/EIS

This page intentionally left blank.



Notes:
1. Data Source: http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST
2. MAF = million acre-feet
3. NAVD88 = North American Vertical Datum of 1988

FIGURE 10A-2B
Simulated Groundwater Elevations versus Time At the Orchards Southeast of Funks Creek
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

Figures 10A-3A and 10A-3B present the simulated increases in groundwater levels in the shallow aquifer for hydraulic conditions consistent with February 1980 and April 1983, respectively. In addition to groundwater level increases, these figures present the simulated areas of groundwater discharge to streams and low-lying topographic areas, and the spring 2016 depth to water measurements.
Figure 10A-3A presents the distribution of simulated increase in groundwater levels for February 1980, which represents the period of maximum difference in groundwater elevations between Alternative B and the Existing Conditions/No Project/No Action Condition. These data suggest that groundwater levels could increase nearly 35 feet along the western $SACFEM_{2013}$ model boundary near Funks Creek.
Figure 10A-3B presents the distribution of simulated increase in groundwater levels for April 1983, which represents the period of highest groundwater elevations during the wettest year in the simulation period. These data suggest that groundwater levels could increase over 25 feet along the western $SACFEM_{2013}$ model boundary near Funks Creek. As shown on Figures 10A-3A and 10A-3B, the distribution of larger magnitude increases in groundwater levels is restricted to the western margin of the Colusa Subbasin, with model forecast increases in groundwater levels of less than 0.5 foot over most of the Primary Study Area. Further, the spring 2016 depths to water posted on Figures 10A-3A and 10A-3B suggest that the depths to water are larger than model forecast increases in groundwater levels (DWR, 2017) where the data and contours coincide. Finally, Figures 10A-3A and 10A-3B present the areas where $SACFEM_{2013}$ forecasts groundwater discharge to streams and low-lying areas. These data indicate that areas of groundwater levels at or near ground surface are primarily coincident with streams, flood bypasses, and wildlife refuges. Further, the model output suggests that there are a very limited number of locations where groundwater levels at or near ground surface are projected to occur under Alternative B through D that are not forecast to occur under the Existing Conditions/No Project/No Action Condition.

10A.2.4 Seepage Estimate Uncertainties

The seepage estimates described above are subject to uncertainty with respect to input values for Equation 1 and numerical model limitations. For example, increasing or decreasing the assumed horizontal hydraulic conductivity would result in proportional decreases or increases in the estimated reservoir seepage. The input parameters are within the mid-range of literature values (Freeze and Cherry, 1979) and are considered reasonable. Additionally, mathematical models can only approximate processes of physical systems. The models are inherently inexact because the mathematical description of the physical system is imperfect, the understanding of interrelated physical processes is incomplete, and the solution non-unique. $SACFEM_{2013}$ incorporated as many details of the physical system as practicable and is considered a powerful tool that can provide useful insights into the physical processes of the aquifer system. However, the nodal resolution in the area of projected increases in groundwater levels is coarse (3,280 feet [1,000 meters]), lending a degree of uncertainty to the estimated increases in groundwater levels.

10A.3 Modeling to Evaluate Impacts of Sacramento River Diversions on Groundwater/Surface Water Interaction

The surface water and groundwater systems are strongly connected in the Primary and Secondary (Sacramento Valley Groundwater Basin) study areas and are highly variable spatially and temporally. Within the Sacramento Valley Groundwater Basin, the Sacramento and Feather Rivers act as drains and are recharged by groundwater throughout most of the year. The exceptions are areas of depressed groundwater elevations attributable to groundwater pumping (inducing leakage from the rivers) and localized recharge to the groundwater system. In contrast, the upper reaches of tributary streams flowing into the Sacramento River from upland areas are generally losing streams (they recharge the groundwater system). These tributary streams usually transition to gaining streams (they receive groundwater) farther downstream, closer to their confluences with the Sacramento or Feather Rivers. Estimates of these surface water and groundwater exchange rates have been developed for specific reaches on a limited number of streams in the Sacramento Valley Groundwater Basin (USGS, 1985), but a comprehensive Valley-wide accounting has not been performed to date. Changes in operation of the surface water conveyance and distribution system will result in changes in the nature and magnitude of the interaction between the Sacramento River and the underlying aquifer system.

Potential changes in groundwater and surface water interaction were evaluated using the CALSIM II surface water routing model in conjunction with the Central Valley Hydrologic Model (CVHM) (USGS, 2009). The Central Valley Hydrologic Model (CVHM) encompasses the alluvial deposits of the entire Central Valley extending from the Cascade Ranges on the north to the Tehachapi Mountains on the south. It is bounded on the east by the Sierra Nevada and on the west by the Coast Ranges (USGS, 2017a). The latest version of the model was downloaded from the USGS web site (USGS, 2016). The model is built on a USGS modification of MODFLOW-2000 (Harbaugh et al., 2000) that incorporates the farm package (Schmid et al., 2006).

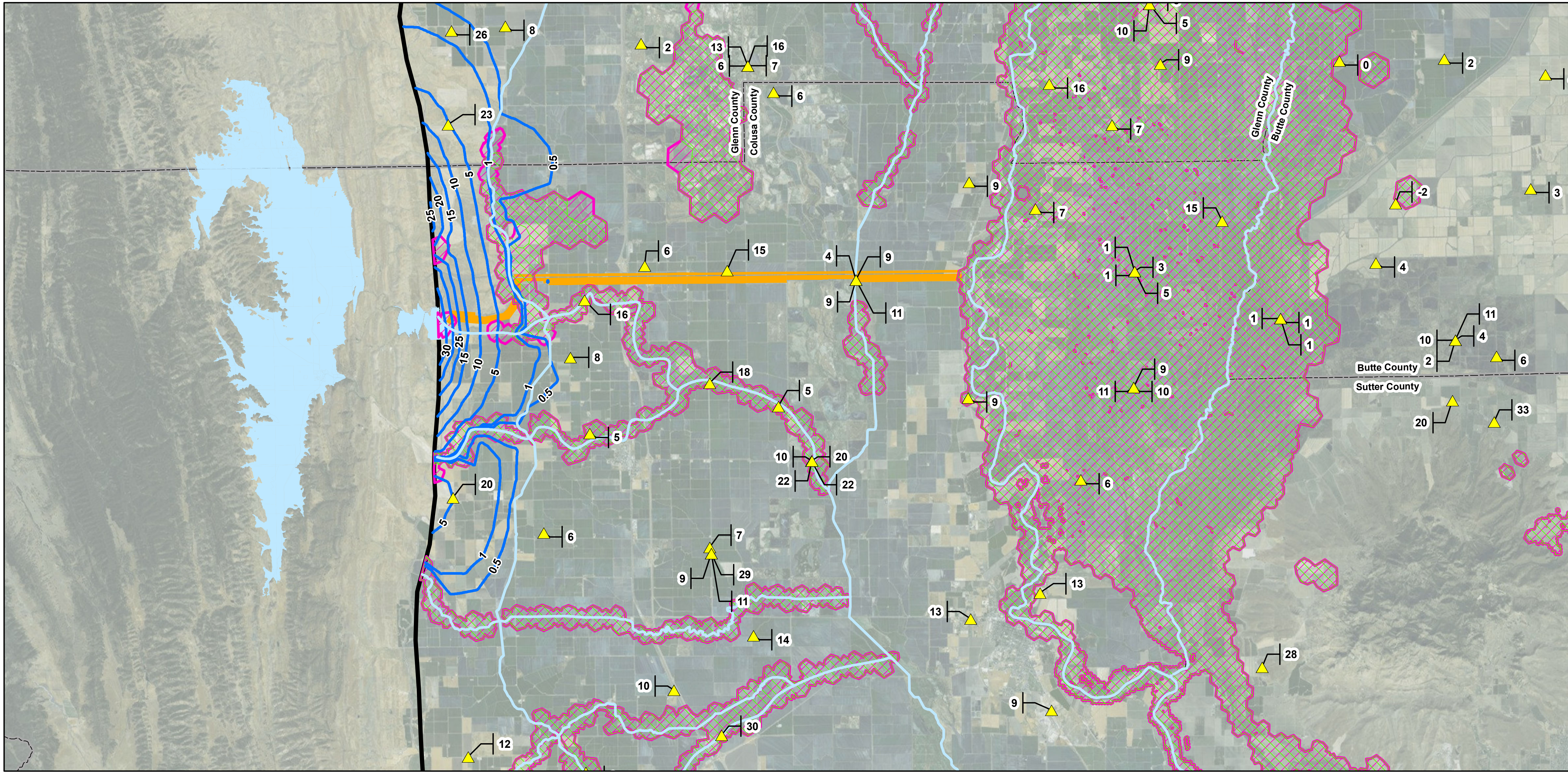
For the purposes of this analysis, the CVHM was modified to incorporate simulation results from the CALSIM II surface water model developed to evaluate the Project alternatives; refer to Appendix 6B Water Resources System Modeling for discussion of the CALSIM II model. Five simulations were performed, one for the Existing Conditions/No Project/No Action Condition (NAA), and one each for Alternatives A through D. The details of these alternatives are provided in EIR Chapter 2 Alternatives Analysis and EIR Chapter 3 Description of the Sites Reservoir Project Alternatives, and will only be discussed as needed herein.

10A.3.1 Modifications to the CVHM

The components of the modifications included the following:

Add three new diversions to the stream-flow routing package (SFR) to account for water needed to fill the Sites Reservoir. This includes new withdrawals from two existing diversions, the Tehama Colusa Canal (TCC) and the Glenn Colusa Canal (GCC), and one new diversion called the Delevan Pipeline (DEL). These diversions were unique for each of the five simulations (NAA plus Alternatives A through D). In NAA, the new diversions were set to zero throughout the simulation period.

- Modify existing semi-routed diversions to be consistent with CALSIM II. This included diversions to satisfy agricultural deliveries to the Corning, Tehama Colusa, and Glenn Colusa canals. Table 10A-1 indicates the relationship between CVHM SFR diversions and CALSIM II equivalent nodes. These diversions were unique for each of the five simulations that were performed.



Legend

- ▲ Spring 2016 Depth to Groundwater (feet bgs)
- SACFEM2013 Stream
- Simulated Change in Groundwater Level (feet)
- SACFEM2013 Model Boundary
- County Boundary
- Area of Groundwater Discharge Alternative B
- Area of Groundwater Discharge Existing Condition/No Project/No Action Condition

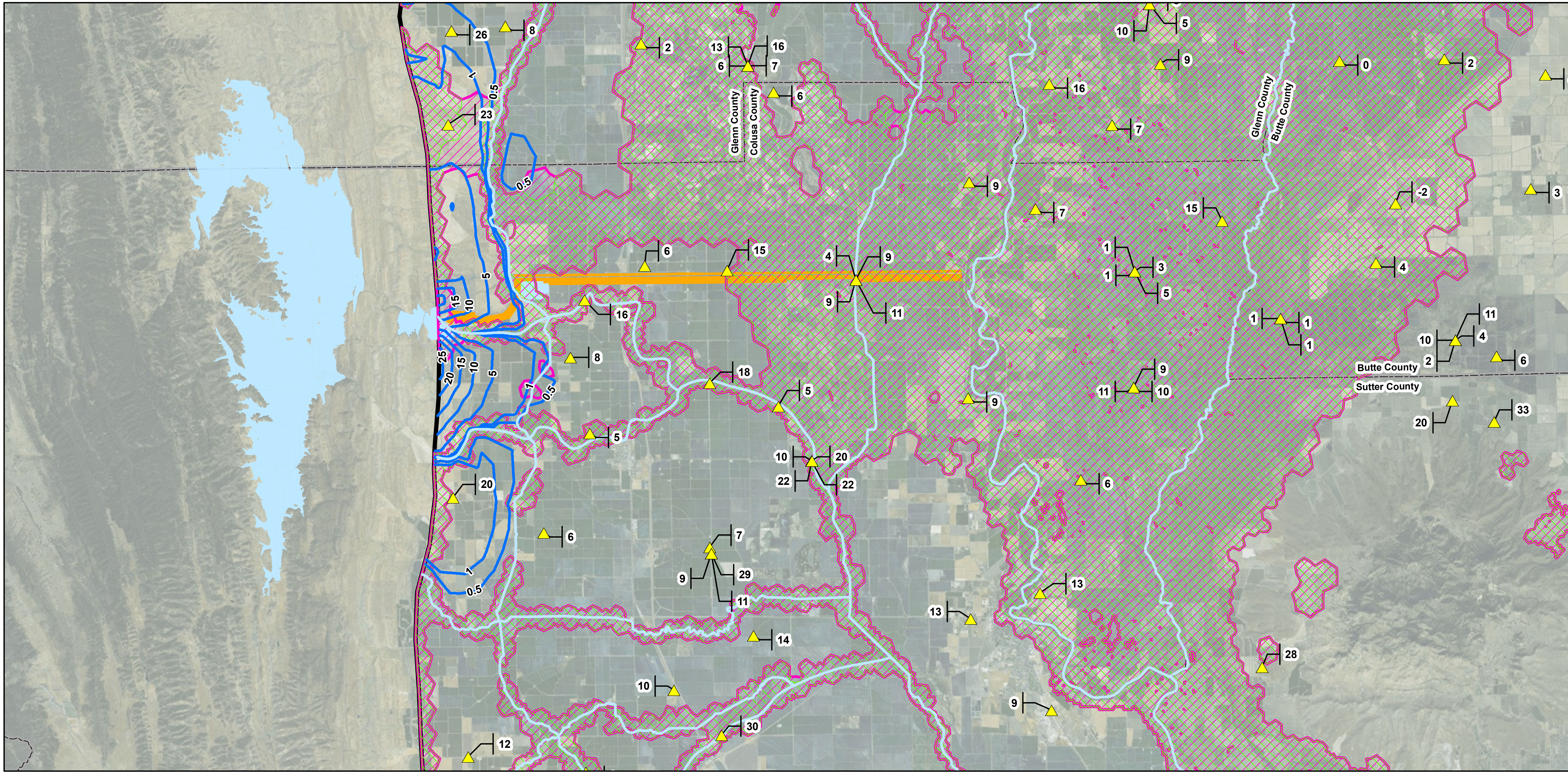
Select Project Features (Locations Approximate)

- Pipeline Construction Disturbance Area
- Reservoir

0 1.25 2.5 5
Miles

Notes:
1. Groundwater Subbasin Boundary and Spring 2016 Depth to Groundwater Source: https://gis.water.ca.gov/app/gicima/
2. bgs = below ground surface
3. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 10A-3A
Simulated Increase in Groundwater Level due to Seepage from Sites and Holthouse Reservoirs, Alternative B Shallow Aquifer, February 1980
Sites Reservoir Project EIR/EIS



Legend

- Spring 2016 Depth to Groundwater (feet bgs)
- SACFEM2013 Stream
- Simulated Change in Groundwater Level (feet)
- SACFEM2013 Model Boundary
- County Boundary
- Area of Groundwater Discharge Alternative B
- Area of Groundwater Discharge Existing Condition/No Project/No Action Condition

Select Project Features (Locations Approximate)

- Pipeline Construction Disturbance Area
- Reservoir

0 1.25 2.5 5
Miles

N

Notes:
1. Groundwater Subbasin Boundary and Spring 2016 Depth to Groundwater Source: https://gis.water.ca.gov/app/gicima/
2. bgs = below ground surface
3. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 10A-3B
Simulated Increase in Groundwater Level due to Seepage from Sites and Holthouse Reservoirs, Alternative B Shallow Aquifer, April 1983
Sites Reservoir Project EIR/EIS

- Add non-routed deliveries to two farming water-balance sub-regions (see Table 10A-1) in CVHM, out of a total of 21, per CALSIM II calculation. These sub-regions are described in the CVHM documentation (USGS, 2017b). The relationship between the two sub-regions that receive non-routed deliveries and the CVHM diversions in the SFR package are also shown in Table 10A-1. These deliveries were non-zero only for Project Alternative D.
- Add 12 additional gage locations downgradient of each new diversion to allow for calculation of the changes in Sacramento River stage due to surface water diversions associated with each of the Project alternatives. These additional gages were at the same locations in all five simulations, so that results were comparable. Table 10A-2 indicates the row-column locations of the gages within the CVHM model in order of their downgradient locations.

Table 10A-1
Relationship Between CVHM Nodes, CALSIM II Nodes, and CVHM Farm Package Sub-regions
Sites Project CVHM Modeling Documentation

CVHM Diversion Node	CALSIM II Equivalent Node	CVHM Description	CVHM Farm Package Sub-region
CORN_0232	D171	Corning Canal	2
TE10_0232	D172	Tehama Colusa Canal	3
TE12_0323	D174 + D178	Tehama Colusa Canal	3
GLEN_0261	D143A + D145A	Glenn Colusa Canal	3

Table 10A-2
Model Row and Column Locations of New Gages for River Stage Output
Sites Project CVHM Modeling Documentation

Sites Diversion	Approximate Downgradient Distance (Miles)	Model Row Location of Sacramento River Node	Model Column Location of Sacramento River Node
TCC	1[a]	41	79
TCC	2	42	78
TCC	3	43	78
TCC	4	44	78
TCC	5	44	77
TCC	6	45	77
TCC	7	46	77
TCC	8	46	76
TCC	9	47	76
TCC	10	47	77
TCC	11	48	76
TCC	12	49	76
GCC	1[a]	59	72
GCC	2	60	72
GCC	3	61	73
GCC	4	61	72
GCC	5	62	72

Sites Diversion	Approximate Downgradient Distance (Miles)	Model Row Location of Sacramento River Node	Model Column Location of Sacramento River Node
GCC	6	63	72
GCC	7	64	72
GCC	8[b]	65	72
GCC	9[b]	66	72
GCC	10[b]	66	73
GCC	11[b]	67	73
GCC	12[b]	68	73
DEL	1[A]	87	56
DEL	2	88	55
DEL	3	88	56
DEL	4	89	56
DEL	5	89	55
DEL	6	90	54
DEL	7	90	55
DEL	8	91	55
DEL	9	91	54
DEL	10	92	53
DEL	11	92	54
DEL	12	93	54

[a] The first model cell for each diversion's new gages was the cell of the diversion itself. Subsequent cells are the consecutive model cells of the Sacramento River in the model, downgradient of the diversion.

[b] The baseline USGS version of the CVHM model has inactive groundwater cells in model layer 1.

The USGS's CVHM simulates Central Valley groundwater conditions from April 1961 through September 2003. Thus, by applying the above modifications, the Project adaptation of the CVHM model is a hybrid of past conditions and various future additions associated with the Project. These simulations are therefore not necessarily forecasts of future groundwater and surface water conditions in the valley, but nevertheless, the potential effects of the four Project Alternatives A through D on groundwater and surface water can be compared against the NAA with this modeling tool, because all of these alternatives are implemented upon the same baseline, which is the USGS CVHM.

The results of the simulations were processed through Zonebudget (Harbaugh, 1990) and GW-Chart (Winston, 2000) to collect the relevant groundwater-surface water exchange data out of the raw cell-by-cell flow terms and water budgets. The purpose of this post-processing was to estimate the changes in flows due to the projects at the same 12 nodes downgradient of the three Sites-filling diversions (Table 10A-2). These flow changes, along with the corresponding groundwater head and Sacramento River stage changes, were the basis for assessing the potential Project impacts to groundwater and surface water via the CVHM. The difference between the groundwater-surface water exchange of a Project alternative and the NAA was calculated for three cumulative distances downstream: 5 miles, 10 miles, and 12 miles. This was done to forecast how the groundwater-surface water exchange might change downstream of each diversion as a result of the Project alternatives.

10A.3.2 Results

For all Project alternatives, simulated heads and Sacramento River stages downgradient of the Project diversions were compared to the NAA after 4.2 years, 24.8 years, and 39.2 years of simulation, reflecting early, middle, and late stages of the 40-year Project simulation period. Groundwater-surface water interaction water budget terms were also reviewed.

The plots of heads downgradient of the GCC diversion in the following section are truncated at 7 miles downstream, whereas the stages at GCC, and both the heads and stages at the other diversions, are continued out to 12 miles downstream. The reason for this truncation of GCC heads is that the USGS CVHM has inactive cells in model layer 1 for the subsequent downgradient reach of the river at this location. Given that the analysis indicates little difference between NAA and the Project alternatives groundwater heads in the active cells, it is assumed that turning on these cells would have made very little difference.

10A.3.2.1 Alternative A

Figures 10A-4 through 10A-6 present plots of CVHM simulated Sacramento River stage and underlying groundwater elevations with distance for the two diversions and one intake/discharge facility, for Alternative A and the NAA, for the three snapshots in time that were compared (4.2 years, 24.8 years, and 39.2 years). The middle time, 24.8 years, had the greatest simulated differences in river stage and groundwater elevations. As shown on Figure 10A-5, the simulated Sacramento River stages and groundwater elevations for the Existing Conditions/No Project/No Action Condition and Alternative A are very similar (Alternative A simulated stages are nearly identical and groundwater elevations are up to 1.1 feet lower) for the Red Bluff Pumping Plant and GCID Canal intakes. For the Delevan Pipeline Intake, CVHM simulations show that stream stage for Alternative A is less than one foot lower than the Existing Conditions/No Project/No Action Condition, and groundwater elevations for Alternative A are up to 3.8 feet lower compared to the Existing Conditions/No Project/No Action Condition. Figure 10A-7 presents plots of changes in groundwater/surface water interaction over time at three distances downstream from the diversions. CVHM results show that for Alternative A there would be an increase in groundwater recharge of up to 3 cubic feet per second (cfs) at the Red Bluff Pumping Plant and GCID Canal intakes compared to the Existing Conditions/No Project/No Action Condition. The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative A is forecasted by the CVHM to be 0.25% at TCC, and 2.0% at GCC. At the Delevan Pipeline intake under Alternative A, groundwater recharge will be reduced by less than 40 cfs in most months, with a maximum decrease of approximately 140 cfs compared to the Existing Conditions/No Project/No Action Condition. The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative A is forecasted by the CVHM to be 0.44% at the Delevan Pipeline intake. The model forecast changes in Sacramento River stage, underlying groundwater elevations, and groundwater/surface water interaction under Alternative A are negligible to minor as compared to the Existing Conditions/No Project/No Action Condition.

10A.3.2.2 Alternative B

Figures 10A-8 through 10A-10 presents plots of CVHM simulated Sacramento River stage and underlying groundwater elevations with distance for the two diversions and one discharge facility, for Alternative B and the NAA, for the three snapshots in time that were compared (4.2 years, 24.8 years, and 39.2 years). The middle time, 24.8 years, again had the greatest simulated differences in river stage and groundwater elevations. As shown on Figure 10A-9, the simulated Sacramento River stages and groundwater elevations for the Existing Conditions/No Project/No Action Condition and Alternative B were very similar (Alternative B simulated stages for Alternative B are almost identical to the Existing Conditions/No Project/No Action Condition and groundwater elevations are up to 2.5 feet lower under Alternative B than for the Existing Conditions/No Project/No Action Condition) for the Red Bluff Pumping Plant and GCID Canal intakes. At the Delevan Pipeline discharge facility, CVHM simulations for Alternative B show a decrease in stream stage of up to 1 foot and a decrease in groundwater elevations of up to 5.5 feet. Figure 10A-11 presents plots of changes in groundwater/surface water interaction over time at three distances downstream from the diversions and discharge facility under Alternative B. Maximum projected increases of up to 3 cfs in groundwater recharge are simulated under Alternative B (compared to the Existing Conditions/No Project/No Action Condition) at the Red Bluff Pumping Plant. At the GCID Canal intakes, the changes in groundwater recharge under alternative B range from increases of up to 2 cfs to decreases of up to 1.5 cfs compared to the Existing Conditions/No Project/No Action Condition. The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative B is forecasted by the CVHM to be 0.22% at TCC, and 2.3% at GCC. At the Delevan Pipeline discharge facility, increases and decreases in groundwater/surface water interaction were less than 40 cfs in most months, with a maximum of approximately 125 cfs compared to the Existing Conditions/No Project/No Action Condition). The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative B is forecasted by the CVHM to be 0.32% at the Delevan Pipeline intake. The model forecast changes in Sacramento River stage, underlying groundwater elevations, and groundwater/surface water interaction under Alternative B are negligible to minor as compared to the Existing Conditions/No Project/No Action Condition.

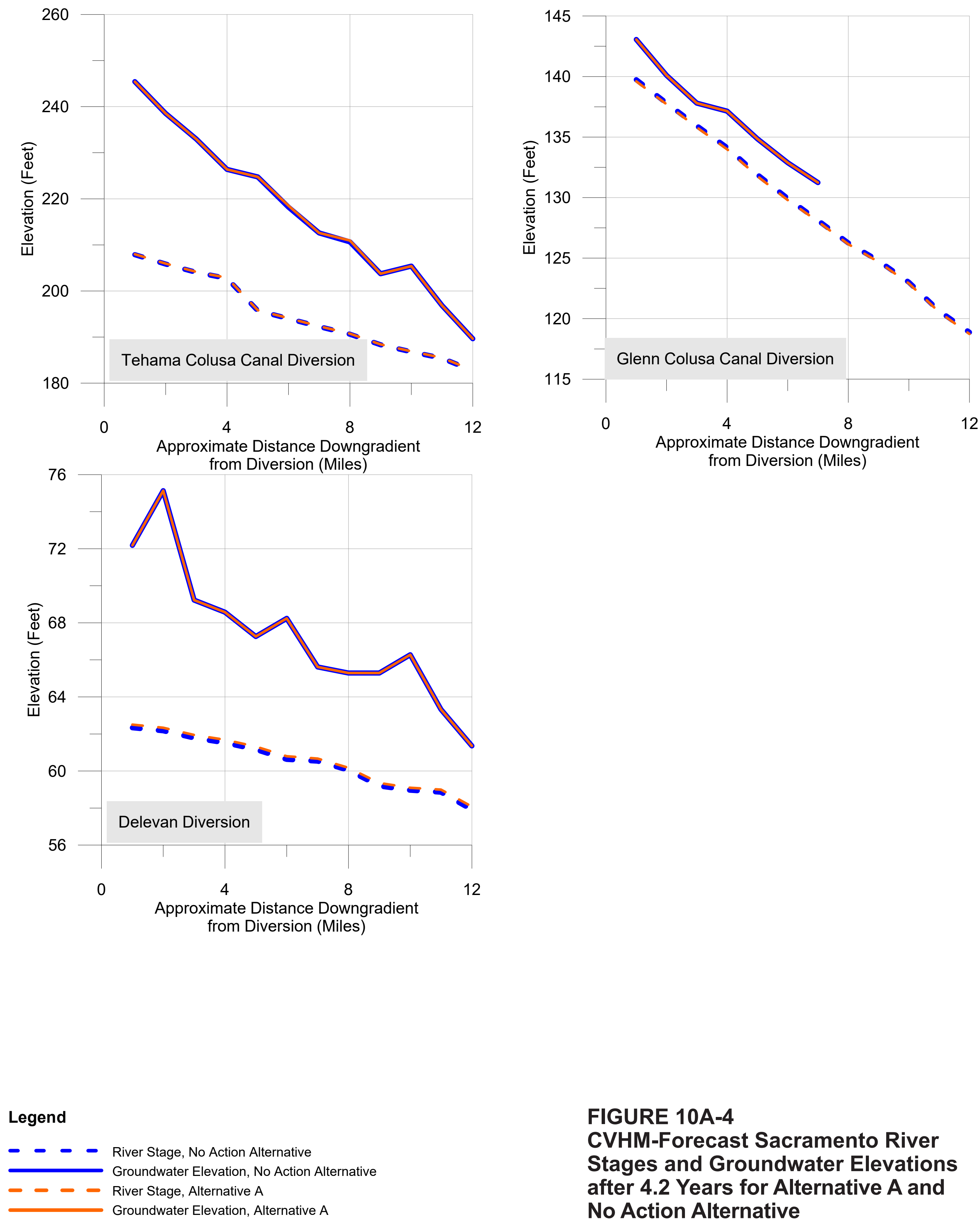
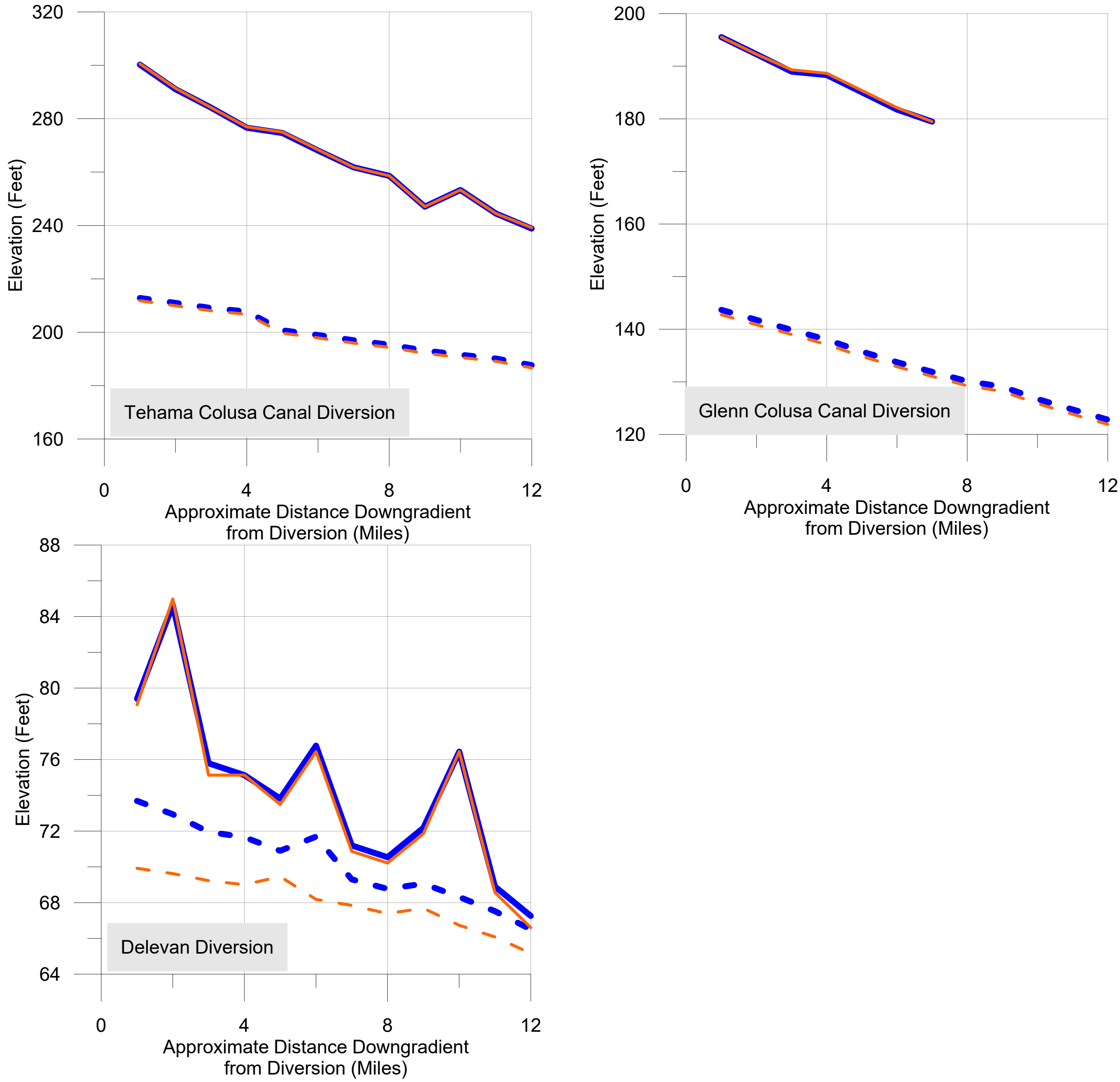


FIGURE 10A-4
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 4.2 Years for Alternative A and No Action Alternative
Sites Reservoir Project EIR/EIS

SL0118171100RDD SPJPA_Fig10A-4_178_V1.ai cmont 03/17/17

This page intentionally left blank.

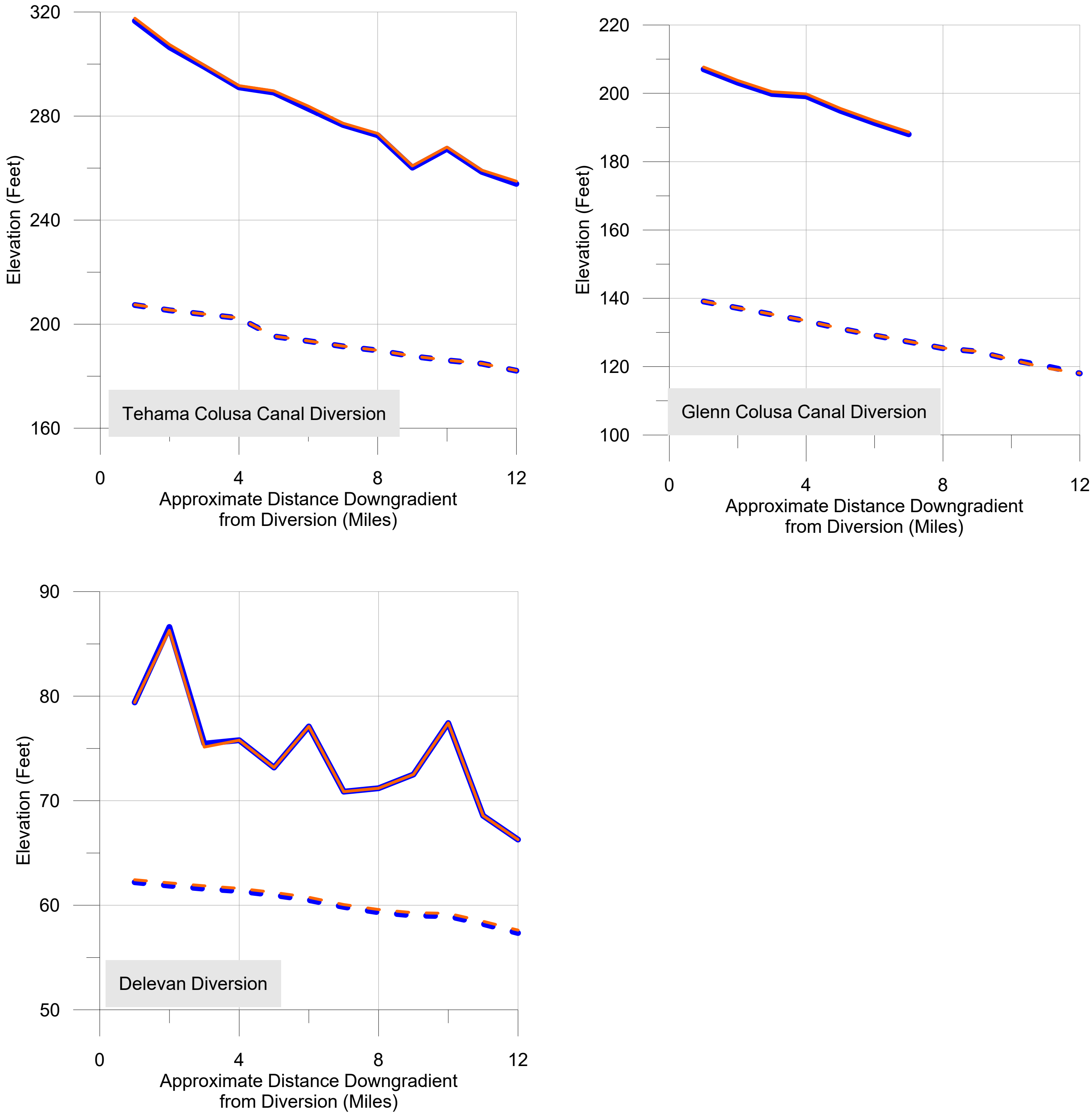


Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative A
- Groundwater Elevation, Alternative A

FIGURE 10A-5
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 24.8 Years for Alternative A and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.



Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative A
- Groundwater Elevation, Alternative A

FIGURE 10A-6
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 39.2 Years for Alternative A and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

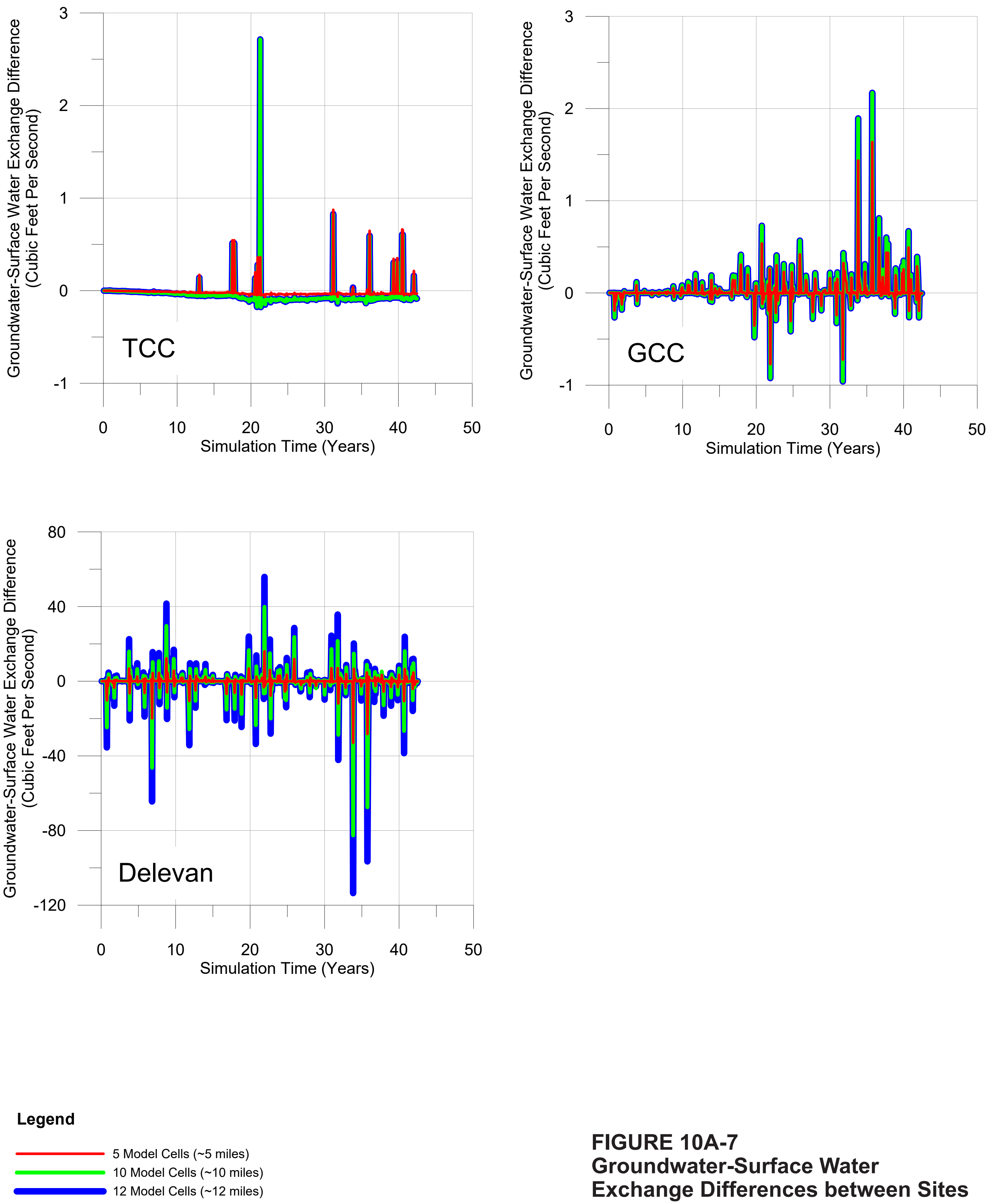


FIGURE 10A-7
Groundwater-Surface Water Exchange Differences between Sites Alternative A and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

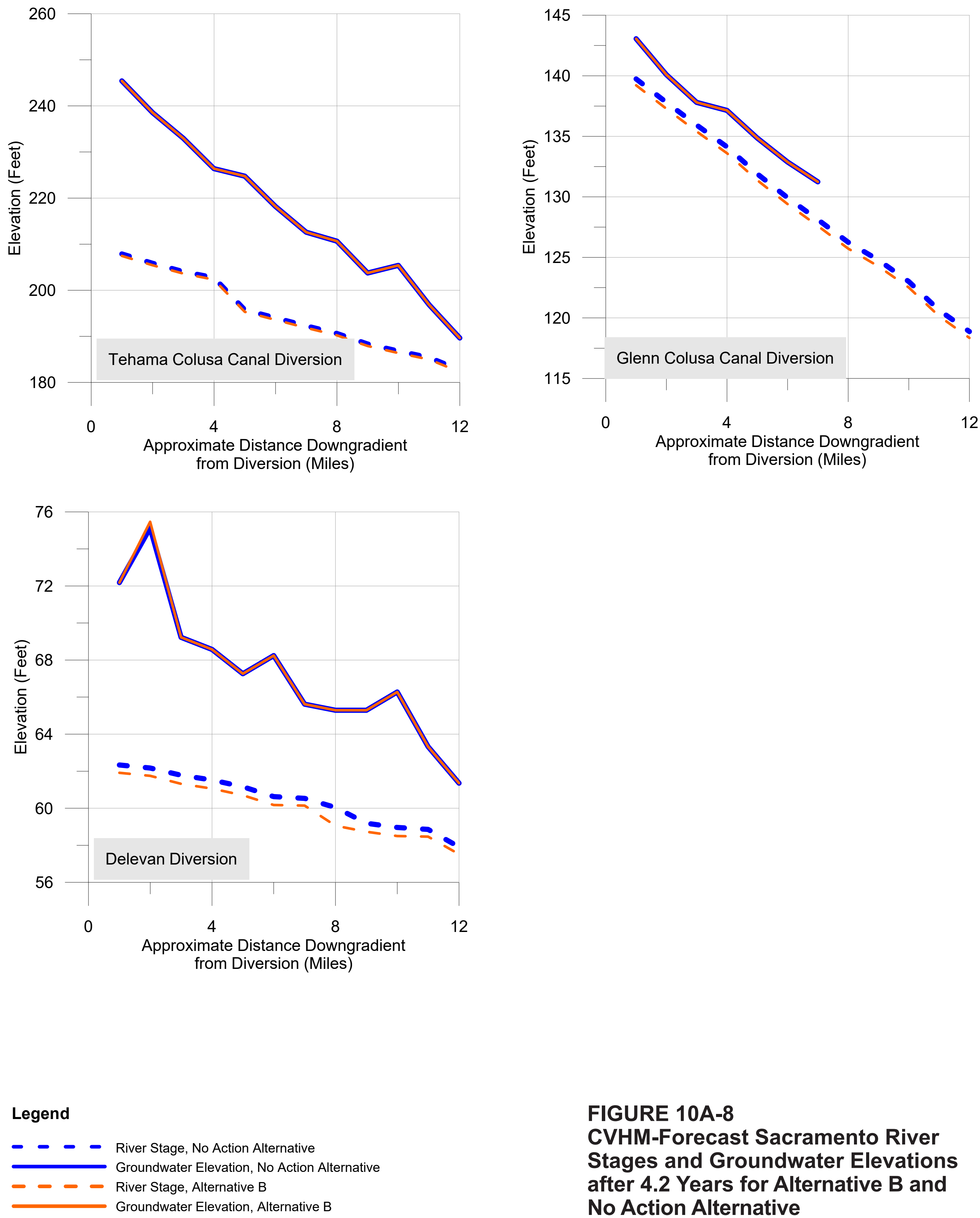
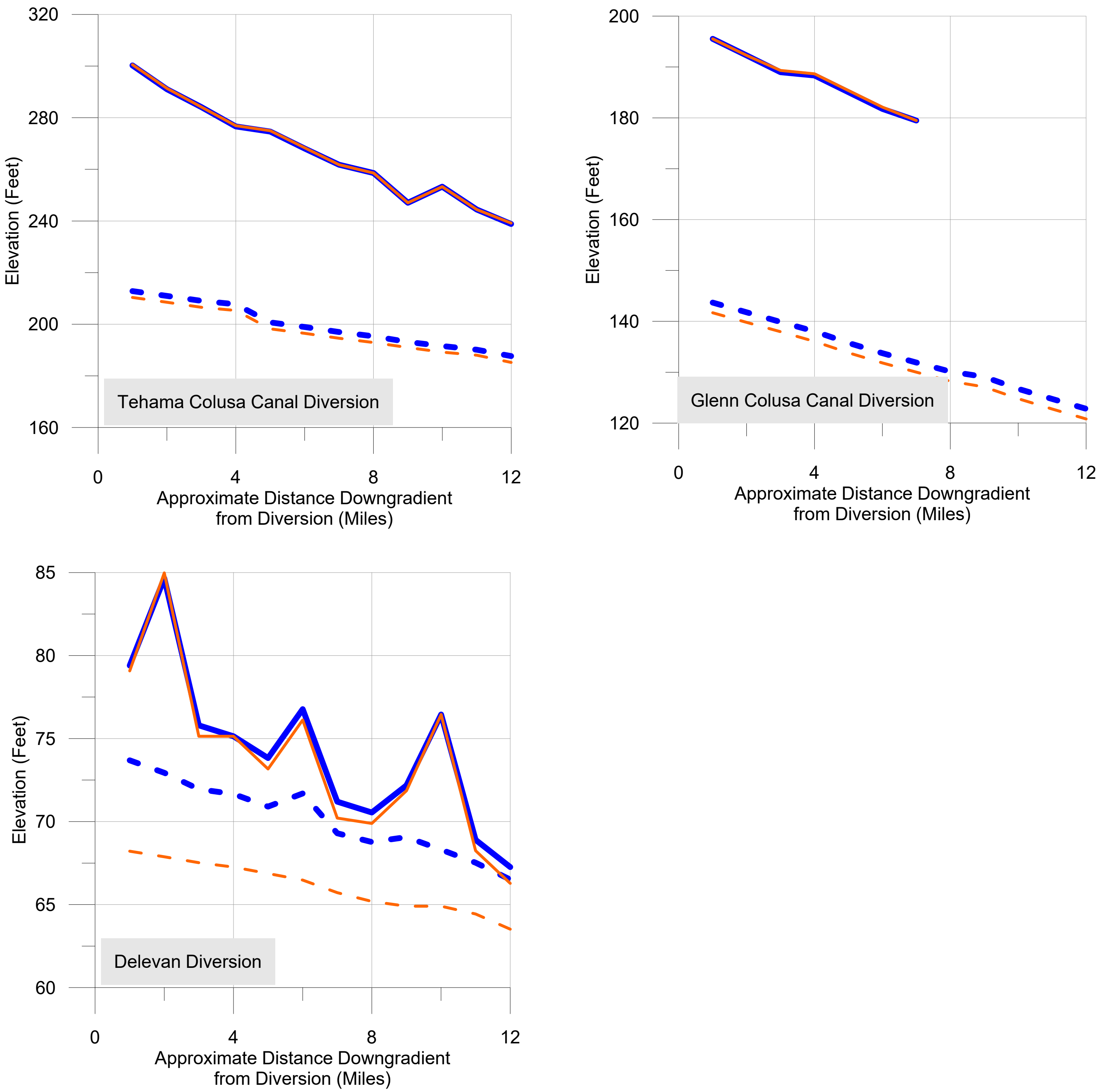


FIGURE 10A-8
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 4.2 Years for Alternative B and No Action Alternative
Sites Reservoir Project EIR/EIS

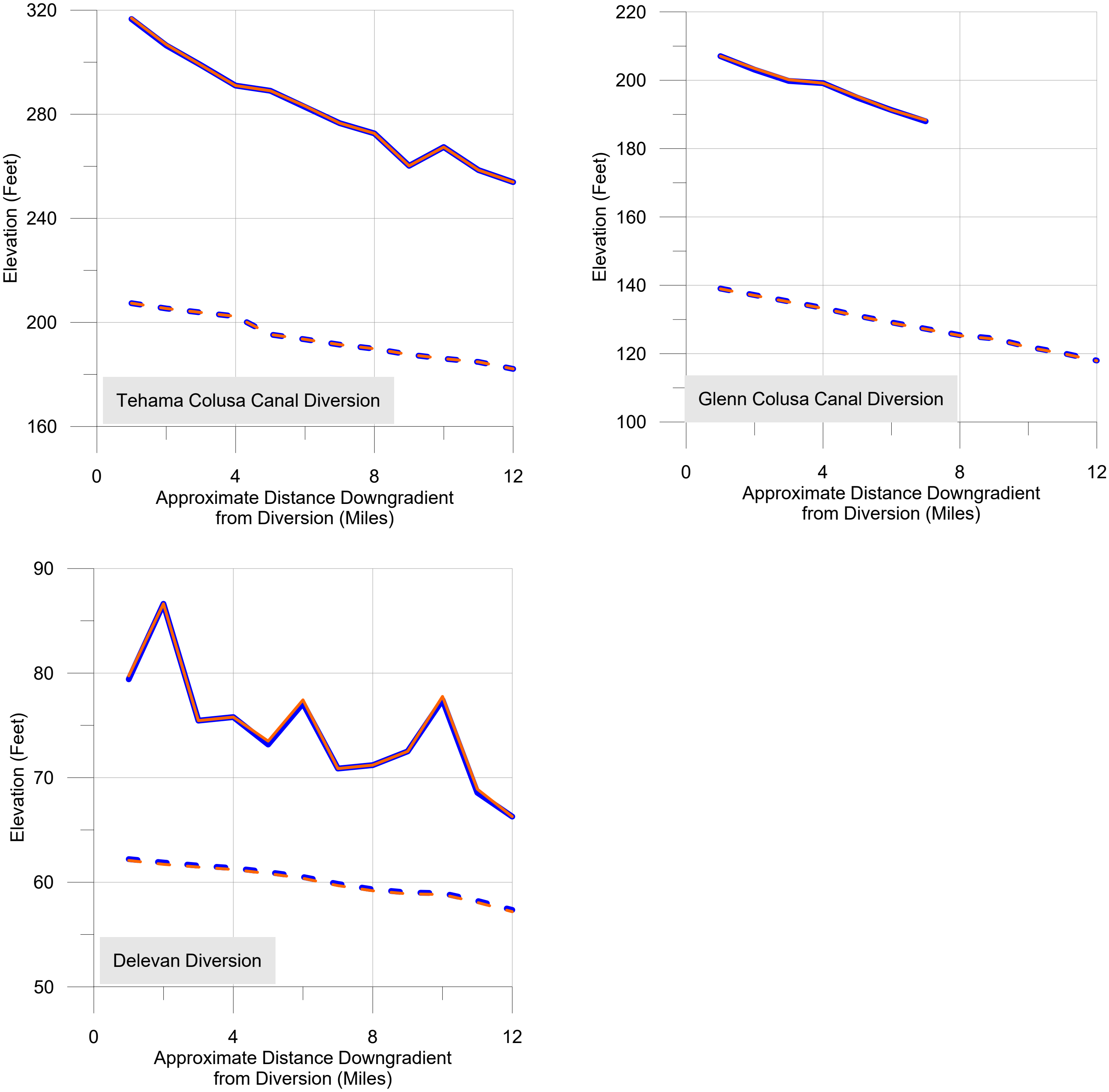
This page intentionally left blank.



Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative B
- Groundwater Elevation, Alternative B

FIGURE 10A-9
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 24.8 Years for Alternative B and No Action Alternative
Sites Reservoir Project EIR/EIS



Legend

River Stage, No Action Alternative
Groundwater Elevation, No Action Alternative
River Stage, Alternative B
Groundwater Elevation, Alternative B

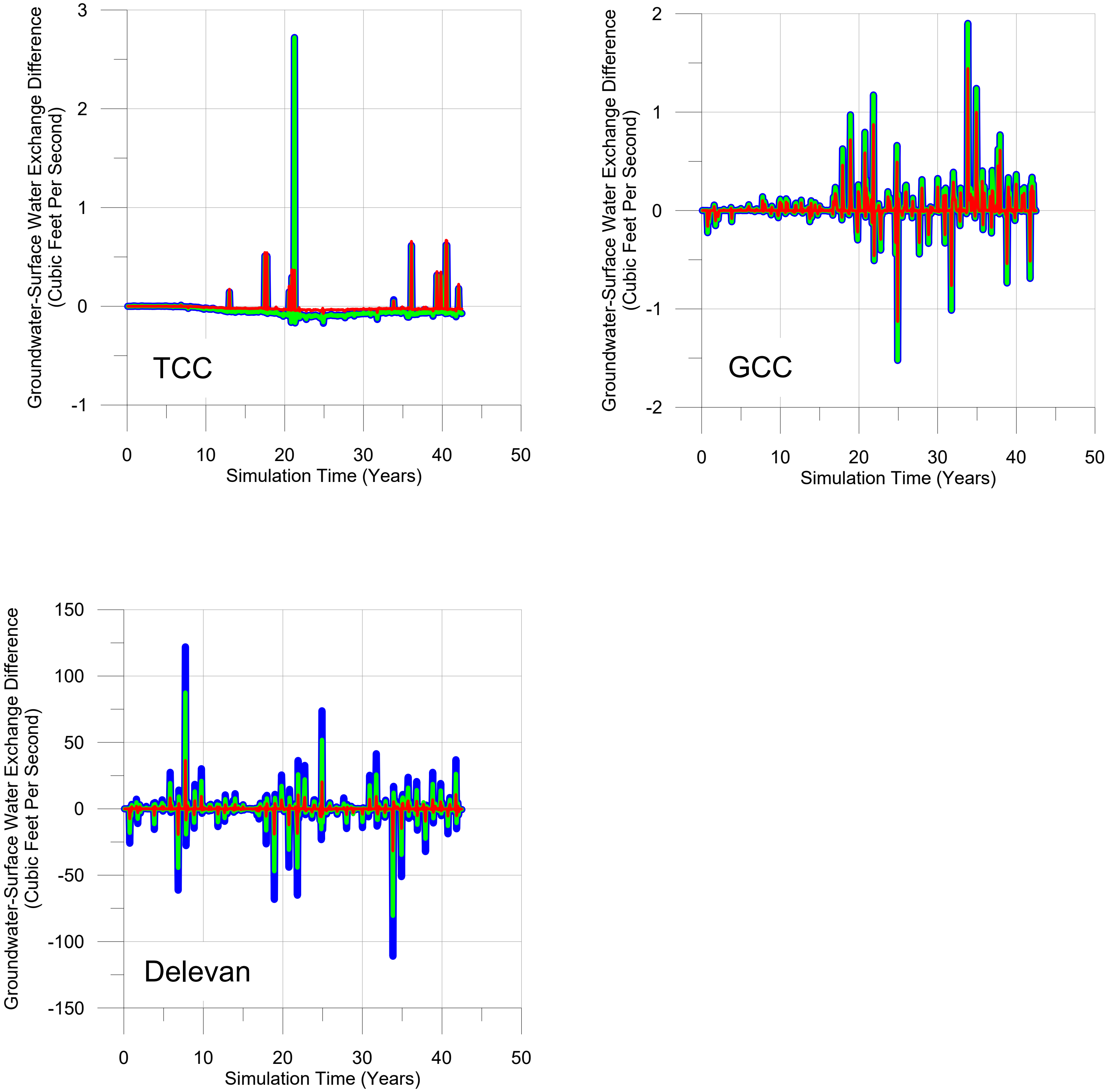
FIGURE 10A-10
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 39.2 Years for Alternative B and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

10A.3.2.3 Alternative C

Figures 10A-12 through 10A-14 presents plots of CVHM simulated Sacramento River stage and underlying groundwater elevations with distance for the two diversions and one discharge facility, for Alternative C and the NAA, for the three snapshots in time that were compared. The middle time period, 24.8 years, again had the greatest simulated differences in river stage and groundwater elevations. As shown on Figure 10A-13, the simulated Sacramento River stages and groundwater elevations for the Existing Conditions/No Project/No Action Condition and Alternative C were very similar. Simulated Sacramento River stages for Alternative C are almost identical to the Existing Conditions/No Project/No Action Condition and groundwater elevations are up to 2.3 feet lower under Alternative C than for the Existing Conditions/No Project/No Action Condition) for the Red Bluff Pumping Plant and GCID Canal intakes. At the Delevan Pipeline discharge facility, CVHM simulations for Alternative C show a decrease in stream stage of up to 5.6 feet and a decrease in groundwater elevations of up to 1 foot. Figure 10A-15 presents plots of changes in groundwater/surface water interaction over time at three distances downstream from the diversions and discharge facility under Alternative C. Maximum projected increases of up to 3 cfs in groundwater recharge are simulated under Alternative C (compared to the Existing Conditions/No Project/No Action Condition) at the Red Bluff Pumping Plant. At the GCID Canal intakes, the changes in groundwater recharge under alternative C range from increases of up to 2 cfs to decreases of up to 2 cfs compared to the Existing Conditions/No Project/No Action Condition. The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative C is forecasted by the CVHM to be 0.30% at TCC, and 1.4% at GCC. At the Delevan Pipeline discharge facility, increases and decreases in groundwater/surface water interaction were less than 40 cfs in most months, with a maximum increase of nearly 80 cfs and decrease of nearly 120 cfs (compared to the Existing Conditions/No Project/No Action Condition). The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative C is forecasted by the CVHM to be 0.08% at the Delevan Pipeline intake. As shown on Figures 10A-12 through 10A-15, the model forecast changes in Sacramento River stage, underlying groundwater elevations, and groundwater/surface water interaction under Alternative C are negligible to minor as compared to the Existing Conditions/No Project/No Action Condition

This page intentionally left blank.

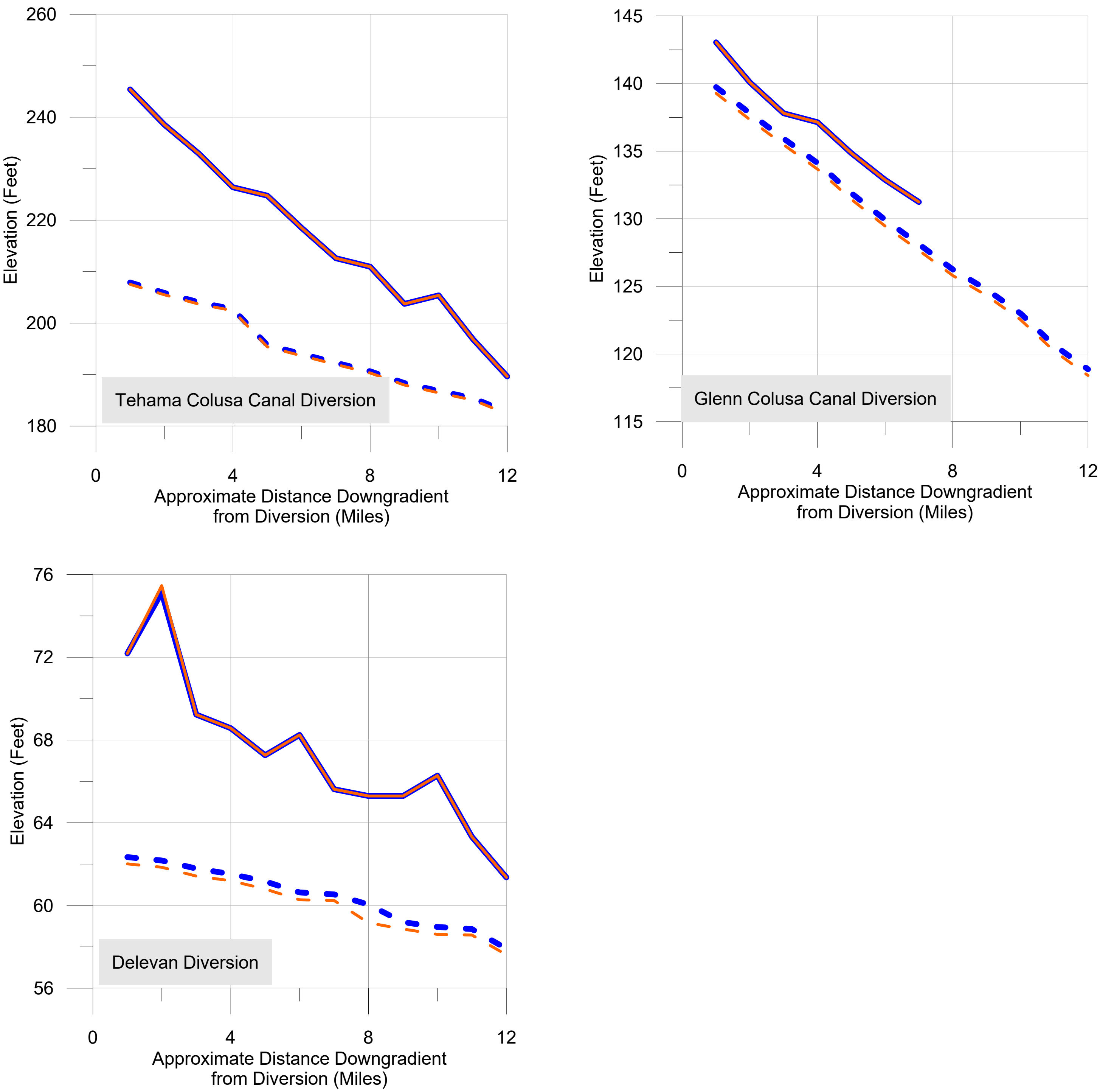


Legend

- 5 Model Cells (~5 miles)
- 10 Model Cells (~10 miles)
- 12 Model Cells (~12 miles)

FIGURE 10A-11
Groundwater-Surface Water Exchange Differences between Sites Alternative B and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

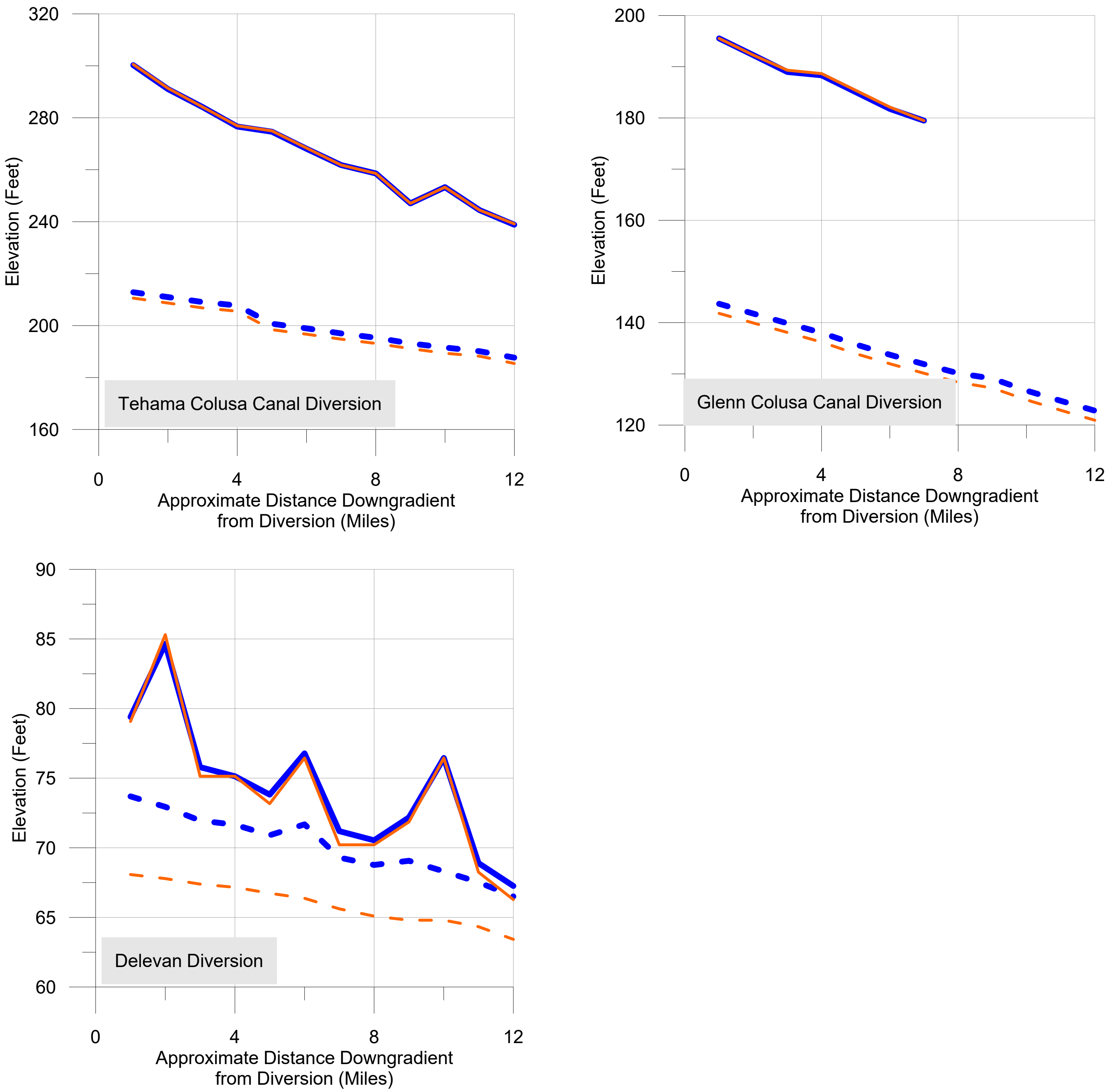


Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative C
- Groundwater Elevation, Alternative C

FIGURE 10A-12
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 4.2 Years for Alternative C and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

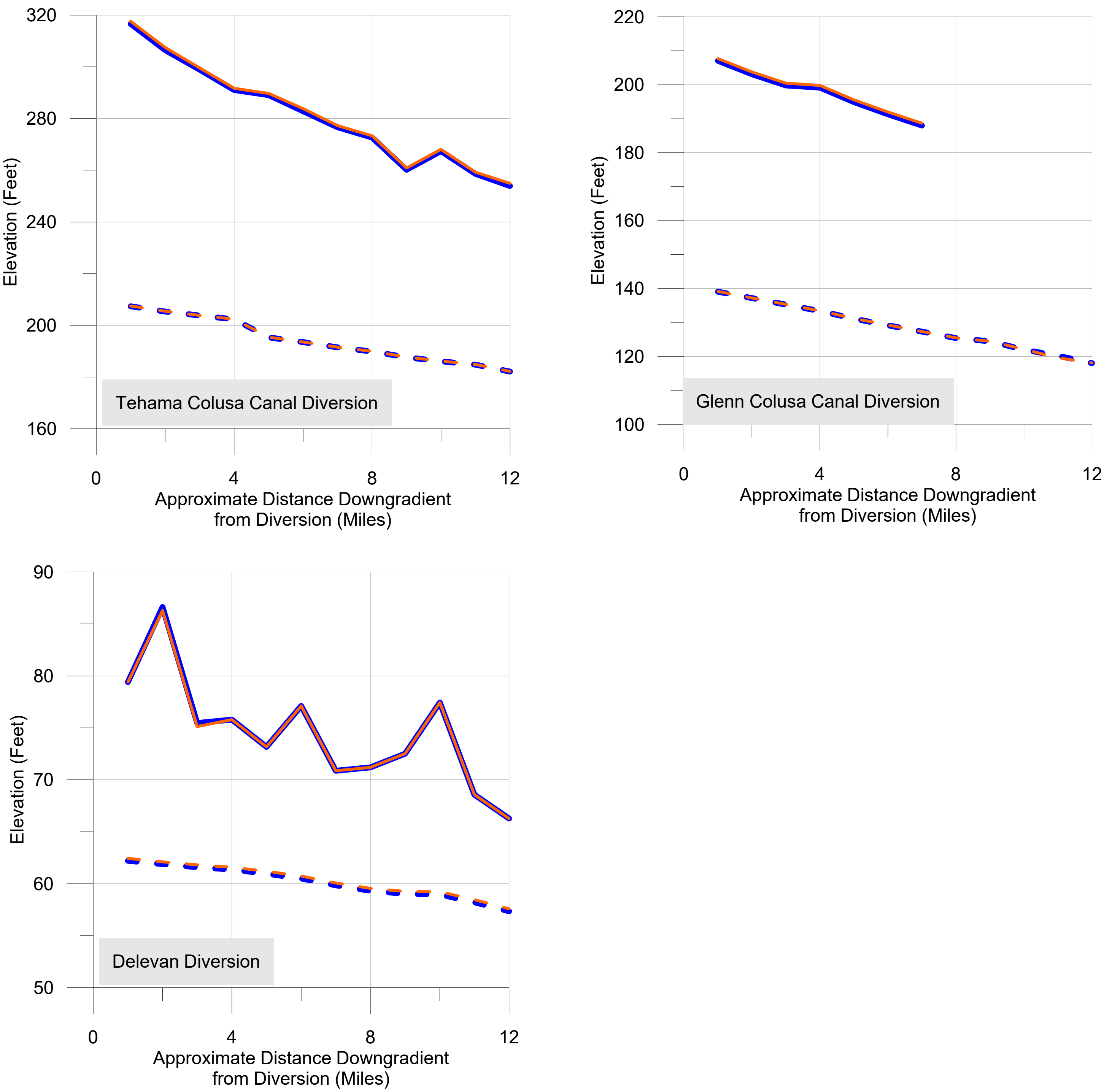


Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative C
- Groundwater Elevation, Alternative C

FIGURE 10A-13
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 24.8 Years for Alternative C and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

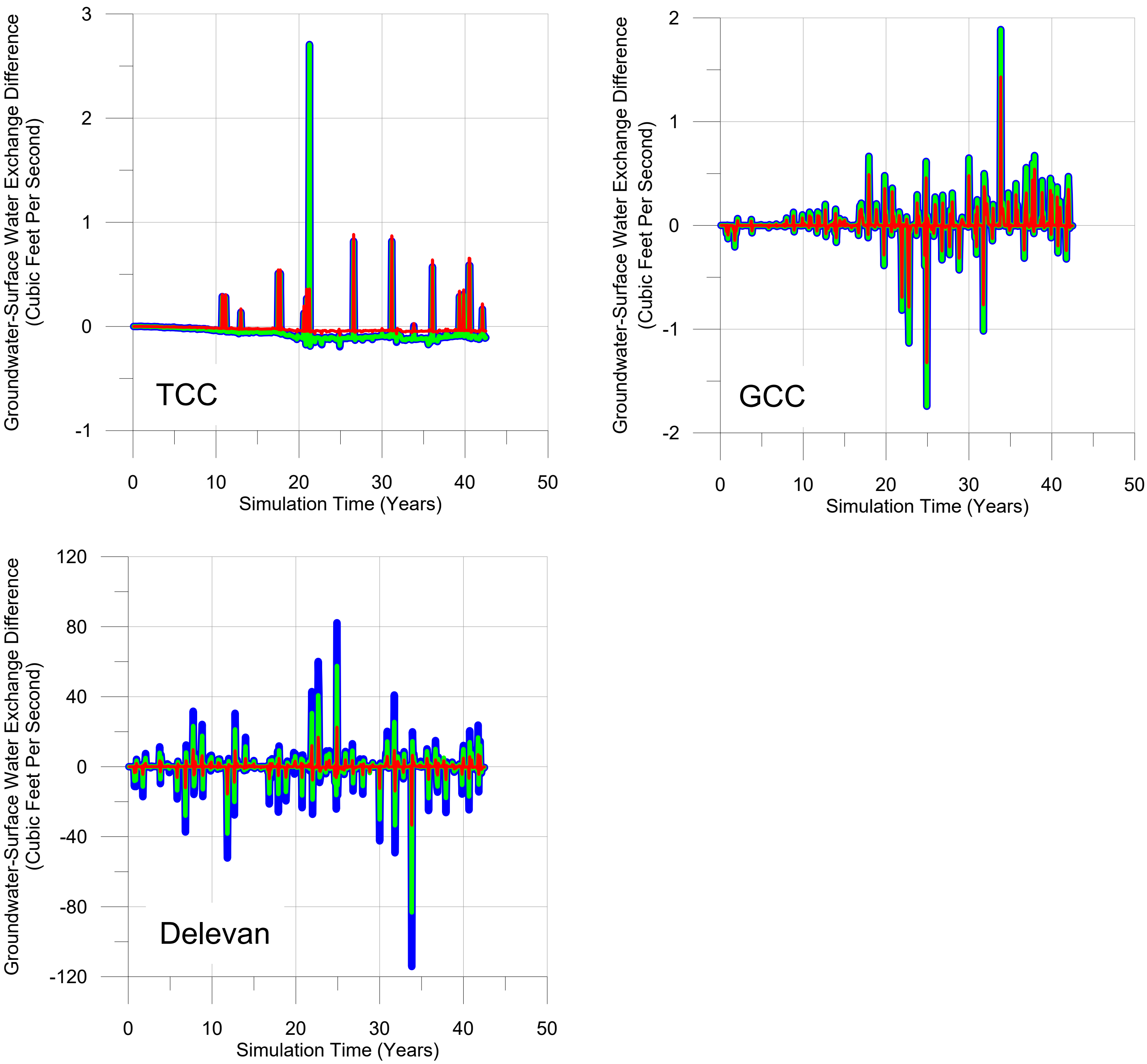


Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative C
- Groundwater Elevation, Alternative C

FIGURE 10A-14
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 39.2 Years for Alternative C and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.



Legend

- 5 Model Cells (~5 miles)
- 10 Model Cells (~10 miles)
- 12 Model Cells (~12 miles)

FIGURE 10A-15
Groundwater-Surface Water Exchange Differences between Sites Alternative C and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

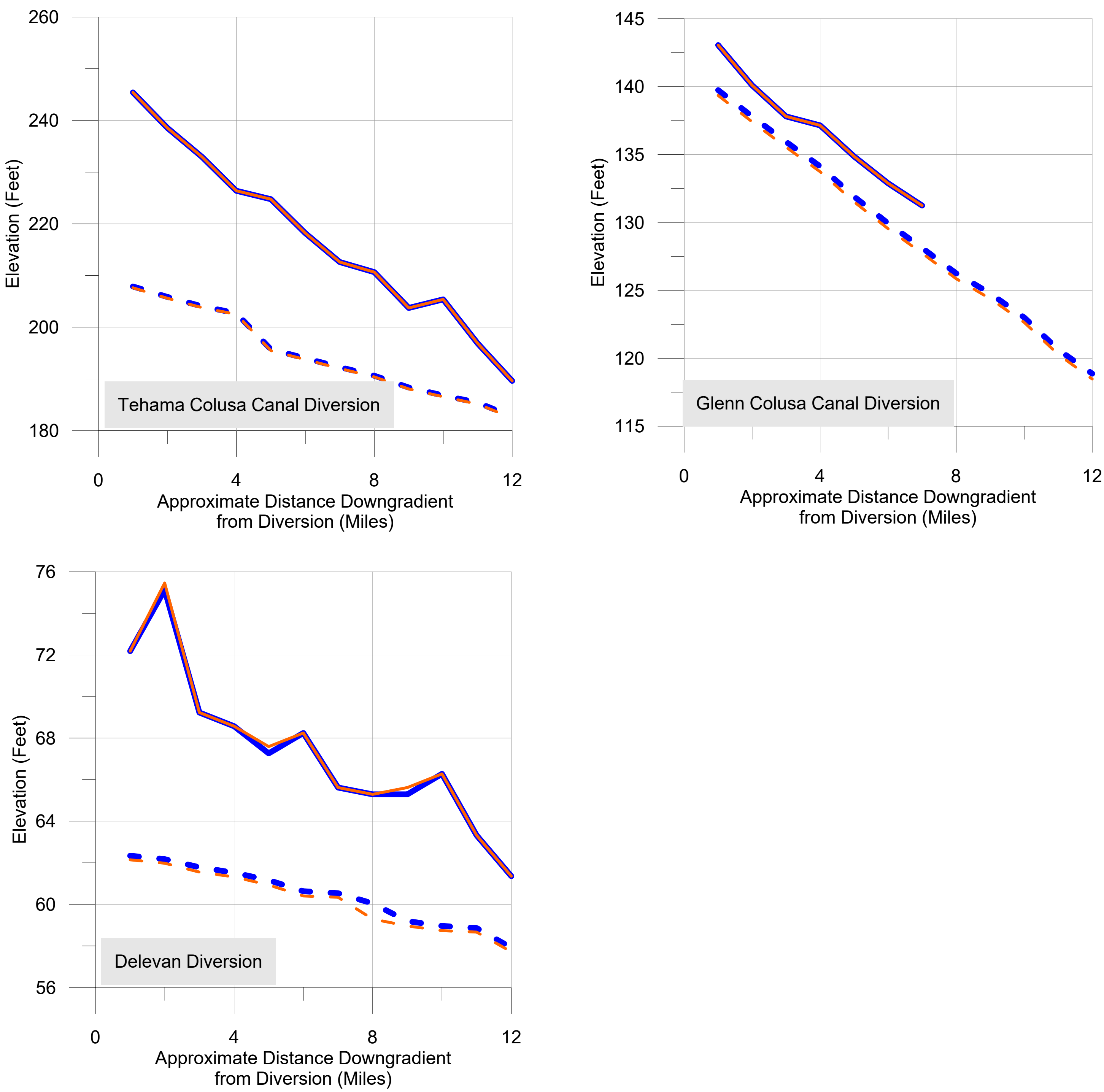
10A.3.2.4 Alternative D

Figures 10A-16 through 10A-18 presents plots of CVHM simulated Sacramento River stage and underlying groundwater elevations with distance for the two diversions and one discharge facility, for Alternative D and the NAA, for the three snapshots in time that were compared. The middle time period, 24.8 years, again had the greatest simulated differences in river stage and groundwater elevations. As shown on Figure 10A-17, the simulated Sacramento River stages and groundwater elevations for the Existing Conditions/No Project/No Action Condition and Alternative D were very similar. Simulated Sacramento River stages for Alternative D and groundwater elevations are almost identical to the Existing Conditions/No Project/No Action Condition (up to 0.2 feet higher) for the Red Bluff Pumping Plant and GCID Canal intakes. At the Delevan Pipeline discharge facility, CVHM simulations for Alternative D show an increase in stream stage of up to 0.3 feet and an increase in groundwater elevations of up to 3 feet. Figure 10A-19 presents plots of changes in groundwater/surface water interaction over time at three distances downstream from the diversions and discharge facility under Alternative D. Maximum projected increases of up to 3 cfs in groundwater recharge are simulated under Alternative D (compared to the Existing Conditions/No Project/No Action Condition) at the Red Bluff Pumping Plant. At the GCID Canal intakes, the changes in groundwater recharge under alternative C range from increases of up to 1.5 cfs to decreases of up to 1.5 cfs compared to the Existing Conditions/No Project/No Action Condition. The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative D is forecasted by the CVHM to be 0.22% at TCC, and 1.4% at GCC. At the Delevan Pipeline discharge facility, increases and decreases in groundwater/surface water interaction were less than 20 cfs in most months, with a maximum increase of nearly 60 cfs and decrease of nearly 60 cfs (compared to the Existing Conditions/No Project/No Action Condition). The average annual volumetric difference in groundwater/surface water exchange between the NAA and Alternative D is forecasted by the CVHM to be 0.23% at the Delevan Pipeline intake. As shown on Figures 10A-16 through 10A-19, the model forecast changes in Sacramento River stage, underlying groundwater elevations, and groundwater/surface water interaction under Alternative D are negligible to minor as compared to the Existing Conditions/No Project/No Action Condition

10A.3.2.5 Combined Analysis

Overall, the plots discussed above suggest that the volumetric and head/stage differences between the Project alternatives and the NAA in the vicinity of the Sites diversions are relatively small. Furthermore, these results suggest that there is generally small differences between the Project alternatives, because their heads, stages, and groundwater-surface water exchanges are forecasted to be similar to the NAA for each alternative. While the Sacramento River stage is lower for the Project Alternatives under most of the conditions that were investigated, the model forecasts that the difference is a fraction of a foot under most circumstances that were reviewed. The one case where the river stage differences were larger was the 24.8-year model snapshot of stages and heads downgradient of the Delevan diversion (the lower-left plot on Figures 10A-5, 10A-9, 10A-13, and 10A-17). But even these differences were a matter of a few feet of river stage at most in the simulations, for the time periods investigated.

The difference in simulated groundwater-surface water interactions for the river reaches downgradient of the TCC and GCC indicate that what differences there are increase between 5 and 10 miles downstream, but that the 10-mile and 12-mile cumulative differences are nearly identical. This result suggests that volumetric groundwater-surface water exchange differences at these locations may be confined to within 10 miles of the diversion. This result does not hold for the Delevan diversion, where the cumulative 12-mile exchange differences are generally still increasing. This suggests that yet larger groundwater-surface water exchange differences would be forecasted for longer reaches downstream of the Delevan diversion.

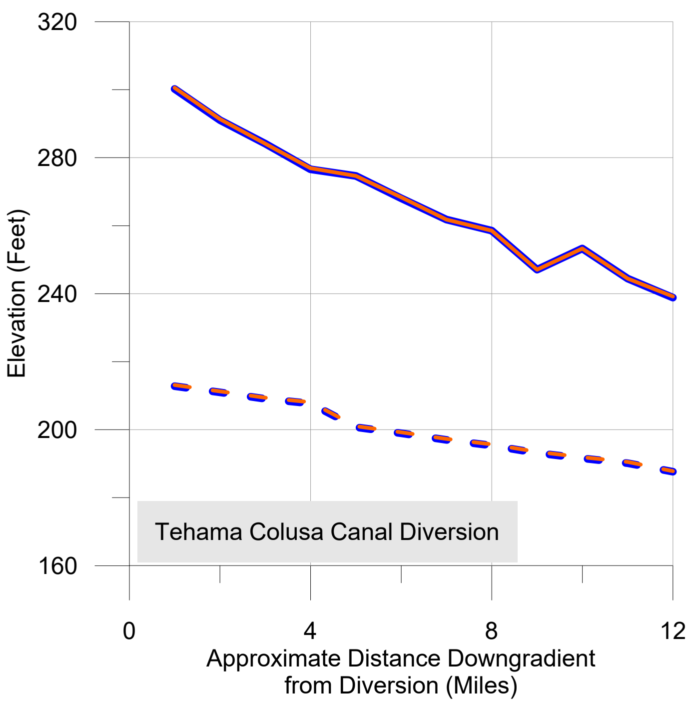


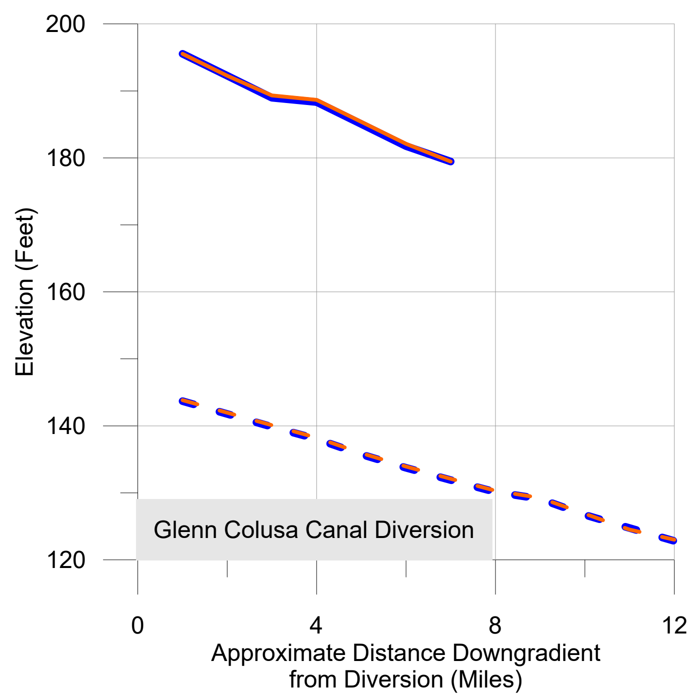
Legend

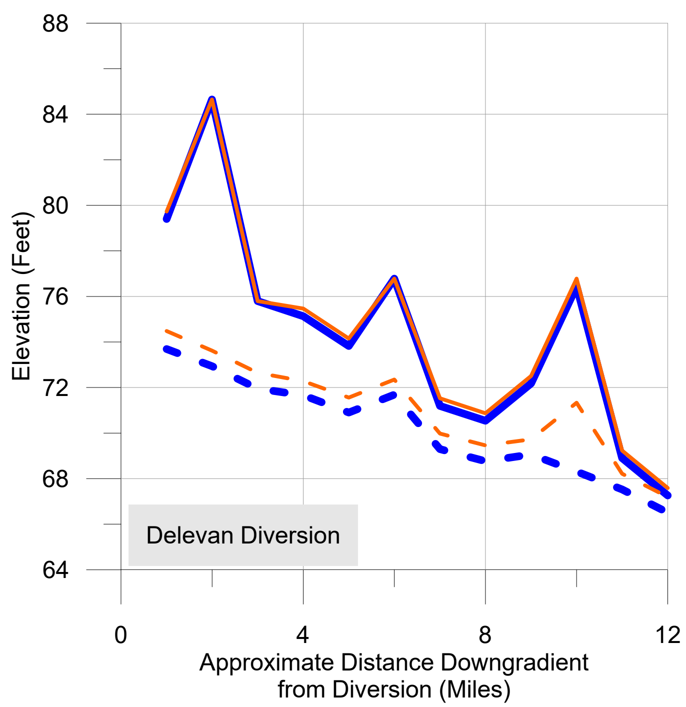
- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative D
- Groundwater Elevation, Alternative D

FIGURE 10A-16
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 4.2 Years for Alternative D and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.





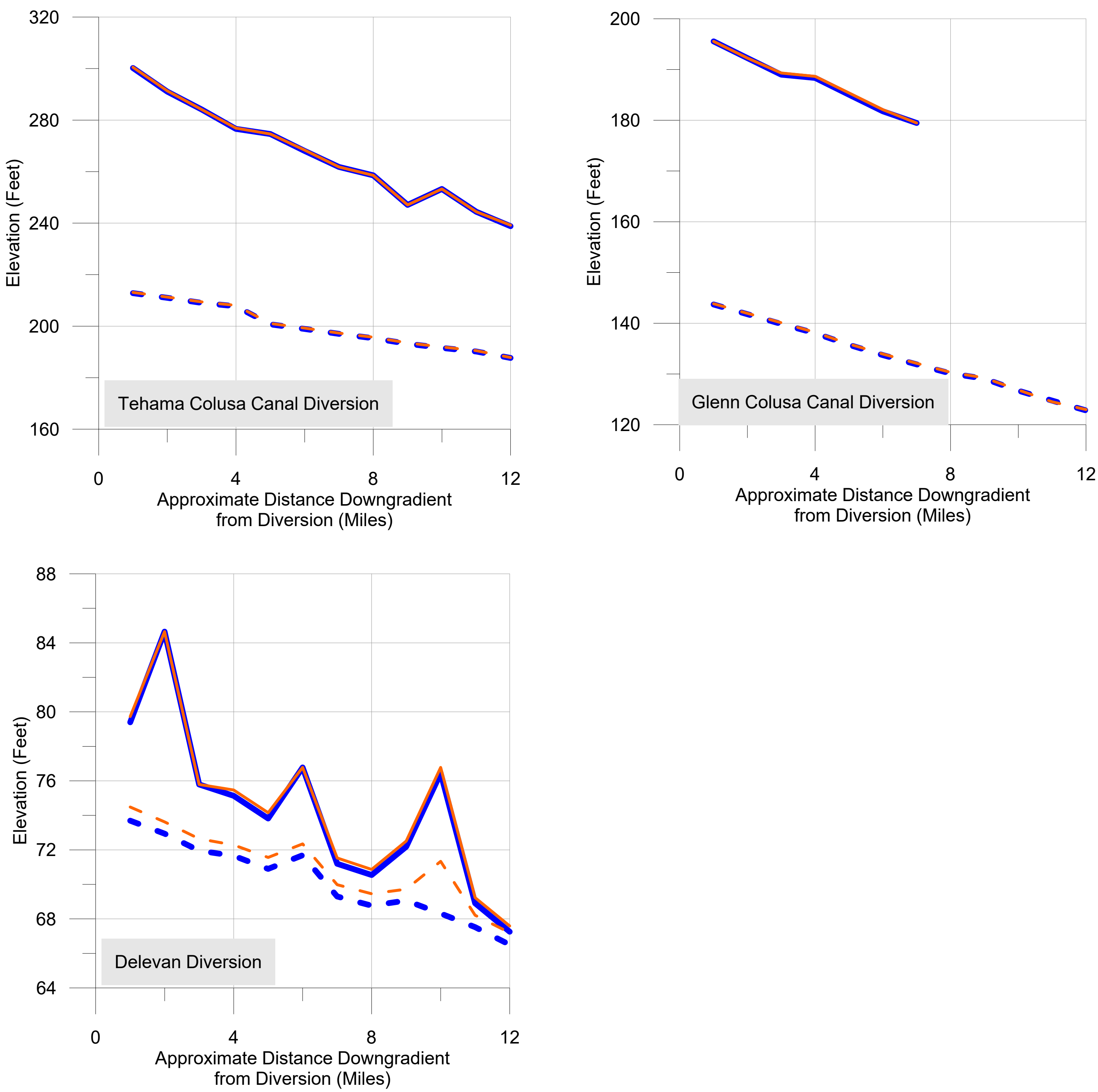


Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative D
- Groundwater Elevation, Alternative D

FIGURE 10A-17
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 24.8 Years for Alternative D and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

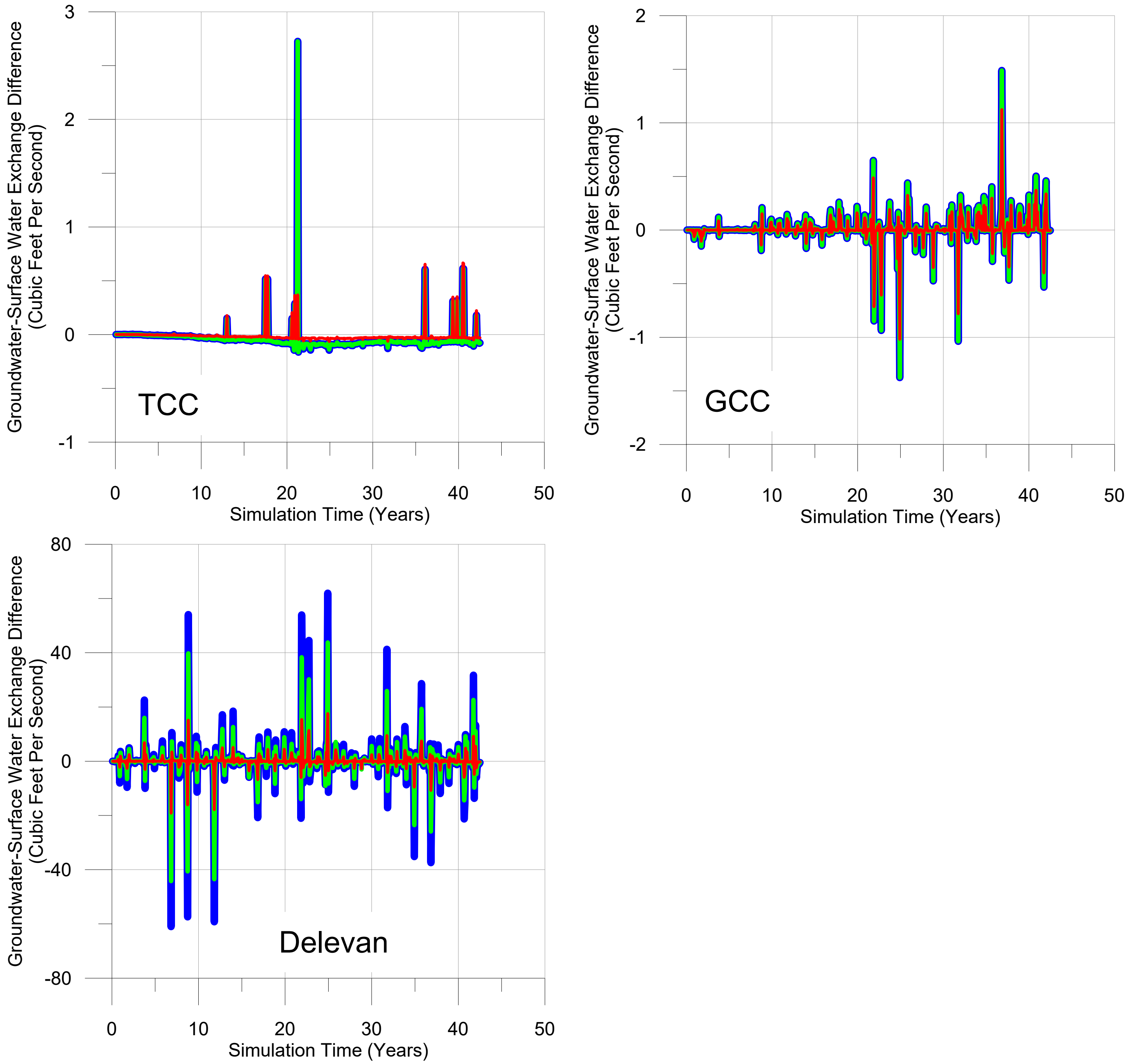


Legend

- River Stage, No Action Alternative
- Groundwater Elevation, No Action Alternative
- River Stage, Alternative D
- Groundwater Elevation, Alternative D

FIGURE 10A-18
CVHM-Forecast Sacramento River Stages and Groundwater Elevations after 39.2 Years for Alternative D and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.



Legend

5 Model Cells (~5 miles)
10 Model Cells (~10 miles)
12 Model Cells (~12 miles)

FIGURE 10A-19
Groundwater-Surface Water Exchange Differences between Sites Alternative D and No Action Alternative
Sites Reservoir Project EIR/EIS

This page intentionally left blank.

However, the model also indicates that the exchange differences after 12 miles are still generally very small relative to the annual average Sacramento River flow, and that sometimes the exchange is greater for the NAA than it is for the Project alternatives, and sometimes it is less.

10A.4 Works Cited

California Department of Water Resources (DWR). 2017. *Groundwater Information Center Interactive Map Application*. https://gis.water.ca.gov/app/gicima/. Accessed January.

CH2M HILL and MBK Engineers. 2014. *Sacramento Valley Finite Element Groundwater Flow Model User's Manual*. Prepared for the United States Department of the Interior Bureau of Reclamation. October.

Freeze, Alan R. and John A. Cherry. 1979. *Groundwater*. Prentice Hall, Inc. 604 pp.

Harbaugh, A.W. 1990. *A Computer Program for Calculating Subregional Water Budgets Using Results from the U.S. Geological Survey Modular Three-Dimensional Finite-Difference Ground-Water Flow Model*. U.S. Geological Survey Open-File Report 90-392.

Harbaugh, A.W. and E.R. Banta. 2000. *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model—User Guide to Modularization Concepts and the Ground-Water Flow Process*. US Geological Survey Open-File Report 00-92.

Schmid, Wolfgang, R.T. Hanson, Thomas Maddock III, and S.A. Leake. 2006. *User Guide for the Farm Process (FMP1) for the U.S. Geological Survey's Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, MODFLOW-2000: U.S. Geological Survey Techniques and Methods 6-A17*. 127 p.

United States Geological Survey (USGS). 2017a. Central Valley Hydrologic Model: Numerical Model. https://ca.water.usgs.gov/projects/central-valley/cvhm-numerical-model.html. Accessed March 4.

United States Geological Survey (USGS). 2017b. Central Valley Hydrologic Model: Farm Process https://ca.water.usgs.gov/projects/central-valley/cvhm-farm-process.html. Accessed March 5.

United States Geological Survey (USGS). 2016. Central Valley Hydrologic Model: Numerical Model. http://pubs.usgs.gov/pp/1766/PP1766-CVHM_input.zip. Accessed December 30.

United States Geological Survey (USGS). 2009. *Groundwater Availability of the Central Valley Aquifer, California. Regional Aquifer System Analysis*. Professional Paper 1766. Sacramento, CA.

United States Geological Survey (USGS). 1985. *Water Budget for Major Streams in the Central Valley, California, 1961–77*. Regional Aquifer System Analysis. Open File Report 85-401. Sacramento, CA.

Winston, R.B. 2000. GW-Chart. Graphical User Interface for MODFLOW, Version 4: U.S. Geological Survey Open-File Report 00-315.

This page intentionally left blank.

CalSim Modeling Discussion

March 9, 2023

Sites

Agenda

- CalSim II Model
  - Model development
  - Future climate hydrology
- Incorporation of Sites
  - Baseline Model
  - Operations overview
  - Diversion criteria
  - Releases
  - Mass balance

CalSim II Model

Steve Micko

CalSim II – Model Development

- CalSim II is applied for comparative analysis of system responses in long-term planning analyses
- Simulates future SWP/CVP project operations based on an 82-year monthly hydrology derived from the 1922 – 2003 period
- Recently used to support the following:
  - California Water Commission (CWC) Water Storage Investment Program (WSIP),
  - 2019 Biological Opinions (BiOps), and
  - 2020 State Water Project (SWP) Incidental Take Permit (ITP)

CalSim II – Model Development (cont.)

- CalSim II is intended to be used in a comparative mode
- CalSim II operates on a monthly time-step, which does not consider operational responses to changes that are on a sub-monthly scale, including:
  - Pulse Flow Protection
  - SWRCB D-1641 compliance
- Results should be reviewed through statistical comparisons of an alternative and baseline

CalSim II – Future Climate Hydrology

- 2035 Central Tendency (CT) hydrology was developed by CA DWR to support the 2020 SWP ITP
  - Reclamation also applied this hydrology in their 2019 BiOps
  - The 2020 SWP ITP and 2019 BiOps applied 15 cm of sea level rise in conjunction with 2035 CT hydrology
- WSIP 2070 hydrology was developed by the CWC to support the WSIP application process
  - The CWC applied 45 cm of sea level rise in conjunction with the WSIP 2070 hydrology

CalSim II – Future Climate Hydrology (cont.)

- Both sets of hydrology are developed with:
  - A sub-selection of CMIP5 global climate model projections, selected by the DWR Climate Change Technical Advisory Group in 2015
  - Ensemble the downscaled precipitation and temperature results from the selected GCM projections
  - Rely on results from the Variable Infiltration Capacity (VIC) hydrologic model to estimate river flows with perturbed temperature and precipitation timeseries data
- VIC
  - Variable Infiltration Capacity (VIC) model
  - A hydrologic model that maintains energy and mass balance

CalSim II – Future Climate Hydrology (cont.)

- Input parameters changed with climate and sea level rise:
  - Inflows from rim watersheds
  - Indices to support system operation decisions
    - Water year types
    - Runoff forecasts
  - Representation of flow – salinity response in the Delta

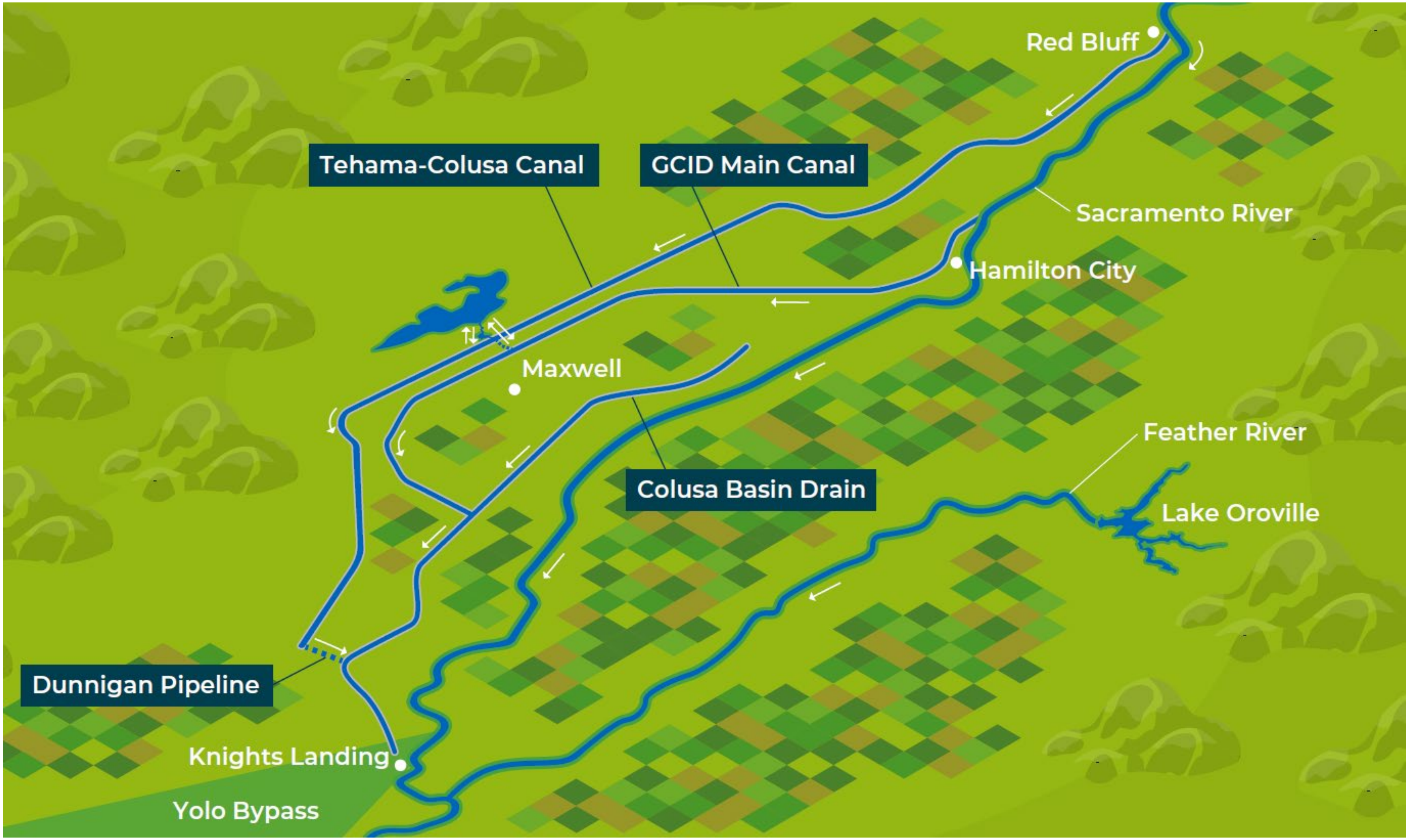
Incorporation of Sites

Steve Micko

Incorporation of Sites – Baseline Model Assumptions

- Baseline/No Action Alternative used 2021 Benchmark
  - CalSim II
  - Developed by Reclamation in coordination with DWR
  - Includes both 2019 BiOps and the 2020 SWP ITP
- All operations/actions included in the baseline were incorporated into the action alternatives ("with Sites")

Incorporation of Sites – Operations Overview



Incorporation of Sites – Operations Overview (cont.)

- Diversions
  - Red Bluff Pumping Plant
  - Hamilton City Pump Station
- Exchanges
  - Reclamation
  - DWR
- Releases
  - TC Canal
  - GCID Canal
  - North Delta (Yolo Bypass)
  - South of Delta
- Exports through the Delta

Incorporation of Sites – Operations Overview (cont.)

Facilities / Operations	Alternative 1	Alternative 2	Alternative 3
Reservoir Size	1.5 MAF	1.3 MAF	1.5 MAF
Hydropower	Incidental upon release	Same as Alt 1	Same as Alt 1
Diversion Locations	Red Bluff Pumping Plant and Hamilton City	Same as Alt 1	Same as Alt 1
Conveyance Release / Dunnigan Release	1,000 cubic feet per second (cfs) into new Dunnigan Pipeline to Colusa Basin Drain	1,000 cfs into new Dunnigan Pipeline to Sacramento River. Partial release into the Colusa Basin Drain	Same as Alt 1
Reclamation Involvement	1. Funding Partner 2. Operational Exchanges a. Within Year Exchanges b. Real-time Exchanges	Operational Exchanges a. Within Year Exchanges b. Real-time Exchanges	Same as Alt 1, but up to 25% investment
DWR Involvement	Operational Exchanges with Oroville and storage in SWP facilities South-of-Delta	Same as Alt 1	Same as Alt 1
Route to West Side of Reservoir	Bridge across reservoir	Paved road around southern end of reservoir	Same as Alt 1

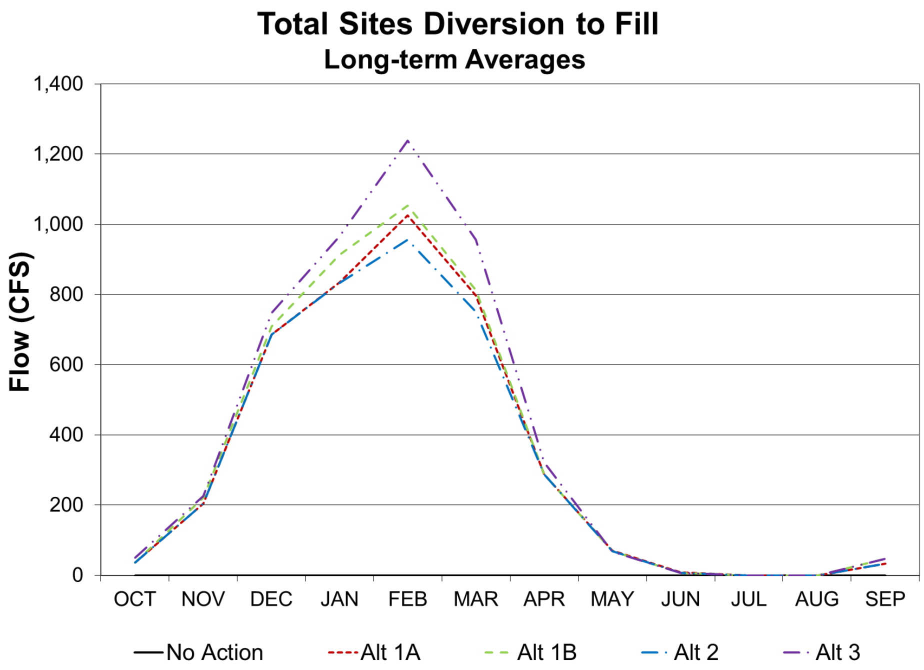
Incorporation of Sites – Diversion Criteria

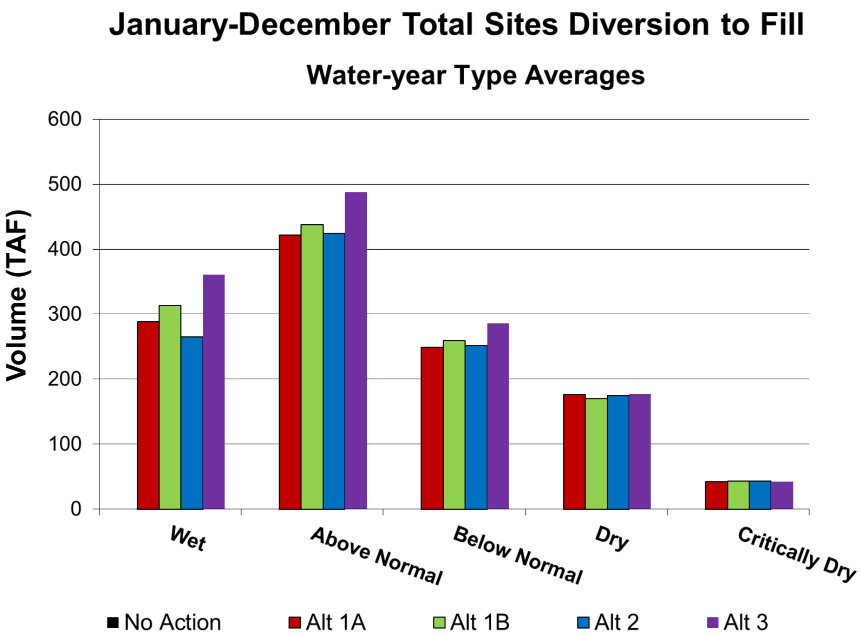
- Sites seeking to divert Sacramento River flows when all of the following conditions are met:
  - Flow exceeds minimum project diversion criteria (next slide)
  - Delta is in “excess” conditions
  - Senior downstream water rights have been satisfied
  - Flows are available above those needed to meet all applicable laws, regulations, BiOps and court orders in place at the time of diversion

Incorporation of Sites – Diversion Criteria (cont.)

- Project-Specific Diversion Criteria:
  - Wilkins Slough Bypass flows:
    - 10,700 cfs October 1 through June 14; 5,000 cfs September (not diverting from June 15 to end of August)
  - Pulse flow protection
    - Includes off-ramp to allow for diversions with the 7-day pulse protection if flows are at or over 29,000 cfs at Bend Bridge
  - Sacramento River at the Red Bluff Pumping Plant (RBPP):
    - A minimum bypass flow in the Sacramento River at RBPP of 3,250 cfs must be met
  - Sacramento River at the Hamilton City Pumping Station
    - A required minimum bypass flow in the Sacramento River at the Hamilton City Pump Station of 4,000 cfs would continue to be in place at all times to stabilize flows in the Sacramento River and ensure proper function of the fish screen.

Incorporation of Sites – Diversion Criteria (cont.)

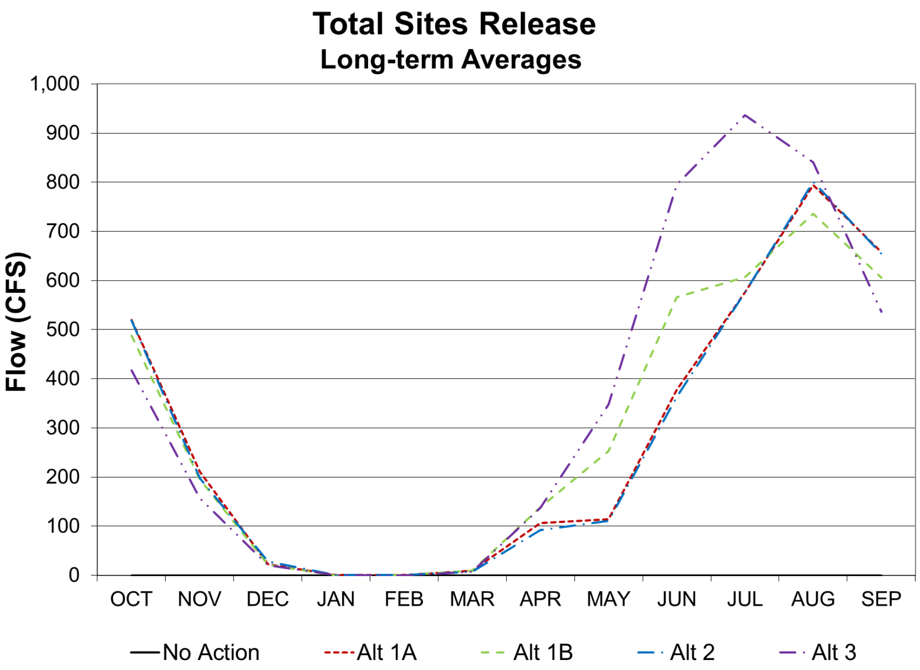


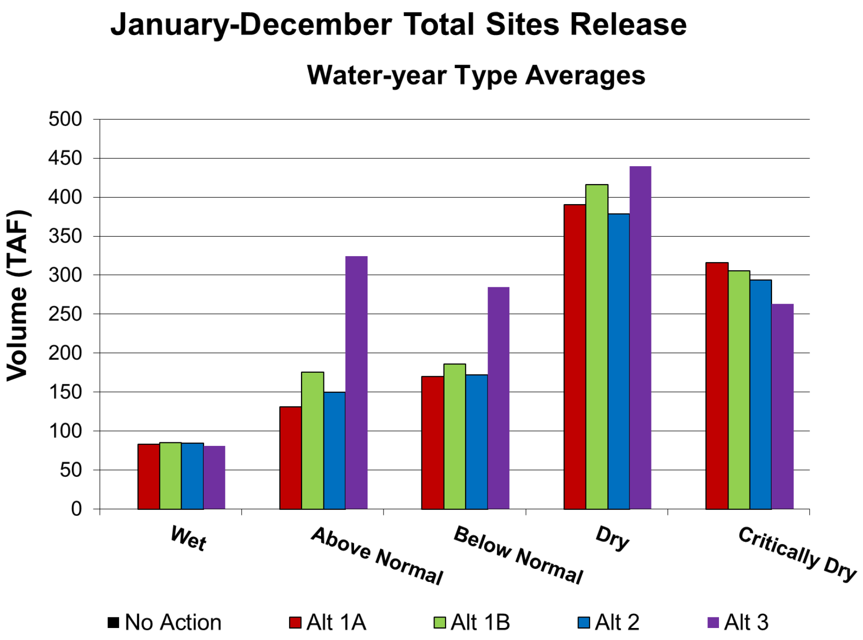


Incorporation of Sites – Releases

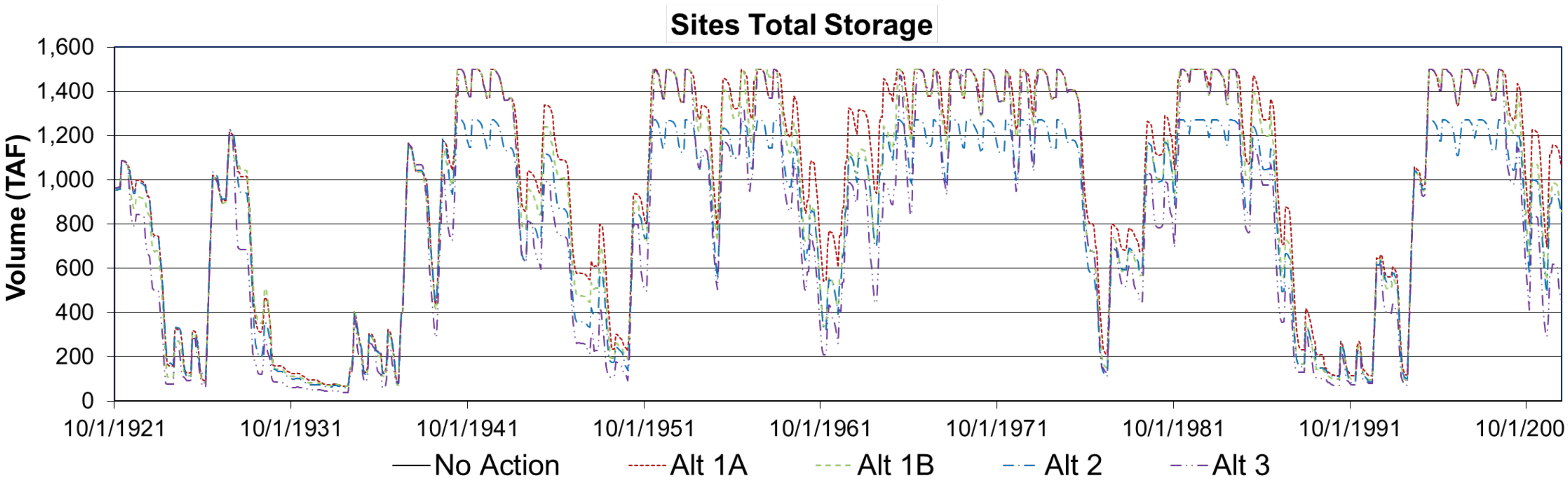
- Releases from Sites Reservoir would be made to meet the needs of the Storage Partners:
  - Environmental Benefits under WSIP:
    - Yolo Bypass
    - IL4 Refuges
  - Reclamation
    - CVP Operational Flexibility
  - Sites Participants
    - North of Delta
    - South of Delta

Incorporation of Sites – Releases (cont.)





Incorporation of Sites – Sites Storage



Incorporation of Sites – Mass Balance

- Sources:
  - Diversions from Sacramento River
  - Local precipitation
- Sinks:
  - Releases
  - Surface water evaporation
- Net evaporation accounts for 27 TAF/year
- CalSim II does not consider seepage
  - Seepage accounting was evaluated in the 2017 Draft EIR/EIS
    - With a 1.8 MAF reservoir, seepage loses are estimated at 3.5 TAF/year

Thank you!

Sites

Sites

Alicia Forsythe

From: OPR California Jobs <California.Jobs@opr.CA.GOV>
Sent: Thursday, October 12, 2023 1:39 PM
To: Ashley Overhouse; Jerry Brown; Alicia Forsythe; OPR California Jobs
Subject: RE: Questions - FW: Sites Reservoir Project - FW: New Infrastructure Streamlining Application Received

Dear Ashley,

Thank you for your email.

OPR is in the process of working with the Governor's Office and our state agency partners to finalize the guidelines for the infrastructure judicial streamlining program. The guidelines will not create new criteria. The criteria for eligibility comes directly from SB 149. The guidelines will make that criteria easier to understand for applicants and the public. Since the guidelines are not yet available, please do not hesitate to reach back out with specific questions about the criteria for water-related infrastructure projects, which are contained in Public Resources Code Sections 21189.81(h) and 21189.82(a)(4) and (c), and 21189.86.

As you noted, SB 149 requires OPR to post the application on its website for 15 days before the Governor can certify the project. That clock starts when the application is posted. The Sites application was posted on OPR's website on October 6th. The listserv notification is provided as a courtesy. OPR began sending e-blasts a few years ago to help keep the public better informed about the judicial streamlining process, but that practice is not statutorily required and the sending of the e-blast does not trigger any deadlines.

Please let us know if there is any additional information that would be helpful.

Best,
The OPR SB 149 team

From: Ashley Overhouse <AOverhouse@defenders.org>
Sent: Thursday, October 12, 2023 11:30 AM
To: jbrown@sitesproject.org; Alicia Forsythe <aforsythe@sitesproject.org>; OPR California Jobs <california.jobs@opr.ca.gov>
Subject: Questions - FW: Sites Reservoir Project - FW: New Infrastructure Streamlining Application Received

Dear Jerry, Alicia, and Austin,

Hope you are all doing well. After reading the language of SB 149, I had a couple questions about the notification and the process for this application for Sites Reservoir.

First, is the Governor's Office of Planning and Research (OPR) and Sites Project Authority planning on giving a full 15 days for the public comment period? If I'm interpreting the notice below correctly, it looks like the public has only 13 days, October 10-October 23, 2023.

Second, is OPR still planning on issuing guidelines for eligible projects? Since no guidelines (as far as I can find) have been issued to determine eligibility, what criteria will OPR be using to determine if Sites Reservoir is eligible for certification?

I have appreciated the transparent and clear communication Sites Project Authority has always given stakeholders. I have the same respect for OPR, it is a critical office for enforcement of the California Environmental Quality Act.

Thank you in advance for any clarifying information you can give me.

Best,
Ashley Overhouse

Ashley Overhouse (She/Her/Hers)
Water Policy Advisor
DEFENDERS OF WILDLIFE
P.O. Box 1189 Santa Clara, CA 95052
TEL: 408.472.4522
Facebook | Twitter | Instagram | Blog

From: Governor's Office of Planning and Research <california.jobs@opr.ca.gov>
Sent: Tuesday, October 10, 2023 9:28 AM
Subject: New Infrastructure Streamlining Application Received

Office of Planning and Research
Infrastructure Streamlining Program (SB 149)

view as webpage

New Infrastructure Streamlining Program Application Received

An application for certification under the Infrastructure Streamlining Program has been submitted to the Governor's Office of Planning and Research (OPR) for the Sites Reservoir Project. The application can be accessed on OPR's website.

Public comments will be accepted on the application until **Monday, October 23, 2023**.

Public comments may be submitted electronically to California.Jobs@opr.ca.gov.

Public comments must include a reference to the Sites Reservoir Project by name. Public comments may be posted to a public website. **Do not submit any sensitive or personal information in the comment letter.**

Public comments submitted to OPR will be considered regardless of the format in which they are received. However**, we encourage public comments to be submitted in a format that complies with State and federal accessibility requirements and the Web Content Accessibility Guidelines 2.0, or a subsequent version, published by the Web Accessibility Initiative of the World Wide Web Consortium at a minimum Level AA success criteria.** Instructions on how to create an accessible document can be found on OPR's Accessibility Page.

Learn More About OPR

Contact Us

1400 Tenth Street
Sacramento, CA 95814
(916) 322-2318
info@opr.ca.gov

Alicia Forsythe

From:	Ashley Overhouse <AOverhouse@defenders.org>
Sent:	Monday, October 23, 2023 4:56 PM
To:	OPR California Jobs
Cc:	Jerry Brown; Alicia Forsythe
Subject:	Comments on the Sites Reservoir Infrastructure Streamlining Program (SB 149) Application
Attachments:	Sites Reservoir SB 149 Application Letter_102323.pdf
Importance:	High

Dear Mr. Kerr and the OPR Team,

On behalf of Defenders of Wildlife, Sierra Club CA, Friends of the River, Save California Salmon, Planning and Conservation League, California Sportfishing Protection Alliance, San Francisco Baykeeper, CalWild, Natural Resources Defense Council, California Coastal Protection Network, Pacific Coast Federation of Fishermen's Associations, Institute for Fisheries Resources, Golden State Salmon Association, Restore the Delta, The Bay Institute and California Water Research, I submit the attached comments on the Sites Project Authority's application for the proposed Sites Reservoir to be certified under the SB 149 Infrastructure Streamlining Program.

Due to the limited comment period, we may be submitting these comments again with additional signatories. However, we understand the deadline is today, October 23, 2023, and wanted to make sure we were included as part of the public record.

Thank you for your time and consideration of our comments. Please do not hesitate to contact us if you have questions or concerns.

Best,

Ashley Overhouse (She/Her/Hers)
Water Policy Advisor
DEFENDERS OF WILDLIFE
P.O. Box 1189 Santa Clara, CA 95052
TEL: 408.472.4522
Facebook | Twitter | Instagram | Blog

Alicia Forsythe

From: Ashley Overhouse <AOverhouse@defenders.org>
Sent: Wednesday, October 25, 2023 5:51 PM
To: OPR California Jobs
Cc: Jerry Brown; Alicia Forsythe; Kimberley Delfino
Subject: RE: Comments on the Sites Reservoir Infrastructure Streamlining Program (SB 149) Application
Attachments: Sites Reservoir SB 149 Application Letter_102523.pdf

Dear Mr. Kerr and the OPR Team,

Please find attached a revised version of our comments with additional signatories. We would greatly appreciate confirmation of receipt.

Thank you,
Ashley

Ashley Overhouse (She/Her/Hers)
Water Policy Advisor
DEFENDERS OF WILDLIFE
P.O. Box 1189 Santa Clara, CA 95052
TEL: 408.472.4522
Facebook | Twitter | Instagram | Blog

From: Ashley Overhouse
Sent: Monday, October 23, 2023 4:56 PM
To: OPR California Jobs <California.Jobs@opr.CA.GOV>
Cc: Jerry Brown <jbrown@sitesproject.org>; Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Comments on the Sites Reservoir Infrastructure Streamlining Program (SB 149) Application
Importance: High

Dear Mr. Kerr and the OPR Team,

On behalf of Defenders of Wildlife, Sierra Club CA, Friends of the River, Save California Salmon, Planning and Conservation League, California Sportfishing Protection Alliance, San Francisco Baykeeper, CalWild, Natural Resources Defense Council, California Coastal Protection Network, Pacific Coast Federation of Fishermen's Associations, Institute for Fisheries Resources, Golden State Salmon Association, Restore the Delta, The Bay Institute and California Water Research, I submit the attached comments on the Sites Project Authority's application for the proposed Sites Reservoir to be certified under the SB 149 Infrastructure Streamlining Program.

Due to the limited comment period, we may be submitting these comments again with additional signatories. However, we understand the deadline is today, October 23, 2023, and wanted to make sure we were included as part of the public record.

Thank you for your time and consideration of our comments. Please do not hesitate to contact us if you have questions or concerns.

Best,

Ashley Overhouse (She/Her/Hers)
Water Policy Advisor
DEFENDERS OF WILDLIFE
P.O. Box 1189 Santa Clara, CA 95052
TEL: 408.472.4522
Facebook | Twitter | Instagram | Blog

Alicia Forsythe

From: Jann Dorman <janndorman@friendsoftheriver.org>
Sent: Tuesday, November 7, 2023 11:21 AM
To: Alicia Forsythe; Ashley Overhouse
Cc: Spranza, John; Laurie Warner Herson
Subject: Re: Sites Project - Current and Upcoming Activities

Categories: Record

Thank you so much Alicia. I just forwarded.

Jann Dorman
Executive Director
925-518-0320

FRIENDS OF THE RIVER FOR 50 YEARS

From: Alicia Forsythe <aforsythe@sitesproject.org>
Date: Tuesday, November 7, 2023 at 9:08 AM
To: Jann Dorman <janndorman@friendsoftheriver.org>, Ashley Overhouse <AOverhouse@defenders.org>
Cc: "Spranza, John" <john.spranza@hdrinc.com>, Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Sites Project - Current and Upcoming Activities

Fantastic! I just sent a meeting invite. Feel free to forward that onto anyone you'd like. Or you can send an invite and I can cancel mine. I am totally flexible. I just wanted to get it on my calendar quickly.

We look forward to the discussion.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Jann Dorman <janndorman@friendsoftheriver.org>
Sent: Tuesday, November 7, 2023 8:14 AM

To: Alicia Forsythe <aforsythe@sitesproject.org>; Ashley Overhouse <AOverhouse@defenders.org>
Subject: Re: Sites Project - Current and Upcoming Activities

Hi Alicia,

After some back and forth. It looks like this Thursday, November 9, at 2pm will work for many.

Hoping that time is still available?

Thanks so much,

Jann Dorman
Executive Director
925-518-0320

FRIENDS OF THE RIVER FOR 50 YEARS

From: Alicia Forsythe <aforsythe@sitesproject.org>
Date: Friday, November 3, 2023 at 5:29 PM
To: Jann Dorman <janndorman@friendsoftheriver.org>, Ashley Overhouse <AOverhouse@defenders.org>
Subject: RE: Sites Project - Current and Upcoming Activities

Yes, absolutely. Below are some dates / times for the following week.

Monday, November 13 – anytime 1 to 3 pm
Wednesday, November 15 – anytime from 9 to 11 am or from 1 to 5 pm
Thursday, November 16 – anytime from noon to 2 pm

I did want to share on our call that our Board anticipates considering certifying the Final EIR and adopting the project at its November 17 meeting. Considering how close these dates are to the meeting, I'll share that now. Meeting materials will be posted on our website here Friday, November 17 - Sites Reservoir (sitesproject.org) at least 72 hours in advance of the meeting.

I hope you have a great weekend!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

From: Jann Dorman <janndorman@friendsoftheriver.org>
Sent: Friday, November 3, 2023 4:42 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Ashley Overhouse <AOverhouse@defenders.org>
Subject: Re: Sites Project - Current and Upcoming Activities

Hi Alicia,

Thanks so much for your email. I just wanted to check in and let you know Im doing some cat herding with dates/times. Would it be possible to move to the following week? Many of us are at a conference next week, and all of us NGO'ers are wrestling with commenting on several very large documents. 😊

With Appreciation,

Jann

Jann Dorman
Executive Director
925-518-0320

FRIENDS OF THE RIVER
FOR 50 YEARS

From: Alicia Forsythe <aforsythe@sitesproject.org>
Date: Wednesday, November 1, 2023 at 1:09 PM
To: Jann Dorman <janndorman@friendsoftheriver.org>, Ashley Overhouse <AOverhouse@defenders.org>
Subject: Sites Project - Current and Upcoming Activities

Hi Jann and Ashley – Its been a while since we've had a chance to catch up. I wanted to reach out to see if you all would be interested in scheduling an hour catch up call. This would be more for me to share what is happening on the Project and upcoming activities and for you all to ask any questions or share any concerns you might have. I am happy to cover any topic you'd like. I was thinking that I'd cover the following:

1. CEQA Process – Final EIR/EIS and Board meeting
2. SB 149 Application – Status and what we see as next steps
3. Water Right Process – Where we are what's going on
4. Prop 1 Benefits Contracts – Status
5. Mitigation Planning – Status on contractor outreach and developing a terrestrial biological mitigation plan

I realize we need to schedule a focused call on the water right protest and I see that as a separate discussion. And I'll get an email out on the water right discussion in the next week.

If you're interested in a catch up, below are some dates/times that work for me.

Friday, November 3 – anytime from 11 am to 1 pm
Monday, November 6 -anytime from 1 pm to 5 pm
Wednesday, November 8 – anytime from noon to 1 pm or 2 to 5 pm
Thursday, November 9 – anytime from noon to 3 pm

Happy to have a large or small group – whatever you all would like.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

Alicia Forsythe

From: Alicia Forsythe
Sent: Tuesday, November 7, 2023 3:29 PM
To: Alicia Forsythe; Chris Shutes; Konrad Fisher; Regina Chichizola; Kasil Willie; Steve Evans; Ashley Overhouse; Glen Spain; gary@ranchriver.com; Carolee Krieger; Erin Woolley; mark rockwell; Barbara Vlamis; James P Pachl; Lowell Ashbaugh; caleenwintu@gmail.com; Gary Bobker; reis@bay.org; peter@tuolumne.org; feathersfurflowers@gmail.com; Ron Stork; julie.zimmerman@tnc.org; bobker@bay.org; bjohnson@tu.org; rhenery@tu.org; cindy@ccharles.net; patrick@tuolumne.org; brandon.dawson@sierraclub.org; Barry Nelson; Jon Rosenfield; Hal Candee (external); Ashley Overhouse; Jann Dorman; jimb@aqualliance.net; Spranza, John; Laurie Warner Herson
Cc: Keiko Mertz; Ron Stork; Doug Maner
Subject: RE: CONFIRMED MEETING WITH: Sites Project - Current and Upcoming Activities

Categories: Record

Sure thing! I just updated the meeting invite to include everyone on this email. Hopefully everyone got it. Let me know if you have any questions on the date/time or suggestions on additional topics.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

-----Original Appointment-----
From: Jann Dorman <janndorman@friendsoftheriver.org> **On Behalf Of** Alicia Forsythe
Sent: Tuesday, November 7, 2023 12:12 PM
To: Chris Shutes; Konrad Fisher; Regina Chichizola; Kasil Willie; Steve Evans; Ashley Overhouse; Glen Spain; gary@ranchriver.com; Carolee Krieger; Erin Woolley; mark rockwell; Barbara Vlamis; James P Pachl; Lowell Ashbaugh; caleenwintu@gmail.com; Gary Bobker; reis@bay.org; peter@tuolumne.org; feathersfurflowers@gmail.com; Ron Stork; julie.zimmerman@tnc.org; bobker@bay.org; bjohnson@tu.org; rhenery@tu.org; cindy@ccharles.net; patrick@tuolumne.org; brandon.dawson@sierraclub.org; Barry Nelson; Jon Rosenfield; Hal Candee (external); Ashley Overhouse; Jann Dorman; jimb@aqualliance.net; Spranza, John; Laurie Warner Herson
Cc: Keiko Mertz; Ron Stork; Doug Maner
Subject: FW: CONFIRMED MEETING WITH: Sites Project - Current and Upcoming Activities
When: Thursday, November 9, 2023 2:00 PM-3:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Hi Alicia,

I think you may have received my forward of the Thursday meeting. However, apparently Teams removed the date and time in what the recipients got. I emailed them again with the date and time.

Would you be so kind as to also add the people in the forward below to your meeting invite directly.

Thanks so much,

Jann Dorman
Executive Director
925-518-0320

From: Jann Dorman <janndorman@friendsoftheriver.org> on behalf of Alicia Forsythe <aforsythe@sitesproject.org>
Date: Tuesday, November 7, 2023 at 11:18 AM
To: Chris Shutes <blancapaloma@msn.com>, Konrad Fisher <k@waterclimate.org>, Regina Chichizola <regina@californiasalmon.org>, Kasil Willie <kasil@californiasalmon.org>, Steve Evans <sevans@calwild.org>, Ashley Overhouse <ashleyoverhouse@gmail.com>, Glen Spain <FISH1IFR@aol.com>, "gary@ranchriver.com" <gary@ranchriver.com>, Carolee Krieger <caroleekrieger7@gmail.com>, Erin Woolley <erin.woolley@sierraclub.org>, mark rockwell <mrockwell1945@gmail.com>, Barbara Vlamis <barbarav@aqualliance.net>, James P Pachl <jamesppachl@gmail.com>, Lowell Ashbaugh <ashbaugh.lowell@gmail.com>, "caleenwintu@gmail.com" <caleenwintu@gmail.com>, Gary Bobker <gary@bayecotarium.org>, "reis@bay.org" <reis@bay.org>, "peter@tuolumne.org" <peter@tuolumne.org>, "feathersfurflowers@gmail.com" <feathersfurflowers@gmail.com>, Ron Stork <RStork@friendsoftheriver.org>, "julie.zimmerman@tnc.org" <julie.zimmerman@tnc.org>, "bobker@bay.org" <bobker@bay.org>, Brian Johnson <bjohnson@tu.org>, "rhenery@tu.org" <rhenery@tu.org>, "cindy@ccharles.net" <cindy@ccharles.net>, "patrick@tuolumne.org" <patrick@tuolumne.org>, "brandon.dawson@sierraclub.org" <brandon.dawson@sierraclub.org>, Barry Nelson <barry@westernwaterstrategies.com>, Jon Rosenfield <jon@baykeeper.org>, "Hal Candee (external)" <hcandee@altshulerberzon.com>, mark rockwell <mrockwell1945@gmail.com>, Glen Spain <fish1ifr@aol.com>, Ashley Overhouse <AOverhouse@defenders.org>, Jann Dorman <janndorman@friendsoftheriver.org>, "jimb@aqualliance.net" <jimb@aqualliance.net>
Cc: Keiko Mertz <keiko@friendsoftheriver.org>, Ron Stork <RStork@friendsoftheriver.org>, Doug Maner <earth1stdoug@gmail.com>
Subject: CONFIRMED MEETING WITH: Sites Project - Current and Upcoming Activities

Hi Everyone,

Please see below for **MS Teams Invite** and proposed agenda topics offered by the Sites Project for general update on status. Please forward this invite to others who may also be interested.

Thanks,

Jann Dorman
Executive Director
925-518-0320

From: Alicia Forsythe <aforsythe@sitesproject.org>
Date: Tuesday, November 7, 2023 at 9:06 AM
To: Jann Dorman <janndorman@friendsoftheriver.org>, Ashley Overhouse <AOverhouse@defenders.org>, "Spranza, John" <john.spranza@hdrinc.com>, Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Sites Project - Current and Upcoming Activities

Agenda:

1. CEQA Process – Final EIR/EIS and Board meeting
2. SB 149 Application – Status and what we see as next steps
3. Water Right Process – Where we are what's going on
4. Prop 1 Benefits Contracts – Status
5. Mitigation Planning – Status on contractor outreach and developing a terrestrial biological mitigation plan
6. Any other items of interest to the group

____

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 237 806 982 432
Passcode: gi2aXX
Download Teams | Join on the web

Or call in (audio only)
+1 916-538-7066,,772299484#   United States, Sacramento
Phone Conference ID: 772 299 484#
Find a local number | Reset PIN

Learn More | Meeting options

____

Alicia Forsythe

From: Alicia Forsythe
Sent: Tuesday, November 7, 2023 9:08 AM
To: Jann Dorman; Ashley Overhouse
Cc: Spranza, John; Laurie Warner Herson
Subject: RE: Sites Project - Current and Upcoming Activities

Categories: Record

Fantastic! I just sent a meeting invite. Feel free to forward that onto anyone you'd like. Or you can send an invite and I can cancel mine. I am totally flexible. I just wanted to get it on my calendar quickly.

We look forward to the discussion.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Jann Dorman <janndorman@friendsoftheriver.org>
Sent: Tuesday, November 7, 2023 8:14 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Ashley Overhouse <AOverhouse@defenders.org>
Subject: Re: Sites Project - Current and Upcoming Activities

Hi Alicia,

After some back and forth. It looks like this Thursday, November 9, at 2pm will work for many.

Hoping that time is still available?

Thanks so much,

Jann Dorman
Executive Director
925-518-0320

FRIENDS OF THE RIVER FOR 50 YEARS

From: Alicia Forsythe <aforsythe@sitesproject.org>
Date: Friday, November 3, 2023 at 5:29 PM
To: Jann Dorman <janndorman@friendsoftheriver.org>, Ashley Overhouse <AOverhouse@defenders.org>
Subject: RE: Sites Project - Current and Upcoming Activities

Yes, absolutely. Below are some dates / times for the following week.

Monday, November 13 – anytime 1 to 3 pm
Wednesday, November 15 – anytime from 9 to 11 am or from 1 to 5 pm
Thursday, November 16 – anytime from noon to 2 pm

I did want to share on our call that our Board anticipates considering certifying the Final EIR and adopting the project at its November 17 meeting. Considering how close these dates are to the meeting, I'll share that now. Meeting materials will be posted on our website here Friday, November 17 - Sites Reservoir (sitesproject.org) at least 72 hours in advance of the meeting.

I hope you have a great weekend!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Jann Dorman <janndorman@friendsoftheriver.org>
Sent: Friday, November 3, 2023 4:42 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Ashley Overhouse <AOverhouse@defenders.org>
Subject: Re: Sites Project - Current and Upcoming Activities

Hi Alicia,

Thanks so much for your email. I just wanted to check in and let you know Im doing some cat herding with dates/times. Would it be possible to move to the following week? Many of us are at a conference next week, and all of us NGO'ers are wrestling with commenting on several very large documents. 😊

With Appreciation,

Jann

Jann Dorman
Executive Director
925-518-0320

From: Alicia Forsythe <aforsythe@sitesproject.org>
Date: Wednesday, November 1, 2023 at 1:09 PM
To: Jann Dorman <janndorman@friendsoftheriver.org>, Ashley Overhouse <AOverhouse@defenders.org>
Subject: Sites Project - Current and Upcoming Activities

Hi Jann and Ashley – Its been a while since we've had a chance to catch up. I wanted to reach out to see if you all would be interested in scheduling an hour catch up call. This would be more for me to share what is happening on the Project and upcoming activities and for you all to ask any questions or share any concerns you might have. I am happy to cover any topic you'd like. I was thinking that I'd cover the following:

1. CEQA Process – Final EIR/EIS and Board meeting
2. SB 149 Application – Status and what we see as next steps
3. Water Right Process – Where we are what's going on
4. Prop 1 Benefits Contracts – Status
5. Mitigation Planning – Status on contractor outreach and developing a terrestrial biological mitigation plan

I realize we need to schedule a focused call on the water right protest and I see that as a separate discussion. And I'll get an email out on the water right discussion in the next week.

If you're interested in a catch up, below are some dates/times that work for me.

Friday, November 3 – anytime from 11 am to 1 pm
Monday, November 6 -anytime from 1 pm to 5 pm
Wednesday, November 8 – anytime from noon to 1 pm or 2 to 5 pm
Thursday, November 9 – anytime from noon to 3 pm

Happy to have a large or small group – whatever you all would like.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Project Authority | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org