

Maxwell Water Intertie Status Update



To:	Daniel Cardona, Lisa Butler (USDA)
From:	Jerry Brown, Kevin Spesert
CC:	JP Robinette, Ali Forsythe, Cheyanne Harris
Date:	March 25, 2021
Quality Review:	Dave Zuber
Subject:	Maxwell Water Intertie Status Update October 2020 – March 2021

Summary

This report covers the time period from October 2020 through March 2021.

During this period, the Sites Project Authority (Authority) continued to make progress to advance the Maxwell Water Intertie (MWI) Project. Work activities included ongoing environmental planning and permitting activities, preliminary engineering and design activities, local agency/landowner engagement, and program management. The Authority will work in the coming months with USDA Rural Development to make necessary adjustments to the current conditions for the loan including establishing loan closing in mid- 2023 and extending the construction start date to 2024 to reflect the most current updated schedule.

Background

The Authority consists of 9 voting members representing 11 public agencies and 2 non-voting members within the Sacramento Valley watershed. The 2 non-voting members consist of the Bureau of Reclamation (Reclamation) and the California Department of Water Resources (CDWR). Reclamation, CDWR, and 5 of the Authority members also serve on the Sites Project Reservoir Committee.

The Sites Project Reservoir Committee consists of 23 voting members who are investing to obtain direct water supply and storage benefits from the proposed Sites Reservoir. They represent the agencies that will finance and construct the project facilities. The Reservoir Committee is comprised of agencies across California including the Sacramento Valley, Bay Area, San Joaquin Valley, and Southern California.

The Authority is advancing the MWI Project to increase the efficiency and reliability of water management in the western Sacramento Valley, increase the region's drought resiliency, and strengthen the region's rural economy. The MWI Project proposes to interconnect the Tehama-Colusa Canal and the Glenn-Colusa Irrigation District's Main Canal and utilize their capacity to divert stormwater flows

from the Sacramento River for use by the Sites Reservoir Project¹ (Sites). The ability of the MWI to move water between the existing canals would greatly benefit Colusa and Glenn County agriculture. When built and operated in coordination with Sites, the MWI can provide significantly more water supply benefits for agriculture and rural communities throughout the Sacramento and San Joaquin Valleys, flood risk reduction for Colusa County, and add much needed reliability, resiliency and flexibility back to the statewide water management system. The MWI has independent utility from the Sites Project and will achieve the following:

- Improve the transfer of water between the regions' 2 major canal systems to increase water supply resiliency and reliability for participating water agencies in the Sacramento Valley, providing a direct benefit to agriculture and benefit the economies of adjacent rural communities
- Provide releases through the Colusa Basin Drain to the Sacramento-San Joaquin Delta for potential export to participating water agencies in the San Joaquin Valley for agricultural use and benefit the economies of adjacent rural communities

Participating Agencies Subscription

Two additional agencies consisting of Irvine Ranch Water District in Orange County and Rosedale-Rio Bravo Water Storage District in the Southern San Joaquin Valley joined the existing Sites Project participants during the reporting period and all of the existing agencies in the project continued their participation, although a few adjusted their participation levels. Funding by each participant is proportional to their requested annualized water supply benefit which is currently measured in acre-feet per year and at the present time the project is at approximately full subscription.

Funding and Financing

- **Local Project Participants:** Since 2015, local project participants have invested \$37 million to advance Sites. In November 2020, the local project participants reaffirmed their investment in Sites by signing an amendment to the existing participation agreement. By signing this amendment, the local project participants have committed to fund work activities through the end of 2021. The Authority is also working with local project participants to develop a Plan of Finance to evaluate the mechanisms for near-term and long-term financing and Water Storage and Supply Service Contract Term Sheets to allocate benefits, costs, financing and ownership obligations. Additionally, the Authority is starting coordination efforts with local project participants to develop a Successor Agreement to fund activities in 2022 and beyond to conclude the planning phase.
- **State of California (Proposition 1):** The State continues to provide funding for development activities through an Early Funding Agreement (EFA) administered by the California Water Commission (CWC) under Proposition 1 Water Storage Investment Program (WSIP), which was executed in 2019. The EFA has a ceiling of \$40.8 million. In January 2021, CWC awarded a 2.5%

¹ The Sites Reservoir Project is a proposed off-stream water storage reservoir being developed, in accordance with the beneficiary pays principle, as a local, state, and federal partnership to primarily provide water supply reliability and environmental flows to benefit rural communities and farms, cities, and ecosystems. The proposed maximum storage capacity of Sites Reservoir is 1,500,000 acre-feet.

inflation adjustment to all of the WSIP projects increasing the overall award. To date, \$12.5 million has been received through the EFA, with an additional \$13 million planned through the end of 2021 in the approved work plan.

- **Bureau of Reclamation (WIIN Act):** In addition to the \$10.35 million from previous appropriations, Congress appropriated \$13.7 million in December 2020. The Authority and Reclamation entered into a Financial Assistance Agreement in August 2020 to allocate \$6.0 million to fund the 2021 work plan activities, including completion of the Federal Feasibility Study, environmental permitting and planning, and geotechnical evaluations. The Authority and Reclamation are coordinating to execute an amendment and new Financial Assistance Agreement to fund activities beyond 2021 using funds from Congressional appropriations in December 2020. The Project is seeking additional FY22 and FY23 WIIN Act appropriations for the next work period.
- **Federal Feasibility Study:** The Authority's efforts with Reclamation to advance the Federal Feasibility Study culminated in Reclamation's release of the Final Feasibility Report and a Secretary of Interior determination of feasibility in December 2020, a key milestone for maintaining eligibility under the WIIN Act.

Work Plan Through 2021

In February 2021, the Authority approved an updated version of its work plan (initially approved in August 2020) reflecting revised assumptions for revenue and expenses through the end of 2021. The updated plan totaling \$33.6 million includes local, state, and federal funding sources to complete the deliverables to satisfy the State of California's eligibility through Proposition 1, improve operational, cost, and permitting certainty while advancing Sites. A critical path schedule is being maintained as part of the approved work plan and includes the following milestones:

- Revised Public Draft Environmental Impact Report and Supplemental Draft Environmental Impact Statement completed in August 2021
- Project Plan of Finance and Successor Agreement approved in September 2021
- Authority's Final State WSIP Feasibility Report approved by the CWC in December 2021
- Reclamation's Biological Assessment submitted to the U.S. Fish and Wildlife Service and National Marine Fisheries Service in December 2021
- Final Programmatic Agreement under the National Historic Preservation Act ready for signature in December 2021
- Clean Water Act 404/401 Permit Applications submitted in December 2021
- Water Right Application submitted in December 2021
- Anticipated start of construction in 2024 based on current schedule and permitting activities
- Submit a Letter of Interest for WIFIA loan for an amount to be determined.

The Authority will be developing Successor Agreement and associated work plan for activities beyond 2022 that is expected to be presented for approval in September 2021.

Reservoir Operations

The Authority is continuing reservoir operations modeling and analysis to further define and refine operations, water diversions, and potential yields in support of the environmental planning and permitting, engineering feasibility, and financing activities.

Environmental Planning & Permitting

The Authority, as the state lead agency, and Reclamation, as the federal lead agency, continue to perform additional environmental analysis to support the development of the Revised Draft Environmental Impact Report / Supplemental Draft Environmental Impact Statement (Revised Draft EIR/Supplemental Draft EIS). During the reporting period, the Authority refined and further described the alternatives while continuing analysis of construction-related environmental effects. Additionally, the Authority has ongoing consultation with Native American tribes through AB 52 outreach efforts and hosts update workshops with non-governmental organizations. As of December 2020, administrative drafts of 19 chapters and appendices of the Revised Draft EIR/Supplement Draft EIS have been completed by the Authority and reviewed by Reclamation.

The Authority has ongoing discussions with the California Department of Fish and Wildlife (CDFW) to discuss Sites, the permit application process, and supporting information for the permit applications. The Authority is currently developing the initial parameters for the water right application which is expected to be submitted in December 2021.

Engineering and Technical

The Authority is continuing to refine and optimize the Sites' design and facilities based on updated ranges of reservoir operations. Ongoing engineering analysis and studies are supporting completion of environmental documentation and permitting activities. The Authority is also supporting Reclamation with ongoing geotechnical investigations to improve the cost estimation accuracy while working to reduce construction cost related risk. Additional engineering analysis is to support the feasibility as a locally sponsored storage project in compliance with the WIIN Act and in compliance with the State of California's Proposition 1 requirements.

A master project schedule was accepted by the Authority Board in November 2020. The plan shows initiating a loan agreement in mid-2023 with the acquisition of the critical permits and water right. The physical construction work is projected to start in 2024 and is approximately 6 years total duration, ending with operational completion in 2030. The timing for construction of the MWI has not yet been determined and will be evaluated in the next work period as the engineering design progresses. The Authority will work in the coming months with USDA Rural Development to make necessary adjustments to the current conditions for the loan including establishing loan closing in mid- 2023 and extending the construction start date to 2024 to reflect the most current updated schedule.

Communications and Local Agency Coordination

The Authority continues to conduct outreach efforts with landowners, local community members, state and federal elected officials, government agencies, non-governmental organizations, and regional coalitions to advance Sites. The Authority also hosted Town Hall Meeting in January 2021 to communicate progress to the general public.

Ad Hoc Environmental Planning and Permitting Work Group Agenda



Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do

Meeting Information:

Date: April 14, 2021 **Location:** Microsoft Teams
Start Time: 1:30 p.m. **Finish Time:** 3:30 p.m.
Purpose: Ongoing update for the Ad Hoc Environmental Planning and Permitting Work Group for 2021

Meeting Participants:

Mike Azevedo, Colusa County	Rob Kunde, WR-M WSD	Jerry Brown, Sites Authority
Ben Barker, PCWA	Eric Leitterman, Valley Water	Linda Fisher, Sites Integration
Thad Bettner, GCID	Jason Marks, City of Roseville	Ali Forsythe, Sites Authority
Dee Bradshaw, MWD	Randall Neudeck, MWD	Erin Heydinger, Sites Integration
Robert Cheng, CVWD	Jeff Sutton, TCCA	Mike Hendrick, ICF
Jeff Davis, SGPWA	Bill Vanderwaal, RD 108	Jay Lloyd, Sites Integration
Heather Dyer, SBVMWD	Chuching Wang, MWD	Danielle Risse, Sites Integration
Katrina Jessup, Valley Water	Jelica Arsenijevic, Sites Integration	John Spranza, Sites Integration
Trevor Joseph, City of Roseville	Ellen Berryman, ICF	Laurie Warner Herson, Sites Integration
Cindy Kao, Valley Water	Monique Briard, ICF	

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductory Remarks and Review of Agenda	Thad / Heather / Ali	5 min
2. Permitting		45 min
a. Progress update on all current permitting activities including agency coordination	John /Jelica	
Feedback needed: Review and provide direction on progress of permitting efforts.	Mike	
3. Revised Draft EIR/Supplemental Draft EIS		45 min
a. CEQA Overview	Ali/ Laurie	
b. NGO Group meetings		

Feedback needed: Review and provide input on CEQA overview briefing in preparation for Friday's Reservoir Committee meeting. Discuss and provide input on outreach efforts with NGO organizations.

4. Schedule and Dashboard Update	Ali	10 min
5. Upcoming Priorities and Timing of Next Meeting	Ali	5 min

Table 2-2. Comparison of Value Planning and Feasibility Estimates

Feature	VP-7 Costs	Feasibility Activities	Feasibility Costs	Change in Costs	Design Changes and Other Factors Influencing Costs	Notes
1. Clearing, Grubbing, and Demolition						
Clearing, grubbing, and demolition	\$11M	Clearing, grubbing, and demolition	\$32M	\$21M	Added and updated detail for demolition of silos, sheds and garages, water towers, removal of motor homes, removal and cleaning of septic systems, removal of asphalt paving, decommissioning and verification of closure for all gas wells, and plugging of groundwater wells. Unit prices adjusted for current conditions.	VP estimate combined this item with Sites Lodoga Road as part of Reservoir Development. See #9 below for Sites Lodoga Road.
2. Golden Gate Dam						
Preconstruction	\$0M	Preconstruction	\$1M	\$1M	New addition at feasibility level; previously included in unit rates.	Not broken out in Value Planning estimate
Process and Haul	\$71M	Process and Haul	\$184M	\$113M	The feasibility estimate is based on purchasing and hauling 2,561,000 tons of aggregate for filters, drains, and transition zone versus 1,945,000 tons for the value planning estimate. Cost increases are associated with unit price increases and quantity increases from design refinements. The value planning estimate relied on older unit rates that were escalated, but escalated rates did not reflect current market conditions.	
Foundation	\$80M	Foundation Excavation	\$37M	(\$6M)	Cost savings. Also reflects a higher level of core foundation cleanup prior to and after foundation grouting to obtain foundation acceptance from DSOD.	
Foundation Grouting	\$9M	Foundation Prep and Grouting	\$43M			
	\$0M	Foundation Below Shell Prep	\$1M			
	\$0M	Foundation Drainage	\$2M			
Embankment/Borrow	\$102M	Embankment/Borrow	\$386M	\$284M	The feasibility estimate added \$92M for removing overburden and stockpiling waste, and \$19M for restoring the borrow areas post construction outside of reservoir. The cost for random fill is the single highest component of the embankment construction with a total project cost of \$142M in the feasibility level estimate versus \$98M for the value planning estimate. Higher unit rates for placing embankment materials for the core zone, rockfill, and random fill increased by 18% to 23% based on updated pricing backup (resulting in a 35% to 46% to the fully loaded project cost). The value planning estimate relied on older pricing data that was escalated but did escalated rates not reflect current market conditions.	
Other Work	\$0M	Other Work	\$16M	\$16M	Other work items include telemetry for long-term monitoring of the dam, re-seeding the disturbed area outside the reservoir limits, haul routes specific to Golden Gate Dam, and an allowance for dewatering.	
Bypass Pipeline	\$0M	Bypass Pipeline	\$8M	\$8M	Revised approach to better manage Funks Creek flows during construction by piping under the dam rather than constructing a diversion channel between Funks Creek and Stone Corral Creek as previously proposed. Eliminating the channel cut reduces management of excess waste material.	
Unlisted Items	\$29M	Unlisted Items	\$7M	(\$22M)	Reduced as a result of added design detail.	
Mob/Demob	\$15M	Mob/Demob	Included above ²	(\$15M)	Increase consistent with increase in the equipment requirements for the greater level of effort.	Applied as a percentage across all facilities for the feasibility estimate.
Golden Gate Dam Total	\$306M		\$687M	\$381M		
3. Sites Dam						
Preconstruction	\$0M	Preconstruction	\$600K	\$600K	New addition at feasibility level; previously assumed to be included in unit rates.	
Process and Haul	\$31M	Process and Haul	\$64M	\$33M	The feasibility estimate is based on purchasing and hauling 881,000 tons of aggregate for filters, drains, and transition zones versus 644,000 tons for the value planning estimate. Cost increases are associated with unit price increases and some double handling of materials. The value planning estimate relied on older pricing data that was escalated and escalated rates did not reflect current market conditions.	

Table 2-2. Comparison of Value Planning and Feasibility Estimates

Feature	VP-7 Costs	Feasibility Activities	Feasibility Costs	Change in Costs	Design Changes and Other Factors Influencing Costs	Notes
Foundation	\$19M	Foundation Excavation	\$13M	\$3M	14% cost growth for foundation related tasks due to updated pricing information and addition of foundation drainage estimate. Also reflects a higher level of core foundation cleanup prior to and after foundation grouting to obtain foundation acceptance from DSOD.	
Foundation Grouting	\$6M	Foundation Prep and Grouting	\$14M			
	\$0M	Foundation Below Shell Prep	\$500K			
	\$0M	Foundation Drainage	\$100K			
Embankment/Borrow	\$54M	Embankment/Borrow	\$139M	\$85M	The feasibility estimate added \$35M for removing overburden and stockpiling waste, and \$8M for restoring the borrow areas post construction outside of reservoir. The cost for rockfill is the single highest component of the embankment construction with a total project cost of \$54M in the feasibility level estimate versus \$31M for the value planning estimate. The cost for random fill similarly increased to \$13M, compared to \$7M for the value planning effort. Higher unit rates for placing embankment materials for the core zone, rockfill, and random fill increased by 18% to 23% based on updated pricing backup (resulting in a 35% to 46% to the fully loaded project cost). The value planning estimate relied on older pricing data that was escalated but did not reflect current market conditions.	
Other Work	\$0M	Other Work	\$10M	\$10M	Other work items include telemetry for long-term monitoring of the dam, re-seeding the disturbed area, haul routes specific to Sites Dam, and an allowance for dewatering.	
Diversion Tunnel	\$17M	Diversion Tunnel	\$97M	\$80M	For value planning, the Sites diversion was only sized for ecosystem-related creek releases of 10-20 cfs. For the feasibility level design, the Sites diversion is sized for ecosystem-related creek releases of up to 400 cfs (per the request of the permitting team) as well as a larger portion of emergency drawdown flows (1,000 cfs for Value Planning versus 2,000 cfs for feasibility). These are different design criteria that result in much higher costs.	
Unlisted Items	\$10M	Unlisted Items	\$2M	(\$8M)	Reduced as a result of added design detail.	
Mob/Demob	\$7M	Mob/Demob	Included above ²	(\$7M)	Increase consistent with increase in the equipment requirements for the greater level of effort.	Applied as a percentage across all facilities for the feasibility estimate.
Sites Dam Total	\$144M		\$342M	\$198M		
4. Saddle Dams 1, 2, 6, and 8A/B						
Preconstruction	\$0M	Preconstruction	\$1M	\$1M	New addition at feasibility level; previously assumed to be included in unit rates.	
Process and Haul	\$12M	Process and Haul	\$29M	\$17M	The \$17M increase in cost is associated with the purchasing and hauling of aggregate for filters, drains, and transition material. The feasibility level estimate is based on 399,000 tons versus 250,000 tons for the value planning estimate. Cost increases are associated with unit price increases and some double handling of materials. The value planning estimate relied on older pricing data that was escalated and did not reflect current market conditions.	
Foundation	\$15M	Foundation Excavation	\$8M	\$4M	27% cost growth for foundation related tasks due to updated pricing information and addition of foundation drainage estimate. Also reflects a higher level of foundation cleanup prior to and after foundation grouting to obtain foundation acceptance from DSOD.	
		Foundation Prep and Grouting	\$10M			
		Foundation Below Shell Prep	\$300K			
		Foundation Drainage	\$300K			
Embankment/Borrow	\$38M	Embankment/Borrow	\$53M	\$15M	The feasibility estimate added \$6M for removing overburden and stockpiling waste, and \$3M for restoring the borrow areas post construction outside of reservoir. The cost for rockfill and random fill are roughly equal with a combined total project cost of \$25M in the feasibility level estimate versus \$21M for the value planning estimate. Higher unit rates for placing embankment materials for the core zone, rock fill, and random fill increased by 18% to 23% based on	

Table 2-2. Comparison of Value Planning and Feasibility Estimates

Feature	VP-7 Costs	Feasibility Activities	Feasibility Costs	Change in Costs	Design Changes and Other Factors Influencing Costs	Notes
					updated pricing backup (resulting in a 35% to 46% to the fully loaded project cost). The value planning estimate relied on older pricing data that was escalated and did not reflect current market conditions.	
Other Work	\$0M	Other Work	\$34M	\$34M	Other work items include telemetry for long-term monitoring of the dam, re-seeding the disturbed area, haul routes specific to the Saddle Dams, and an allowance for dewatering.	
Unlisted Items	\$0M	Unlisted Items	\$1M	\$1M	Unlisted items were not included in the Value Planning estimates for saddle dams.	
Slurry Wall	\$900K	See Notes	Included in Foundation item above.		Costs for the slurry wall were absorbed into the foundation work for the feasibility level estimate	Replaced with grout curtains in feasibility level estimate under the Foundation activity.
Mob/Demob	\$3M	Mob/Demob	Included above ²	(\$3M)	Increase consistent with increase in the equipment requirements for the greater level of effort.	Applied as a percentage across all facilities for the feasibility estimate
Saddle Dams 1, 2, 6, and 8A/B Total	\$69M		\$139M	\$70M		
5. Saddle Dam 3						
Preconstruction	\$0M	Preconstruction	\$1M	\$1M	New addition at feasibility level.	
Process and Haul	\$12M	Process and Haul	\$53M	\$41M	The \$41M increase in cost is associated with the purchasing and hauling of aggregate for transition zones, filters and drains. The feasibility design included 730,000 tons versus 265,000 tons for the Value Planning estimate. Cost increases are also associated with unit price increases and some double handling of materials. The value planning estimate relied on older pricing data that was escalated and did not reflect current market conditions.	
Foundation	\$19M	Foundation Excavation	\$15M	\$21M	121% cost growth for foundation related due to more extensive excavation, preparation, and grouting. Costs were also affected by updated pricing information and addition of foundation drainage estimate. Also reflects a higher level of foundation cleanup prior to and after foundation grouting to obtain foundation acceptance from DSOD.	
		Foundation Prep and Grouting	\$22M			
		Foundation Below Shell Prep	\$1M			
		Foundation Drainage	\$1M			
Embankment/Borrow	\$37M	Embankment/Borrow	\$135M	\$98M	The feasibility estimate added \$15M for removing overburden and stockpiling waste, and \$5M for restoring the borrow areas post construction outside of reservoir . The cost for rockfill was \$33M and the cost of random fill was \$40M in the feasibility level estimate versus \$7M and \$18M, respectively, for the value planning estimate. Higher unit rates for placing embankment materials for the core zone, rock fill, and random fill increased by 18% to 23% based on updated pricing backup (resulting in a 35% to 46% to the fully loaded project cost). The value planning estimate relied on older pricing data that was escalated and did not reflect current market conditions.	
Other Work	\$0M	Other Work	\$10M	\$10M	Other work items include telemetry for long-term monitoring of the dam, re-seeding the disturbed area, haul routes specific to the Saddle Dams, and an allowance for dewatering.	
Unlisted Items	\$0M	Unlisted Items	\$2M	\$2M	An allowance for unlisted items was not included in the Value Planning estimate.	
Slurry Wall	\$1M	See Notes	Included in foundation item above.		Costs for the slurry wall were absorbed into the foundation work for the feasibility level estimate.	Replaced with grout curtains in feasibility level estimate under the Foundation activity
Mob/Demob	\$2M	Mob/Demob	Included above ²	(\$2M)	Increase consistent with increase in the equipment requirements for the greater level of effort.	Applied as a percentage across all facilities for the feasibility estimate
Saddle Dam 3 Subtotal	\$74M		\$243M	\$169M		
6. Saddle Dam 5						
Preconstruction	\$0M	Preconstruction	\$1M	\$1M	New addition at feasibility level.	

Table 2-2. Comparison of Value Planning and Feasibility Estimates

Feature	VP-7 Costs	Feasibility Activities	Feasibility Costs	Change in Costs	Design Changes and Other Factors Influencing Costs	Notes
Process and Haul	\$8M	Process and Haul	\$20M	\$12M	The \$12M increase in cost is associated with the purchasing and hauling of aggregate for transition zones, filters and drains. The feasibility design included 283,000 tons versus 167,000 tons for the Value Planning estimate. Cost increases are also associated with unit price increases and some double handling of materials. The value planning estimate relied on older pricing data that was escalated and did not reflect current market conditions.	
Foundation	\$12M	Foundation Excavation	\$7M	\$6M	50% cost growth for foundation related due to more extensive excavation, preparation, and grouting. Costs were also affected by updated pricing information and addition of foundation drainage estimate.	
		Foundation Prep and Grouting	\$10M			
		Foundation Below Shell Prep	\$700K			
		Foundation Drainage	\$90K			
Embankment/Borrow	\$31M	Embankment/Borrow	\$43M	\$12M	The feasibility estimate added \$5M for removing overburden and stockpiling waste, and \$2M for restoring the borrow areas post construction outside of reservoir. The total project cost for rockfill and random fill was about \$20M in the feasibility level estimate versus \$17M for the value planning estimate. Higher unit rates for placing embankment materials for the core zone, rock fill, and random fill increased by 18% to 23% based on updated pricing backup (resulting in a 35% to 46% to the fully loaded project cost). The value planning estimate relied on older pricing data that was escalated and did not reflect current market conditions.	
Other Work	\$0M	Other Work	\$7M	\$7M	Other work items include telemetry for long-term monitoring of the dam, re-seeding the disturbed area, haul routes specific to the Saddle Dams, and an allowance for dewatering.	
Unlisted Items	\$0M	Unlisted Items	\$900K	\$900K	An allowance for unlisted items was not included in the Value Planning estimate.	
Slurry Wall	\$1M	See Notes	Included in Foundation item above.		Costs for the slurry wall were absorbed into the foundation work for the feasibility level estimate.	Replaced with grout curtains in feasibility level estimate under the Foundation activity
Mob/Demob	\$3M	Mob/Demob	Included above ²	(\$3M)	Increase consistent with increase in the equipment requirements for the greater level of effort.	Applied as a percentage across all facilities for the feasibility estimate
Saddle Dam 5 Subtotal	\$56M		\$92M	\$36M		
7. Emergency Release Structures						
Release structures to Hunters Creek	\$91M	Release structures to Hunters Creek	\$96M	\$5M	The value planning report had no supporting drawings for pricing the release structures. Take-off quantities were developed from feasibility level drawings to support the current estimate.	
8. Inlet/Outlet Facilities						
Construct Multi-Level Inlet/Outlet Tower	\$103M	Construct Multi-Level Inlet/Outlet Tower	\$113M	\$10M	Feasibility estimate uses drawing take-offs to produce quantities for tower.	
Construct Dual Inlet/Outlet Tunnels	\$199M	Construct Dual Inlet/Outlet Tunnels	\$214M	\$15M	Raising the I/O tunnel reduced the length, resulting in \$37M savings. Net is \$15M additional cost for feasibility estimate.	
Miscellaneous Allowances	\$0	Miscellaneous Allowances	\$5M	\$5M		
I/O Facilities Subtotal	\$302M		\$334M	\$32M		
9. Sites Lodoga Road						
Sites Lodoga East and West Roadways (outside inundation area)	\$39M	Sites Lodoga East and West Roadways (outside inundation area)	\$71M	\$32M	Road length increased from 21,700 ft to 29,000 ft. Cost per linear foot increased from \$1,802 per lf to \$2,208 per lf. Unit prices were revised to match recent pricing data.	
Embankment for Sites Lodoga Road Bridges	\$93M	Embankment for Sites Lodoga Road Bridges	\$142M	\$49M	Approximately \$70M for embankments and \$72M for rock slope protection. The rock slope protection is a new feature. Embankment cost increased by \$36M from flattening the slopes from a 2:1 to a 3:1 for the embankment to	

Table 2-2. Comparison of Value Planning and Feasibility Estimates

Feature	VP-7 Costs	Feasibility Activities	Feasibility Costs	Change in Costs	Design Changes and Other Factors Influencing Costs	Notes
					accommodate rapid reservoir drawdown that could jeopardize the stability of the embankments.	
	\$132M		\$213M	\$81M		
10. Sites Lodoga Bridge						
VP7 – One Bridge (L = 1106 feet) Feasibility – Two Bridges (L1 = 1400 feet; L2 = 1633 feet)	\$180M	Two Bridges	\$168M	(\$12M)	Value planning estimate included embankment for bridge (see under Sites Lodoga Road above). The feasibility cost is now only bridge cost and this increased due to a second bridge being added, which increased the total bridge length nearly 3 times. The unit price for the bridge increased from \$600 per sf to \$1,355 per sf due to design of foundation (piers and pier caps) and bridge deck columns. Considered seismic loading.	
11. Huffmaster Road Realignment						
Huffmaster Rd Realignment	\$41M	Huffmaster Road Realignment	\$49M	\$8M	The roadway width was reduced from 24 feet to 15 feet. The roadbed depth was reduced from 18 inches to 12 inches. Cut and fill volumes were adjusted based on comparative earthwork modeling of Sites Lodoga Road. Unit prices were revised to match recent pricing data.	
12. North Construction Access Road						
North Construction Access Road	\$30M	North Construction Access Road	\$28M	(\$2M)	Unit prices were revised to match recent pricing data.	
Other Roads						
Other Roads	\$79M	Other Roads	\$69M	(\$10M)	Additional access roads were previously undetermined. Also added canal bridge replacements and revised the roadway construction technique from conventional replacement to full depth reclamation for the existing County Roads that was not addressed in the Value Planning estimate.	
Total Estimated Cost	\$1,515M		\$2,492M	\$977M		

¹ Totaling individual costs may not add up to the subtotal or total costs due to rounding.

² In the feasibility estimate, contractor indirect mark-ups (including mobilization) and non-contract costs have been distributed into each of the respective line items.

3.0 Comments on Dams

3.1 Summary of Borrow Areas and Aggregate Sources

Comment: Provide a summary of borrow areas and aggregate sources and how material will be handled (e.g., which quarries will the Authority purchase and develop versus which areas would be owned and operated by others).

Response: (see also Section 3.2)

A typical dam section for the Sites and Golden Gate dams is shown on Figure 3-1. The location of onsite haul routes, borrow, disposal, stockpile, staging, and rock processing areas are shown on Figure 3-2. The location of offsite quarries is shown on Figure 3-3. A material balance diagram for Golden Gate dam that illustrates the quantities and sources of the zone materials is shown on Figure 3-4. The following discusses the zones and sources:

- Zone 1 – Impervious Core – The central core of the dam will consist of clayey alluvium from within the reservoir. The borrow areas for Zone 1 are shown on Figure 3-2 with Z1 designation. For example, the core material for Golden Gate dam would come from GG-Z1 Borrow. The volume of Zone 1 material for Golden Gate is shown on the Material Balance Diagram on Figure 3-4.
- Zone 2 – Filter, Drain and Transition Zones – These zones flank the core and cover the downstream foundation. The materials will be sands and gravels that meet the durability requirements for concrete aggregate. The source of this material is assumed to be from an offsite commercial sand and gravel quarry. It is assumed this material will come from the quarries located between Willows and Orland shown on Figure 3-3. It is assumed that the Contractor would enter into an agreement with these commercial quarries to supply the Zone 2 materials. The ability of the existing quarries to expand to meet the requirements of the project is a risk factor that should be further evaluated as design progresses.
- Zone 3 – Rockfill Shell – This zone is the upstream shell of the dam. The materials are high quality sandstone rock quarried from the reservoir east rim. The borrow locations are shown on Figure 3-2 with the designation Z3. For example, the rockfill shell for Golden Gate dam will come from GG-Z3 Quarry 1 and 2. The larger quarry is located outside of the reservoir on the eastern side of the east rim because this is where the majority of the high-quality sandstone can be obtained. The western side of the east rim appears to contain more mudstone than sandstone. It is assumed that the Authority will acquire the land for these quarries and make them available to the dam Contractor to develop and use them for the dam construction. The volume of Zone 3 from the borrow areas and required for Golden Gate dam construction are shown on the Material Balance Diagram on Figure 3-4. Visual and other potential impacts will need to be mitigated for major rock quarries located on the east side of the reservoir ridge.
- Zone 4 Random – This zone is the downstream shell and upstream cofferdam of the dams. The materials are the more weathered rock and mudstones. The material will break down to a mixture of soil and rock particles when excavated and compacted in the dam. A portion of Zone 4 will be generated from the dam foundation excavations and that material would be used for the cofferdams. The borrow locations are shown on Figure 3-2 with the designation Z3; Zone 4 materials would also be obtained from the same quarries as Zone 3.

The Zone 3 quarries have a significant quantity of weathered rock at the surface and the less weathered sandstones that supply Zone 3 are interbedded with layers of mudstone that can be used for Zone 4 but not for Zone 3. As stated above, visual and other potential impacts will need to be mitigated for major rock quarries located on the east side of the reservoir ridge.

The volume of Zone 4 needed for Golden Gate dam and the volume of material from the quarries are shown on the Material Balance Diagram on Figure 3-4. A significant volume of weathered rock and mudstone would be developed in the quarry that is in excess of the volume of Zone 4 required in the dam. This excess material is designated for disposal and quarry restoration on Figure 3-4. Quarry restoration would consist of backfilling the lower portions of the quarry. As discussed above, it is assumed that the Authority will acquire the land for these quarries and make them available to the dam Contractor to develop and use them for the dam construction. It is also noted that one of the current VE alternatives is to modify the zonation of the upstream shell to include both Zone 3 and Zone 4. This would help reduce the excess material that would have to be disposed and the size of the quarries.

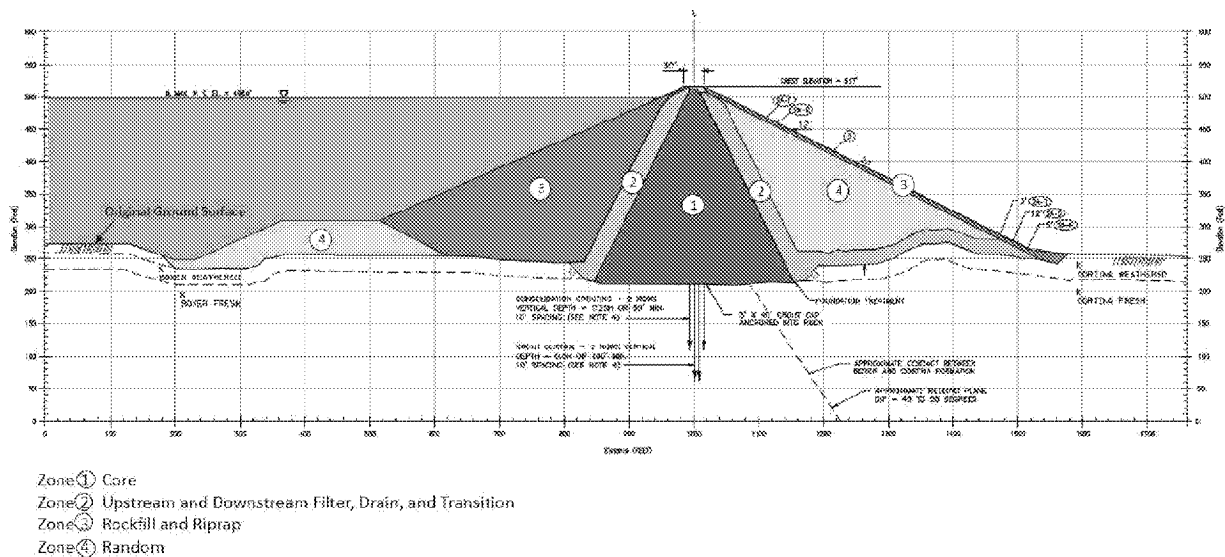


Figure 3-1. Typical Dam Section

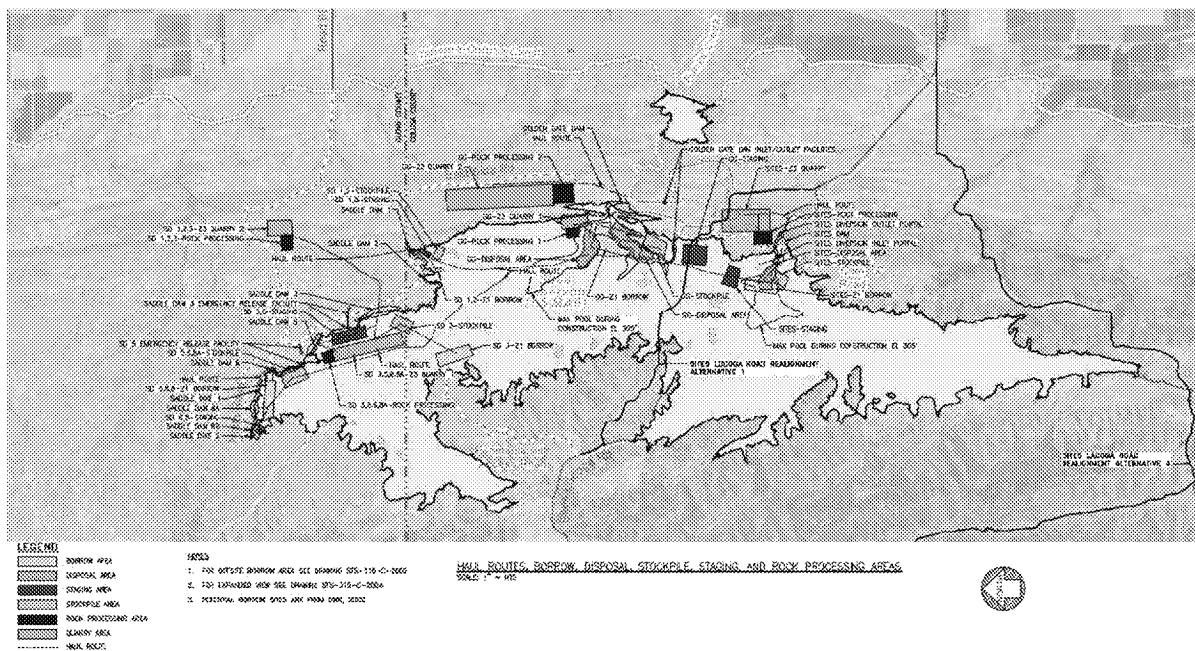


Figure 3-2. Haul Routes, Borrow, Disposal, Stockpile, Staging and Rock Processing Areas

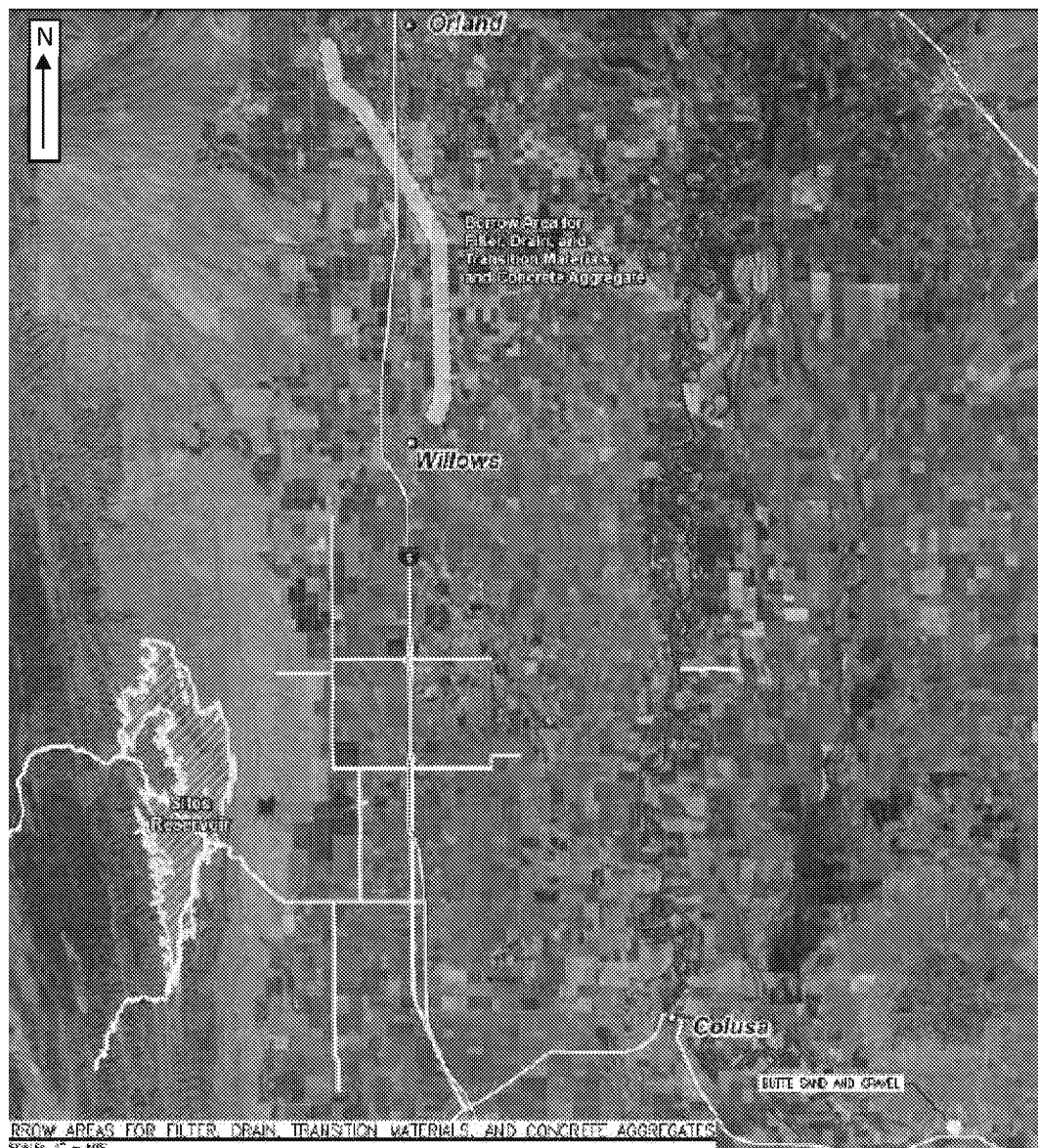


Figure 3-3. Offsite Quarries Location

**MATERIALS BALANCE
GOLDEN GATE DAM - 1.5 MAF RESERVOIR**

Conducted by SR
Reviewed by SR
SRM January 2013

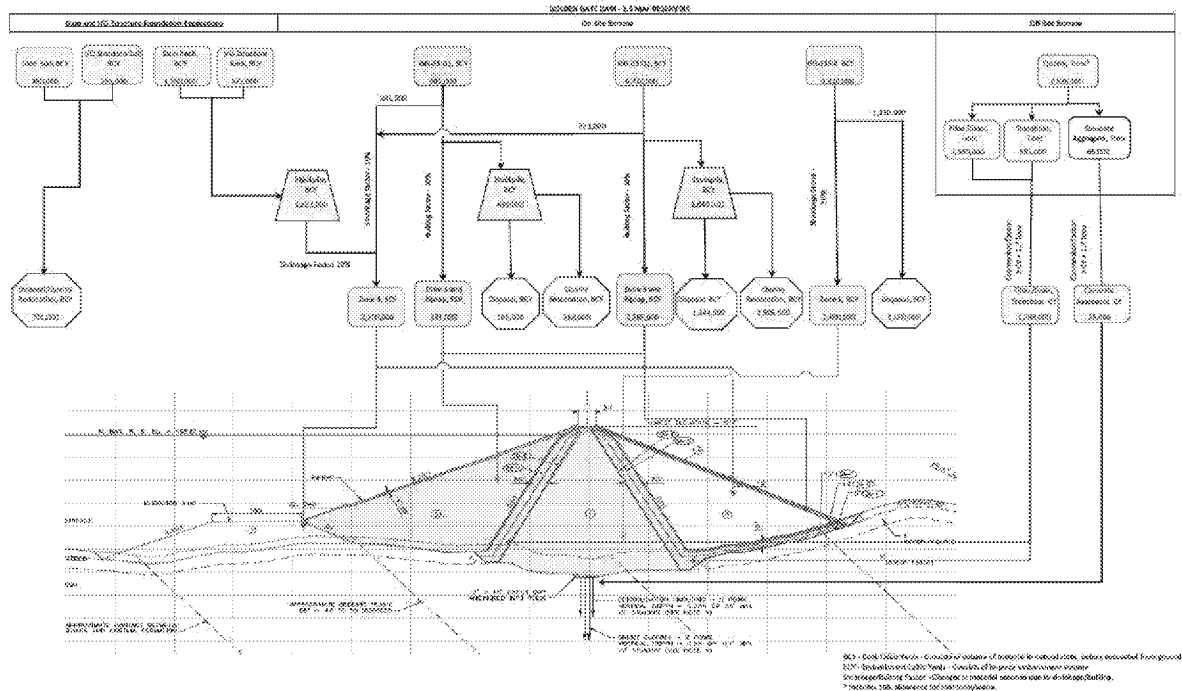


Figure 3-4. Material Balance Diagram - Golden Gate Dam

3.2 Quarry Assumptions and Approach

Comment: Follow-up on quarry assumptions and approach.

Response:

3.2.1 Private Development of On-site Quarries

Private development of on-site quarries to produce Zone 3 rockfill was evaluated to confirm the issues facing this approach. We have consulted with our construction team member, Dan Hertel of Engineering Solutions, for this evaluation. The approach of taking the quarries out of the direct control of the Authority and the dam Contractors presents the following potential issues:

- Gearing up for the exploration, permitting, etc. that needs to happen in a timely manner will be challenging for some type of local ownership.
- Under private ownership, exploration and permitting by a third party could create liability issues associated with potential geotechnical observations and conclusions, as well as permit stipulations that may be beyond the bounds or intent of the Sites Project.
- Ramping up for construction activities would be a substantial task and investment in planning, labor and equipment. Early investment would include acquisition of, or commitment to equipment, including for mining, processing, loading and hauling, and for disposal and shop

facilities. The cost of early investment would likely be more than several million dollars per quarry and could exceed \$20-\$30 million per quarry.

- This work would be on the critical path for most of the construction duration. As such, the quarries should be in direct control of the contractors. Any delays caused by the quarry operation that is not under the dam Contractor's direct control would result in claims to the Authority and incur significant cost penalties. Furthermore, any materials produced by private quarries that fail to meet specified requirements would delay approvals by DSOD and create liability for the Authority as these materials would be "owner-furnished". It appears that any third party quarry operator would need to provide some type of performance bond to help insure that adequate production and quality were met.

The development of aggregate road base materials by a third party supplier poses less risk and is a smaller magnitude endeavor. This will be further evaluated as the design proceeds. Further work is needed as design progresses to verify the approach to obtaining quarried materials.

3.2.2 Production of Filter, Drain and Concrete Aggregate Materials

We have not identified a currently active gravel mining operation on Stony Creek closer than Orland. There are significant gravel deposits along Stony Creek, which could potentially be mined for use in the filter, drain, and as concrete aggregate materials. The gravel bed appears to be approximately 100 to 300 feet wide. Since no currently active quarry appears to exist, mining materials from Stony Creek would require purchasing rights to mine the gravel, developing the site, and obtaining the necessary environmental permits.

The Stonyford location is closer to the Sites Project, so there may be opportunities for cost savings. The materials might be purchased at a lower price and hauled directly to the site and processed there, as opposed to hauling 35 miles from Orland. Pros and cons of this approach are:

- Pros: Shorter material haul and less reliance on commercial quarries to produce materials.
- Cons: Would need to haul more materials to account for more waste than from the commercial quarries, and construction water demand would increase due to the need to wash the materials. In addition, the mining rights may need to be purchased and the site developed prior to producing suitable materials for construction. There are also potentially significant environmental review and permitting requirements.

3.3 Potential Benefits of Using Excess Materials West TRR in HR Facilities

Comment: Provide an evaluation of the potential benefits of using waste from the west Terminal Regulating Reservoir (TRR) excavation to construct Golden Gate Dam (we should evaluate other options also, including use for roads).

Response:

Jacobs Engineering/Geosyntec indicated that excess materials from the TRR excavation could amount to about 9 million cubic yards of total material (e-mail from Peter Rude, Jacobs Engineering, March 18, 2021). These excess excavated materials are being considered for use in the HR facilities. The geotechnical characteristics and volume of the excavated materials would need to be confirmed. Besides material balance (excavation at TRR and use in HR), hauling costs would need to be considered because the TRR is about 4 miles east of Golden Gate Dam.

The weathered rock materials from the TRR excavation are being considered for use in the Golden Gate Dam (Zone 4 earthfill) or in the roadway fills. Use of earthfill in the upstream shell would need DSOD to weigh in on the acceptability of this option.

The VE idea discussed during the March 3, 2021, LMC meeting, *“Replace upstream shell zone and eliminate upstream filter/transition zones¹”*, minimizes excess earthfill by using it as a part of the upstream shell zone (see Section 3.1 above). Utilizing the full amount of TRR excess excavation materials would convert the entire upstream shell into earthfill. Seismic stability for a dam with earthfill upstream shell may be a concern to DSOD due to the adequacy of compaction of the earthfill to preclude excessive seismic deformations. To evaluate the viability of using the TRR material in the Zone 4 upstream shell of the dams, seismic stability would need to be evaluated; this would likely include test fills using weathered rock during the geotechnical investigation phase.

Other limitations on using the TRR excavation materials in Golden Gate Dam include the following:

- If used on the upstream side of the dam, the haul route would need to cross the embankment core and chimney filter and drains, creating potential contamination issues, potentially interfering with dam construction, and disturbing the compacted materials. The TRR excavated materials could be used on the downstream side of the dam to avoid hauling across the top of the dam.
- If used on the upstream side of the dam, the haul route lengths would be increased, possibly by 10 miles or more, to avoid crossing the dam.
- The availability of the TRR materials would need to be compatible with the construction schedule.

Instead of using the excess excavated materials in the dam, the materials may be used in the less stringent road fills (not DSOD jurisdictional) on the east side of the reservoir. The demand for the fill material versus the amount available from TRR would need to be evaluated, and locating disposal sites would be required for excess materials.

We understand that the HC Contractor will estimate the cost of the TRR by adding the 4-mile hauling cost to the cost of excavation.

Alternatively, excess material could be disposed of in the deadpool of the reservoir or along the roads.

3.4 Cost Comparison for 40% Increase in Foundation Preparation and 50% Increase in Processing and Hauling

Comment: Provide breakdown/cost comparison for 40% increase in foundation preparation and 50% increase in processing and hauling.

¹ This VE option was presented at the 3/3/21 LMC meeting. It replaces a portion of the upstream shell rockfill (Zone 3) with earthfill (Zone 4).

Response:

Refer to Table 2-2 for response to this comments. This comment was expanded to include reviewing all cost increases, not only the cost for foundation preparation and processing and hauling.

3.5 Double Handling of Commercially-Obtained Material

Comment: Justify/support assumption for double-handling of commercially obtained material – reason for transporting to stockpile area instead of directly to placement.

Response:

This is a question on material availability and timing of the demand. For the feasibility cost estimate, AECOM assumed 70 percent direct haul and 30 percent stockpile onsite prior to placement in the dams. The reason is the demand for the materials will vary significantly with time, the quantities are large, and the Contractor will need to have the material available for placement without delaying construction. For example, a significant quantity of blanket drain material will be quickly needed to cover large areas of the downstream shell foundation upon receipt of DSOD approval of the foundation.

Due to the volumes of material required, particularly for the large dams, placing the materials by direct delivery may not be achievable and a surge pile may be needed for blanket placement to keep pace with the schedule. The construction schedule shows the first use of filter/drain material starting in the Saddle Dams in late 2026 (AECOM, 2021b). Golden Gate Dam construction would start in 2027 and Sites Dam in 2028. The final use of filter/drain would be in 2028 for the Saddle dams and in 2029 for Golden Gate and Sites dams. As stated above, the demand for the materials would vary significantly and our opinion is that would require a surge pile of material on site to help meet the peak demands. In addition, to even out the demand on the offsite quarries, it was assumed that filter/drain delivery to the site would need to begin in 2025. Therefore, double handling of a portion of the filter/drain materials would be needed. As such, our estimate for feasibility is 70 percent direct haul and 30 percent stockpile/double handling of the filter/drain materials.

4.0 Comments on Roads and Bridges

4.1 Reevaluation of Bridge Length and Fill Prism

Comment: Re-evaluate the bridge length and fill prism (we know from an engineering perspective how to proceed but are unsure if this would result in any environmental impacts other than handling the additional fill prism – suggest coordination with ICF, maybe including their limnologist). Evaluate option for one bridge (only eastern span).

Response

The Environmental Team has been consulted regarding the potential for additional environmental impacts and mitigation needs. A response is forthcoming.

The additional fill required to replace the 1,400-foot-long westerly bridge has been evaluated and results in approximately \$14M savings. The 1,400-foot-long bridge would be replaced with approximately 3.6M cubic yards of local fill material, 260,000 cubic yards of rock slope protection, 1,760 cubic yards of aggregate base, and 1,200 tons of hot-mix asphalt, for the fill prism and roadway elements. The engineering issue is the absence of geotechnical data and analysis of the alluvium to

evaluate its use to support a large fill prism on the valley floor. This cost savings will need to be verified once the subsurface materials investigations are complete.

4.2 Realignment of Sites-Lodoga Road

Comment: Sites Lodoga Road – an alternative alignment closer to the water’s edge may provide some savings.

Response:

A comparative analysis has been performed of the current alignment relative to the reservoir water’s edge alignment and the cost savings would be roughly \$10M. The water’s edge alignment traverses approximately 900 feet of less difficult mountainous terrain, but is approximately 1,800 feet longer overall. However, the net is still expected to be a savings based on approximately 1,300 additional tons of hot-mix asphalt, 2,000 additional cubic yards of aggregate base, 21,000 less square feet of retaining walls, 550,000 less cubic yards of roadway excavation, and approximately 3,000 linear feet of full-depth reclamation of roadway. Figure 4-1 shows the comparison of the two alignments.

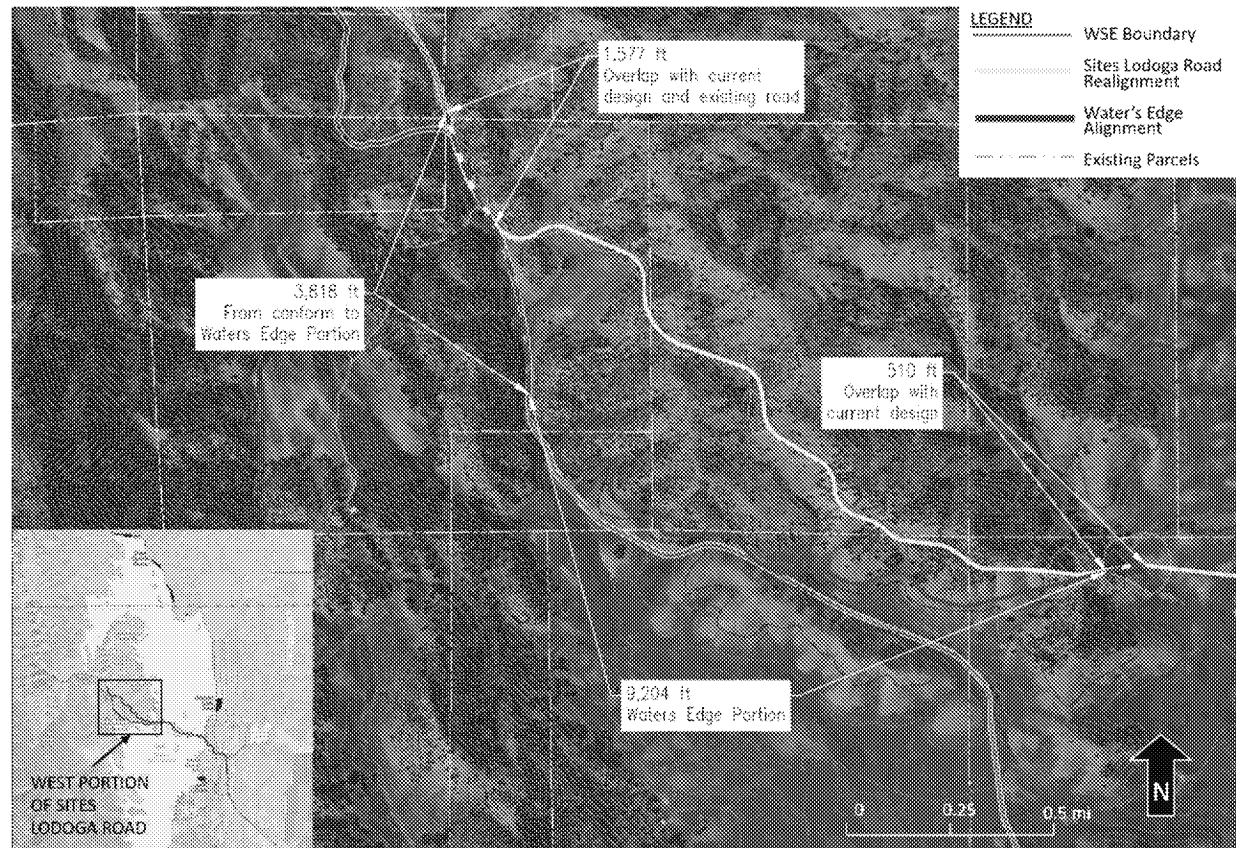


Figure 4-1. West Sites-Ladoga Road Alternative Alignment Options

4.3 Reduction of Length of Huffmaster Road Realignment

Comment: It appears possible to reduce the road length of Huffmaster Road realignment by tying in to the existing Huffmaster Road north of “Ladybug’s” residence (this alignment change would need to be coordinated with the environmental team).

Response:

The reduced length of Huffmaster Road realignment is approximately 4,000 feet and would result in approximately \$4M in savings. The reduction in length reduces the roadway excavation by approximately 150,000 cubic yards, reduces the aggregate base by approximately 2,200 cubic yards, and reduces the retaining walls by approximately 6,000 square feet. Figure 4-2 shows the reduced roadway length.

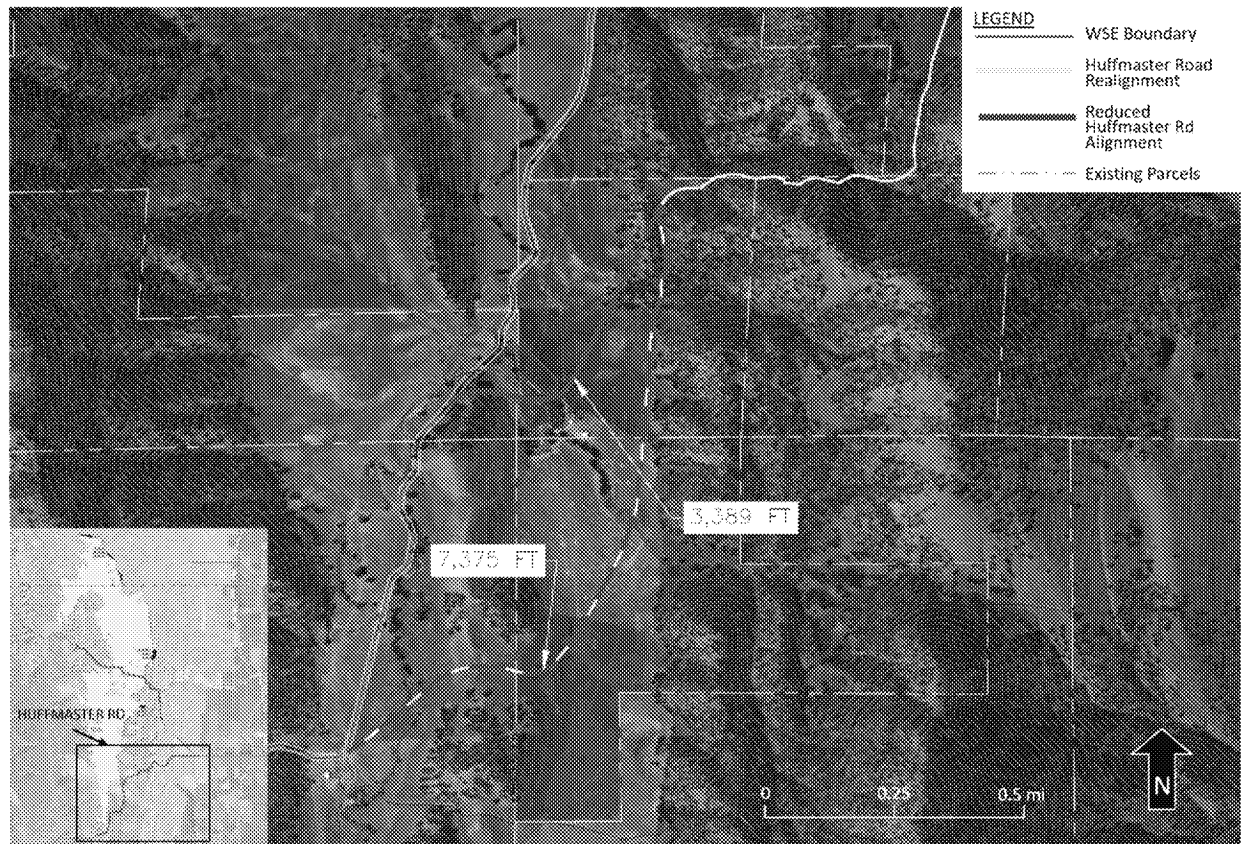


Figure 4-2. South Huffmaster Road Realignment Options

4.4 Colusa County Cost Data

Comment: Coordinate with Mike Azevedo to obtain recent Colusa County data on costs/linear foot and review for application to the road cost estimate.

Response:

Colusa County provided their Lodoga-Stonyford Road Project construction documents and bid results dated September 24, 2020, for our evaluation. This project involves partial depth reconstruction of the roadway structural section. The cost evaluation of this Lodoga-Stonyford Road Project compares well with the Site Reservoir Project as demonstrated below and affirms the cost estimate established for the reconstruction of County roads that would provide construction access from Interstate 5 to the Sites Reservoir site. Table 4-1 summarizes the evaluation.

Table 4-1. Comparison of Road Project Features

Sites Reservoir - County Roads Full Depth Reclamation (FDR)	Colusa County – Lodoga Stonyford Road Rehabilitation Project (County Rehab)
\$233 per lf of roadway based on engineers estimate	\$91.10 per lf of roadway based on bid results
14 inch deep pulverizing with 2 inch AC overlay (16 inch total structural section)	5 inch deep pulverization with 4 inch AC overlay (9 inch total structural section)
Additional items not included in the Lodoga-Stonyford Road Project: Metal pipe culvert and concrete box culvert replacements, and intersection upgrades	No additional items
28 ft wide road	22 ft wide road
Additional items not included in the Lodoga-Stonyford Road Project: 2 feet of shoulder widening on each side of the road which involves an additional bid item for roadway excavation	No shoulder widening or roadway excavation
Project Comparison Summary – Equivalent Basis	
\$189 per lf without the additional items *	\$206 per lf with factored width and depth *
21.28 miles combined length	2.07 miles long
Total cost = \$26.25M (high economy of scale)	Total cost = \$1M (low economy of scale)

* Equating Project Cost:

- FDR 16-inch deep structural section : County Rehab 9-inch deep section (1.78:1 ratio)
- FDR 28-foot road width : County Rehab 22-foot road width (1.27:1 ratio)
- County Road factored cost: $\$91.10 \text{ per lf} \times 1.78 \times 1.27 = \206 per lf
- FDR equivalent cost: \$189 per lf (high economy of scale)

As would be expected based on the relative economy of scale, the FDR equivalent cost per linear foot is less but reasonably close to the County Rehabilitation project cost (\$189 per lf vs \$206 per lf).

Land Management Committee Meeting Minutes



Date: March 3, 2021

Location: Maxwell / Virtual

Time: 1:00pm – 4:00pm

Leader: Supervisor Gary Evans

Recorder: Conner McDonald

Purpose: Update on activities associated with geotechnical field activities and in-progress project cost estimate

Attendees:

Supervisor Gary Evans (Colusa)	Jerry Brown (Sites)	Pete Rude (Jacobs)
Supervisor Ken Hahn (Glenn)	Kevin Spesert (Sites)	Jeff Herrin (AECOM)
Jeff Sutton (TCCA)	Conner McDonald (HDR)	Howard Michael (AECOM)
Logan Dennis (GCID)	Henry Luu (HDR)	Michael Smith (AECOM)
Thad Bettner (GCID)		Michael Forrest (AECOM)
Mike Azevedo (Colusa)		

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductory Remarks	Evans	5 minutes
2. Meeting Minutes and Action Item Follow-Up	Evans	5 minutes
3. In-Progress Project Cost Estimate - Status of In-Progress Cost Estimate - Project Facilities Costs (roads, dams, conveyance) - Potential Value Engineering Opportunities Requested Action: Feedback/Direction	Luu	2.5 hours
4. Update on 2020-21 Geotechnical Field Work Requested Action: Informational	Spesert	15 minutes
5. Action Items and Closing Comments	Evans	5 minutes

1. Agenda Item #1 – Introductory Remarks – Supervisor Evans

Meeting called to order at 1:10pm.

Kevin Spesert confirmed Attendees.

Meeting Chair Supervisor Evans advised that the meeting would review project numbers, and function as a follow-up to the meeting from approximately one year ago.

Attendees introduced themselves.

2. Agenda Item #2 – Meeting Minutes & Action Item Follow-Up – Supervisor Evans

Meeting Minutes from prior meeting have been reviewed.

Jerry Brown provided an update to the minutes regarding the Emergency Draw-Down Modeling discussed at the January 2021 Meeting and advised that Inundation Mapping is still in progress.

3. Agenda Item #3 – In-Progress Project Cost Estimate – H Luu

Jerry Brown advised that the cost estimate is in progress, and some of its components relate to Land Management Committee items. As the estimate is being further developed and refined, additional input is needed from the Land Management Committee. All components of the estimate are open for discussion; and certain components need input.

Henry Luu introduced the cost estimate, provided a summary of changes that have occurred since the Value Planning Process, and advised that the Project Team is seeking input on the cost estimate items that have the most influence on overall project cost.

Jeff Herrin reported that over the last year-and-a-half, there has been much more detailed design performed on the roads and dams, resulting in the current in-progress cost estimate. The ultimate cost of the project will be determined by bids from contractors, and, as such, AECOM has employed the services of a Constructability Expert Sub-Consultant, who reviews construction bids, and is informing AECOM's estimating process. The Value Planning estimate was the result of an interpolation between a 1.3MAF design, and a 1.8MAF design, with quantities originally being estimated as 12% less than what is currently estimated.

Jeff Herrin presented on the project components which the Team anticipates to have a) a High Probability of Value Engineering Savings; and b) a High-to-Medium Probability of Value Engineering Savings, with a rounded estimate of \$3.9B in project cost, if all High Probability components are optimized; and a rounded estimate of \$3.7B, if all identified components are optimized.

Jeff Herrin advised that the engineering process and the estimating process are iterative – as design advances, estimating can get tighter.

Howard Michael reported on the roadway design / estimating. VP7 identified the Huffmaster Road estimate as \$41M; the current estimate is \$49M. There have been cost-containing measures already envisioned in reducing the length, width, and depth of the road.

To square current project estimates with a real-world example, the AECOM Team compared the proposed Huffmaster Road and Sites-Lodoga Road to the completed SR-299 Buckhorn Summit Realignment. The Committee advised that this comparison may not be comparable.

Howard Michael advised that there is no design-level topography available at this time, so estimating can only be so accurate, and incorporates many assumptions, such as the need for retaining walls, for example.

Howard Michael presented on the changes to the Sites-Lodoga Road and Bridge since the VP7 process, and advised that there was an increase in the size of the feature due to the need for more water circulation within the reservoir, to avoid anticipated algal growth. The Committee advised that this water quality issue should be reviewed, and it should be evaluated to see if it can be addressed in a more efficient manner.

Howard Michael advised that re-alignment of Sites-Lodoga Road to the water's edge could allow for the roadway to follow the land contours, and discussions have been initiated within the Project Team to ensure the area is environmentally cleared for this option.

With regard to Huffmaster Road, it was discussed that the road may be able to be shortened, as the water level has receded; and the road owned by USBR may be able to be maintained by TCCA. The Project Team will perform an analysis of the possibility to tuck Huffmaster Road towards the reservoir.

Howard Michael advised that additional geotechnical and topographical information could allow for refined cost estimating.

The Committee advised that Colusa County is performing road work in the project area, and the cost data of these activities could be used in the Project Team's analysis.

Mike Forrest presented on the current status of design and cost estimating for the reservoir dams, and advised that, at the time of VP7, there were no drawings to take estimates off of. Since VP7, the Project Team has identified cost items related to materials and quarries, with 100 drawings being produced since VP7. These drawings are now available to estimate quantities, and the quantities can inform cost estimating. An additional component of the estimated cost differential from VP7 is the foundation preparation for the dams. The cost estimating has used the Chimney Hollow Dam, Isabella Dam, and Calaveras Dam as comparisons.

Mike Forrest advised that there are Low-, Medium-, and High- Probability opportunities for value engineering in the dam construction process. Some items result in a trade-off of lower construction costs, but higher operations and maintenance costs, such as the orientation of the intake structure. Others may be affected by jurisdictional / regulatory input, such as DSOD's caution regarding spillways.

Pete Rude reported on the status of conveyance design, and the estimated costs. After 10 months of design work, there is more confidence regarding costs. At the time of VP7, the only high-level engineering that was completed was for the Dunnigan Pipeline.

Pete Rude advised that 123 drawings and quantity calculations have been completed since VP7, and there has been developed 15 grouped bid packages for cost estimating. Some of the cost-increase drivers are: cement deep soil mixing anticipated for TRR; increased steel costs for pipeline; electric transmission facilities; and GCID improvements.

Pete Rude reported that value engineering opportunities exist with regard to the size and footprint of TRR; comparison of TRR location ground conditions; and additional information that is pending from PG&E and WAPA.

The Committee advised that the project is not only an engineering effort, but a financial effort, as well.

Jerry Brown advised that construction cost is only one piece of the cost estimating analysis of the project. With current interest rates, financing can result in large savings. The allocation of costs to the appropriate payors is an important cost analysis that is being performed. Looking at how agencies use their water, and accounting for USBR's demand is key in developing a more complete understanding of the financial aspect of the project.

Supervisor Evans advised that if more field activities, such as geotech, topographical survey, etc are needed, those needs should be identified as soon as possible, and shared with Supervisor Evans and the Committee. Developing relationships with Landowners, to allow for that access, is a long-lead item, and needs to be done correctly, with sufficient lead time.

Kevin Spesert advised that any field activity effort will require coordination with the Real Estate Team, and the Project Team must get out ahead of the field access needs to establish the best environment for success.

Henry Luu advised that the Project Team would meet to determine field access needs.

4. Agenda Item #4 – Update on 2020-2021 Geotechnical Field Work – K Spesert

Kevin Spesert reported that the Project Team is finishing the field activities that were begun in November of 2020. There is an anticipated completion of Mid-March, with one bore hole in progress, and geophysical studies proposed in the coming weeks. Access, community relations, environmental, and cultural matters have progressed well, with successful coordination between the Sites Project Team, USBR, TCCA, RD-108, DWD, Colusa County, Yolo County, and others. These activities were only possible due to early engagement with stakeholders, and the current success of these efforts will hopefully result in future permission for access needs.

Conner McDonald reported on the field work, inter-agency coordination, and landowner relations between November 2020 and current.

Kevin Spesert advised that the Project Team must be mindful of its community relations at all times, and the interaction with fellow agencies, community members, and landowners is a critical and ongoing process.

5. Agenda Item #5 – Action Items and Closing Comments – Supervisor Evans

The Committee reviewed the action item next steps, and the meeting was adjourned at 3:57pm.

Action Items:

No.	Action Items	Lead
1	Evaluate extension of embankment fill prism in lieu of a bridge structure on the west side of the proposed Sites Lodoga Road re-alignment.	HR
2	Evaluate an alternative alignment for Sites Lodoga Road that is closer to the reservoir maximum normal operating water elevation.	HR
3	Evaluate potential reduction in road improvement length by tying in Huffmaster Road Realignment to the existing Huffmaster Road north of Ladybug's residence.	HR
4	Obtain recent Colusa County data on costs/linear foot and review for application to the road cost estimate.	HR
5	Provide a summary of borrow areas and aggregate sources and how material will be handled.	HR
6	Evaluate potential benefits of using excavation/excess material from TRR West to construct Golden Gate Dam and/or other project features.	HC/HR
7	Present updated Emergency Release preliminary hydraulic model and obtain LMC input before incorporating VE savings related to removal of Saddle Dam 3 and 5 emergency release structures.	HC
8	Present breakdown/cost comparison for 40% increase in foundation preparation and 50% increase in processing and hauling.	HR
9	Justify/support assumption for double handling of commercially obtained material.	HR
10	Provide Jeff Sutton with backup and estimate for the Red Bluff pump costs.	HC
11	Follow up with GCID re: Hamilton City pumping plant at high river flows.	HC
12	Identify access needs for additional geotech/surveying, so communication with land owners can be started as soon as possible.	HC/HR
13	Follow up with LMC late April 2021	All

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/1/2021 5:42:34 PM
To: Spranza, John [john.spranza@hdrinc.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]; henry.luu@hdrinc.com; Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]; Linda Fisher (linda.fisher@hdrinc.com) [linda.fisher@hdrinc.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Revised EIR/EIS Figures

Flag: Follow up

All:

ICF has uploaded revised figures for the Batch 1A and 1B chapters we previously reviewed.

☐ https://sitesreservoirproject.sharepoint.com/:f:/r/EnvPlanning/RDEIRSDEIS%20Review/Revised_Batch1A_1B_Figures?csf=1&web=1&e=keaz4K

Please let me know if you have any comments or suggested changes to these figures. I don't think any of us had time to scrutinize the original figures when the Batch 1A and 1B be chapters were originally submitted so this gives us another chance before we get completed chapters in May.

Comments by April 15th would be appreciated. Thank you !!

Laurie

Laurie Warner Herson
Principal/Owner



Environmental Planning

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Sites Reservoir

 **Sites**

Our Strength is in Our Broad Statewide Participation

Sacramento Valley

Carter Mutual Water Company
City of American Canyon
Colusa County
Colusa County Water Agency
Cortina Water District
Davis Water District
Dunnigan Water District
Glenn County
Glenn-Colusa Irrigation District
LaGrande Water District
Placer County Water Agency
Reclamation District 108
City of Roseville
Sacramento County Water Agency
City of Sacramento
Tehama-Colusa Canal Authority
Westside Water District
Western Canal Water District

Bay Area

Santa Clara Valley Water District
Zone 7 Water Agency

San Joaquin Valley

Wheeler Ridge-Maricopa Water Storage District
Rosedale-Rio Bravo Water Storage District

Southern California

Antelope Valley - East Kern Water Agency
Coachella Valley Water District
Desert Water Agency
Irvine Ranch Water District
Metropolitan Water District
San Bernardino Valley Municipal Water District
San Geronio Pass Water Agency
Santa Clarita Valley Water Agency



Affordable, Permittable, Buildable

Sites underwent a rigorous value planning effort that resulted in a “right-sized” project. The Sites Reservoir of today:

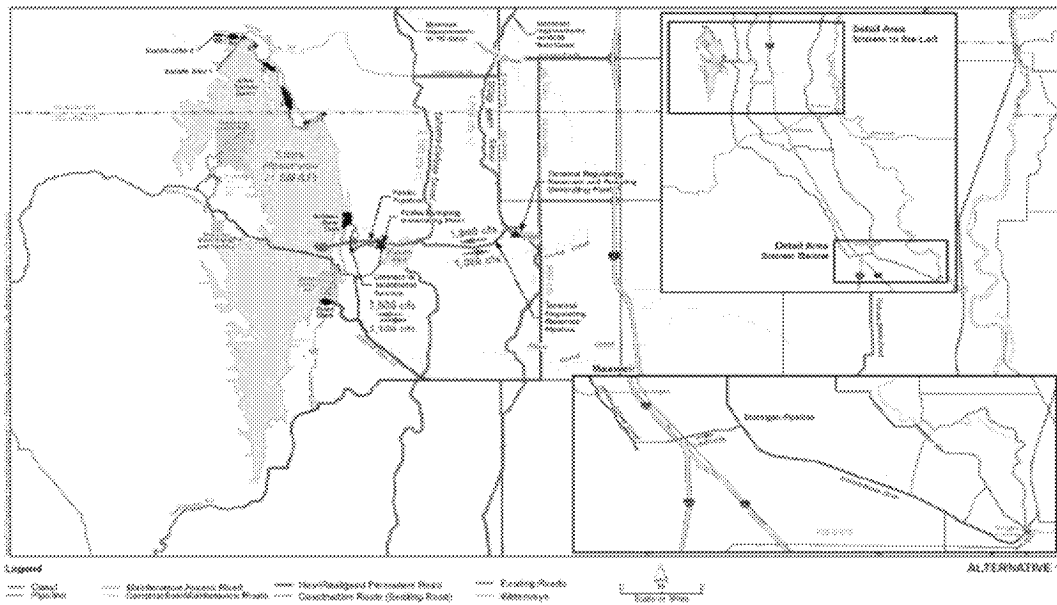
- ✓ Has a smaller footprint than the previous iteration
- ✓ Meets the water supply needs of current participants
- ✓ Comes at a lower cost
- ✓ Supports State’s environmental goals
- ✓ Creates flexibility for participants
- ✓ Performs under most challenging climate change scenarios

The right-sized project cuts roughly \$2 billion from the original proposal.

Sites is now more affordable, permittable, and buildable.



Affordable, Permittable, Buildable



JP has map

Provides Climate Change Resiliency

How does Sites Reservoir address these challenges?

- ✓ Captures excess flows from Sacramento River – rain instead of snowmelt
- ✓ Off-river storage increases environmental benefits by not damming major river system
- ✓ Adds 1.5 million acre-feet of water into the statewide system, easing pressure on other sources during droughts
- ✓ Supplies water for people, farms and environment during the longer dry spells California experiences
- ✓ Allows other reservoirs, like Shasta, to conserve more cold water during dry periods in order to benefit fisheries

Project performance is expected to improve by approximately 5% under anticipated climate change conditions



Provides a Resilient Supply of Water

SITES PROJECT NEW WATER SUPPLY

Year Type	Water Supply (thousand acre-feet)
Wet	80-90
Above Normal	92-292
Below Normal	190-296
Dry	398-429
Critically Dry	308-348
Long-Term Average	207-260

One thousand acre-feet of water supply can serve about 2,000-3,000 households for one year, or 200-500 acres of productive California agriculture.



Provides Important Environmental Benefits

Sites Reservoir provides water dedicated to environmental use

A significant portion of the Sites Reservoir Project's annual water supplies will be dedicated to environment uses:

Preserve cold-water pool in Lake Shasta later into the summer months to support salmon development, spawning and rearing

Provide a reliable supply of refuge water to improve Pacific Flyway habitat for migratory birds and other native species

Provide water dedicated to help improve conditions for the Delta Smelt

Water dedicated for the environment provided by Sites Reservoir will be managed by state resources agency managers who will decide how, and when, this water would be used - creating a water asset for the state that does not currently exist



Environmental Protections

- Diverting during excess conditions, when all senior water rights and water quality and flow requirements are met
- Using existing diversion locations and state-of-the-art fish screens
- Relying to the extent possible on existing infrastructure for releases
- Diversion criteria have been shifted upstream for operations at diversion locations
- Additional pulse protection criteria added to protect migrating juvenile salmon



EIR Project Alternatives

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 use of 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

Ali has slide to send.

Project Costs and Affordability

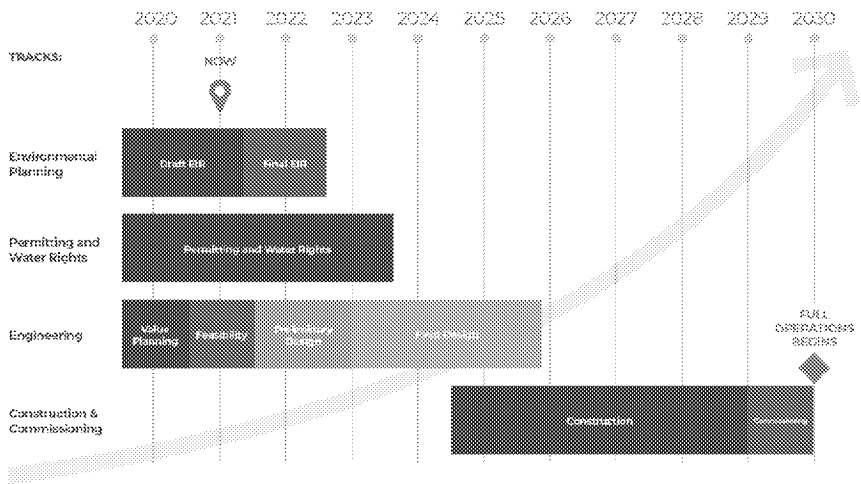
Reservoir Size (MAF)	Alternative 1 (LSMAF)
Total Project Cost (2019\$, billions)	\$3.3 +/-
Annualized AF/year release (AFY)	230,000
Range of Annual Costs During Repayment Without WIFIA Loans (2020\$, \$/AF)	\$650 - \$710
Range of Annual Costs During Repayment With WIFIA Loans (2020\$, \$/AF)	\$600 - \$660



Looking Ahead

Sites Reservoir Project Schedule

Sites Reservoir Project Schedule



Creating an Affordable, Permittable & Buildable Project

2021 Goals

- ✓ Submit key project permits
- ✓ Meet the Proposition 1 (WSIP) requirement for 75% local cost share
- ✓ Update and refine cost estimate to support Water Commission Feasibility Determination
- ✓ Update and refine Master Project Schedule through construction completion
- ✓ Circulate the revised Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement for public review and comments
- ✓ Develop Operating Agreement Term Sheets with DWR, Bureau of Reclamation and local facility partners
- ✓ Continue to collaboratively engage with landowners, tribes and local communities





Erin – once we have run the course re questions (real time or prepared), we will closely watch the time and ensure we wrap with five minutes to spare.

Jerry/Fritz: If we do have time, I could offer one or both of you to make some closing comments. That would be a nice touch. Let's consider and we can prepare, or you can simply make notes throughout the TH sessions, and plan your individual wrap-ups – 60-90 seconds?

Fish and Water Quality Mitigation Discussion - Agenda



Affordable Water, Sustainably Managed

*Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do*

Meeting Information:

Date: April 28, 2021 **Location:** Webex
Start Time: 1:00 p.m. **Finish Time:** 3:00 p.m.
Purpose: Discuss EIR/EIS mitigation options for fish and water quality.

Meeting Participants:

Jelica Arsenijevic, Sites Integration	Marin Greenwood, ICF	Laurie Warner Herson, Sites Integration
Monique Briard, ICF	Mike Hendrick, ICF	Rick Wilder, ICF
Lisa Erecius, ICF	Anne Huber, ICF	Nicole Williams, ICF
Linda Fisher, Sites Integration	Harry Oakes, ICF	
Ali Forsythe, Sites Authority	John Spranza, Sites Integration	

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Welcome/Introductions	Linda/All	5 mins
2. Water Quality		45 mins
a. Generally Complete		
i. Metals & Mitigation Measure (MM)/Reservoir Management Plan (RMP)	Anne/Nicole	
ii. Harmful Algal Blooms & RMP/Best Management Practices (BMP) in Appendix 2D	Lesa/Anne	
iii. Mercury & RMP/BMPs in Appendix 2D	Lesa/Anne	
b. Currently Evaluating		
i. Pesticides & CDFW	Anne/Nicole	
c. Outstanding		
i. Conflict or obstruct with water quality control plan	Anne/Nicole	
3. Fish		60 mins
a. Overall Status	Mike	

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/2/2021 2:30:58 PM
To: Thad Bettner [tbettner@gcid.net]
Subject: Re: Graphs of "What if Sites Existed in 2021?"
Attachments: image001.png

They are modeling the "operationalized" soft agreement diversion criteria on a monthly time step with extrapolation to daily values. Same as what's in the EIR. I know there are multiple conditions for diversions to occur and not sure how much the bypass flow dictates.

From: Thad Bettner <tbettner@gcid.net>
Date: Friday, April 2, 2021 at 1:36 PM
To: Jerry Brown <jbrown@sitesproject.org>
Subject: RE: Graphs of "What if Sites Existed in 2021?"

Thanks, only thing I see is that perhaps 2019 and 2020 diversions to fill seem high, if 8500 bypass flow assumed.

Thaddeus L Bettner PE, General Manager
Glenn-Colusa Irrigation District
PO Box 150
Willows, CA 95988
530.934.8881 (office)
530.588.3450 (cell)



From: Jerry Brown <jbrown@sitesproject.org>
Sent: Friday, April 2, 2021 12:54 PM
To: Thad Bettner <tbettner@gcid.net>
Subject: Graphs of "What if Sites Existed in 2021?"

The attached graphs show the basis for the what if result of how much water would be in Sites Reservoir this year if it had already been built. The only difference between Alt 1B and Alt 3 is the level of Bureau participation, 7%/25%. As you can imagine there are quite a few assumptions that go into developing the what if scenarios but I'm confident in the result because they used two modeling approaches and both came in with about the same result.

I'm guessing you're thinking that participation demand last year would have been higher than shown, and all I can say is that we're using demand patterns that are generally triggered by SWP and CVP allocations. I believe last year was 20%, 50% and 100% so my feeling is the releases shown are low which is why I use the term "around 1MAF" given this and all the other caveats and disclaimers of "what ifs".

Let me know any concerns.

From: Marguerite Patil [mpatil@ccwater.com]
Sent: 4/2/2021 5:48:07 PM
To: Jerry Brown [jbrown@sitesproject.org]; Okita, David@DWR [David.Okita@water.ca.gov]; Maureen Martin [mmartin@ccwater.com]
CC: Kirkland, Marianne@DWR [Marianne.Kirkland@water.ca.gov]; Maroney, Jagruti@DWR [Jagruti.Maroney@water.ca.gov]; Cooke, Robert@DWR [Robert.Cooke@water.ca.gov]; Marcia Kivett [MKivett@sitesproject.org]; Sherri Ferronato [sferronato@ccwater.com]
Subject: RE: Water Rights

Agree – virtual meeting sounds great. And correct that Sherri is the best contact for scheduling here at CCWD.

Have a great weekend everyone!

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Friday, April 2, 2021 5:46 PM
To: Okita, David@DWR <David.Okita@water.ca.gov>; Marguerite Patil <mpatil@ccwater.com>; Maureen Martin <mmartin@ccwater.com>
Cc: Kirkland, Marianne@DWR <Marianne.Kirkland@water.ca.gov>; Maroney, Jagruti@DWR <Jagruti.Maroney@water.ca.gov>; Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>; Marcia Kivett <MKivett@sitesproject.org>; Sherri Ferronato <sferronato@ccwater.com>
Subject: Re: Water Rights

Hi Dave – You raise several big topics on several big projects that have lengthy backgrounds, ongoing coordination, and require responses that are probably better suited for a virtual meeting. I wholeheartedly agree that coordination is good for all of us and will put forth the effort to make it happen. Since your immediate driver for inquiry is staffing decisions within DWR, might I ask what your schedule is for making these decisions which would give us all some sense of the timing for meeting. Are you days, weeks, or months out from having to make your staffing requests?

Can your assistant reach out to Marcia (for Sites) and ?(Sherri I assume for LVE) to get a meeting on our calendars and can you put together an agenda so we can ensure we cover all of the topics? Eventually I could this being a worthy topic for an upcoming P1 Storage Roundtable Meeting that we conduct regularly about every 6-8 weeks where we discuss coordination among the projects.

Look forward to the discussion.

Jerry

From: "Okita, David@DWR" <David.Okita@water.ca.gov>
Date: Friday, April 2, 2021 at 3:13 PM
To: Jerry Brown <jbrown@sitesproject.org>, Marguerite Patil <mpatil@ccwater.com>, Maureen Martin <mmartin@ccwater.com>
Cc: "Kirkland, Marianne@DWR" <Marianne.Kirkland@water.ca.gov>, "Maroney, Jagruti@DWR" <Jagruti.Maroney@water.ca.gov>, "Cooke, Robert@DWR" <Robert.Cooke@water.ca.gov>
Subject: Water Rights

Jerry, Marguerite and Maureen:

DWR has been looking at staffing up for future water rights hearings involving the SWP and have identified about a dozen potential water rights proceedings that will involve SWP in some ways over the next decade. WSIP projects included. The list includes big things like Delta Conveyance and Voluntary Agreements.

In addition to DWR staff involvement, there is a big question if the SWRCB has the resources to handle major water rights proceedings simultaneously.

Have you had any conversations with the SWRCB about the timing of processing water right changes for Sites and LVE? I am wondering if the WSIP projects can be done in advance of other big potential water rights hearings.

DWR will be submitting a 1707 petition for the WSIP pulse flow projects to the SWRCB. When I discussed this with SWRCB they said that if there were no protests, no hearing would be necessary and implied that this could be done expeditiously. Any DWR water rights petition that gets no protests would be unusual, but you never know.

I have not asked SWRCB if they are planning to group WSIP water rights hearings together or address them as they come in. Have any of you had this discussion?

We are doing CEQA on the 1707 application and have not determined if we are doing a MND or an EIR. Either way we could submit the application in 2022, but nothing is final. I would expect that the 1707 process would be simpler than your two projects.

I would like to inform our folks who are doing water rights staff planning what the Sites and LVE expected timing is for submittal of petitions and any indications from the SWRCB when they would be heard. We have DWR staff identified to work on WSIP water rights matters such as drafting petitions. My expectations are that your projects will take the lead in the process but that DWR will still be very much involved regarding SWP water rights.

In the future we should talk about how the petitions are submitted - individually or jointly. I understand that Sites is different than LVE, but there are some common issues.

We will need to coordinate along with other partners such as Reclamation.

Thank you for your thoughts on this matter.

David Okita, PE
Department of Water Resources
530 902-7588

From: Okita, David@DWR [David.Okita@water.ca.gov]
Sent: 4/2/2021 6:38:59 PM
To: Jerry Brown [jbrown@sitesproject.org]; Marguerite Patil [mpatil@ccwater.com]; Maureen Martin [mmartin@ccwater.com]
CC: Kirkland, Marianne@DWR [Marianne.Kirkland@water.ca.gov]; Maroney, Jagruti@DWR [Jagruti.Maroney@water.ca.gov]; Cooke, Robert@DWR [Robert.Cooke@water.ca.gov]; Marcia Kivett [MKivett@sitesproject.org]; Sherri Ferronato [sferronato@ccwater.com]
Subject: Re: Water Rights

I'll set up a call.

DWR staffing issue is more longer term. We have identified staff to work on current WSIP project petitions, but if these go to long hearings with many witnesses, then that gets challenging. We can discuss more later.

David Okita, PE
Department of Water Resources
530 902-7588

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Friday, April 2, 2021 5:45 PM
To: Okita, David@DWR <David.Okita@water.ca.gov>; Marguerite Patil <mpatil@ccwater.com>; Maureen Martin <mmartin@ccwater.com>
Cc: Kirkland, Marianne@DWR <Marianne.Kirkland@water.ca.gov>; Maroney, Jagruti@DWR <Jagruti.Maroney@water.ca.gov>; Cooke, Robert@DWR <Robert.Cooke@water.ca.gov>; Marcia Kivett <MKivett@sitesproject.org>; Sherri Ferronato <sferronato@ccwater.com>
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Look forward to the discussion.

Jerry

From: "Okita, David@DWR" <David.Okita@water.ca.gov>
Date: Friday, April 2, 2021 at 3:13 PM
To: Jerry Brown <jbrown@sitesproject.org>, Marguerite Patil <mpatil@ccwater.com>, Maureen Martin <mmartin@ccwater.com>
Cc: "Kirkland, Marianne@DWR" <Marianne.Kirkland@water.ca.gov>, "Maroney, Jagruti@DWR"

<Jagruti.Maroney@water.ca.gov>, "Cooke, Robert@DWR" <Robert.Cooke@water.ca.gov>

Subject: Water Rights

Jerry, Marguerite and Maureen:

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In the future we should talk about how the petitions are submitted - individually or jointly. I understand that Sites is different than LVE, but there are some common issues.

We will need to coordinate along with other partners such as Reclamation.

Thank you for your thoughts on this matter.

David Okita, PE
Department of Water Resources
530 902-7588

From: Chandra Chilmakuri [cchilmakuri@swc.org]
Sent: 4/5/2021 8:59:47 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: RE: Sites Project Modeling

Hi Ali,

Sorry for the delay I getting back to you. I saw an email from Erin. I will follow up with her.

Hope you are well! Thanks for reaching out!

Chandra Sekhar Chilmakuri, Ph.D., P.E.
State Water Contractors
P: 916.562.2583 | M: 916.335.3017 | cchilmakuri@swc.org

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, March 17, 2021 10:04 AM
To: Chandra Chilmakuri <cchilmakuri@swc.org>; Heydinger, Erin <erin.heydinger@hdrinc.com>
Subject: Sites Project Modeling

Hi Chandra – Jerry Brown talked with Jennifer a few weeks ago and mentioned to me that we should spend some time with you on the Sites Project modeling. I suspect you're more aware of our modeling efforts than most folks out there as you likely worked on the model at some point. 😊

I wanted to electronically introduce you to Erin Heydinger. She is with the Project Integration team and is leading the Authority's efforts on modeling. She works directly with CH/Jacobs on our modeling effort on the Authority's behalf.

We are in the final stages of completing our modeling effort for our Revised Draft EIR/Supplemental Draft EIS. We'd love to get you up to speed on our recent modeling and Erin will reach out to you to see how best to do this. Erin's contact info is below for your use.

Erin Heydinger, PE, PMP
Project Manager
Water/Wastewater

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

I hope you're doing well and enjoying the new role!

Ali

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

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Fluvial Geomorphology Mitigation Discussion - Agenda



*Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do*

Meeting Information:

Date: April 6, 2021 **Location:** Webex
Start Time: 9:30 a.m. **Finish Time:** 11:00 p.m.
Purpose: Discuss EIR/EIS mitigation options for fluvial geomorphology

Meeting Participants:

Jelica Arsenijevic, Sites Integration	Mike Hendrick, ICF	John Spranza, Sites Integration
Monique Briard, ICF	Harry Oakes, ICF	Laurie Warner Herson, Sites Integration
Linda Fisher, Sites Integration	Jeff Peters, ICF	Nicole Williams, ICF
Ali Forsythe, Sites Authority		

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductions	Linda/All	5 mins
2. Fluvial Geomorphology	All	60 mins
a. Impact Background		
b. Mitigation Options		
c. Coordination with Permitting		
3. Action Items	All	5 min

From: Luu, Henry [Henry.Luu@hdrinc.com]
Sent: 4/6/2021 9:18:14 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Spranza, John [john.spranza@hdrinc.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: RE: Sites - NGO Question on Low Level Release Structure

Hi Ali,

I apologize for the delay, I thought I had hit sent on this email...apparently not.

In addition to the Saddle Dam and Dikes, I recommend referencing Ron to the Main Dams, Low-Level Intake, and I/O Tower discussions. I believe these discussions are in the same section, so shouldn't be too difficult to find. Just a note – the low-level release structures are in vicinity of the Main Dams, while the high-level releases (intended for use during emergency releases) are located in vicinity of Saddle Dams 3 and 5.

I hope this helpful,

Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Monday, April 5, 2021 2:43 PM
To: Luu, Henry <Henry.Luu@hdrinc.com>
Cc: Spranza, John <John.Spranza@hdrinc.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: Sites - NGO Question on Low Level Release Structure

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.

Hi Henry – We got a question from Ron Stork with Friends of the River regarding our flood control benefits and the design of the low level release structure. I think I am going to just refer him to the Saddle Dam and Saddle Dikes discussions in the Project Description to see if this meets the need. Is there anything more I should include or share?

Ali

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

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From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/6/2021 10:59:49 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Linda Fisher (linda.fisher@hdrinc.com) [linda.fisher@hdrinc.com]
Subject: geomorphology - ICF annotated outline

As a reminder, ICF addressed geomorphology in their annotated outline. This seemed reasonable at the time:

Appendix G of the CEQA Guidelines does not include criteria that are specific to fluvial geomorphology. The evaluation criteria used for this impact analysis were based on professional judgment that considers current regulations, standards, and/or consultation with agencies, knowledge of the area, and the context and intensity of the environmental effects, as required pursuant to NEPA. For the purposes of this analysis, an alternative would result in a potentially significant impact if it would result in any of the following:

- Substantial alteration of natural river geomorphic processes such as bank erosion, sinuosity, gradient, flow velocity, sediment transport, bed coarseness, depth, and width.
- Substantial alteration of natural river meandering, bank erosion, and deposition.
- Substantial alteration of the amount of IWM, boulders, shaded riverine aquatic habitat, or spawning gravel in rivers (Author: use discretion about this, it might be too aquatic biological resources related; but if there is a threshold that should be here, please replace, or just delete because the bullet above seems like it might be enough)

They went on to state:

From the work plan: Information/analysis noted in Fluvial Geomorphology Chapter would be added to Wildlife Resources chapter for impacts to various riparian species (i.e., riparian to Wildlife Resources to keep terrestrial habitat discussions together and habitat complexity to Wildlife Resources to keep habitat discussions together)

From the work plan: Information/analysis noted in Fluvial Geomorphology Chapter would be added to Wildlife Resources chapter for impacts to various riparian species (i.e., riparian to Wildlife Resources to keep terrestrial habitat discussions together and habitat complexity to Wildlife Resources to keep habitat discussions together)

Laurie Warner Herson
Principal/Owner



Environmental Planning

916.201.3935
laurie.warner.herson@phenixenv.com
State of California Small Business (#1796182)
Supplier Clearinghouse Women Business Enterprise (#16000323)

<http://phenixenv.com/>

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/6/2021 12:37:31 PM
To: Garrett Durst [garrett@naturalresourceresults.com]
CC: Roger Gwinn [rgwinn@tfgnet.com]; Kevin Spesert [kspesert@sitesproject.org]
Subject: Senator Padilla Follow-up
Attachments: Sites_Overview 2021 Update .pdf

Garrett - Please make sure to get this slide deck over to Sarah Swig. She asked for it in our call this morning. We met with the Senator's State staff (James Schwab, Daniel Chen (formerly with Ms. Harris' office) and Tehrya Cohen) as part of an ACWA briefing Feb 23 and I can't recall if these are the exact same slides, but I'm sure they are pretty close.

Happy to help with anything else she needs.

Thanks
Jerry

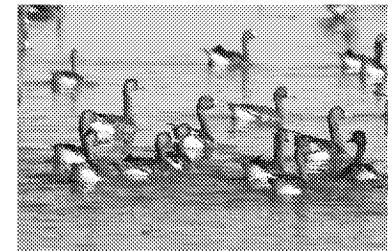
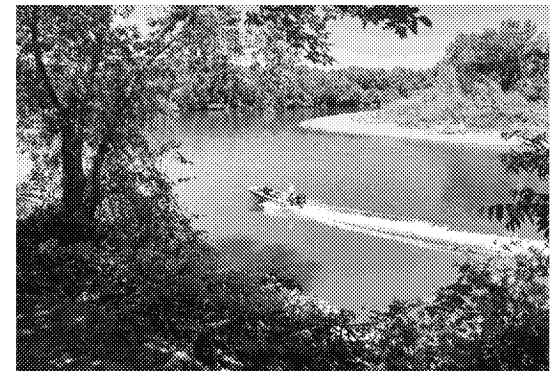
Sites Reservoir



Sites

21st Century Solution to California's Water Reliability Challenges

Sites Reservoir is a generational opportunity to construct a multi-benefit water storage project that helps restore flexibility, reliability, and resiliency to our statewide water supply.



Our Strength is in Our Broad Statewide Participation

Sacramento Valley

Carter Mutual Water Company
City of American Canyon
Colusa County
Colusa County Water Agency
Cortina Water District
Davis Water District
Dunnigan Water District
Glenn County
Glenn-Colusa Irrigation District
LaGrande Water District
Placer County Water Agency
Reclamation District 108
City of Roseville
Sacramento County Water Agency
City of Sacramento
Tehama-Colusa Canal Authority
Westside Water District
Western Canal Water District

Bay Area

Santa Clara Valley Water District
Zone 7 Water Agency

San Joaquin Valley

Wheeler Ridge-Maricopa Water Storage District
Rosedale-Rio Bravo Water Storage District

Southern California

Antelope Valley - East Kern Water Agency
Coachella Valley Water District
Desert Water Agency
Irvine Ranch Water District
Metropolitan Water District
San Bernardino Valley Municipal Water District
San Gorgonio Pass Water Agency
Santa Clarita Valley Water Agency



Affordable, Permittable, Buildable

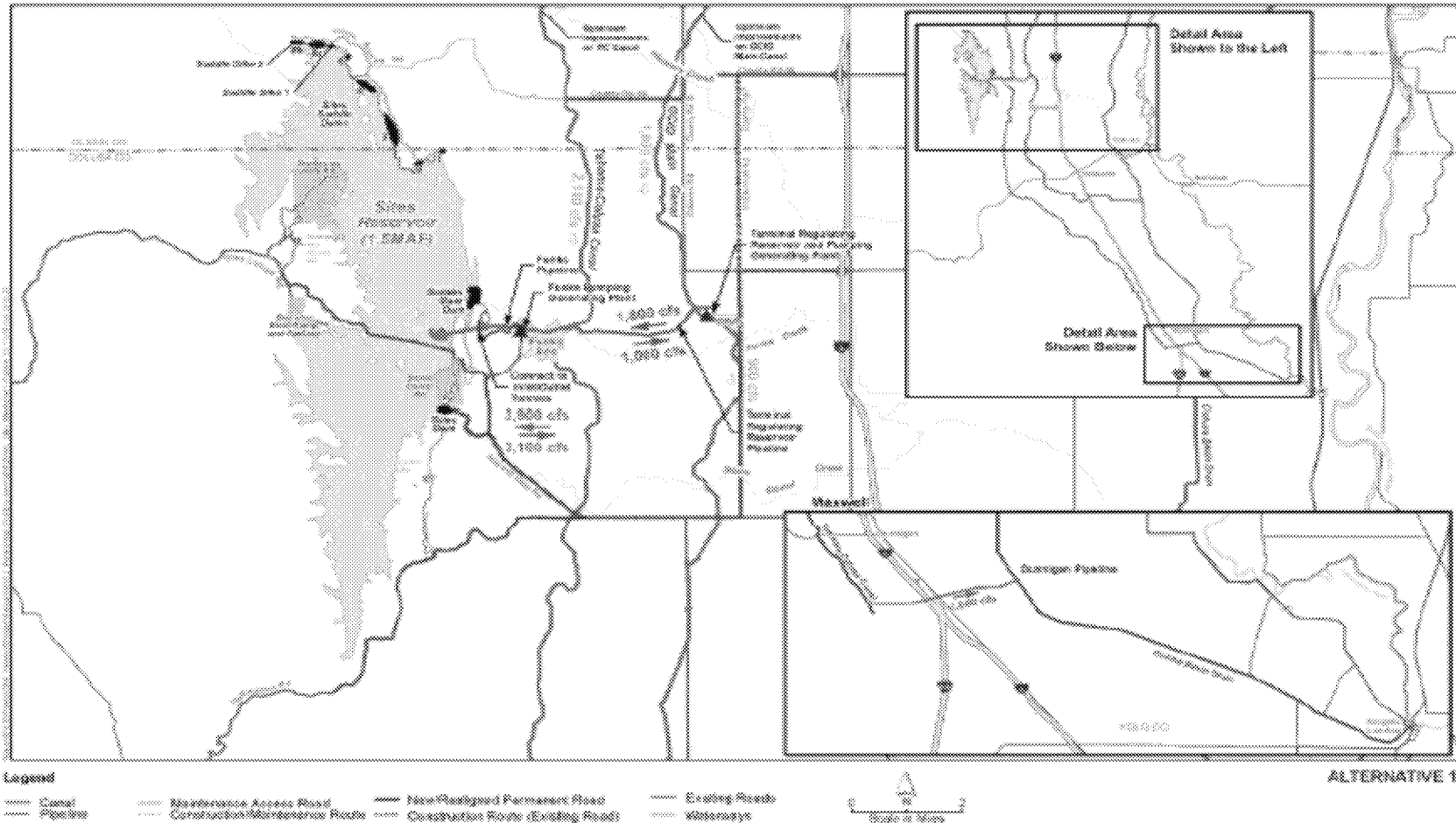
Sites underwent a rigorous value planning effort that resulted in a “right-sized” project. The Sites Reservoir of today:

- ✓ Has a smaller footprint than the previous iteration
- ✓ Meets the water supply needs of current participants
- ✓ Comes at a lower cost
- ✓ Supports State’s environmental goals
- ✓ Creates flexibility for participants
- ✓ Performs under most challenging climate change scenarios

The right-sized project cuts roughly \$2 billion from the original proposal.

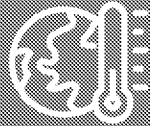
Sites is now more affordable, permittable, and buildable.

Affordable, Permittable, Buildable



Modern Solution to Mounting Challenges

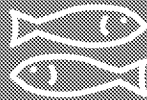
California's current water system is not designed to meet the challenges we are facing today.



Climate Change



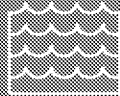
Droughts



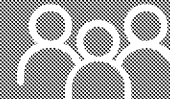
Declining Fish
Populations



Aging
Infrastructure



Floods



Population
Growth

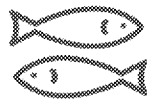
Modern Solution to Mounting Challenges

A modern water storage project designed to create a resilient water supply for California

Sites Reservoir is a unique solution that will restore flexibility, reliability, and resiliency to our statewide water supply. The project:

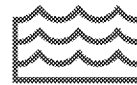
- ✓ Performs best under most challenging climate change scenarios
- ✓ Captures more water from storms to save for dry periods
- ✓ Offers flexibility to participants
- ✓ Is built off-stream and would not dam a major river system
- ✓ Has net positive impact on statewide water system

Provides Statewide Benefits for Generations to Come



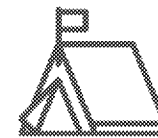
Off-stream Storage

Does not create a barrier to native fish migration



Cooperative Operation

Increases effectiveness and efficiency of existing water storage infrastructure



Recreational Opportunities

Provides northern Sacramento Valley with additional opportunities for recreation



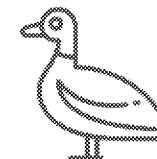
Federal and State Agencies Manage Environmental Water

Adaptable to current and future conditions and priorities



Adaptable to Climate Change

Contributes to system reliability and performance with climate change



Environmental Support

Provides environmental water in drier periods for native fish, and habitat for native species and birds



Local Leadership and Cooperation

Aligns with Sacramento Valley's values and fosters regional and statewide collaboration



Dry Year Water Supply

Reliable dry year water supply for California communities, farms and businesses

Provides Climate Change Resiliency

How does Sites Reservoir address these challenges?

- ✓ Captures excess flows from Sacramento River – rain instead of snowmelt
- ✓ Off-river storage increases environmental benefits by not damming major river system
- ✓ Adds 1.5 million acre-feet of water into the statewide system, easing pressure on other sources during droughts
- ✓ Supplies water for people, farms and environment during the longer dry spells California experiences
- ✓ Allows other reservoirs, like Shasta, to conserve more cold water during dry periods in order to benefit fisheries

Project performance is expected to improve by approximately 5% under anticipated climate change conditions

Provides a Resilient Supply of Water

SITES PROJECT NEW WATER SUPPLY

Year Type	Water Supply (thousand acre-feet)
Wet	80-90
Above Normal	92-292
Below Normal	190-296
Dry	398-429
Critically Dry	308-348
Long-Term Average	207-260

One thousand acre-feet of water supply can serve about 2,000-3,000 households for one year, or 200-500 acres of productive California agriculture.

Provides Important Environmental Benefits

Sites Reservoir provides water dedicated to environmental use

A significant portion of the Sites Reservoir Project's annual water supplies will be dedicated to environment uses:

Preserve cold-water pool in Lake Shasta later into the summer months to support salmon development, spawning and rearing

Provide a reliable supply of refuge water to improve Pacific Flyway habitat for migratory birds and other native species

Provide water dedicated to help improve conditions for the Delta Smelt

Water dedicated for the environment provided by Sites Reservoir will be managed by state resources agency managers who will decide how, and when, this water would be used - creating a water asset for the state that does not currently exist



Environmental Protections

- Diverting during excess conditions, when all senior water rights and water quality and flow requirements are met
- Using existing diversion locations and state-of-the-art fish screens
- Relying to the extent possible on existing infrastructure for releases
- Diversion criteria have been shifted upstream for operations at diversion locations
- Additional pulse protection criteria added to protect migrating juvenile salmon

EIR Project Alternatives

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 use of 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

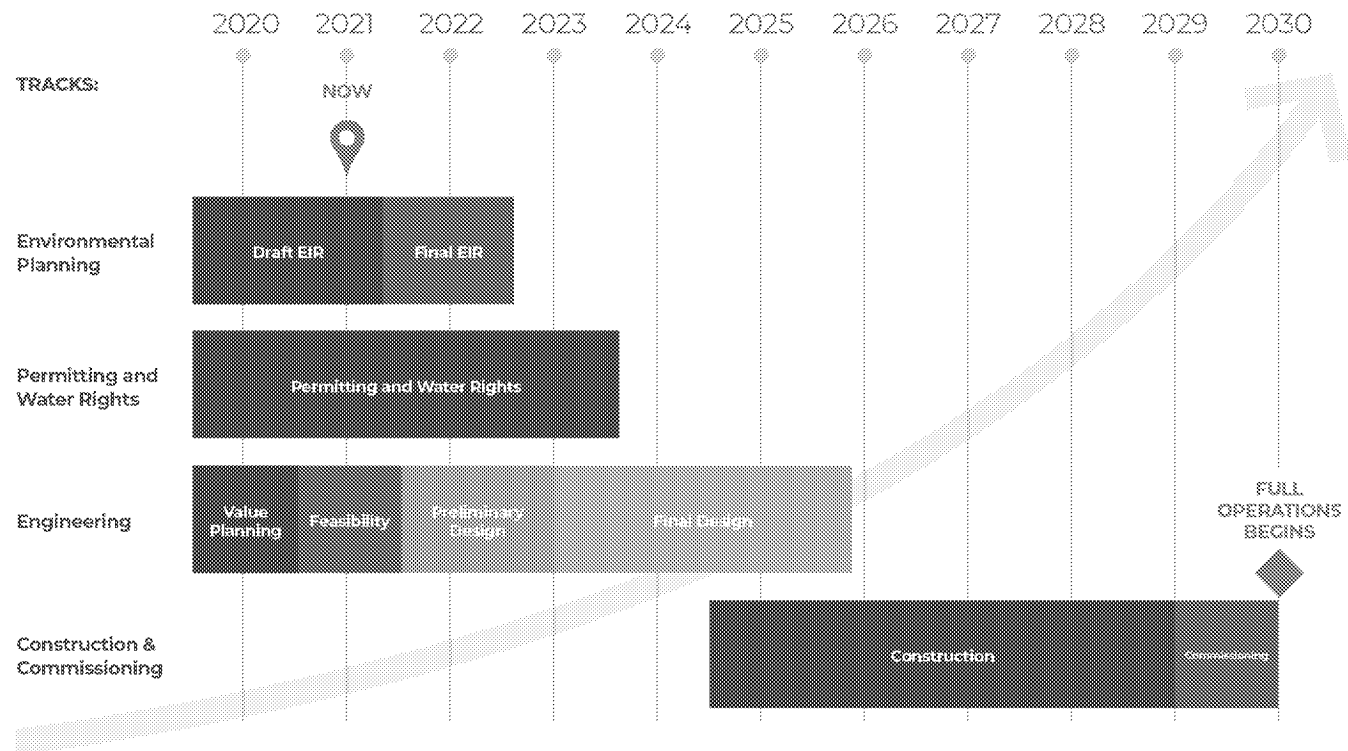
Project Costs and Affordability

Reservoir Size (MAF)	Alternative 1 (1.5MAF)
Total Project Cost (2019\$, billions)	\$3.3 +/-
Annualized AF/year release (AFY)	230,000
Range of Annual Costs During Repayment Without WIFIA Loans (2020\$, \$/AF)	\$650 - \$710
Range of Annual Costs During Repayment With WIFIA Loans (2020\$, \$/AF)	\$600 - \$660

Looking Ahead

Sites Reservoir Project Schedule

Sites Reservoir Project Schedule



Creating an Affordable, Permittable & Buildable Project

2021 Goals

- ✓ Submit key project permits
- ✓ Meet the Proposition 1 (WSIP) requirement for 75% local cost share
- ✓ Update and refine cost estimate to support Water Commission Feasibility Determination
- ✓ Update and refine Master Project Schedule through construction completion
- ✓ Circulate the revised Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement for public review and comments
- ✓ Develop Operating Agreement Term Sheets with DWR, Bureau of Reclamation and local facility partners
- ✓ Continue to collaboratively engage with landowners, tribes and local communities

info@sitesproject.org

sitesproject.org



From: Heydinger, Erin [Erin.Heydinger@hdrinc.com]
Sent: 4/7/2021 10:53:16 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Spranza, John [john.spranza@hdrinc.com]; Thompson, Luke [Luke.Thompson@hdrinc.com]
Subject: Graphics Update
Attachments: storagePools_v3.pdf; Draft Schedule Figure.jpg; GoldenGate&Sites.pdf; Draft Diversion Figure.jpg

Flag: Follow up

Hi Ali,

I wanted to update you on where we are with all of the graphics.

- Storage/dead pool: three versions attached that I figured could be used for different purposes (Storage Allocation, EIR/EIS, etc.)
- Schedule: latest version attached. Working on updating for TRR East/West
- Golden Gate & Sites Dam Sections (let me know if other drawings in the PD need to go thru graphics too)
- Diversion Criteria graphic – draft attached

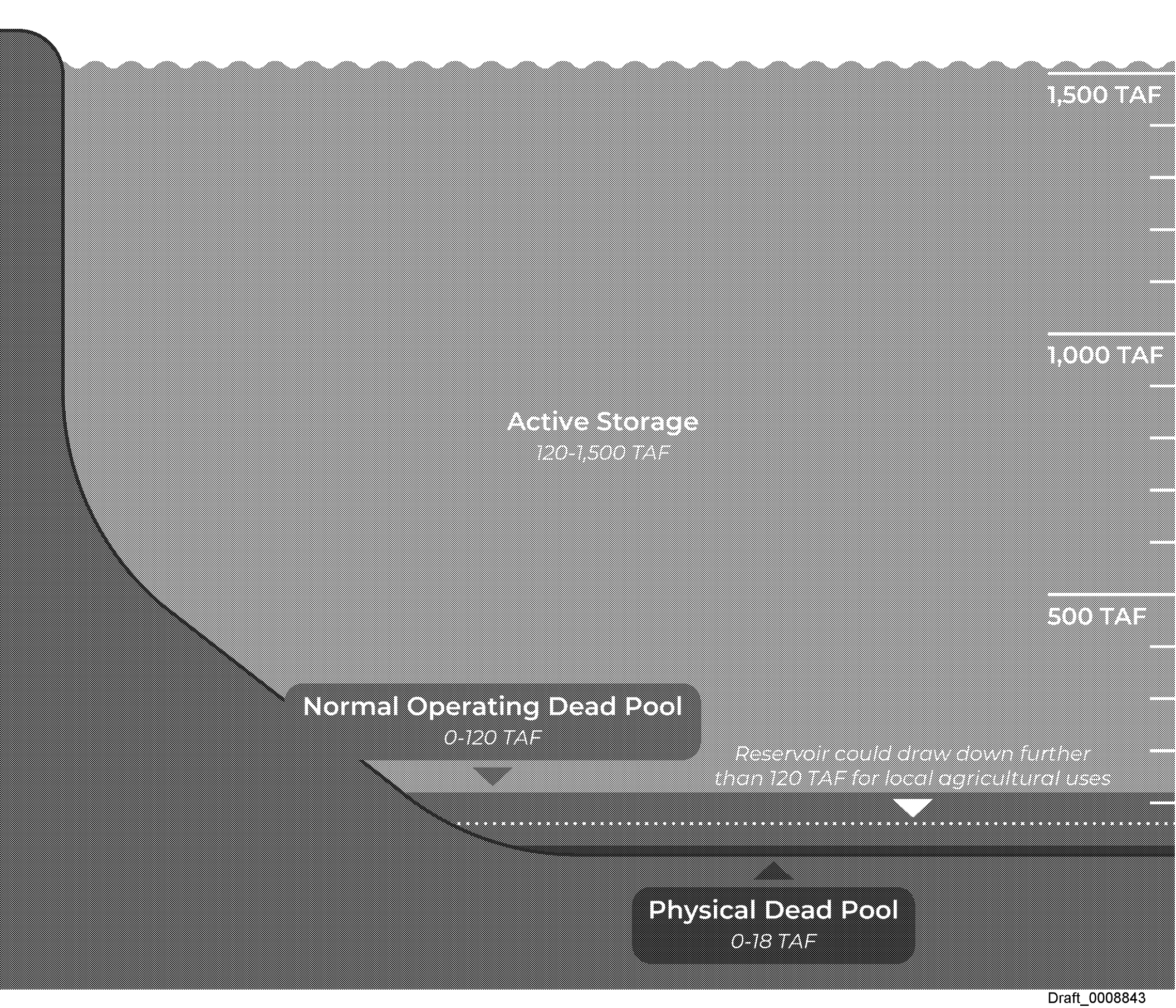
Big thanks to Luke for coordinating these!

Erin

Erin Heydinger, PE, PMP
Project Manager
Water/Wastewater

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

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1,500 TAF

1,000 TAF

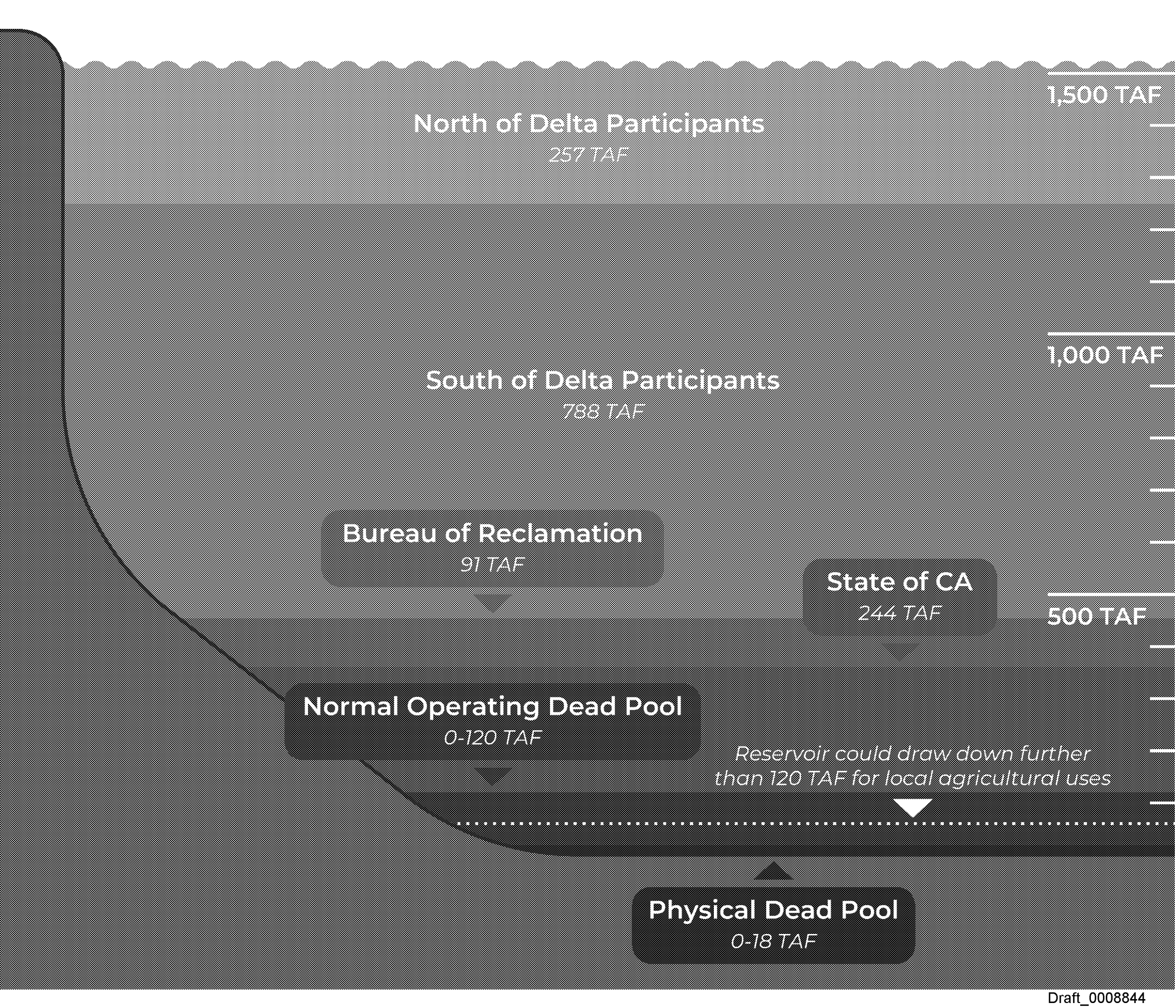
500 TAF

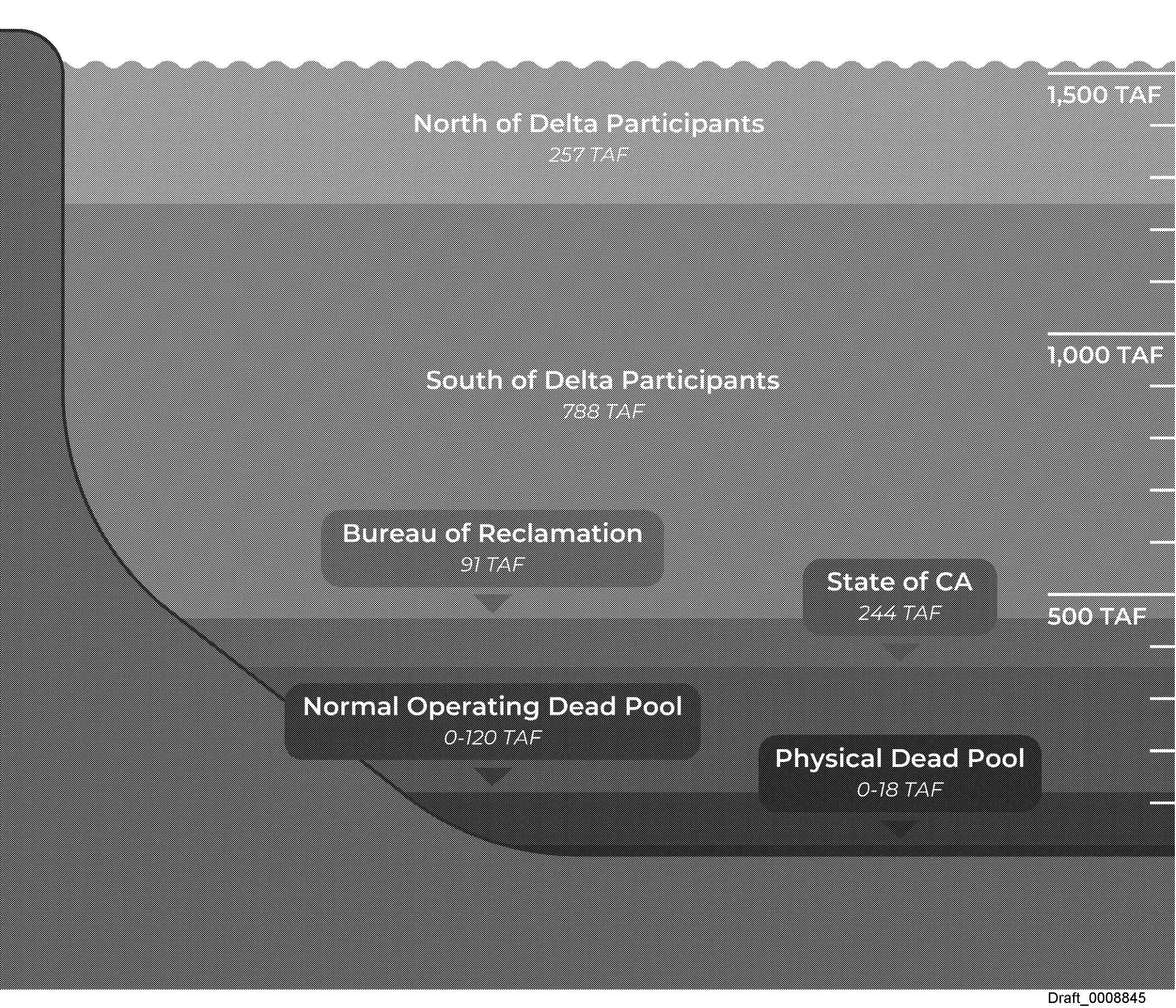
Active Storage
120-1,500 TAF

Normal Operating Dead Pool
0-120 TAF

Reservoir could draw down further
than 120 TAF for local agricultural uses

Physical Dead Pool
0-18 TAF





	Description	2024				2025				2026				2027				2028				2029			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Roads and Bridges	Northern Construction Access Roads																								
	Southern Construction Access Roads																								
	Sites Lodoga Road Realignment and Bridge																								
	Huffmaster Road Alignment																								
	Process and Haul Filter Materials to Project																								
Dams and Dikes	Golden Gate Dam																								
	Sites Dam																								
	Saddle Dam 3																								
	Saddle Dam 5																								
	Minor Saddle Dams (1,2,6,8A)																								
	Saddle Dam 8B – Spillway																								
	Emergency Release Structure No. 1																								
	Emergency Release Structure No. 2																								
	Inlet Outlet Facilities																								
Reservoir Site Development	Reservoir Footprint Mitigation Actions																								
	Site Access and Staging Development																								
	Demolition and Clearing																								
Conveyance to Sacramento River	Dunnigan Pipeline – Alt 1																								
	Dunnigan Pipeline – Alt 2																								
Regulating Reservoir and Conveyance	Funks/TRR Pipelines																								
	Funks Reservoir																								
	Funks Pumping Generating Plant																								
	TRR East Reservoir																								
	TRR East Pumping Generating Plant																								
	Transmission Powerlines																								
	Substations																								
Sacramento River Diversion and Conveyance	Red Bluff Pumping Plant Improvements																								
	GCID Improvements																								

State Water Project Participants Modeling Meeting Agenda



Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do

Meeting Information:

Date: April 13, 2021 **Location:** [Click here to join the meeting](#)
833-255-2803,,895164312#

Start Time: 2:00 p.m. **Finish Time:** 4:00 p.m.

Purpose: Discuss modeling assumptions and information available for Delta and South of Delta participants.

Meeting Participants:

Felix Hernandez	Becky Sheehan	Chandra Chilmakuri
Dwayne Chisam	Dan Bartel	Jerry Brown
Robert Cheng	Bob Tincher	Ali Forsythe
Petya Vasileva	Heather Dyer	Erin Heydinger
Mark Krause	Jeff Davis	JP Robinette
Robert Kunde	Lance Eckhart	Rob Leaf
Paul Weghorst	Eric Leitterman	Steve Micko
Kellie Welch	Dirk Marks	Reed Thayer
Randall Neudeck	Amparo Flores	
Chuching Wang	Lillian Xie	
Dee Bradshaw		

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductions/Overview	Kunde	5 min
a. Objectives		
2. Purpose of Modeling and Work to Date	Heydinger	10 min
a. Modeling platform and baseline conditions		
b. EIR/EIS modeled alternatives		
3. Data Currently Available to Participants	Heydinger	10 min
4. Conveyance of Water Through the Delta	Micko	20 min
a. Timing and Demand Assumptions		
b. Carriage water		

5. Exchanges with Oroville	Leaf	15 min
6. Use of San Luis Reservoir and Carryover	Leaf	10 min
7. Deliveries	Leaf	15 min
8. Next Steps:	Heydinger	10 min
a. Proforma		
b. Operations Plan		
9. Action Items	Heydinger	5 min

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/8/2021 7:21:51 AM
To: Marcia Kivett [MKivett@sitesproject.org]
Subject: Re: Timeline of Significant NGO Engagement - 2017 to Present

Thanks

From: Marcia Kivett <MKivett@sitesproject.org>
Date: Thursday, April 8, 2021 at 7:19 AM
To: Jerry Brown <jbrown@sitesproject.org>
Subject: Timeline of Significant NGO Engagement - 2017 to Present



<https://sitesreservoirproject.sharepoint.com/:f:/r/reservoircommittee/Shared%20Documents/Administrative%20Information/Executive%20Management%20and%20Administrative/Jerry%27s%20Working%20Documents/Timeline%20of%20Significant%20NGO%20Engagement%20-%202017%20to%20present?csf=1&web=1&e=WqVkl8>

Marcia Kivett
Sites Project Admin
Phone: 561.843.9740
Email: mkivett@sitesproject.org
Web: www.SitesProject.org
P.O. Box 517
122 Old Hwy 99W
Maxwell, CA 95955

From: Micko, Steve/SAC [Steve.Micko@jacobs.com]
Sent: 4/8/2021 10:55:30 AM
To: Marcia Kivett [MKivett@sitesproject.org]; Jerry Brown [jbrown@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Leaf, Rob/SAC [Rob.Leaf@jacobs.com]
Subject: RE: Carriage Water and Delivery Schedule Strategy
Attachments: Draft_CarriageWaterOverview_20191101_ADA_SitesMarkUp_20210407.pdf

Hi all,

Carriage water working draft for discussion purposes is attached.

Best,
Steve

-----Original Appointment-----

From: Marcia Kivett <MKivett@sitesproject.org>
Sent: Tuesday, March 30, 2021 12:16 PM
To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Micko, Steve/SAC; Leaf, Rob/SAC
Subject: Carriage Water and Delivery Schedule Strategy
When: Thursday, April 8, 2021 4:00 PM-5:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Steve/Rob – if this does not work with your schedule the only **other option is April 9 at 1:00.**

Microsoft Teams meeting

Join on your computer or mobile app

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+1 213-379-5743, 72551967# United States, Los Angeles
(888) 404-2493, 72551967# United States (Toll-free)

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A Brown and Caldwell Teams meeting has been created for this event.

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Draft Carriage Water Overview for Non-Project and Sites Water Transfers

**(October 2019 by Anna Fock, State Water Project Analysis Office;
April 2021 by Jacobs)**

The purpose of this paper is to explain the concept of carriage water and how the Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) calculate and apply carriage water to non-Project¹ water transfers.

As background, the Department of Water Resources (DWR) operates the State Water Project (SWP) and the United States Bureau of Reclamation (Reclamation) operates the Central Valley Project (CVP) (collectively, Projects). Projects' operations must comply with various requirements, including (but not limited to): (1) the State Water Resources Control Board (State Water Board) Water Right Decision 1641 (D-1641), (2) the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion for the coordinated operations of the CVP and SWP and its effects on the listed Delta smelt, and (3) the 2009 National Marine Fisheries Service (NMFS) Biological Opinion for the coordinated operations of the CVP and SWP and its effects on listed anadromous fish and marine mammals. The two Biological Opinions restrict the transfer window for exporting non-Project transfer water from the Sacramento-San Joaquin Delta (Delta) to July through September.

The Sites Project Authority (Authority) would operate the Sites Reservoir Project (Sites) in coordination with the SWP and CVP. In most years, Sites would release water to the Sacramento River or the Yolo Bypass. Sites releases to the Sacramento River for South of Delta water uses, through pumping at the SWP Banks Pumping Plant and CVP Jones Pumping Plant, would typically occur in Dry and Critically Dry years. In most years, Sites would also release water to the Delta through the Yolo Bypass for habitat benefits. As such, Sites operations would modify Delta flows in most years by changing Sacramento River at Freeport flow, Yolo Bypass flow, South of Delta Exports, and/or Delta outflow.

Considering long-term operations, Sites releases are unique to carriage water calculations because:

- Sites reliably influences Delta flows over an interannual time period.
 - A long-term operational agreement, considering Sites benefits to Delta water quality (noted below), is more robust than year-by-year carriage water calculations.
- Sites releases to the Yolo Bypass would reliably benefit Delta water quality in late-Summer and Fall of Wet and Above Normal years.
 - Without a long-term agreement, SWP and CVP could yield delivery benefits from Sites releases to Yolo Bypass.

¹ The term "non-Project water" refers to water that has not been appropriated or acquired by either DWR or Reclamation.

- Sites provides inflows to the Delta at two locations when transferring water South of Delta: Yolo Bypass and Sacramento River.
 - Delta water quality benefits, per unit volume of release, are dependent on Delta inflow location (Freeport versus Yolo Bypass). Per incremental increase, inflows from Yolo Bypass yield greater water quality benefits than Freeport.
- Reliability of Sites operations in July and August of Dry years could allow the SWP and CVP to more aggressively operate San Luis Reservoir.

Delta Salinity and Projects Export

The Delta is connected to the Pacific Ocean via the San Francisco Bay (Bay). Water in the Bay is more saline than fresh water from rivers upstream of the Delta. Salt water from the Bay enters the Delta through tidal effects and, if there was no Delta outflow, could move upstream potentially as far as the City of Sacramento on the Sacramento River and Vernalis on the San Joaquin River. Many factors affect salinity levels in the Delta, such as the quantity and quality of Delta inflow, tides, winds, the quantity and quality of in-Delta diversifiers' return flows, Delta channel conditions (e.g., capacities, water levels, and circulation), and SWP and CVP operations (e.g., Delta Cross Channel Gate positions, South Delta pumping rates, and temporary barrier conditions).

The Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) includes water quality and flow objectives to protect the Bay-Delta watershed. D-1641 implements the Bay-Delta Plan and assigns to the Projects the responsibility for meeting the flow and water quality objectives. The Projects must manage export operations to comply with applicable regulatory requirements, including Delta salinity standards.

The Projects export water to serve their water supply contractors south and west of the Delta at the SWP Banks Pumping Plant and the CVP Jones Pumping Plant. These exports alter flow patterns in Delta channels and at times induce more saline ocean water to enter into the Delta from the Bay.

The terms “baseline” and “without-transfer” areis hereinafter used interchangeably to describe conditions when only Project water is being exported. The term “with-transfer” is used to describe conditions when the Projects are exporting short-term transfer water in additionto Project water. For the purposes of Sites transfers South of Delta, consideration of water quality is specific to water quality compliance. Over a long-term basis, Sites operations shall not impact SWP and CVP operations to manage water quality in the Delta.

Salinity Impact of Transfers and Carriage Water as Mitigation

If the Projects were to export all transfer water south of the Delta that third parties make available, then there may be incremental impacts to Delta water quality due to increased disruption to natural flow conditions. To mitigate the potential for increased salinity, an additional water quantity is required to carry a unit of water across the Delta to the Projects' export facilities in order to maintain a constant salinity level at a given

location or provide the additional outflow needed to offset the degradation to water quality as a result from the increased exports for transfers. In practice, carriage water is assessed by dedicating a portion of the transfer water as Delta outflow to keep Delta salinity at the same level as it would have been in the baseline (or without-transfer) conditions. Thus, carriage water is the additional water needed for Delta outflow to compensate for the additional exports made on behalf of a transfer to assure compliance with the water quality requirements of the SWP and CVP.

Carriage water is expressed as a percentage of the amount of transfer water. For example, if a transferor provides 100 acre-feet (AF) as Delta inflow from the Sacramento River at Freeport, and 30 AF is needed to offset the incremental increase in Delta salinity, then the remaining 70 AF of the transfer water is available for export. The assessment of carriage water in this example would be 30 percent (30/100). In other words, 30 percent of the transfer would be used to maintain Delta salinity conditions as it would have been absent the 100-AF transfer.

DSM2 for Carriage Water Calculation

DWR uses the Delta Simulation Model 2 (DSM2) to simulate with and without-transfer conditions to determine carriage water during years when DWR and Reclamation facilitate water transfers from the Sacramento River. Since 2008, carriage water has varied between 20 and 35 percent of the transfer amount depending upon hydrology and other operational parameters. Based on DSM2 results, exporting transfer water originating from the San Joaquin River does not affect salinity at Jersey Point, Bethel Island, and Bacon Island; therefore, the Projects do not assess carriage water on San Joaquin River transfers. However, the Projects currently assess a conveyance loss of 10 percent, which is subject to update when new science and data is available, to transfer water through the San Joaquin River mainstem.

Pre-Transfer Carriage Water Estimation for Sites Reservoir Deliveries to South of Delta Storage Partners

Before the water transfer window opens, the Authority DWR-estimates the carriage water that will be applied to each-Sites transfers. DWR-The Authority develops the carriage water estimate using an estimated amount of transfer water with an assumed pattern, forecasted hydrology, and forecasted operations through the following steps (see Figure 1):

1. Perform a DSM2 simulation for a baseline scenario to represent salinity conditions (expressed as electrical conductivity, or EC) that would have occurred absent the transfers while meeting all regulatory requirements.
2. Perform a DSM2 simulation for a with-transfers scenario with assumed Sites carriage water. Sites carriage water calculations consider Sites releases to Yolo Bypass for Proposition 1 Ecosystem Benefits. As such, Sites carriage water is the sum of additional Delta inflow at Freeport and the Yolo Bypass.
3. Compare salinity results of the baseline (Step 1) to the with-transfers scenario (Step 2) at Jersey Point, Bethel Island, and Bacon Island (or Holland Island). These three locations provide a good representation of interior Delta salinity

conditions that often control the Projects operations.

4. Repeat Step 2 and Step 3 by adjusting the carriage water percentage until the results of Step 2 show minimal EC differences from the results of Step 1.

Three stations, Jersey Point, Bethel Island, and Bacon Island (or Holland Island) have been identified to represent Delta locations with salinity standards or markers that often control Delta water operations (e.g., the 250 mg/l chloride standard at Contra Costa Canal in D-1641) are considered during two periods of the transfer window: July – August, September – November. During each period, the station with the highest carriage water percentage is controlling. For example, if 20 percent carriage water is needed to maintain the same salinity at Jersey Point, 25 percent at Bethel Island, and 30 percent at Bacon Island, then 30 percent is the estimated carriage water. Selecting less than 30 percent would result in impacts to the Projects through export reduction and/or additional reservoir releases to ensure that Bacon Island salinity is not affected by the water quality degradation from facilitating non-Project transfers.

After determining the estimated carriage water, DWR and Reclamation apply the same estimation to all Sites transfers during each period of the entire transfer period window to negate temporal disparities of daily transfer amounts, avoid any priority conflicts, and address the effects of the antecedent water quality conditions to compliance concerns.

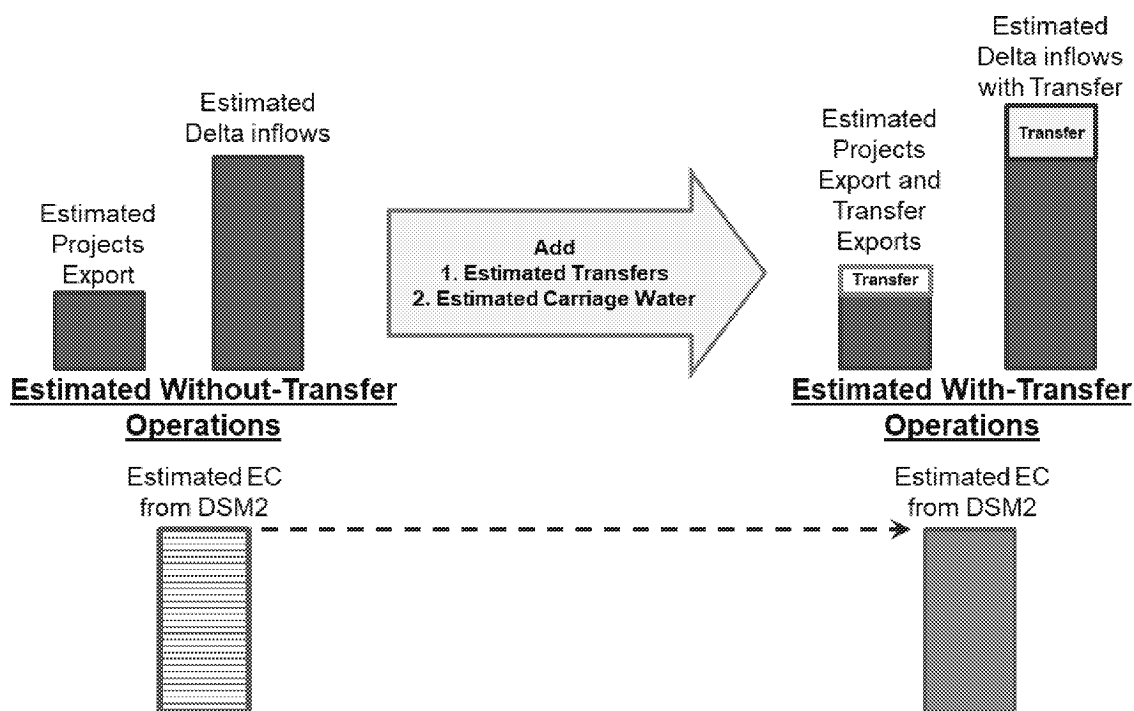


Figure 1. Pre-Transfer Carriage Water Estimation

Analysis While Transfers Are in Progress

While transfers are in progress, DWR and Reclamation operate the Projects in real-time to comply with all applicable regulatory standards. Pursuant to D-1641, DWR and Reclamation operate under the approved State Water Board's Water Quality Response

Plan and Water Level Response Plan (Response Plans). Per the Response Plans, the Projects must provide a seven-day notice to South Delta Water Agency (SDWA) prior to any third-party transfer operations. This seven-day notice includes DSM2 water quality and water level results² comparing baseline and with-transfer conditions. The Projects are to implement proper mitigation measures or may suspend the water transfer if the water transfer results in an incremental impact to water levels and/or water quality.

Final Carriage Water Determination at Conclusion of Transfer Season

Once the water transfer season is over, data collected during the water transfer period are used to develop a final carriage water value based on the actual conditions. The process to develop a final carriage water value is as follows (see Figure 2):

1. Perform a DSM2 simulation with actual data for with-transfer inflows and exports during the transfer period.
2. Perform a DSM2 simulation for a without-transfer scenario with hypothetical exports and Delta inflows:

Without-transfer inflows = Actual inflow – (Actual transfer amount into Delta + Sites Releases to Yolo Bypass)

Without-transfer export = Actual pumping – (1 – estimated carriage water percentage) × (Actual transfer amount into Delta + Sites Release to Yolo Bypass)

3. Compare salinity results of the actual with-transfer conditions (Step 1) to the estimated without-transfer conditions (Step 2) at Jersey Point, Bethel Island, and Bacon Island. Only Sites transfers may consider Sites release to Yolo Bypass.
4. Repeat Step 2 and Step 3 by adjusting the carriage water percentage until the results of Step 2 show minimal EC differences from the results of Step 1. This is the final carriage water percentage.

As stated previously, the station with the highest carriage water percentage controls the final carriage water determination.

² Water quality compliance locations are San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge. Water level compliance locations are Old River near Tracy Road Bridge, Doughty Cut above Grant Line Canal Barrier, and Middle River near the Howard Road Bridge.

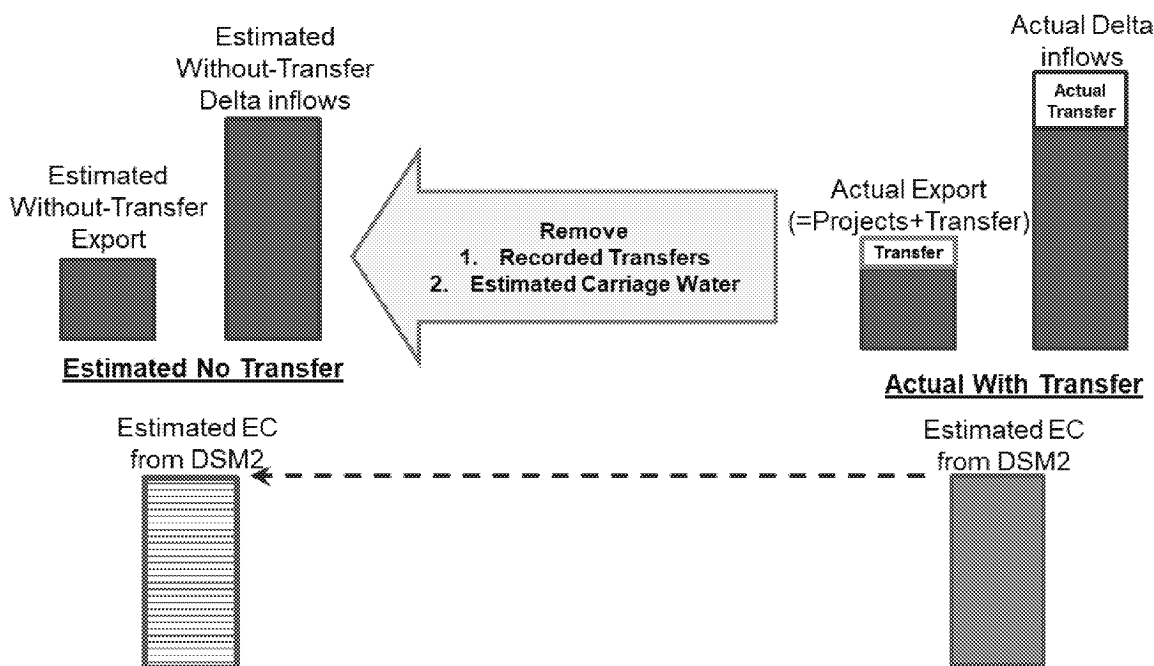


Figure 2. Final Carriage Water Determination

Carriage Water Accounting and Adjustments for SWP Contractors

As provided for in the “Conveyance” article of all conveyance agreements involving DWR, carriage water and other water losses are assessed for water transfers facilitated and approved by DWR. The estimated carriage water for each year is communicated to the buyers and sellers before any water transfers begin.

For SWP contractors who participate in transfers, the conveyance agreement also has a provision under the article titled “Reclassification of Transfer Water Deliveries” to allow for adjustment should the final carriage water value differ from the estimated value. There are two scenarios in which adjustments may be made to the accounting for the transfer water and Table A water that DWR delivered to a particular SWP contractor:

1. If the final carriage water is higher than the estimated carriage water, then the adjustment is to show DWR delivered less transfer water to the buyer, and the buyer received more Table A water. DWR reduces the buyer’s Table A carryover amount to compensate for the adjustment. There is no change to the actual overall quantity of water delivery for that year.
2. If the final carriage water is lower than the estimated carriage water, then the adjustment is to show DWR delivered more transfer water to the buyer, and the buyer received less Table A water. DWR increases the buyer’s Table A carryover amount to compensate for the adjustment. There is no change to the actual overall quantity of water delivery for that year.

The State Water Project Analysis Office maintains the delivery data and carryover amounts for the SWP contractors.

Carriage Water Accounting and Adjustments for Non-SWP Contractors

For non-SWP contractors who participate in transfers facilitated by DWR, the process is more complicated and not as flexible. In the conveyance agreement, while there is an article titled “Conveyance” to address carriage water and other losses, there is no means for reclassifying the transfer water (as opposed to what is done for SWP contractors, as described above) should the final carriage water value differ from the estimated value. Therefore, the estimated carriage water is defined as a fixed value in the conveyance agreement.

The lack of reclassification is a result of the fact, that should the final carriage water be lower than the estimated carriage water, there is no simple way to return the water to the buyer. Likewise, should the final carriage water be higher than the pre-transfer estimation, there is no simple way for the buyer to return the water to DWR.

Carriage Water Accounting and Adjustments for Sites Transfers

For Sites transfers, carriage water cost is adjusted when final carriage water value differs from the estimated value. There are two scenarios in which adjustments may be made to the accounting for the Sites transfer water that was delivered to a Sites Storage Partner:

1. If the final carriage water is higher than the estimated carriage water, then the adjustment is to show DWR delivered more transfer water to the Sites storage partner. The Authority reduces the storage partner’s storage volume to compensate for the adjustment. There is no change to the actual overall quantity of water delivery for that year.
2. If the final carriage water is lower than the estimated carriage water, then the adjustment is to show DWR delivered more transfer water to the buyer, and the buyer received less Sites water. DWR increases the buyer’s Sites storage to compensate for the adjustment. There is no change to the actual overall quantity of water delivery for that year.

The State Water Project Analysis Office and Sites Authority maintain the delivery data and carryover amounts for the SWP contractors and Sites storage partners.

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/8/2021 4:46:54 PM
To: Jerry Brown [jbrown@sitesproject.org]; Alicia Forsythe [ali@forsythe-group.com]
Subject: RE: WQ Follow-up

Thanks Jerry. Ali and I had Bruce on our radar and he's on our list to talk with.

John Spranza

D 916.679.8858 M 818.640.2487

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Thursday, April 8, 2021 3:37 PM
To: Alicia Forsythe <ali@forsythe-group.com>; Spranza, John <John.Spranza@hdrinc.com>
Subject: WQ Follow-up

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.

You mentioned that concerns were raised during the WQ NGO workshop about mercury and other naturally occurring potential contaminants in the area of the reservoir, and potentially affecting diversions. I have found Bruce Houdeshedt to be a great resource when it comes to water quality information for the area. I would encourage you to outreach to him for any data needs in preparing responses to the concerns.

Operations Modeling Criteria and Assumptions Overview

Technical Memorandum



To: Project File Pre-Decisional Draft

Date: April 1, 2021

From: John Spranza

Quality Review by: Erin Heydinger

Authority Agent Review by: Ali Forsythe

1.0 Introduction

This memorandum presents the basis for and description of diversion the Sites Project diversion criteria developed to protect outmigration of juvenile winter-, spring-, fall- and late fall-run Chinook salmon and operate consistent with all applicable laws, regulations, biological opinions and incidental take permits, and court orders in place at the time that diversion occurs. As a result of comments on the 2017 Draft Environmental Impact Report / Environmental Impact Statement (Draft EIR/EIR), discussions with state and federal resource agencies, recent scientific publications, project changes related to the Sites Project Value Planning Alternatives Appraisal Report as well as the October 2019 Biological Opinions on Long-term Operations of the Central Valley Project and State Water Project (ROC on LTO BiOps) and the March 2020 Incidental Take Permit for Long-term Operations of the State Water Project (SWP ITP), several changes to the Sites Project and the modeling and diversion criteria have occurred since 2017 and are discussed below.

2.0 Changes to the Model

As detailed in the Authority's Modeling Criteria Overview Memorandum (2020), the fundamental assumptions of the modeling have not change and the Project would hold a junior water right on the Sacramento River and would only divert water from the Sacramento River when there is excess unregulated flow available, all senior water rights are met, water quality requirements are satisfied, other environmental requirements imposed by the State and Federal government are met. However, several components of the CalSim model have been refined over the past year to make the model current with regulatory and Sites Project Authority decisions. Changes include the following:

1. Updates to use ROC on LTO BiOps as the baseline, with further adjustments forthcoming based on an updated SWP Delivery Capability Report (DCR) 2019 with SWP ITP actions
2. Updating participation levels to reflect Amendment 2
3. Updating facilities to reflect Value Planning changes
4. Operational changes related to the Bureau of Reclamation participation from the Federal Feasibility Report
5. Improved ability to refine federal participation and coordination.

3.0 Diversion Criteria Development

The diversion restriction criteria described below were developed during a multi-year process to provide a range of statewide benefits including ecosystem enhancement actions; water supply reliability improvement for

Status: Predecisional Working Draft, subject to change
Filename: OPS-TMS-Operational diversion criteria development
Notes:

Phase: 2 Revision:
Date: [DATE \@ "MMMM d, yyyy"]
Page: 1 of 5

statewide agricultural, urban, and environmental uses (including increasing the survival of anadromous and endemic fish); and maintain water quality in the Delta (see Table 1).

3.1 Diversion Restriction Criteria to Protect Pulse Flow Conditions:

The following is assumed as part of the potential Sites Project diversion operating criteria that will be included in the modeling for the revised Draft EIR/EIS and Feasibility Study. These assumptions are for modeling purposes only and have been generalized for use in monthly and daily operations analysis.

1. Monitoring of flows for pulse protection occurs at Sacramento River at Bend Bridge (Bend Bridge). Using Bend Bridge flow measurements to identify pulse signals favors preservation of pulse flow conditions that connect the spawning and rearing habitat (below Keswick Dam) to the full outmigration pathway (to the Pacific Ocean) and utilizes existing flow monitoring infrastructure. Use of Bend Bridge flows underestimates flow contributions from downstream tributaries to formation of pulse flow conditions at specific locations of interest on the Sacramento River, e.g. Wilkins Slough, Fremont Weir, or Rio Vista. Monitoring at any of these other three alternative locations would be downstream of both intakes for the project and require consideration of other facilities operations. Bend Bridge was assumed as a reasonable simplification for modeling purposes only.
2. The period for pulse protection extends from October through May to address outmigration of juvenile winter-, spring-, fall- and late fall-run Chinook salmon, as well as a portion of the steelhead juvenile outmigration period. It is recognized that research regarding the benefits of pulse flows is ongoing, and further research and adaptive management would be utilized to develop and refine a pulse flow protection strategy for fish migration, and as such, this assumption was used for modeling and informational purposes only.
3. Pulse flows are defined by peaks in the impaired hydrograph, rather than scheduled operational events. The peak flows considered originate primarily from tributaries (precipitation-generated flows) that flow into the Mainstem Sacramento River downstream of Keswick Dam. These events maintain variability in pulse flow occurrence that is necessary to protect adaptive response behavior to flow conditions and enhance the turbidity effects as noted by Cavallo (2010).
4. If the 3-day trailing average of Bend Bridge flows exceeds 8,000 cfs and 3-day trailing average tributary flow upstream of Bend Bridge (Cow Creek, Cottonwood Creek and Battle Creek) exceeds 2,500 cfs, a pulse event is initiated if the previous day was not already in a pulse event. This flow level is consistent with NOAA NMFS recommendations of 10,700 cfs at Wilkins Slough (considering increases from tributary inflows).
5. A pulse event pumping restriction is terminated seven days after initiation of a qualified pulse event.
6. After completion of a pulse protection period, the following conditions must occur before another pulse event is triggered: (1) 3-day trailing average of Bend Bridge flow was less than 7,500 cfs for seven consecutive days and (2) 3-day trailing average of tributary flow upstream of Bend Bridge (Cow Creek, Cottonwood Creek and Battle Creek) was less than 2,500 cfs for seven consecutive days.
7. Diversions to Sites Reservoir are restricted (1) if pulse conditions exist at Bend Bridge and (2) if a qualified pulse event has occurred. Diversions are otherwise unrestricted by the pulse flow diversion criteria.

3.2 Minimum Bypass Flows at Sacramento River Pumps

- Red Bluff Pumping Plant: 3,250 cfs minimum bypass flow at all times; rate of diversion controlled by fish screen design.
- Sacramento River at the Hamilton City Pump Station: 4,000 cfs minimum bypass flow at all times; rate of diversion controlled by fish screen design.

3.3 Wilkins Slough Diversion Restrictions

8,000 cfs in April and May; 5,000 cfs all other times. The Sacramento River flow threshold of 8,000 cfs at Bend Bridge corresponds to 10,700 cfs at Sacramento River near Wilkins Slough.

3.4 Fremont Weir Notch Diversion Restrictions

No more than 1% reduction in flow over weir when spill over the weir are less than 600 cfs. No more than a 10% reduction when flow over weir when spills over the weir are between 600 cfs and 6,000 cfs. No restriction when flows over the weir are greater than 6,000 cfs.

3.5 Sutter Bypass Diversion Restrictions

None, operations consistent with all applicable laws, regulations, biological opinions and incidental take permits, and court orders in place at the time that diversion occurs.

3.6 Freeport Bypass Flow Diversion Restrictions

None, operations consistent with all applicable laws, regulations, biological opinions and incidental take permits, and court orders in place at the time that diversion occurs.

3.7 Net Delta Outflow Index (NDOI) Diversion Restrictions

Operations consistent with all applicable laws, regulations, biological opinions and incidental take permits, and court orders in place at the time that diversion occurs. This includes 44,500 cfs April-May minimum flows per SWP ITP delta Outflow requirements.

4.0 Next Steps

Initial CalSim results are now available and are being reviewed by the operations and fisheries team. Following the initial review, secondary, iterative model simulations will be run to assess the following:

- Water quality effects
- Aquatic resources effects
- Economic effects

The Sites Project team will also work with state and federal resource agencies to review the suite of model results and finalize the diversion criteria for inclusion into state and federal Endangered Species Act (ESA) permit applications. Finally, the Draft EIR/EIS will be updated such that any modifications to the diversion criteria that have been made during the state and federal ESA discussions that have been included in the Biological Assessment or California Incidental Take Permit application packet will also be included in the Final EIR/EIS.

Table 1; Sites Diversion Criteria Used in the Draft EIR/EIS

Sites Diversion Criteria	
Bend Bridge Pulse Protection Season	October - May
Bend Bridge Pulse Protection Initiation Criteria	3-day average Sacramento River must exceed 8,000 cfs; 3-day average tributary flow must exceed 2,500 cfs
Bend Bridge Pulse Protection Duration	7 days upon initiation
Bend Bridge Pulse Protection Re-Setting Criteria	After completion of pulse protection period, resetting criteria must be met for another pulse protection period to commence: 3-day Sacramento River flow must go below 7,500 cfs for 7 consecutive days; 3-day moving average tributary flow must go below 2,500 cfs for 7 consecutive days
Wilkins Slough Bypass Flow	8,000 cfs April - May ¹ ; all other times, 5,000 cfs
Fremont Weir Notch Criteria	Prioritize the Fremont Weir Notch, Yolo Bypass preferred alternative, flow over weir within 10% when spill range between 600 cfs and 6,000 cfs; First 600 cfs of spill are protected within 1%
Flows into the Sutter Bypass System	None
Freeport Bypass Flow	None
Surplus Delta Outflow	7 days of flow availability in February – March is required before diversions can be made in those months
SWP ITP Delta Outflow	44,500 cfs April - May

¹ The Sacramento River flow threshold of 8,000 cfs at Bend Bridge corresponds to 10,700 cfs at Sacramento River near Wilkins Slough.

Pre-Decisional Draft

Cultural Resources Mitigation Discussion - Agenda



*Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do*

Meeting Information:

Date: April 9, 2021 **Location:** Webex
Start Time: 3:00 p.m. **Finish Time:** 4:00 p.m.
Purpose: Discuss EIR/EIS mitigation options for cultural resources.

Meeting Participants:

Monique Briard, ICF	Jay Lloyd, Sites Integration	John Spranza, Sites Integration
Linda Fisher, Sites Integration	Harry Oakes, ICF	Ellen Unsworth, ICF
Ali Forsythe, Sites Authority	Danielle Risse, Sites Integration	Laurie Warner Herson, Sites Integration
Christiaan Havelaar, ICF	Jennifer Rodgers, ICF	Nicole Williams, ICF
Susan Lassell, ICF		

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Welcome/Introductions	Linda/All	5 mins
2. CEQA Analysis	ICF	20 mins
a. Cultural Resource Management Plan		
b. Key Impacts and CRMP – inundation area vs. remaining project area		
c. Residual Impacts		
3. Other Considerations	All	30 mins
a. Integrating with Section 106 PA Stipulation for a CRMP		
b. Budgeting Implementation of CRMP Procedures		
4. Action Items	All	5 min

Ad Hoc Environmental Planning and Permitting Work Group Agenda



Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do

Meeting Information:

Date: April 14, 2021 **Location:** Microsoft Teams
Start Time: 1:30 p.m. **Finish Time:** 3:30 p.m.
Purpose: Ongoing update for the Ad Hoc Environmental Planning and Permitting Work Group for 2021

Meeting Participants:

Mike Azevedo, Colusa County	Eric Leitertman, Valley Water	Ali Forsythe, Sites Authority
Ben Barker, PCWA	Jason Marks, City of Roseville	Erin Heydinger, Sites Integration
Thad Bettner, GCID	Randall Neudeck, MWD	Mike Hendrick, ICF
Dee Bradshaw, MWD	Jeff Sutton, TCCA	Jay Lloyd, Sites Integration
Robert Cheng, CVWD	Bill Vanderwaal, RD 108	Danielle Risse, Sites Integration
Jeff Davis, SGPWA	Chuching Wang, MWD	John Spranza, Sites Integration
Heather Dyer, SBVMWD	Jelica Arsenijevic, Sites Integration	Laurie Warner Herson, Sites Integration
Katrina Jessup, Valley Water	Ellen Berryman, ICF	Nicole Williams, ICF
Trevor Joseph, City of Roseville	Monique Briard, ICF	
Cindy Kao, Valley Water	Jerry Brown, Sites Authority	
Rob Kunde, WR-M WSD	Linda Fisher, Sites Integration	

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductory Remarks and Review of Agenda	Thad / Heather / Ali	5 min
2. Permitting		60 min
a. Progress update on all current permitting activities including agency coordination	John /Jelica	
b. Comparison of 2017 vs. 2021 preferred project terrestrial species impact acreage	Ellen/ John	
c. Aquatic Species Results	Mike	
Feedback needed: Review and provide direction on progress of permitting efforts.		

3.	Revised Draft EIR/Supplemental Draft EIS		30 min
a.	CEQA Overview	Ali/ Laurie	
b.	NGO Group meetings		
	Feedback needed: Review and provide input on CEQA overview briefing in preparation for Friday's Reservoir Committee meeting. Discuss and provide input on outreach efforts with NGO organizations.		
4.	Schedule and Dashboard Update	Ali	10 min
5.	Upcoming Priorities and Timing of Next Meeting	Ali	5 min

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/9/2021 7:00:56 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Marcia Kivett [MKivett@sitesproject.org]
Subject: FW: Timeline of Significant NGO Engagement - 2017 to Present

Flag: Follow up

Can you ask John and Laurie to continue to update this chronology to current conditions including the NGO workshops already held? We spent quite a bit of time a couple months ago building this and I want to keep it up to date. I'm already getting inquiries from RC members about our outreach efforts. Need by end of April. Thanks

Marcia – please make sure this is on the chairs meeting agenda for May.

From: Marcia Kivett <MKivett@sitesproject.org>
Date: Thursday, April 8, 2021 at 7:19 AM
To: Jerry Brown <jbrown@sitesproject.org>
Subject: Timeline of Significant NGO Engagement - 2017 to Present



<https://sitesreservoirproject.sharepoint.com/:f:/r/reservoircommittee/Shared%20Documents/Administrative%20Information/Executive%20Management%20and%20Administrative/Jerry%27s%20Working%20Documents/Timeline%20of%20Significant%20NGO%20Engagement%20-%202017%20to%20present?csf=1&web=1&e=WqVkl8>

Marcia Kivett
Sites Project Admin
Phone: 561.843.9740
Email: mkivett@sitesproject.org
Web: www.SitesProject.org
P.O. Box 517
122 Old Hwy 99W
Maxwell, CA 95955

From: Heydinger, Erin [Erin.Heydinger@hdrinc.com]
Sent: 4/9/2021 1:02:23 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Spranza, John [john.spranza@hdrinc.com]
Subject: Diversion Criteria/Fish Screen
Attachments: SitesRDEIRSDEIS-Alternatives-ModelingCriteria-20210210.pdf

FYI – attached is what the agencies received with the model. We might re-send it and answer the question specifically. That we are not taking all flow between 3,330 cfs and 5,050 cfs.

Erin

Erin Heydinger, PE, PMP
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

Sites RDEIR/SDEIS Alternatives Summary

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	1A: Operational Exchanges Only • Within Year Exchanges • Real-time Exchanges 1B: Funding Partner up to 7% Cost-Share, Including Operational Exchanges	Operational Exchanges • Within Year Exchanges • Real-time Exchanges	Same as Alt 1B, but up to 25% investment
DWR Involvement	Operational Exchanges with Oroville and use of 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

Sites Reservoir RDEIR/SDEIS Modeling Criteria

Criteria	Purpose	Description
Baseline		
Baseline Model	Update assumed operations to reflect current requirements and conditions.*	CalSim II 2020 Benchmark developed by Reclamation in coordination with DWR and CDFW.
Fixed Flows		
Trinity River Fixed	Reflect real conditions	Yes - flows held constant
Sites Facilities		
<i>Sites Reservoir</i>		
Reservoir capacity	Reflect project design	1.5 MAF for Alternatives 1 and 3, 1.3 MAF for Alternative 2
Dead pool size	Reflects project design and water quality considerations	120 TAF for export, 60 TAF for local use
<i>Red Bluff Diversion/Tehama-Colusa Canal Authority Canal</i>		
Diversion capacity	Reflect capacity at site	Up to 2,100 cfs - see following pages for description of diversion function **
Bypass flow	Stabilize flow, protect redds	3,250 cfs
<i>Hamilton Diversion/Glenn-Colusa Irrigation District Main Canal</i>		
Diversion capacity	Reflect capacity at site	1,800 cfs - see following pages for description of diversion function**
Bypass flow	Ensure proper fish screen function in oxbow	Up to 4,000 cfs
Glenn-Colusa Irrigation District maintenance window	Maintain earthen canal	2 weeks (January/February)
<i>Dunnigan Pipeline</i>		
Release capacity	Reflect design limit	1,000 cfs
Terminus	Reflect design	Colusa Basin Drain for Alt 1 and Alt 3, Sacramento River with turnout to Colusa Basin Drain for Alt 2
Location-Specific Regulations		
Bend Bridge Pulse Protection	Survival of emigrating juvenile salmon	Every pulse
Scaled Diversions	Ensure proper screen function	Rate of diversion controlled by screen design (see following pages)
Wilkins Slough Bypass Flow	Facilitate hatchery fish release	8,000 cfs in April and May; 5,000 cfs all other times

Sites Reservoir RDEIR/SDEIS Modeling Criteria

Criteria	Purpose	Description
Fremont Weir Notch Criteria	Limit encroachment on Reclamation obligation, maintain frequency and duration of spills	Versus no action alternative, there can be no more than 1% reduction in flow over weir when spill is less than 600 cfs and no more than a 10% reduction when flow over weir is between 600 and 6,000 cfs. No restriction when flows are greater than 6,000 cfs.
Net Delta Outflow Index (NDOI)	Do not impact implementation of existing regulations	Operations consistent with D-1641 as amended. CA SWP ITP requirements considered.
X2	Do not impact implementation of existing regulations	Operations consistent with 2019 BO, CA SWP ITP.
Delta Water Quality	Do not impact implementation of existing regulations	Operations consistent with Delta water quality requirements
*Spring pulse flow protection as identified in the 2019 ROC on LTO BiOp is included in the baseline and is preserved in all action alternatives. **Actual diversions would be slightly higher to account for losses between diversion locations and pumping-generating plants.		

TCCA Red Bluff Facility Operations

Table 3. TCCA Red Bluff Available Diversion Capacity by Streamflow

Sites Project Authority – Sacramento River Intake Fish Screen Operations

Streamflow at Gage (cfs)	River WSEL at U/S Work Point (feet, NAVD88)	Available Facility Diversion Capacity (cfs)
2,010	241.2	1,417
2,175	241.3	1,445
2,350	241.4	1,472
2,525	241.5	1,500
2,700	241.6	1,527
2,875	241.7	1,554
3,075	241.8	1,582
3,275	241.9	1,609
3,330	241.9	1,617
3,475	242.0	1,637
3,675	242.1	1,664
3,950	242.2	1,692
4,225	242.3	1,719
4,500	242.4	1,746
4,775	242.5	1,774
5,050	242.6	1,801
5,325	242.7	1,829
5,350	242.7	1,835
5,600	242.9	1,900
5,925	243.1	1,904
6,250	243.2	1,938
6,575	243.4	1,973
6,900	243.5	2,000
7,184	243.6	2,034
7,468	243.7	2,062
7,751	243.8	2,089
7,862	243.8	2,100
8,035	243.9	2,117
8,319	244.0	2,130

8,714	244.1	2,175
9,109	244.3	2,206
9,266	244.4	2,237
9,898	244.5	2,240
10,254	244.6	2,295
10,610	244.7	2,322
10,965	244.8	2,350
11,321	244.9	2,377
11,677	245.0	2,380
12,139	245.1	2,432
12,600	245.2	2,500



Diversions limited by instream flow requirement of 3,250 cfs

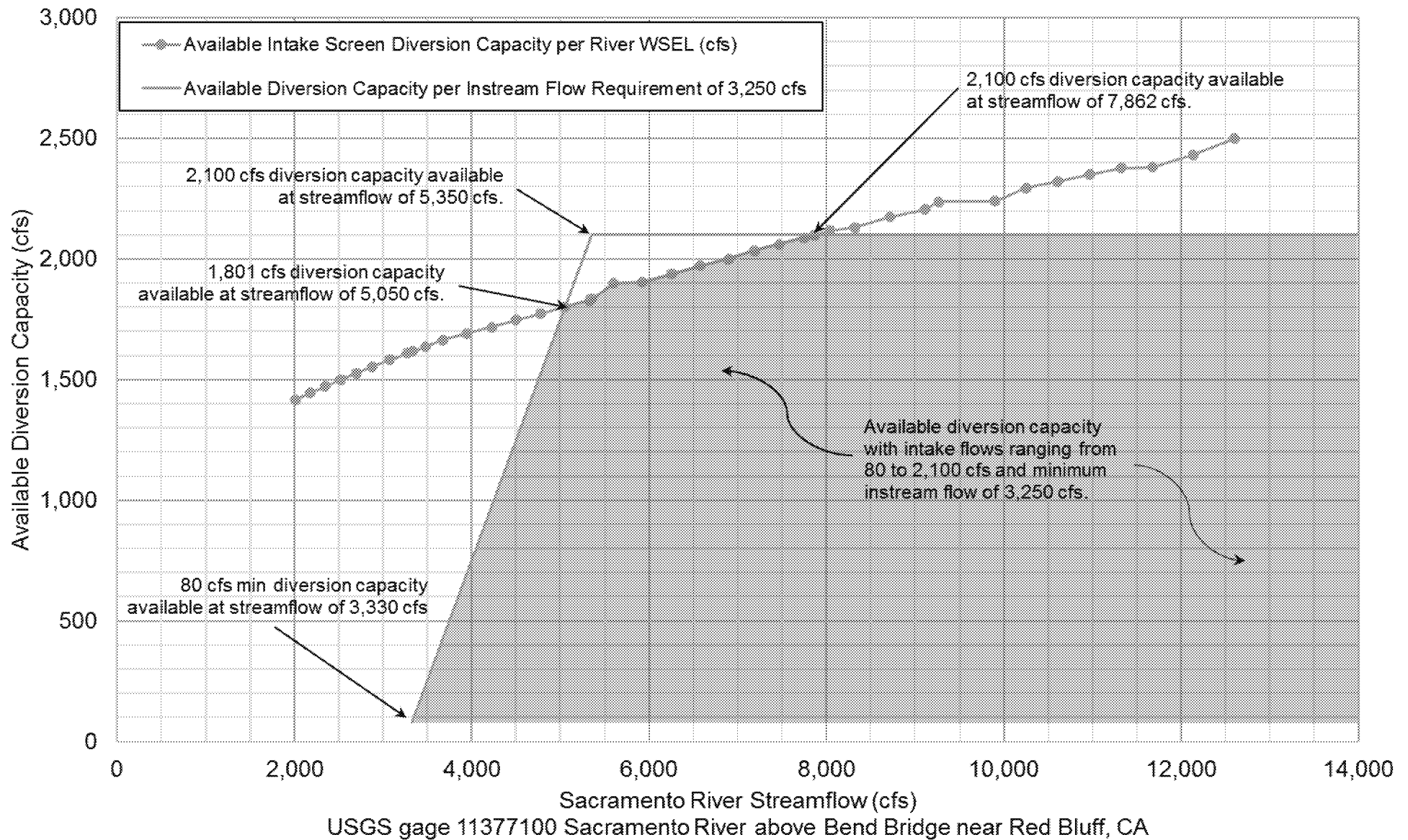


Diversions limited by River WSEL and submerged screen area



No restrictions (assumes use of future Pump Nos. 2 and 10)

TCCA Red Bluff Available Diversion Capacity (cfs) vs. Streamflow (cfs)



GCID Hamilton City Facility Operations

Table 4. GCID Hamilton City Available Diversion Capacity by Streamflow

Sites Project Authority – Sacramento River Intake Fish Screen Operations

Streamflow Upstream of Oxbow (cfs)	River WSEL at U/S Oxbow (feet, NGVD29)	Available Facility Diversion Capacity (cfs)
900	132.5	1,744
938	132.6	1,777
977	132.7	1,809
1,018	132.8	1,841
1,061	132.9	1,873
1,105	133.0	1,906
1,151	133.1	1,938
1,200	133.2	1,970
1,250	133.3	2,002
2,690	133.4	2,035
2,765	133.5	2,067
2,842	133.6	2,099
2,921	133.7	2,131
3,002	133.8	2,164
3,086	133.9	2,196
3,172	134.0	2,228
3,260	134.1	2,260
3,351	134.2	2,292
3,445	134.3	2,325
3,541	134.4	2,357
3,639	134.5	2,389
3,741	134.6	2,421
3,845	134.7	2,454
3,952	134.8	2,486
4,062	134.9	2,518
4,176	135.0	2,559
4,292	135.1	2,583
4,412	135.2	2,615
4,534	135.3	2,647
4,661	135.4	2,679

4,791	135.5	2,717
4,924	135.6	2,744
5,061	135.7	2,776
5,203	135.8	2,808
5,348	135.9	2,841
5,497	136.0 (begin possible gravity diversion)	2,874
5,650	136.1	2,905
5,807	136.2	2,937
5,969	136.3	2,969
6,135	136.4	3,002
6,306	136.5	3,031

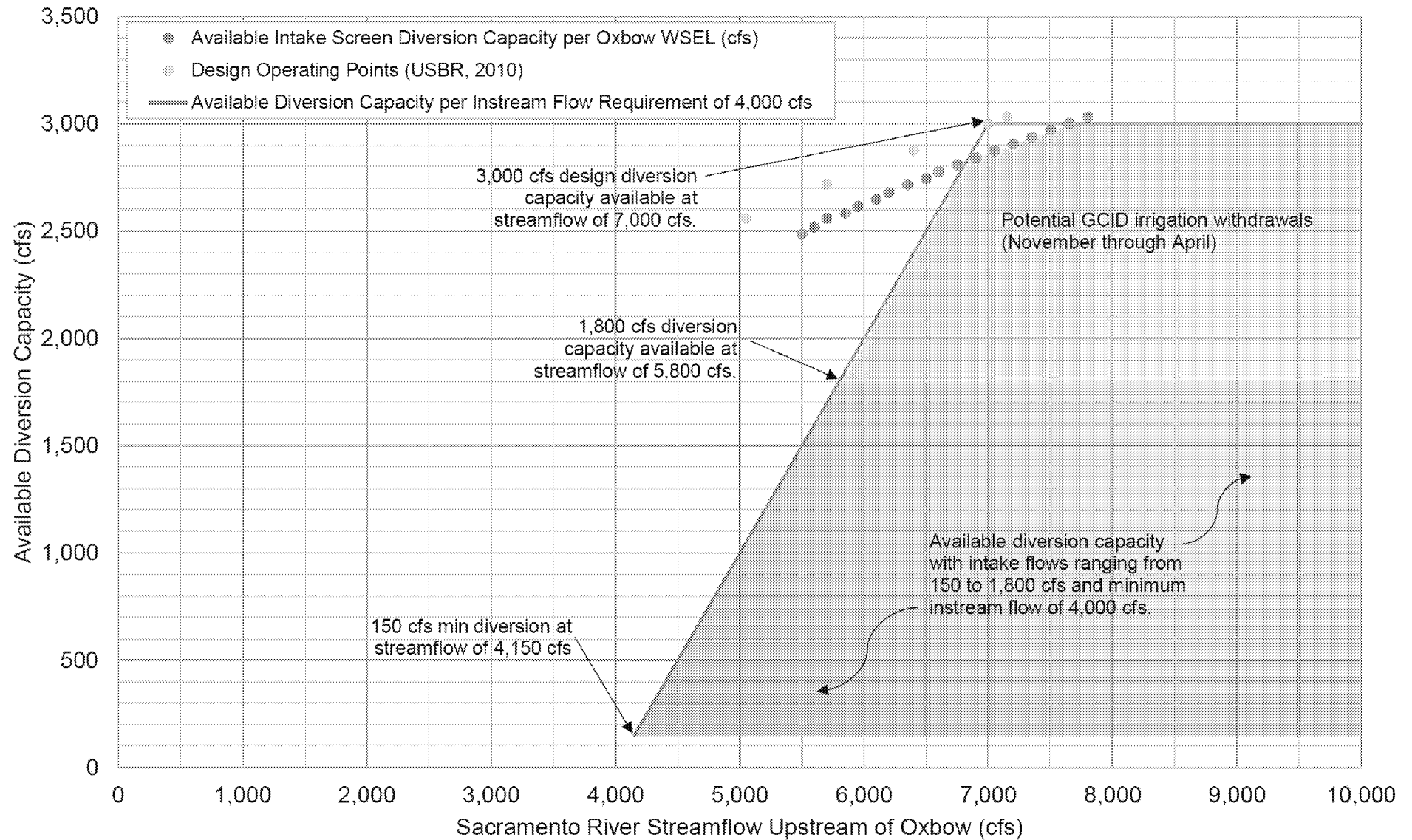


Diversions limited by instream flow requirement of 4,000 cfs



No restrictions, assuming GCID irrigation withdrawals are less than approximately 1,000 cfs

GCID Hamilton City Available Diversion Capacity (cfs) vs. Streamflow Upstream of Oxbow (cfs)



From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/9/2021 2:55:43 PM
To: tstokely@att.net; jimb@aqualliance.net; dobegi@nrdc.org; reis@bayecotarium.org; rzwillinger@defenders.org; DLucero@ButteCounty.net; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com; regina@californiasalmon.org; Huber, Anne [Anne.Huber@icf.com]; Williams, Nicole (Nicole.Williams@icf.com) [Nicole.Williams@icf.com]; steve.micko@jacobs.com; David Zelinsky [zelinsky.david@gmail.com]; asanchez@calwild.org; Ron Stork [RStork@friendsoftheriver.org]
CC: Alicia Forsythe [aforsythe@sitesproject.org]; Davis, Ryan A [rdavis@usbr.gov]; Dekar, Melissa D [mdekar@usbr.gov]; King, Vanessa M [vking@usbr.gov]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Morgan, Joseph [Morgan.Joseph@epa.gov]; Gordon, Stephanie (Skophammer) [GORDON.STEPHANIES@EPA.GOV]; Wolder, Natalie L [nwolder@usbr.gov]; Deeds, Daniel A [ddeeds@usbr.gov]
Subject: Sites Project Water Quality Group Discussion-Materials
Attachments: 20210407_Water Quality Discussion_Presentation_Final.pptx; WQ Data Graphs_20210407.pdf

Hello,

Thank you for attending our Water Quality Discussion on Wednesday. I wanted to follow up and provide the presentation and the supplemental figures for Metals, Nutrients, and Pesticides that we discussed, they are attached.

I will follow up on the Action Items below in a separate email, please let me know if you have any additions.

1. Discussion of the Preferred Alternative selection
2. Provide a table with data details such as location, timing and number of data points
3. Schedule 90 minute meeting in May

Lastly, the following are future agenda topics that were identified during our meeting:

- Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of the reservoir.
- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

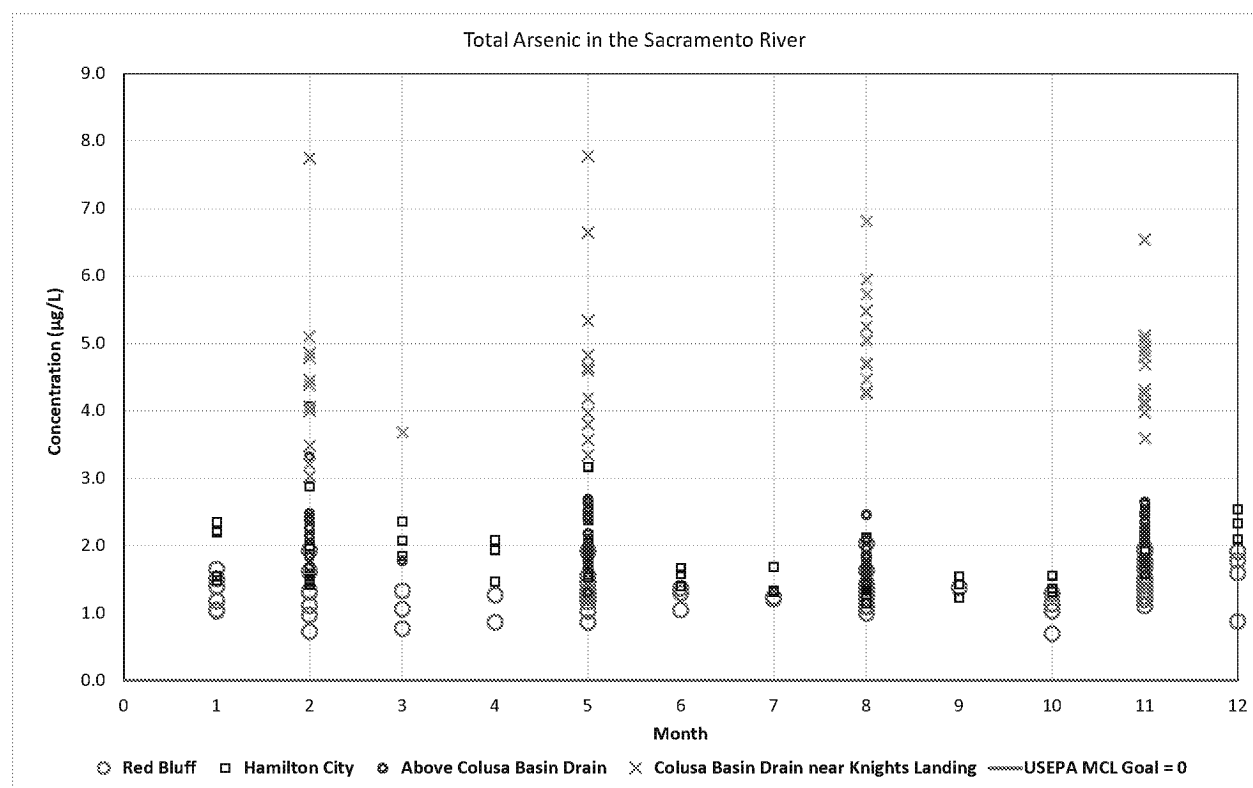
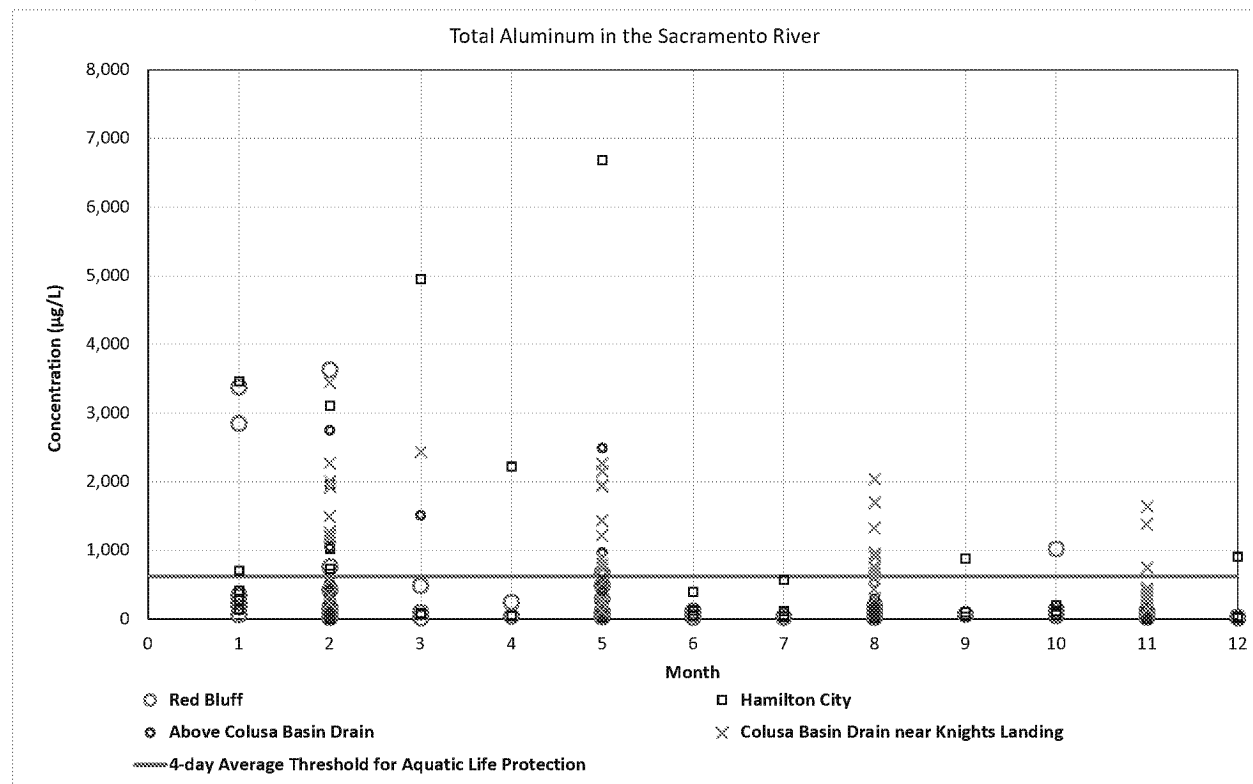
John

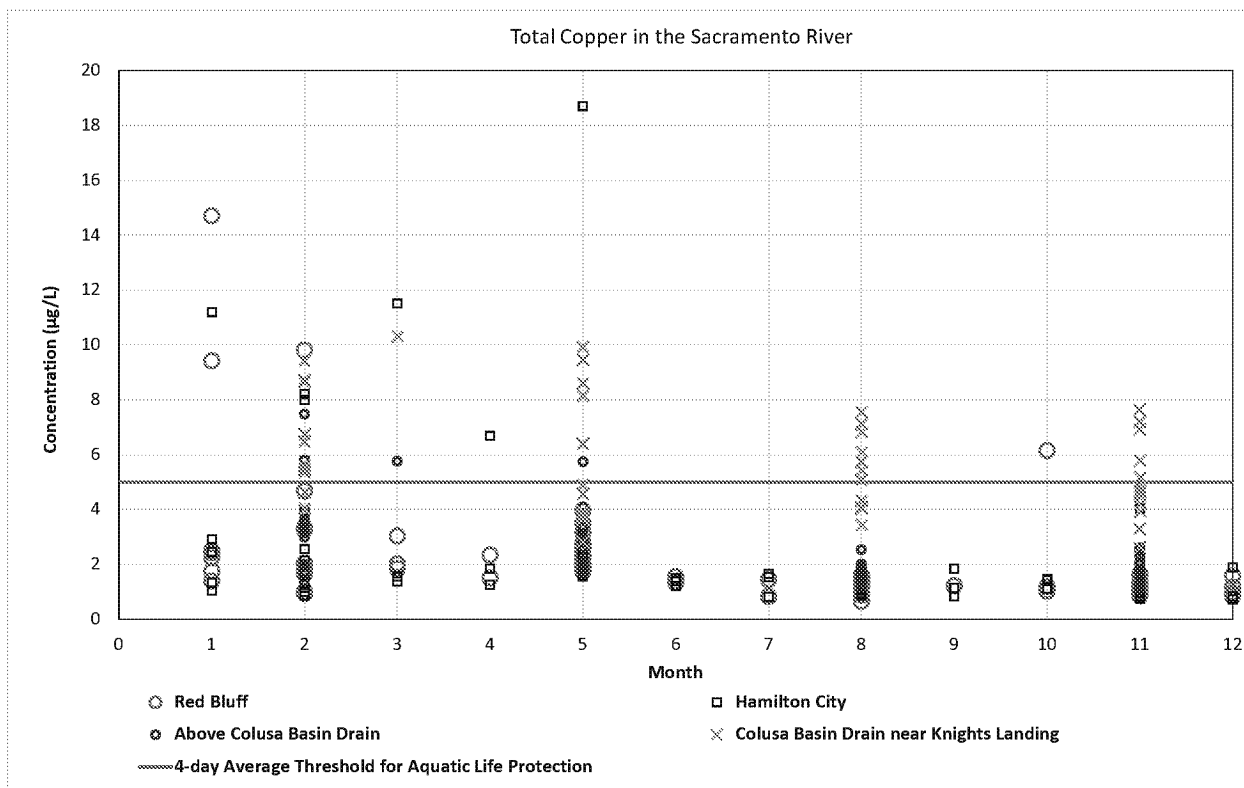
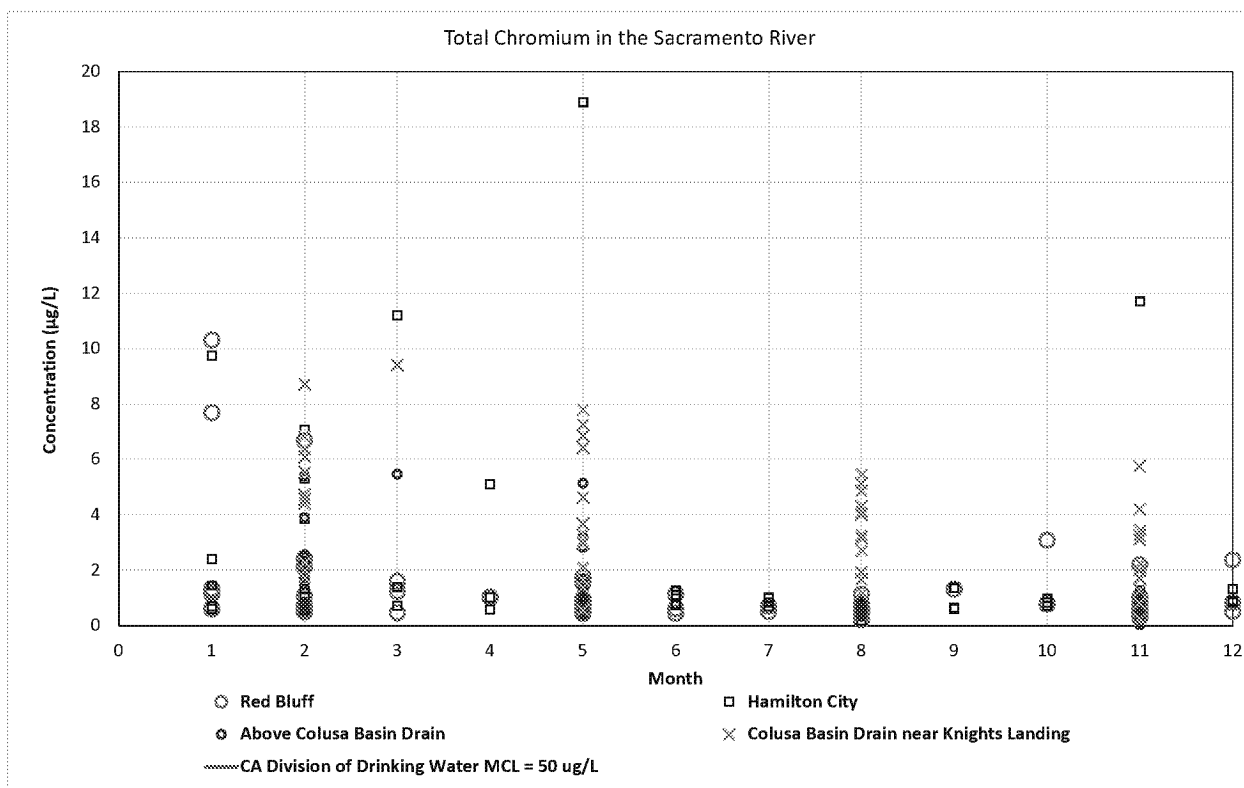
John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

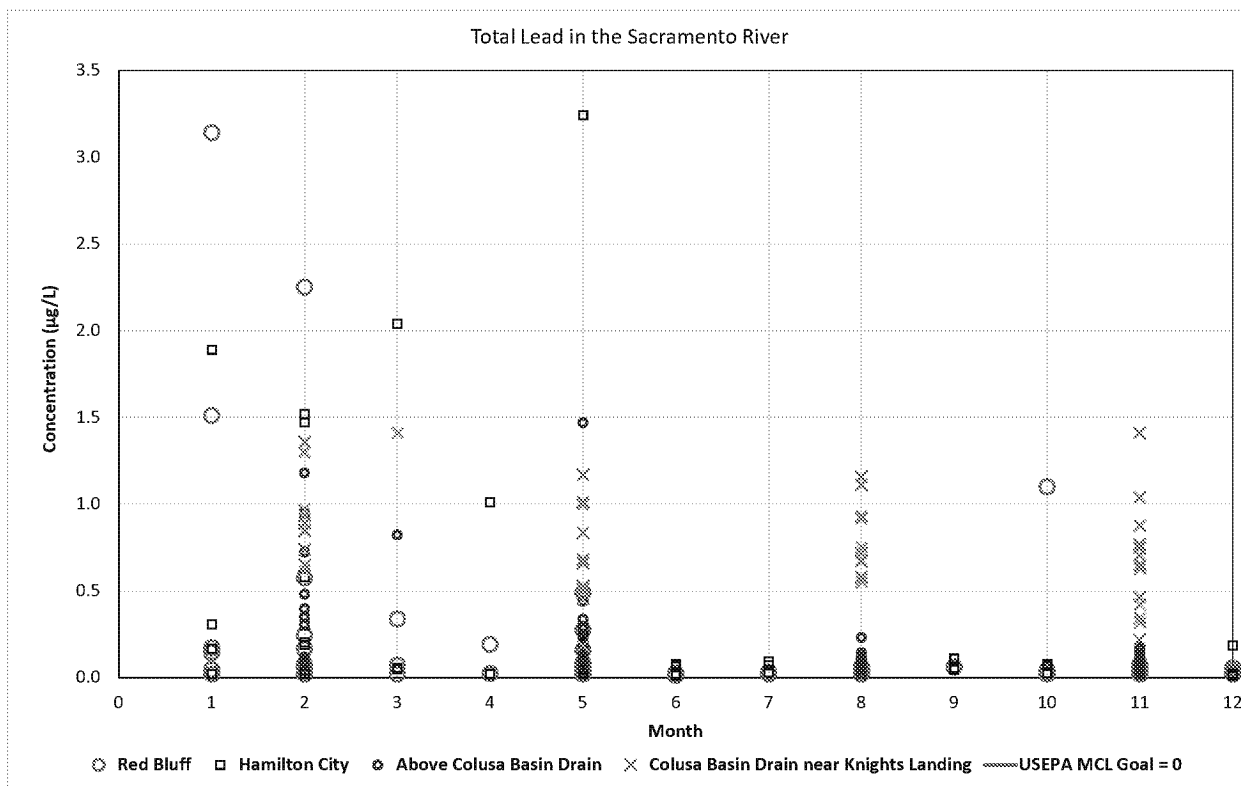
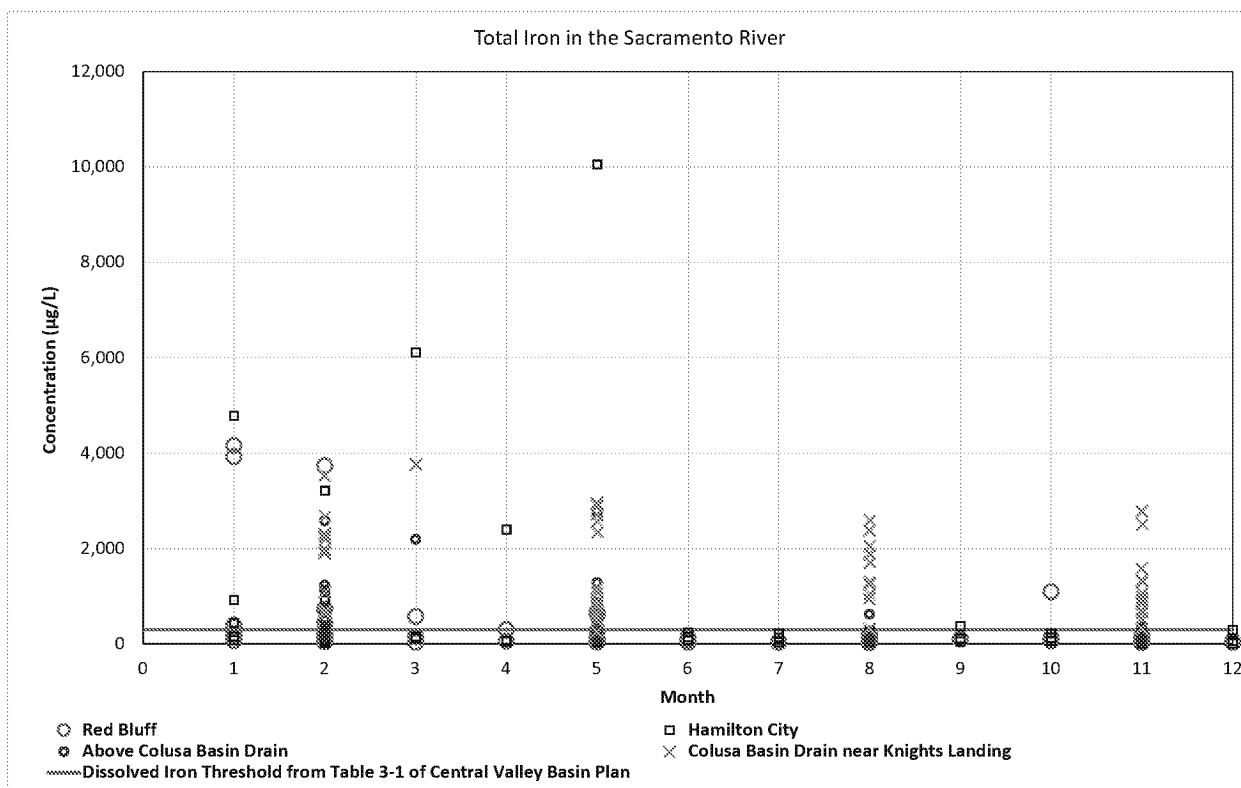
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2379 Gateway Oaks Drive, Suite 200
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john.spranza@hdrinc.com

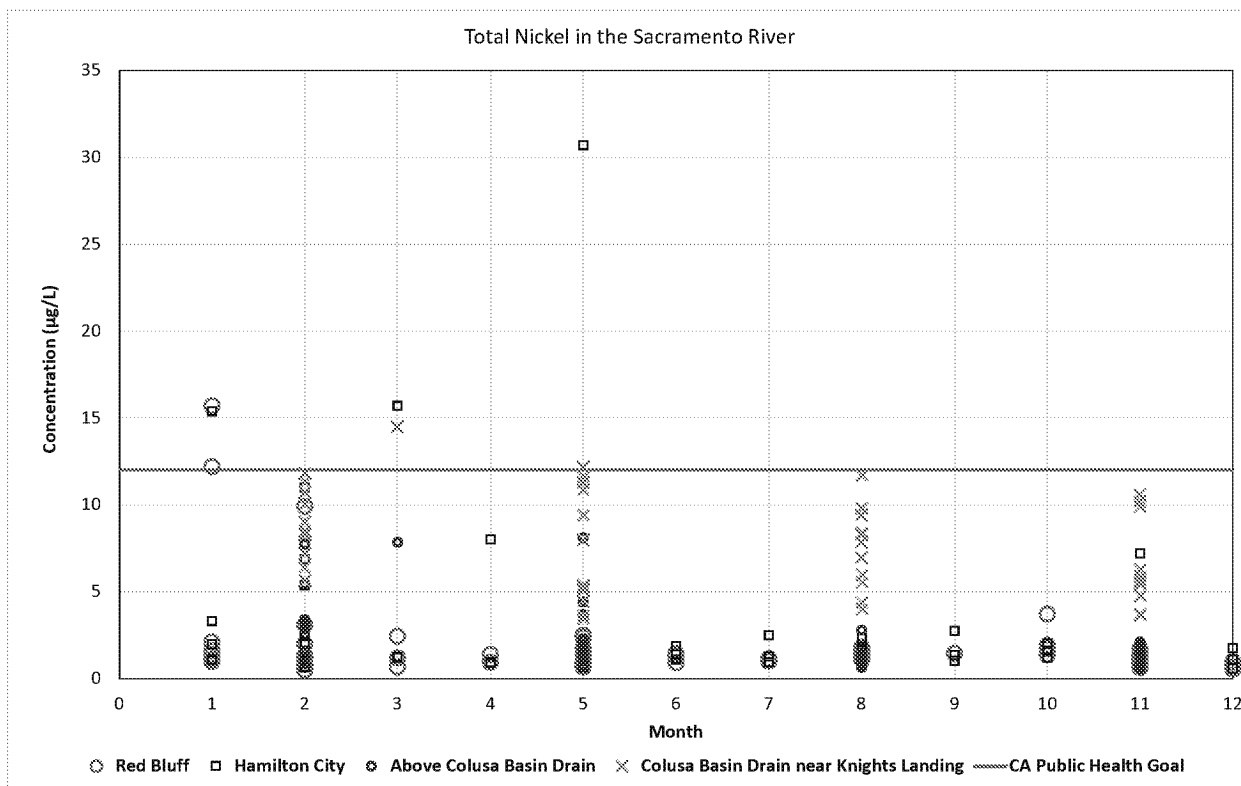
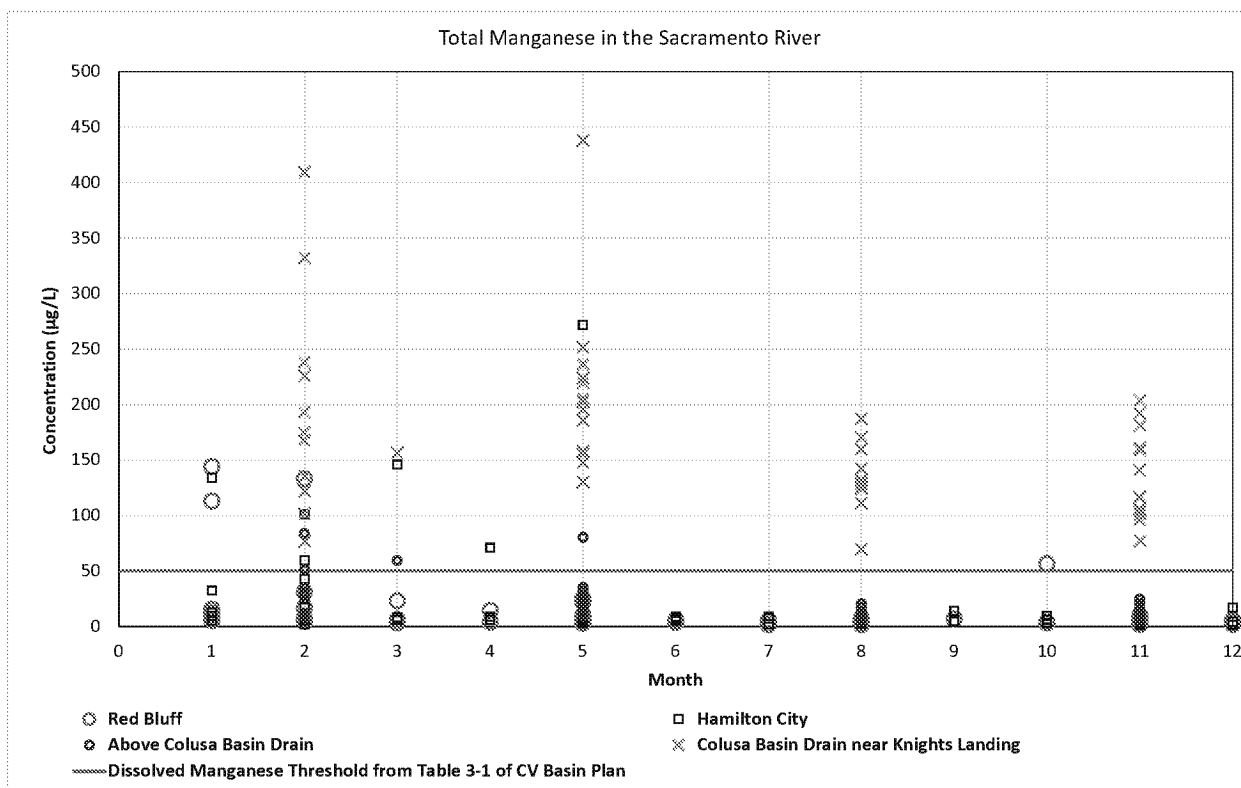
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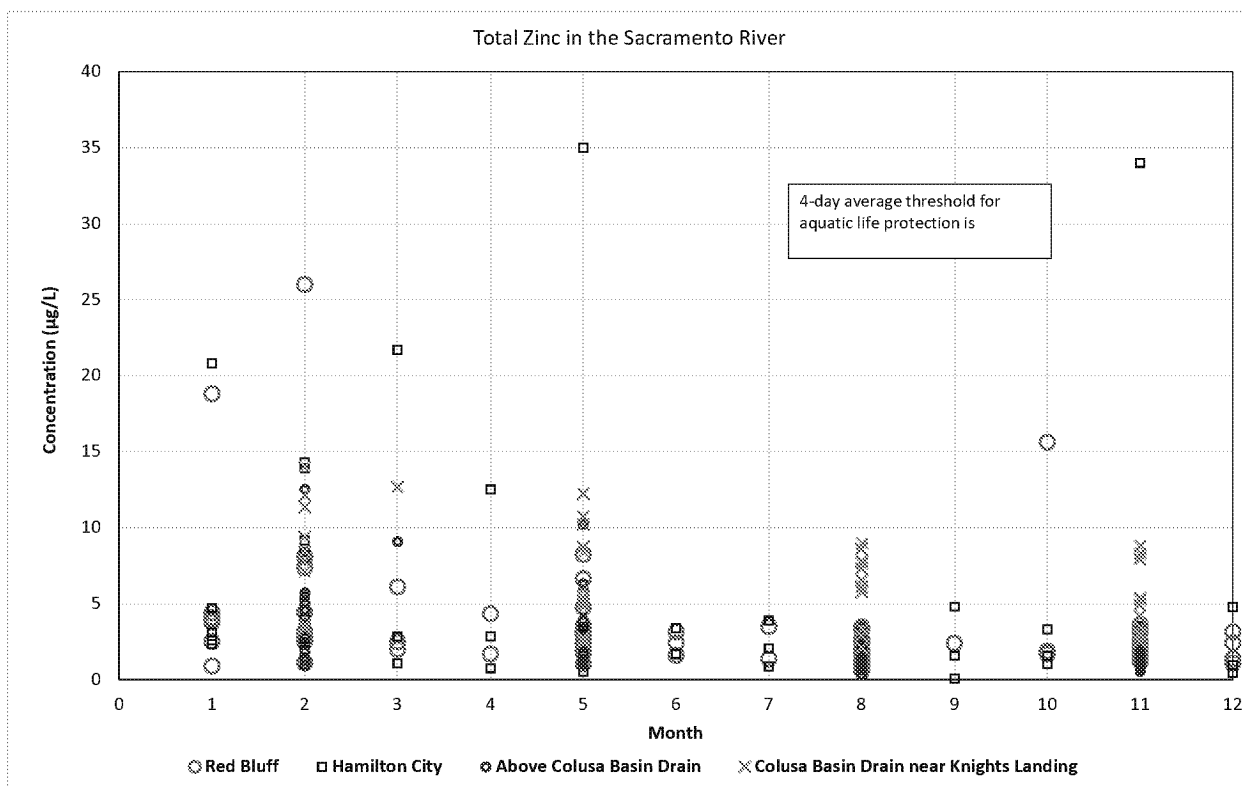
Metals Data by Month



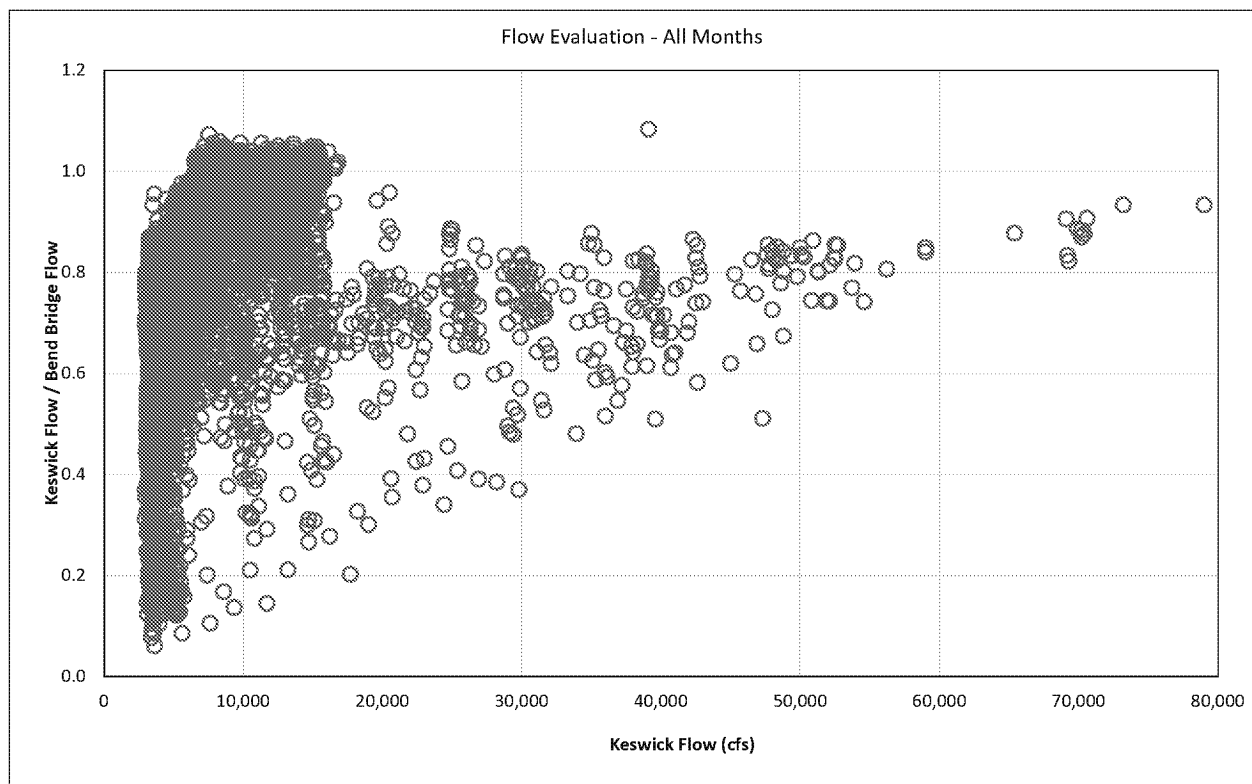


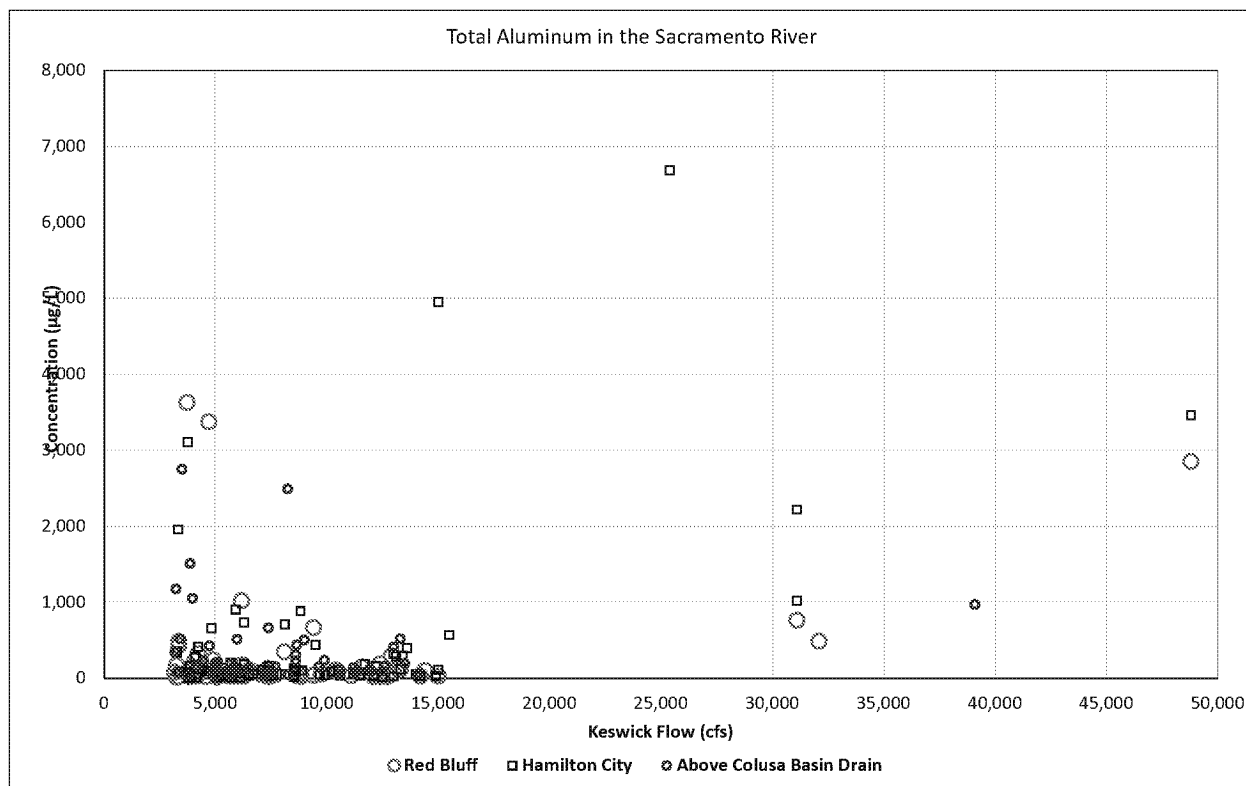
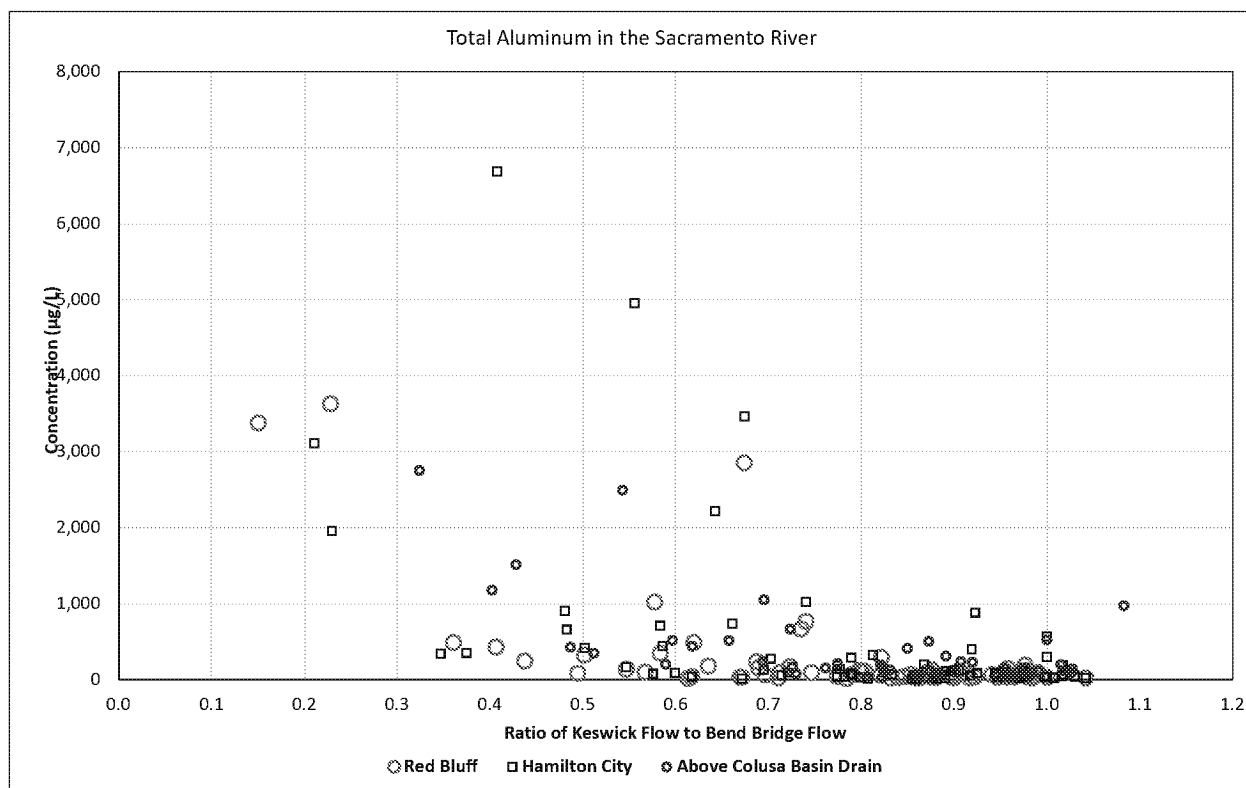


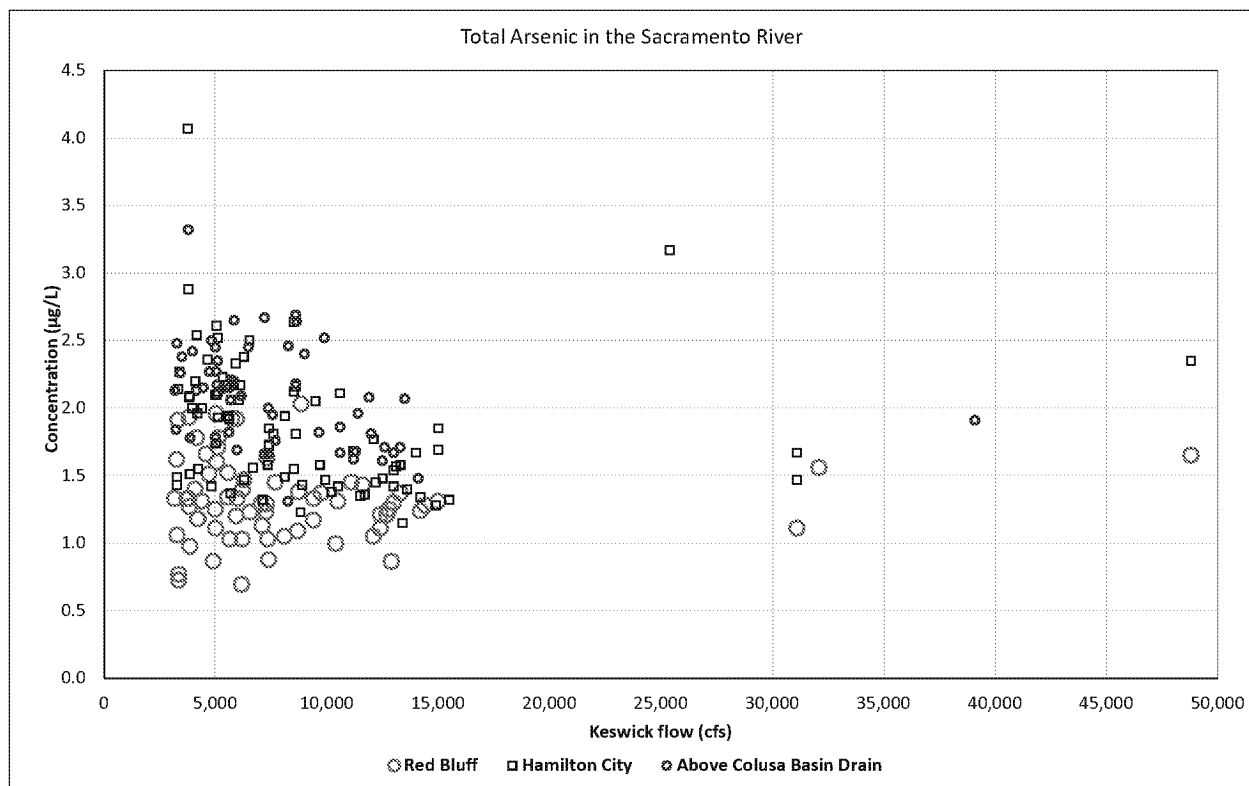
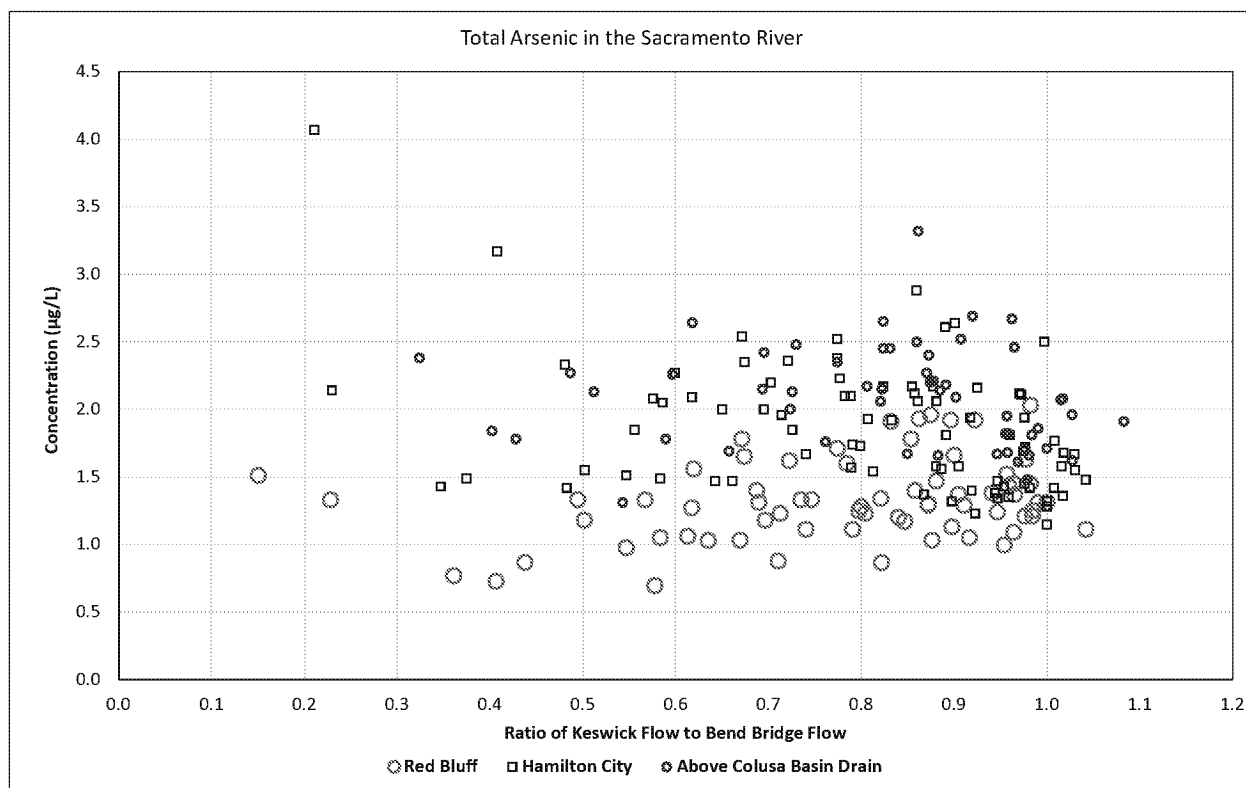


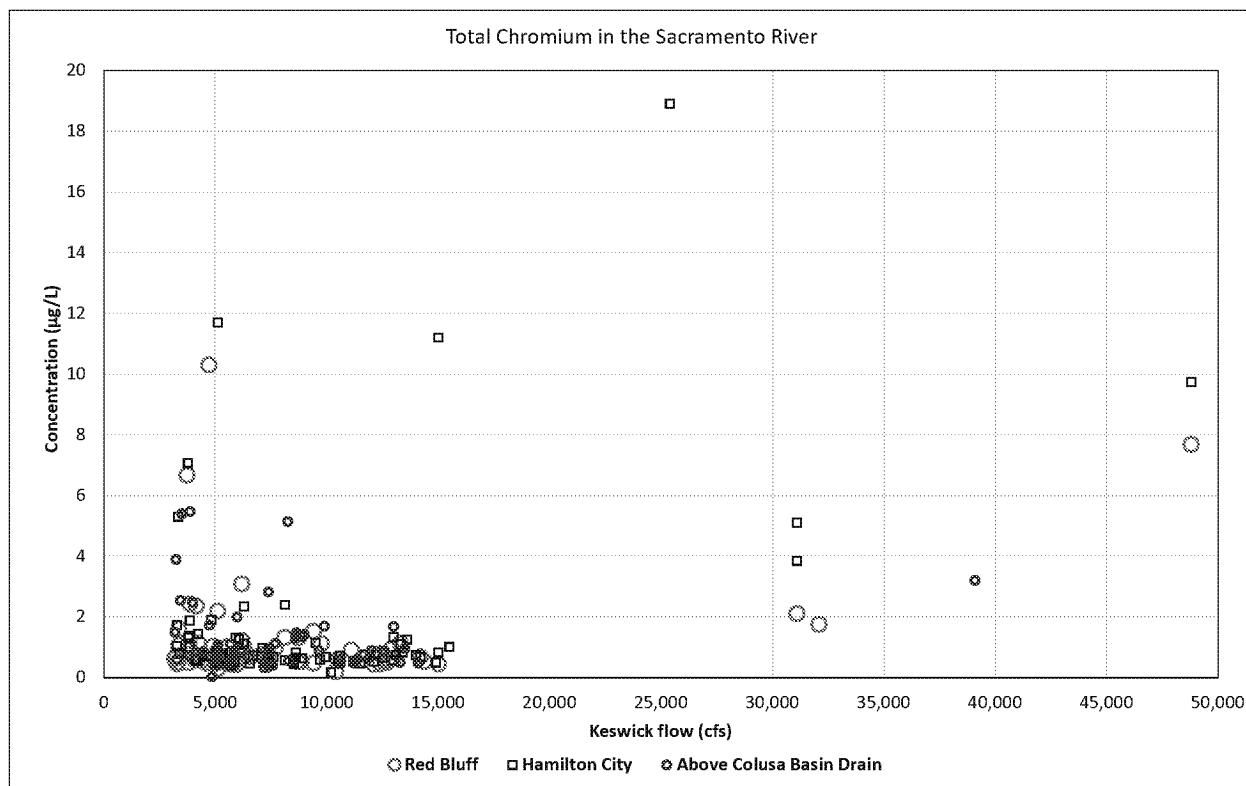
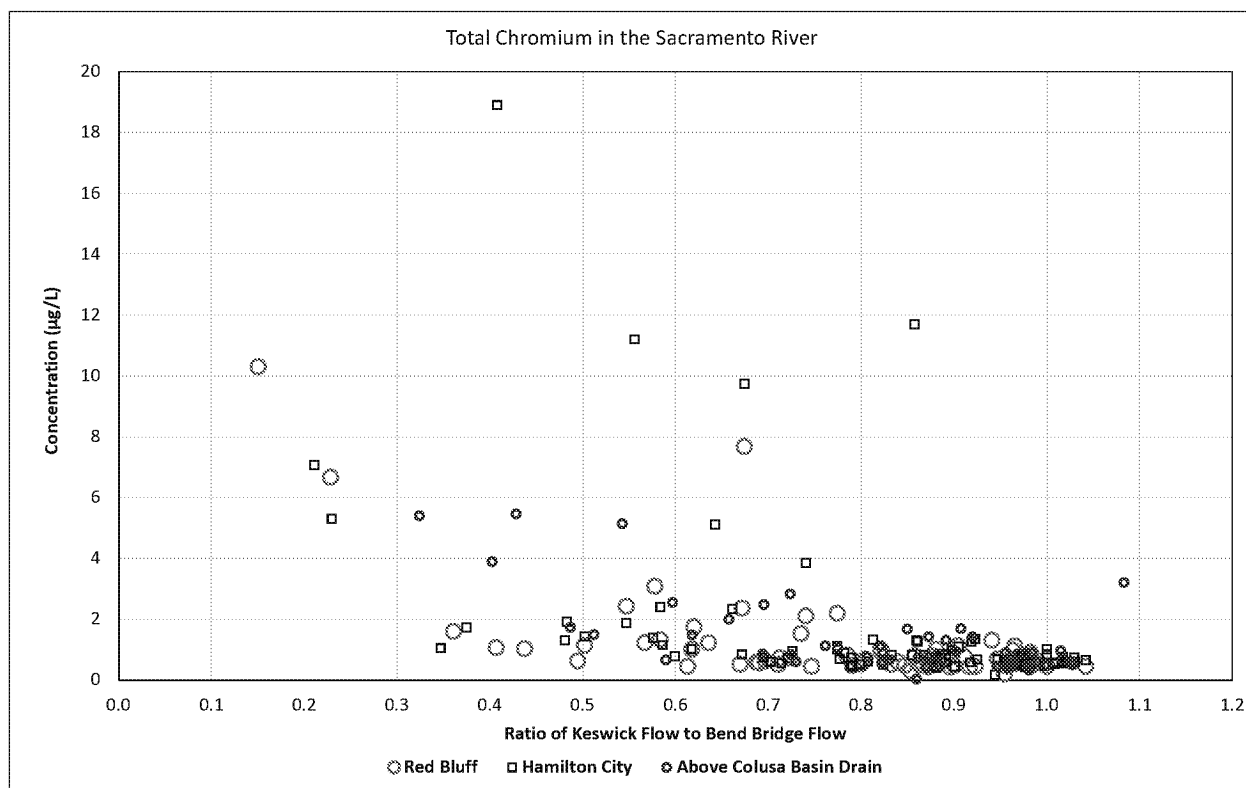


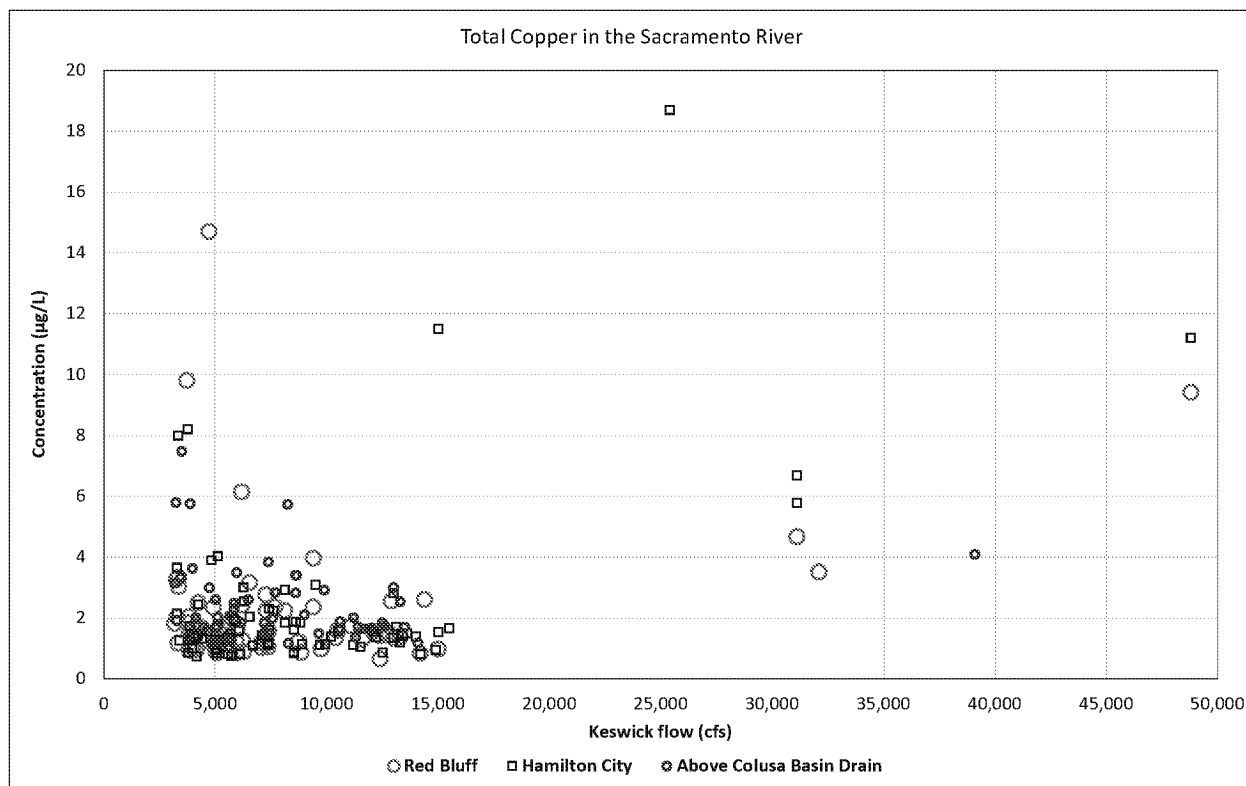
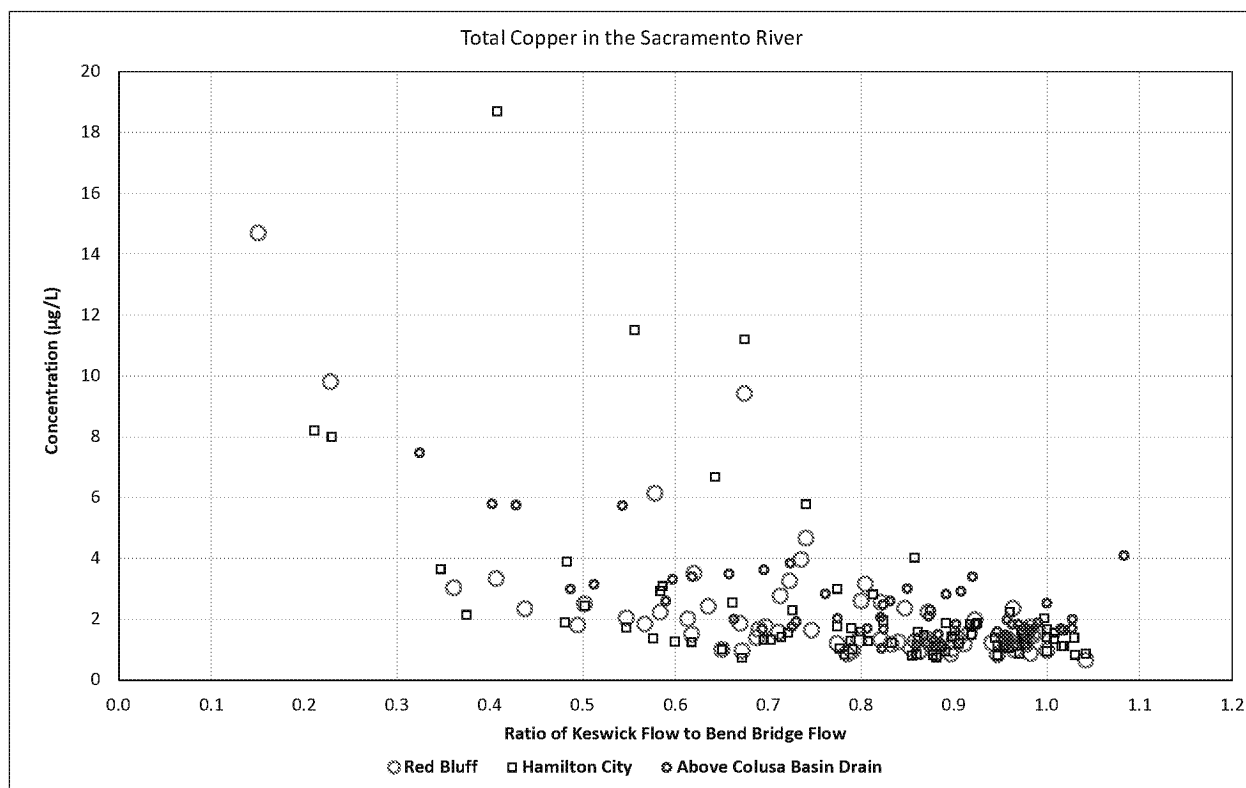
Metals Data Versus Flow

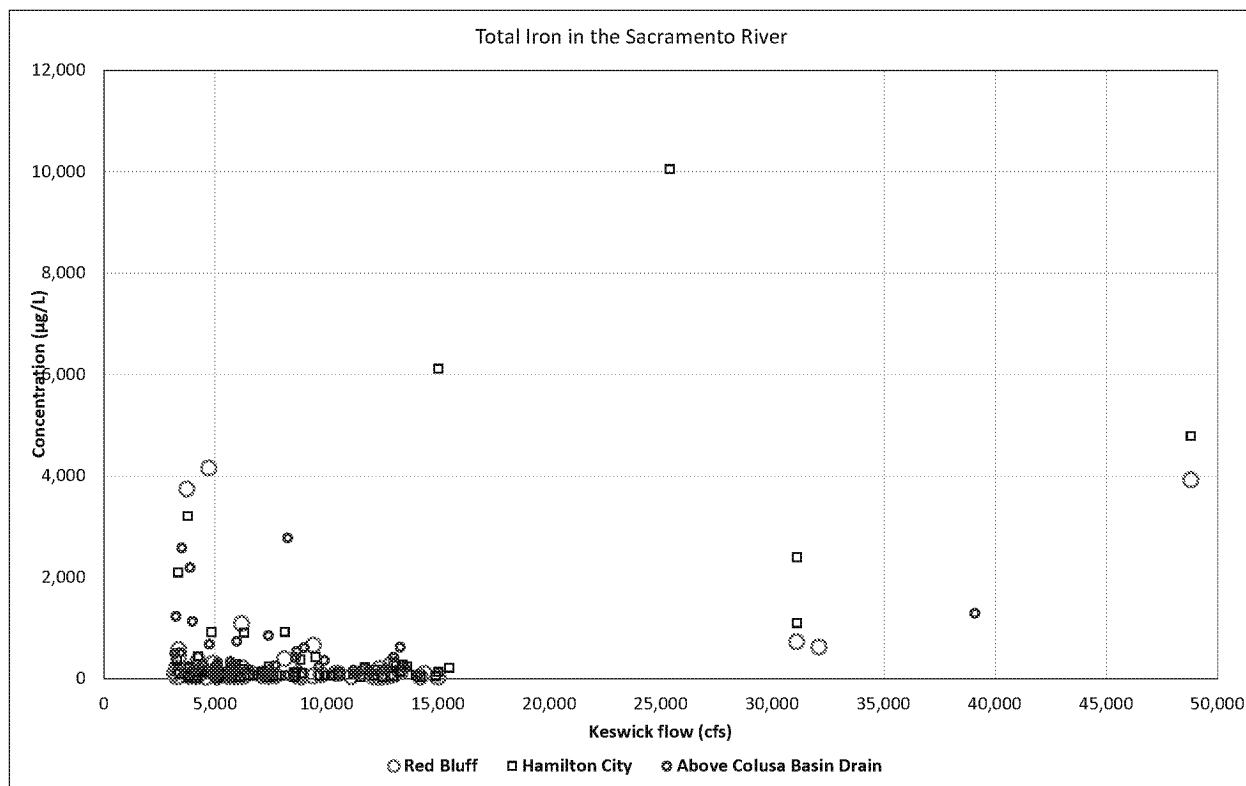
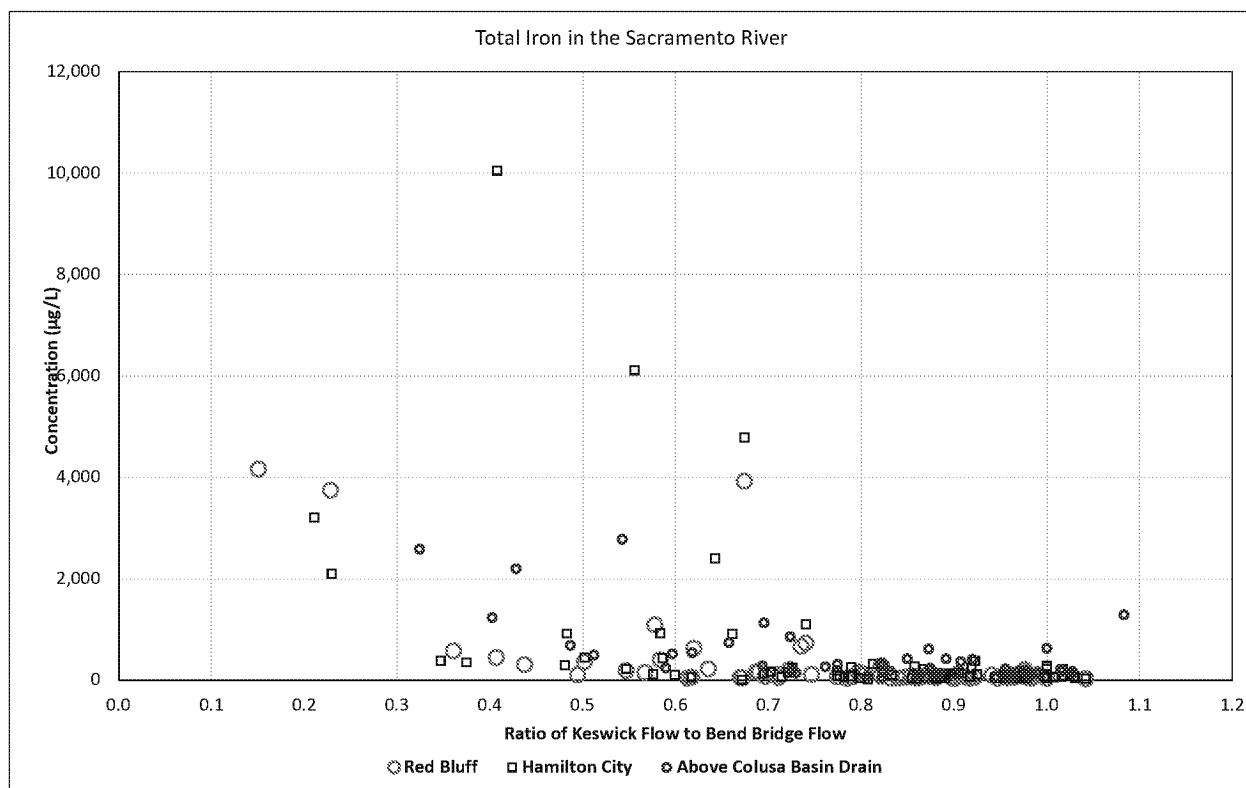


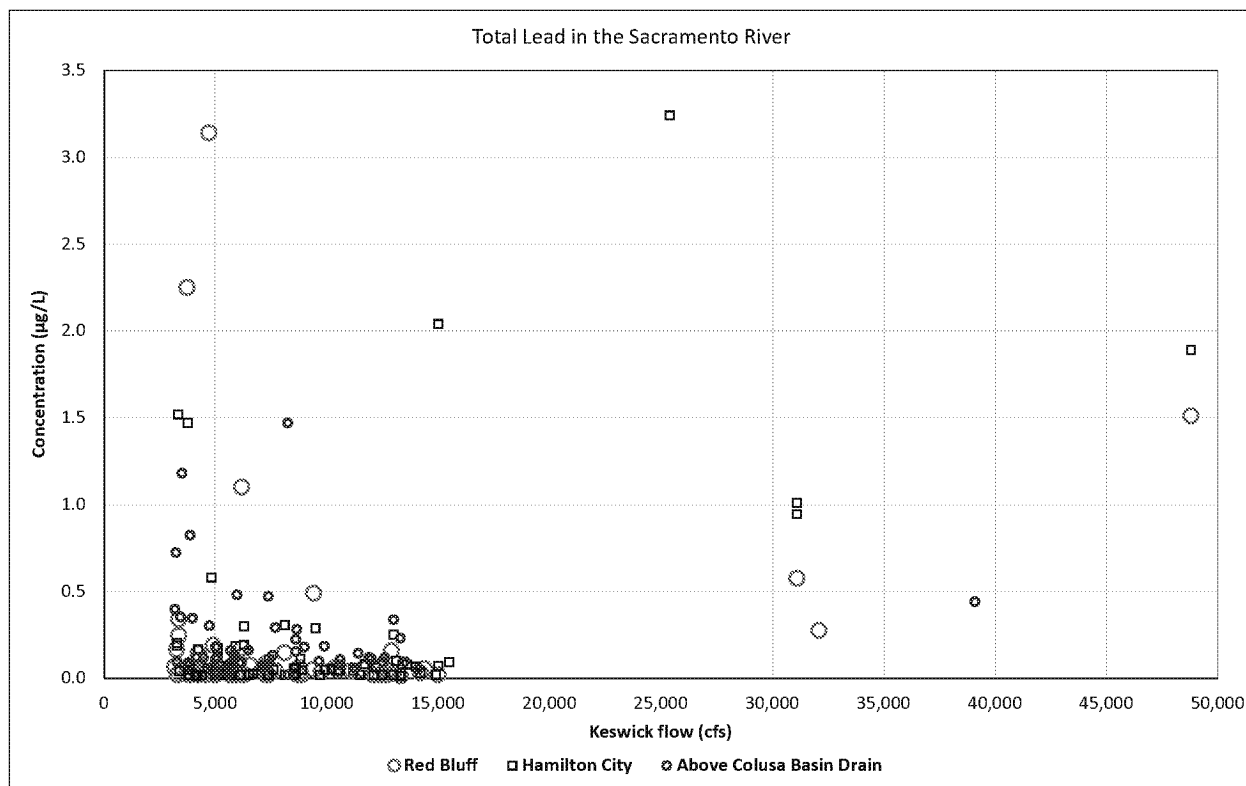
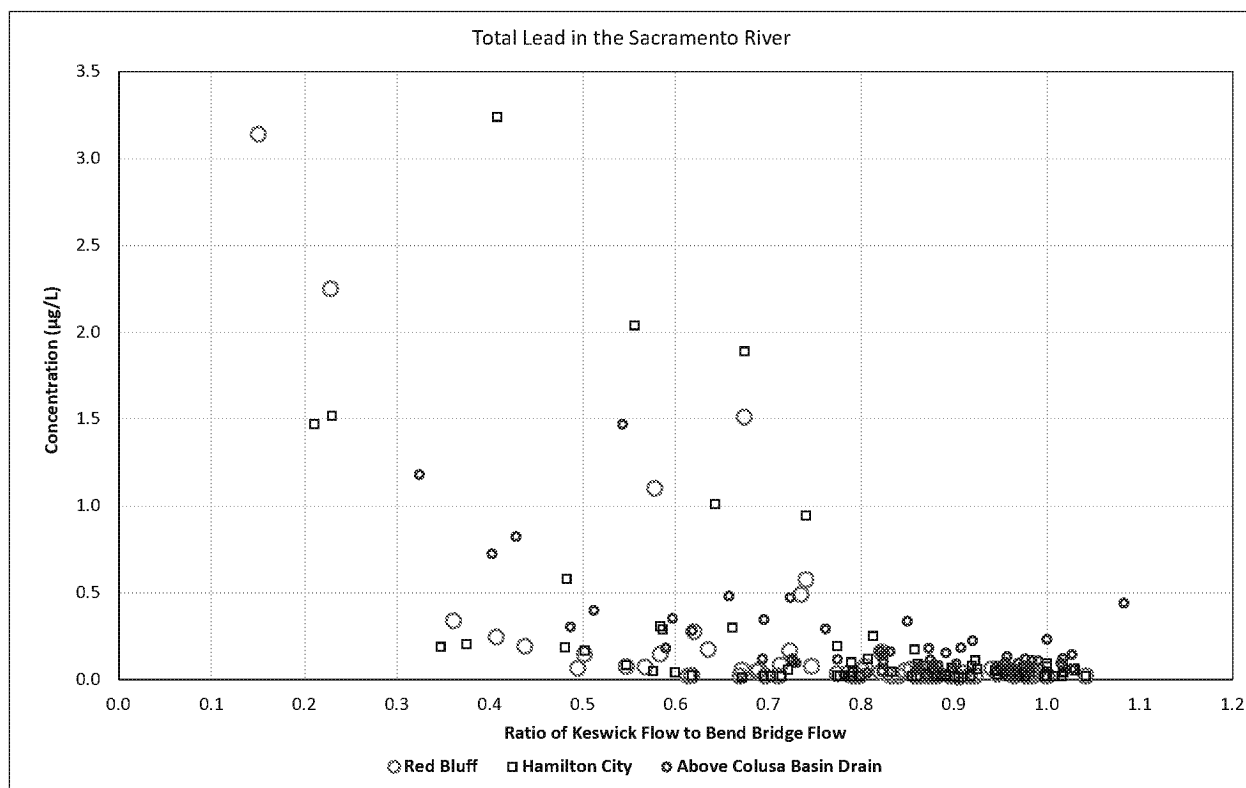


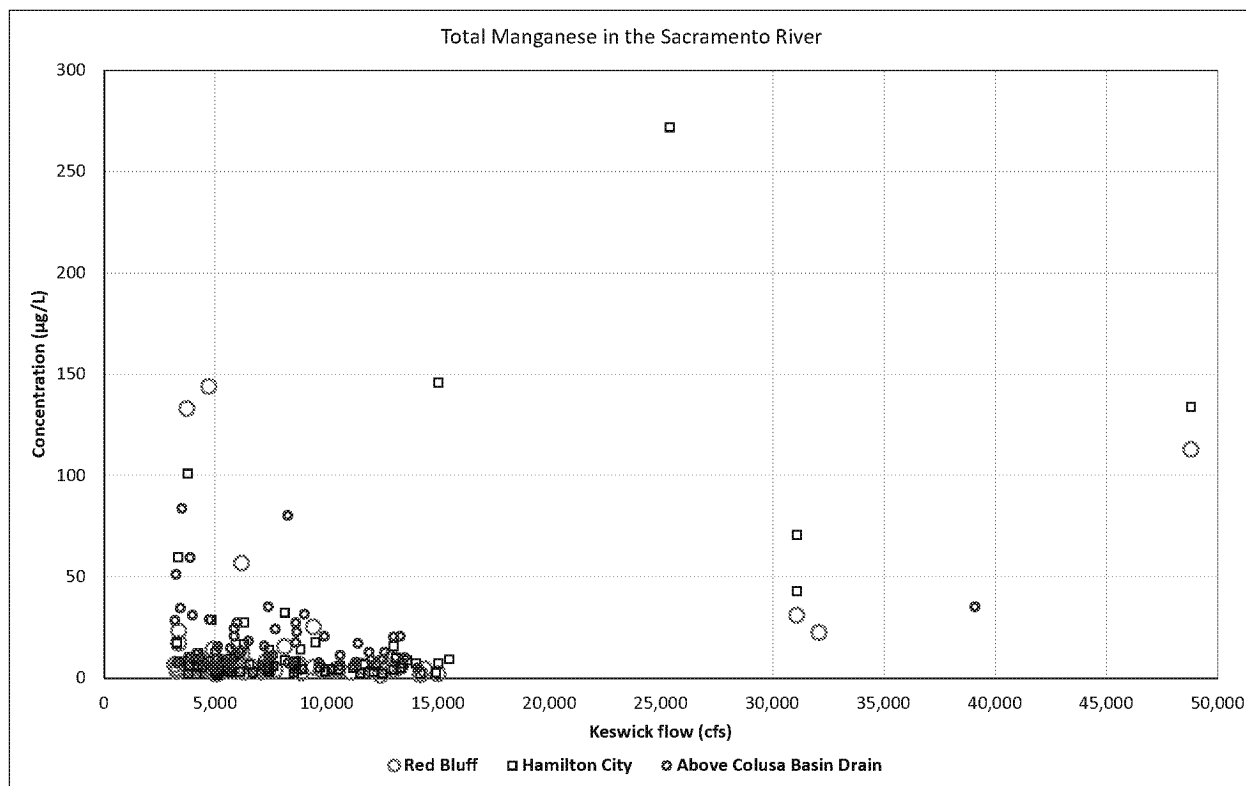
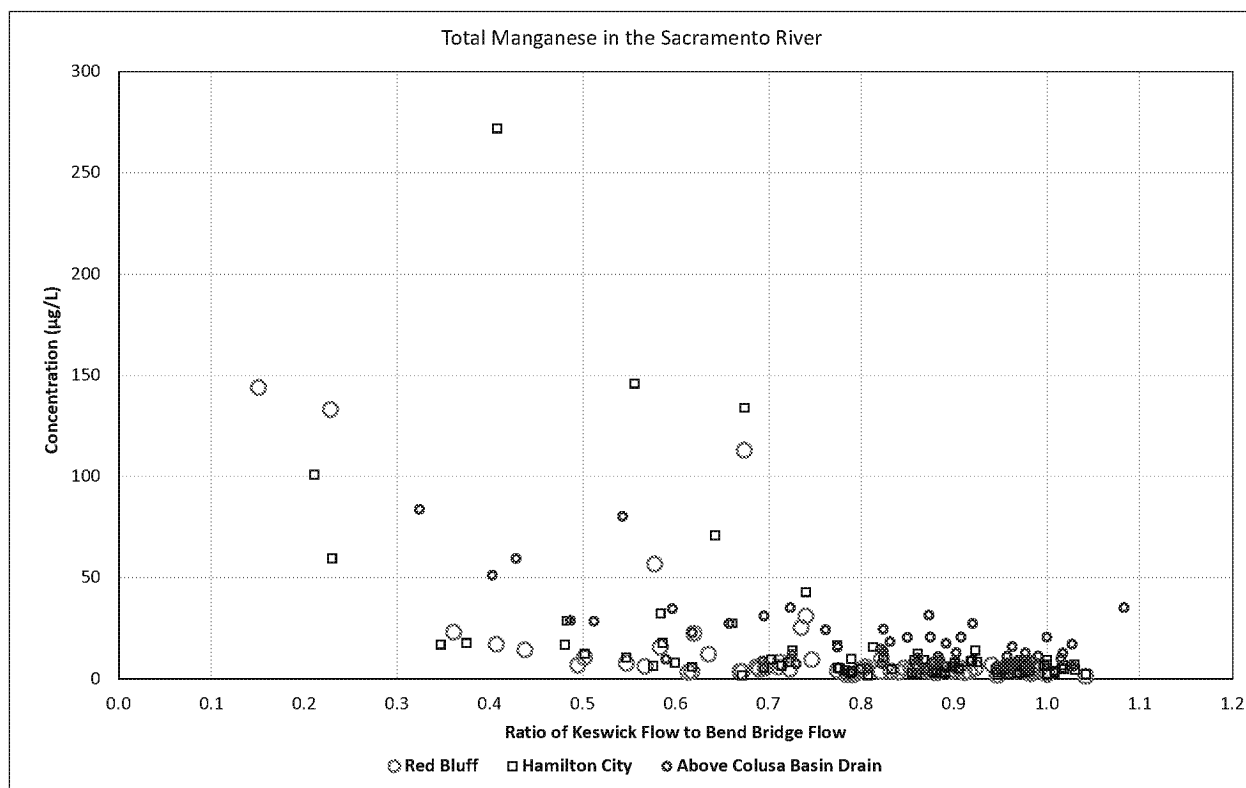


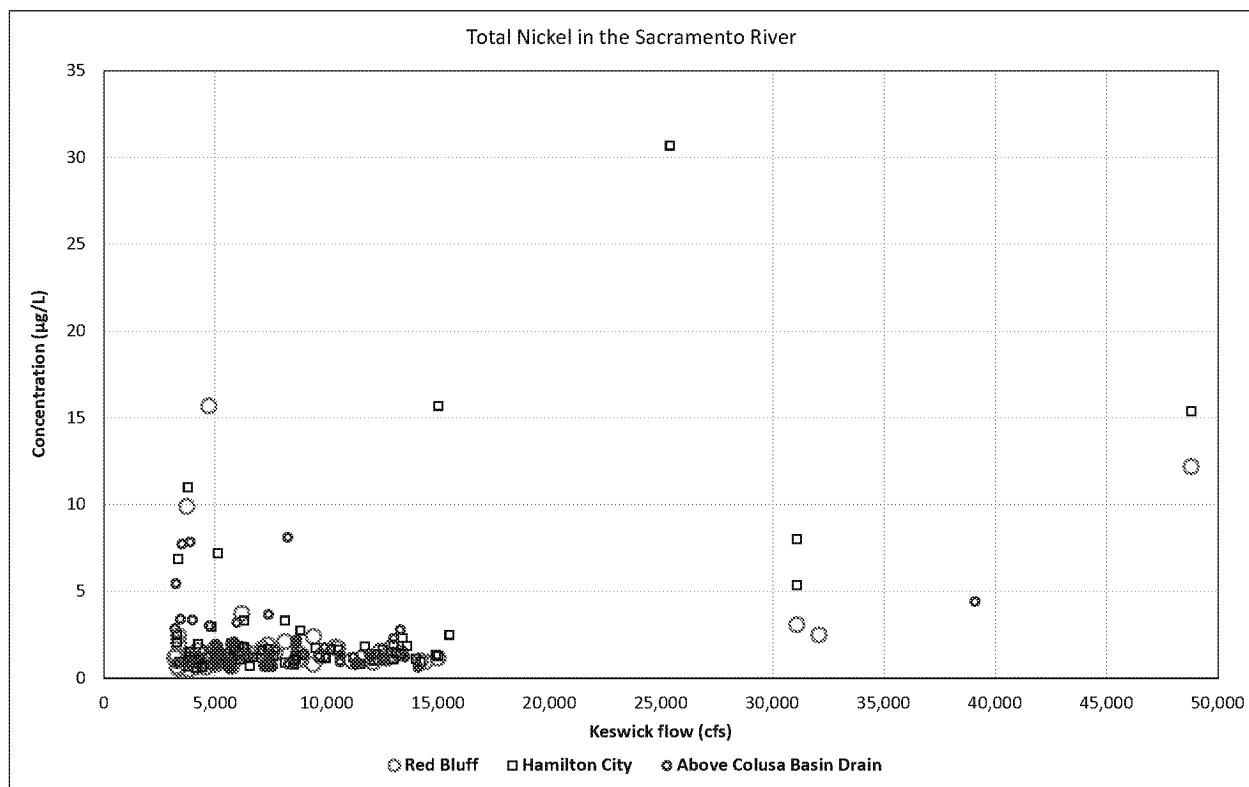
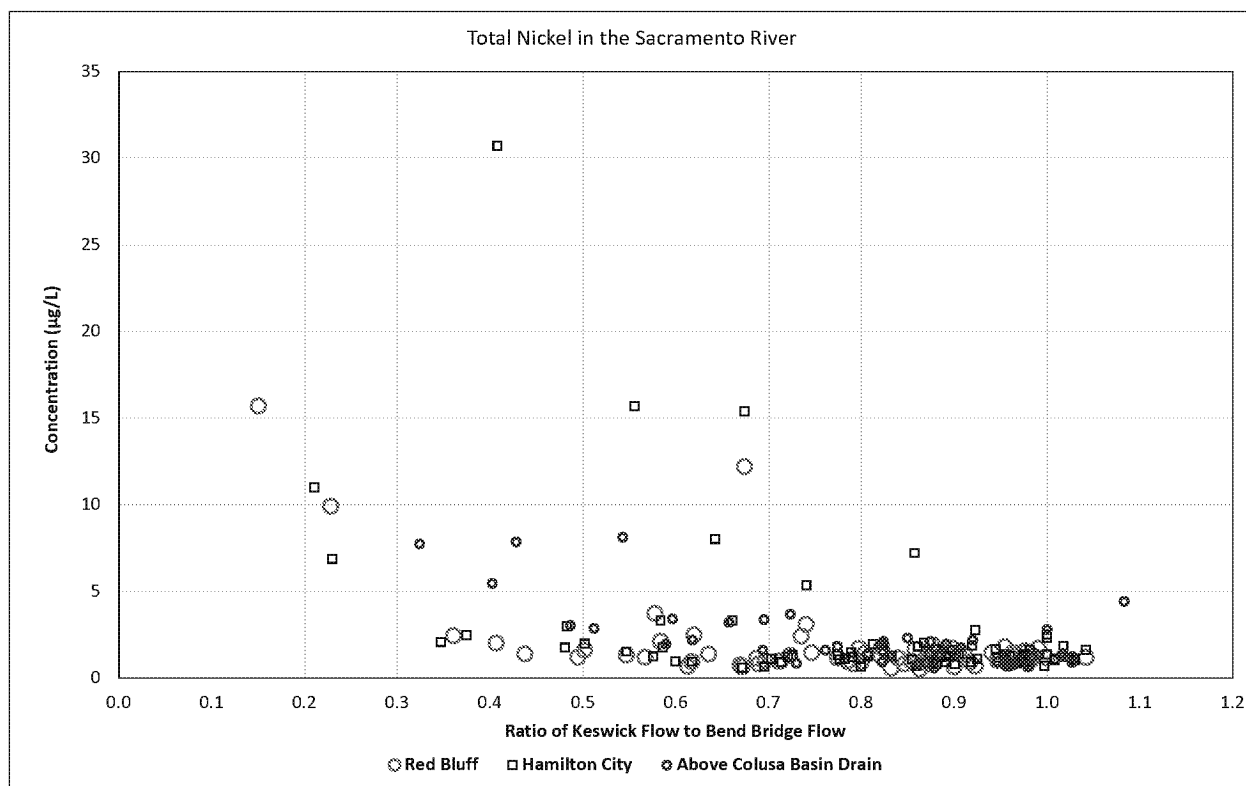


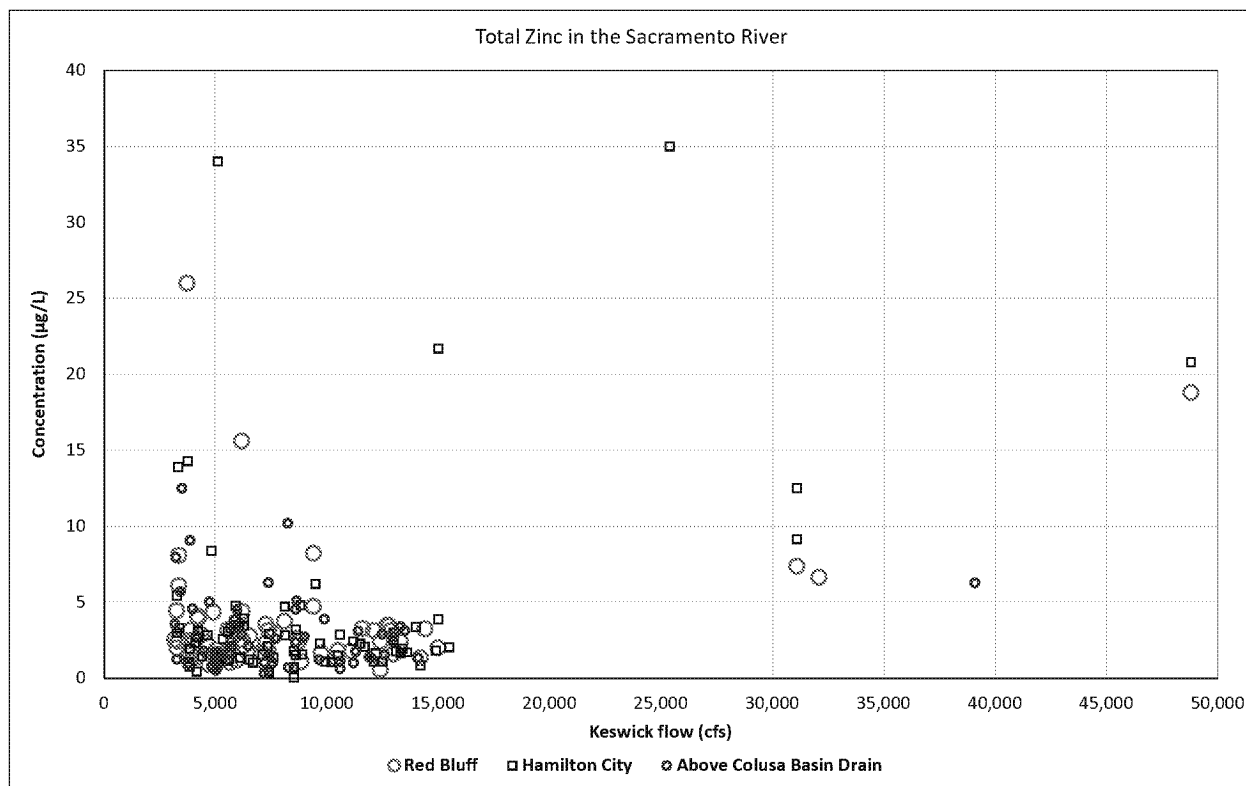
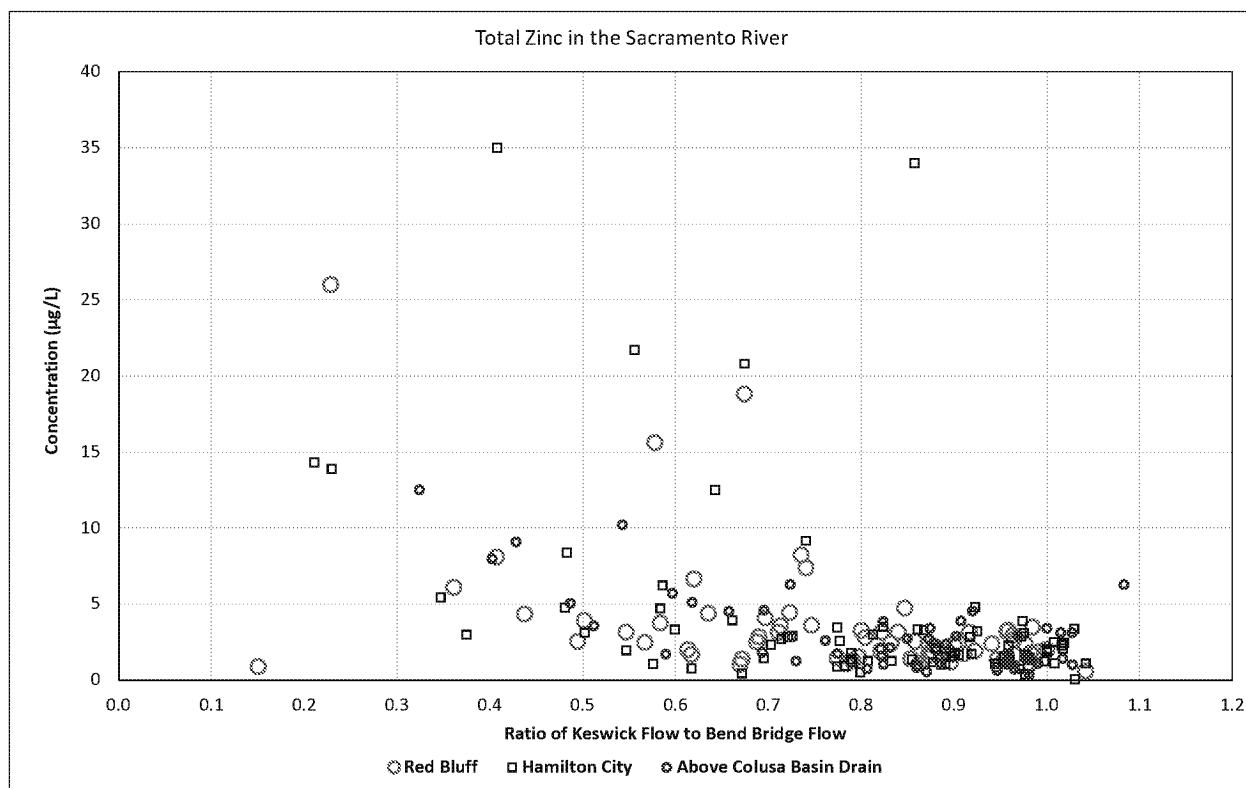




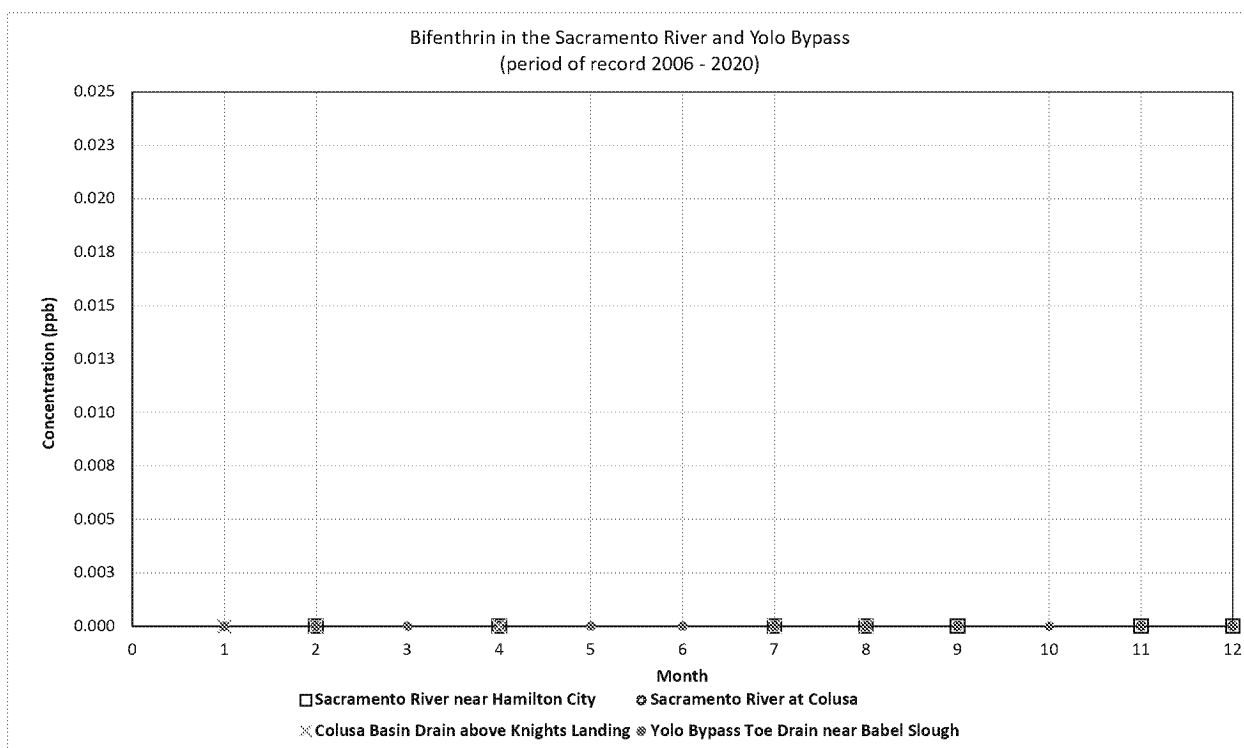
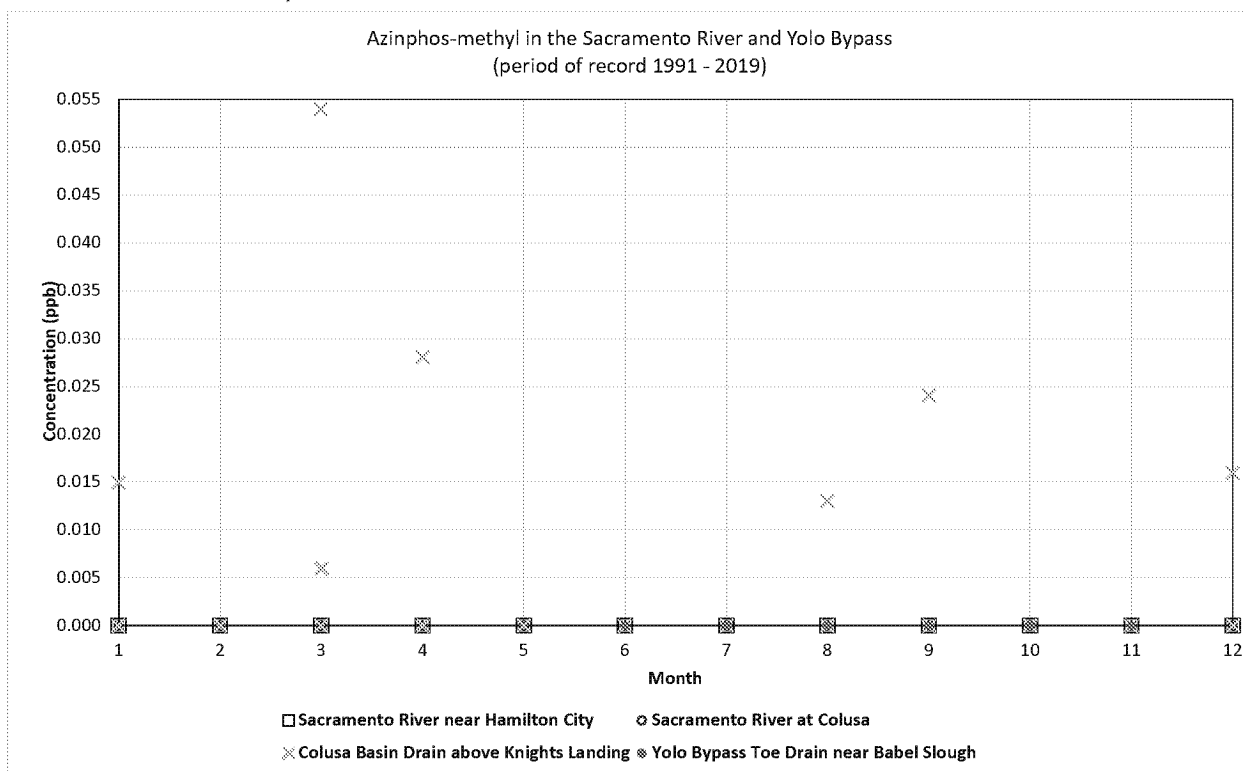


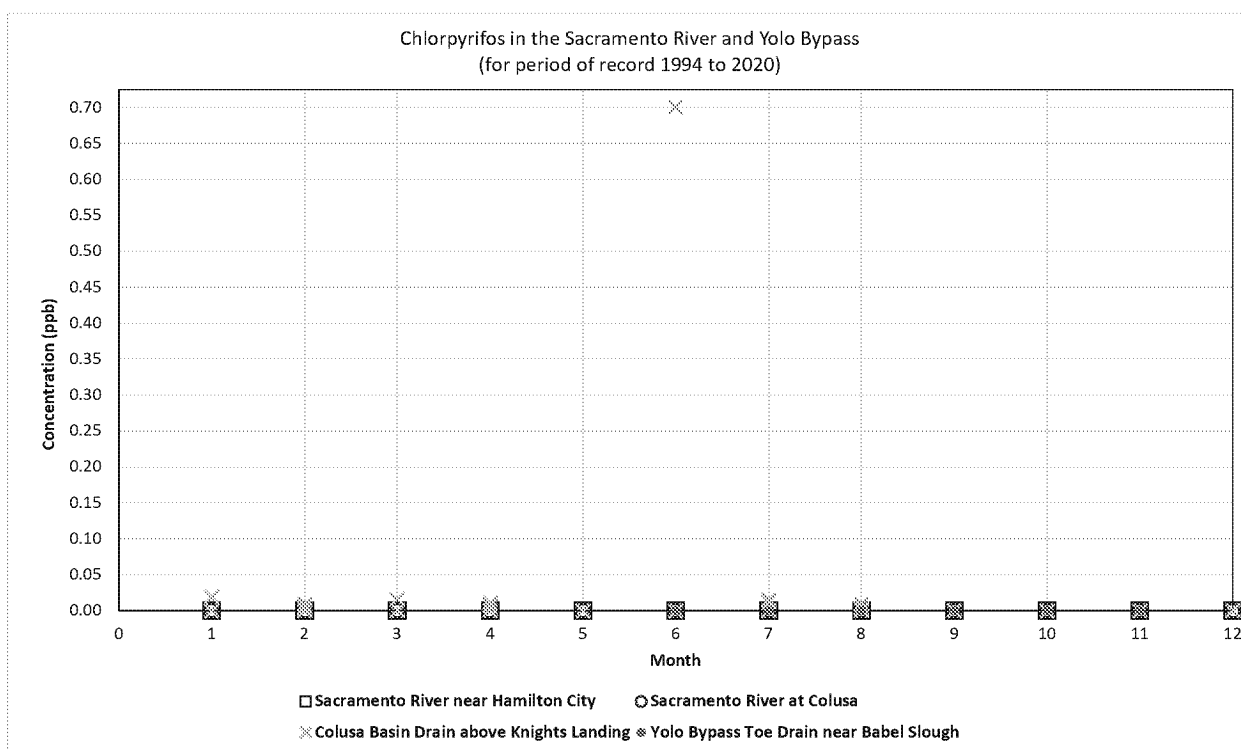
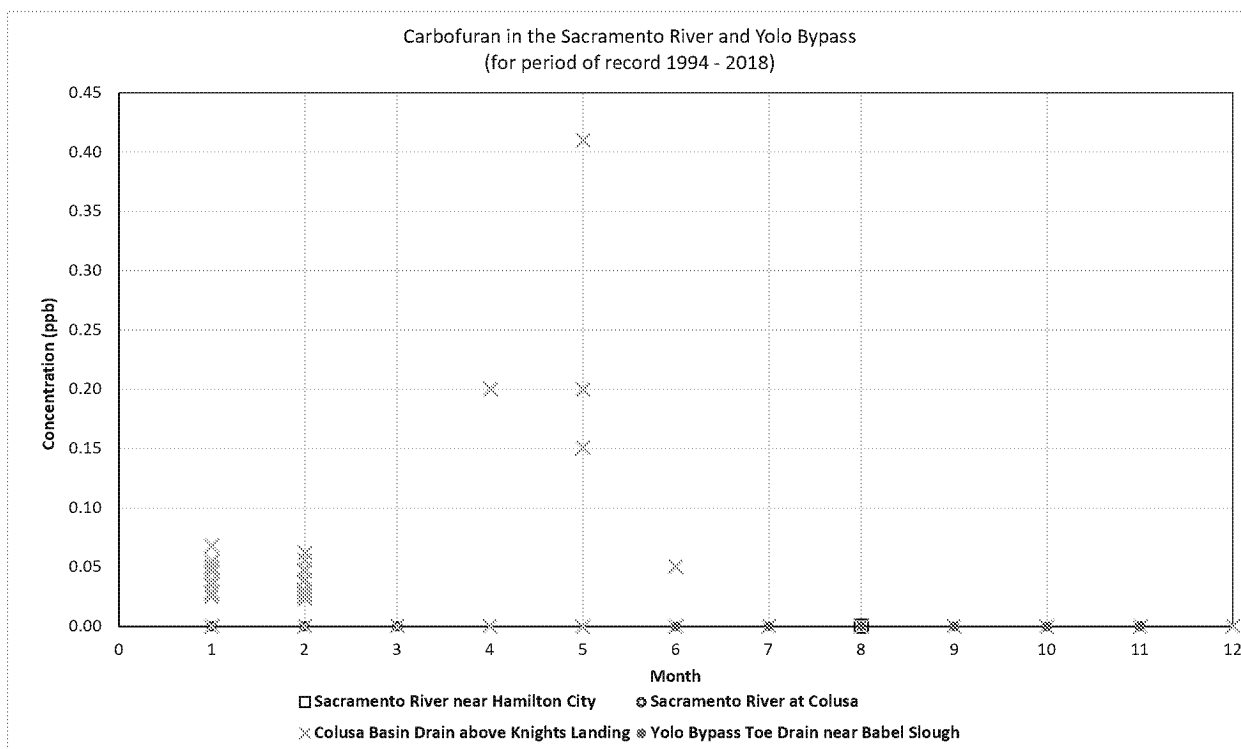


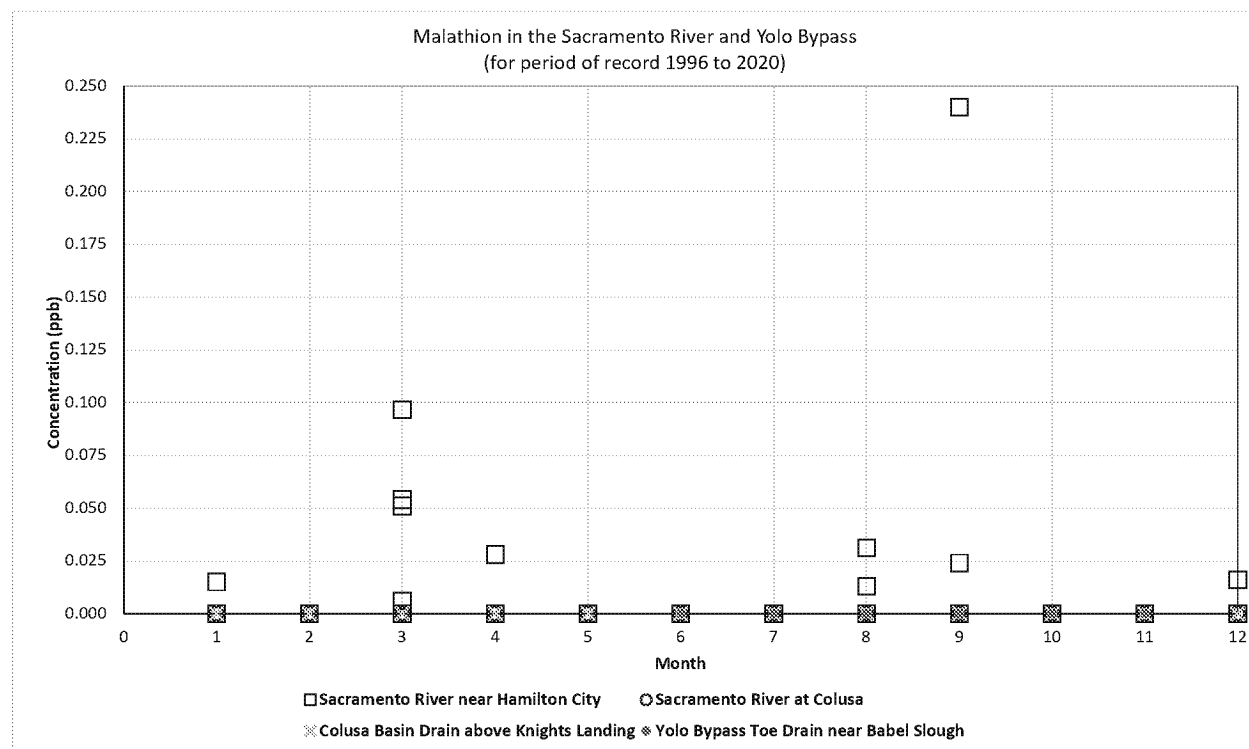
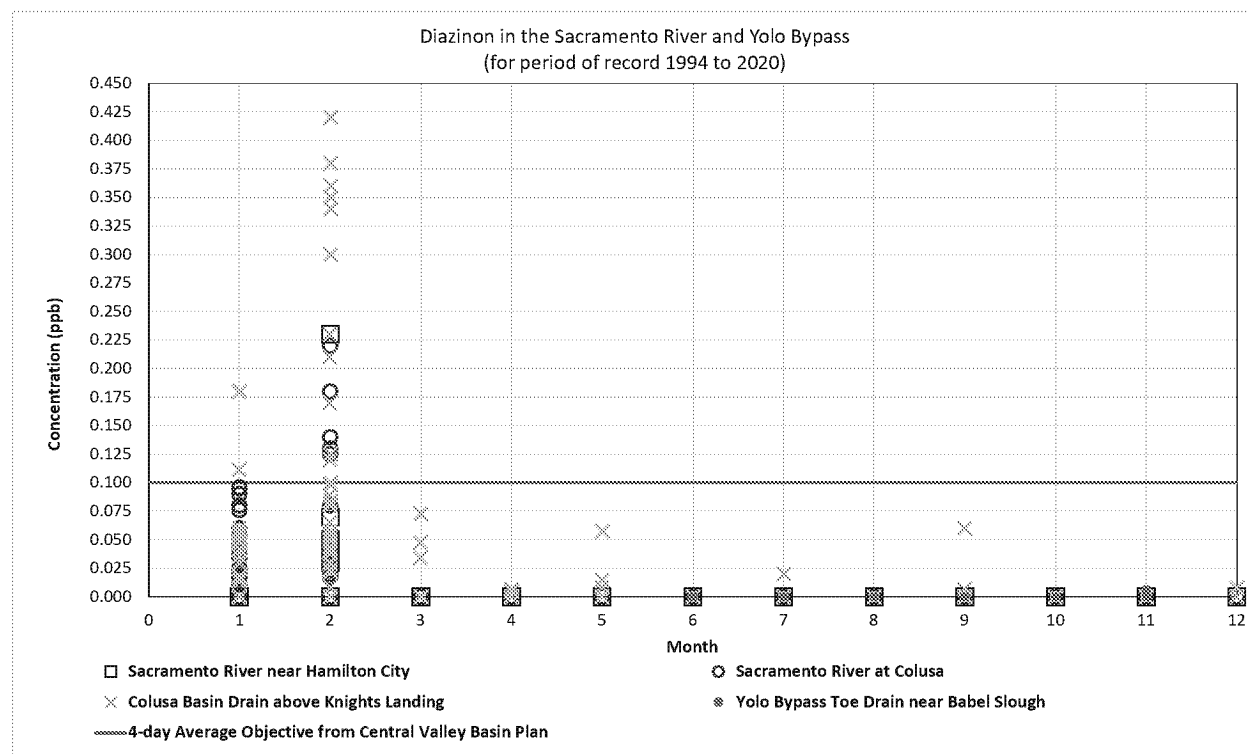


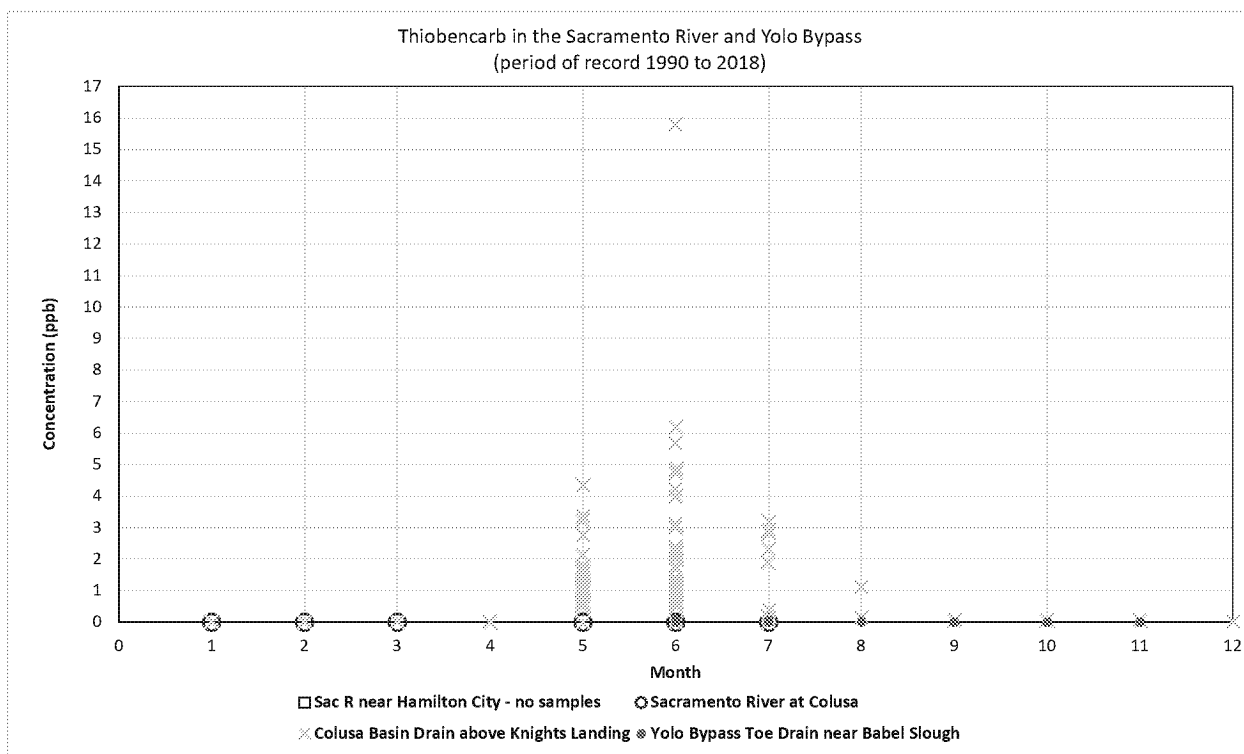


Pesticide Data by Month

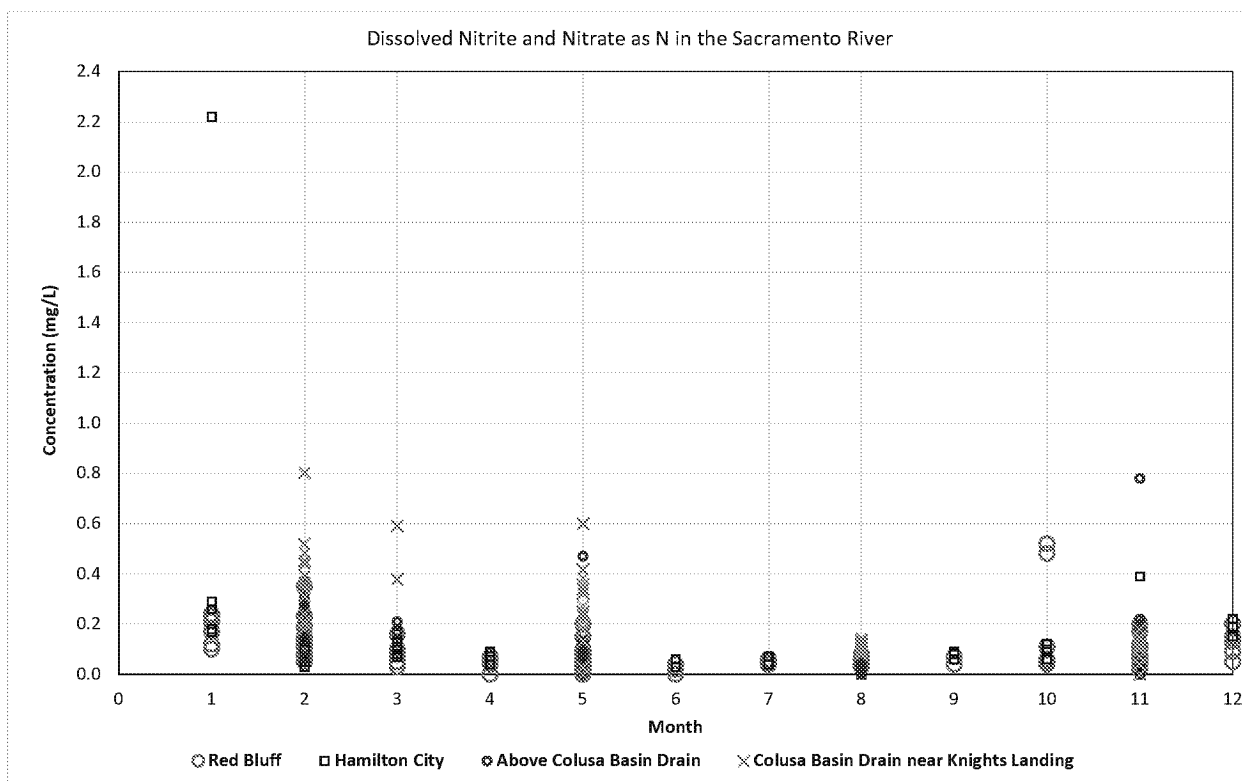
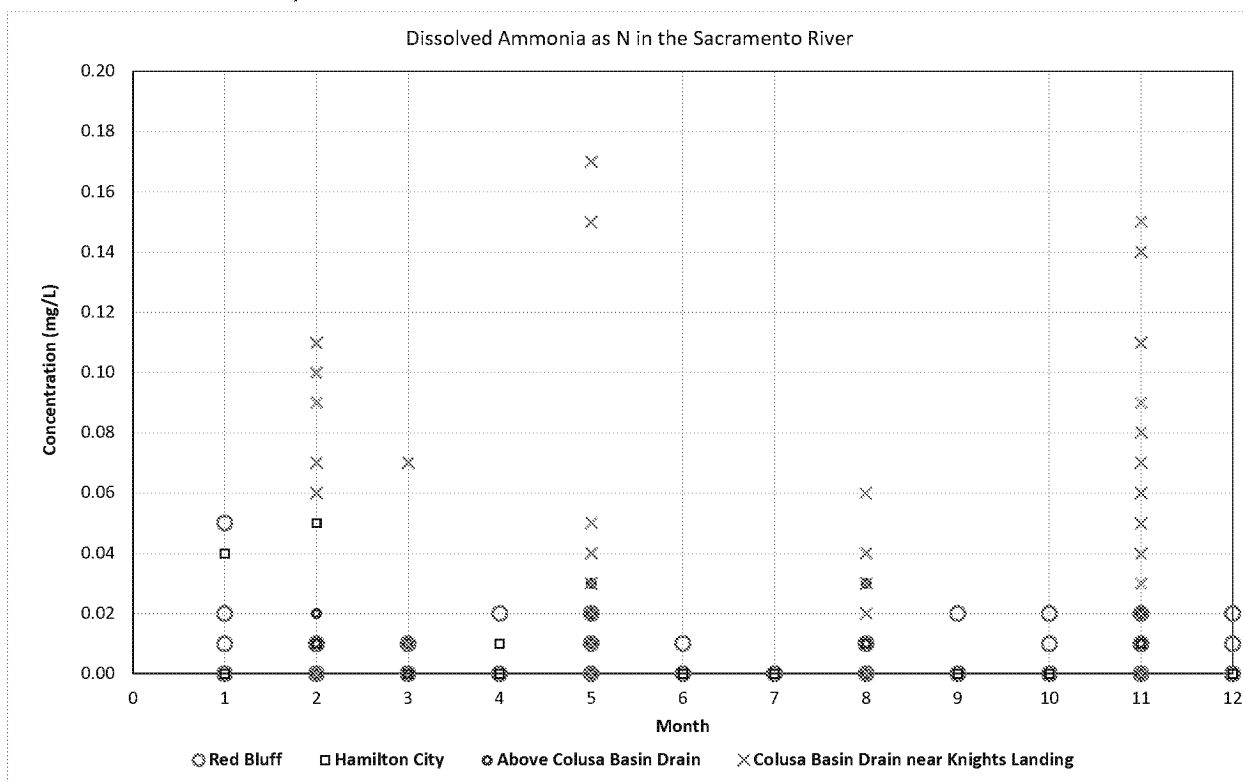


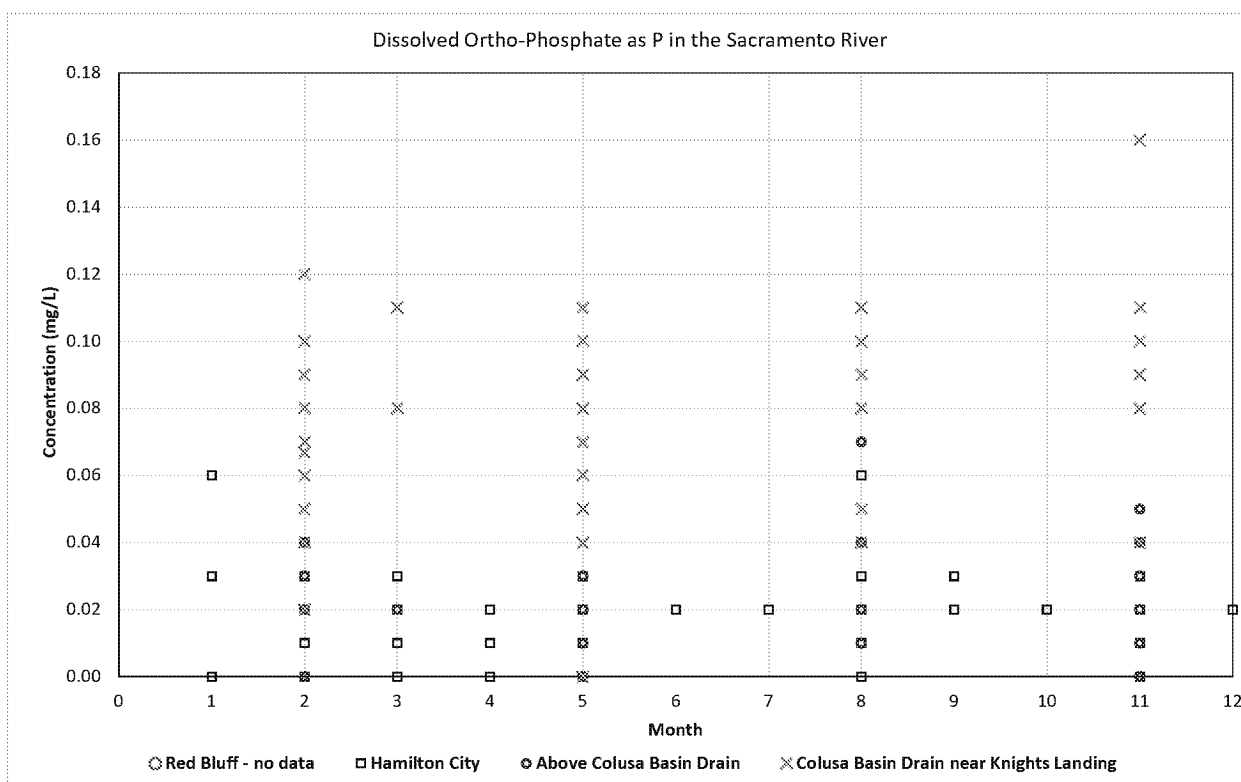
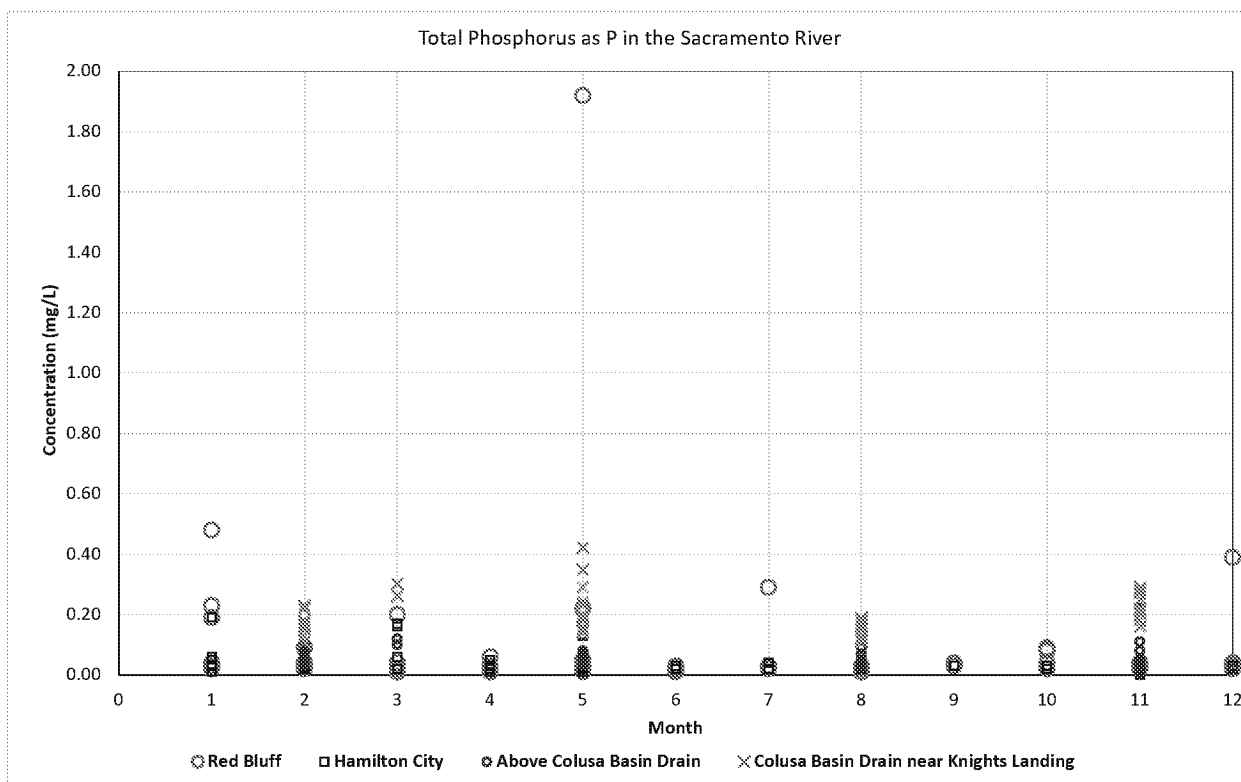






Nutrients Data by Month





From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/9/2021 3:57:21 PM
To: Charles Gardiner [Charles@CatalystGroupCA.com]
Subject: New Governance Responsibilities

Here's the trigger points in the project timeline that we felt were significant in terms of when governance elements. I've represented what I think would work best. However I think at this stage you can pick out the themes between the input you get from Gary and I to come up with a list of the "responsibilities" for consideration in each stages of the project. Let me know any questions.

Entitlement Milestone

1. Certified EIR and Associated Commitments – Encumbers the project with legal conditions

- AB continues to oversee that EIR/MMRP conditions are being met. Frequency of check-in annually.
- RC delegated full responsibility for meeting EIR conditions in developing project
- Remedies/dispute resolution established to protect AB if RC found not meeting conditions
- RC delegated authority to design the project within conditions established by AB in the certified EIR and Associated Commitments
- Project Agreement expands delegation of authority to RC from AB but continues to keep AB oversight.

2. Acquisition of Significant Assets (Land/WaterRights) and Liabilities (loan agreements) – Creates LT ownership responsibilities

- AB retains property deeds and responsibility to SWRCB for water right compliance
 - AB leases assets (100 years) to RC with conditions for 5 yr compliance certification with conditions for cure and dissolution of lease if necessary
 - New financing Authority overseen by RC that signs loan agreements
- (* most likely at this stage the RC becomes its own JPA with its own board for governance over its responsibilities)

3. Enter Construction Contracts – risk assignment for built facilities

- AB finds that RCs design meets project encumbrances
- RC delegated authority to design/construct/own/operate project facilities
- RC assigned all design/construction risks
- Prior operating agreements by the AB are assigned to the RC, no further oversight of operating agreements by AB.

4. Long Term Operations – operating the project as an independent public utility

- AB finds the built project complete to legal conditions and absolves itself of all future responsibility except water right compliance
- RC JPA continues as the facility operator/owner

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/10/2021 8:46:30 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Ad-Hoc

Hi,

I've finished the permitting Ad-Hoc component and reviewed (and formatted grrrr) ICF's part. The last slide that is remaining is the 2017 vs 2021 impacts. Ellen is pulling total impact numbers out of the 2016 mitigation report from CH. That's the best we can do for now as we are still trying to track down the actual numbers from 2017, and I don't have a lot of faith that we will ever find them.

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

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From: Berryman, Ellen [Ellen.Berryman@icf.com]
Sent: 4/10/2021 11:34:23 AM
To: Spranza, John [john.spranza@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Old Versions for Mitigation Evaluation

Hi John. Will do – I'll let you know as soon as I talk with David on Monday.

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Saturday, April 10, 2021 11:33 AM
To: Berryman, Ellen <Ellen.Berryman@icf.com>; aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>
Subject: RE: Old Versions for Mitigation Evaluation

Hey Ellen,

So, something easy is turning into quite the challenge. Let's go with Plan B and have David run the new species models using the 2019 footprint that you used for that BA. I realize this is last minute, so after you coordinate with him Monday like we discussed, let me know what the ETA is.

Ali, this comparison is meaningless as so much has changed and there is no GIS data from 2016/7. So, to have anything meaningful to compare, the GIS analysis will be needed and if David can get to it Monday, we are looking at late Tuesday or early Wednesday at best. I'll circle back with you on Monday.

John Spranza

D 916.679.8858 M 818.640.2487

From: Berryman, Ellen <Ellen.Berryman@icf.com>
Sent: Saturday, April 10, 2021 11:18 AM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: RE: Old Versions for Mitigation Evaluation

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Take a look when you get a chance, before I complete. It's still like apples and oranges. The only way to do a real comparison would be to apply the current models (with current land cover mapping) to the old footprint, which we could do.

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Friday, April 9, 2021 4:30 PM
To: Berryman, Ellen <Ellen.Berryman@icf.com>
Subject: RE: Old Versions for Mitigation Evaluation

We can just do total acreage

Listed Species	2017 Acres	2021 Acres
----------------	------------	------------

Keck's checker-mallow		
Palmate-bracted bird's beak		
Vernal pool crustaceans		
Valley elderberry longhorn beetle		
California red-legged frog		
Giant garter snake		
Tricolored blackbird		
Swainson's hawk		
Western yellow-billed cuckoo		
Bank swallow		
Crotch and western bumblebees*		

John Spranza

D 916.679.8858 M 818.640.2487

From: Berryman, Ellen <Ellen.Berryman@icf.com>

Sent: Friday, April 9, 2021 3:41 PM

To: Spranza, John <John.Spranza@hdrinc.com>

Subject: RE: Old Versions for Mitigation Evaluation

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I see mitigation numbers. Are impact numbers in there too?

From: Spranza, John <John.Spranza@hdrinc.com>

Sent: Friday, April 9, 2021 3:11 PM

To: Berryman, Ellen <Ellen.Berryman@icf.com>

Subject: FW: Old Versions for Mitigation Evaluation

Ellen,

I think the best we are going to come up with is the attached Excel table from the 2016 mitigation technical report. It has acres of landcover/habitat and I am wondering if you can use it to estimate the 2017 numbers.

John Spranza

D 916.679.8858 M 818.640.2487

From: Herrin, Jeff <jeff.herrin@aecom.com>
Sent: Friday, April 9, 2021 1:14 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: Old Versions for Mitigation Evaluation

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.

John,

Let me know if this has what you were looking for.

Jeff

From: David Zelinsky [zelinsky.david@gmail.com]
Sent: 4/10/2021 12:21:55 PM
To: Spranza, John [john.spranza@hdrinc.com]
CC: tstokely@att.net; jimb@aqualliance.net; dobegi@nrdc.org; reis@bayecotarium.org; rzwilling@defenders.org; DLucero@ButteCounty.net [DLucero@buttecounty.net]; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com; regina@californiasalmon.org; Huber, Anne [Anne.Huber@icf.com]; Williams, Nicole (Nicole.Williams@icf.com) [Nicole.Williams@icf.com]; steve.micko@jacobs.com; asanchez@calwild.org; Ron Stork [RStork@friendsoftheriver.org]; Alicia Forsythe [aforsythe@sitesproject.org]; Davis, Ryan A [rdavis@usbr.gov]; Dekar, Melissa D [mdekar@usbr.gov]; King, Vanessa M [vking@usbr.gov]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Morgan, Joseph [Morgan.Joseph@epa.gov]; Gordon, Stephanie (Skophammer) [GORDON.STEPHANIES@epa.gov]; Wolder, Natalie L [nwolder@usbr.gov]; Deeds, Daniel A [ddeeds@usbr.gov]
Subject: Sites Project Water Quality Group Discussion-Materials

You might reach out to Tim Johnson of the California Rice Commission. I suspect he will support Sites, but I want to hear what his comfort level is on the effect of Sites on metals in rice, such as arsenic, if any.

Perhaps they could be prevailed upon to help with water testing too.

Thank you.

David Zelinsky
530-417-6116

On Friday, April 9, 2021, Spranza, John <John.Spranza@hdrinc.com> wrote:

Hello,

Thank you for attending our Water Quality Discussion on Wednesday. I wanted to follow up and provide the presentation and the supplemental figures for Metals, Nutrients, and Pesticides that we discussed, they are attached.

I will follow up on the Action Items below in a separate email, please let me know if you have any additions.

1. Discussion of the Preferred Alternative selection
2. Provide a table with data details such as location, timing and number of data points
3. Schedule 90 minute meeting in May

Lastly, the following are future agenda topics that were identified during our meeting:

- Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of the reservoir.
- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

John

John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

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From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/10/2021 1:46:05 PM
To: Leaf, Rob/SAC (Rob.Leaf@jacobs.com) [Rob.Leaf@jacobs.com]; Davis-Fadtke, Kristal@Wildlife [kristal.davis-fadtke@wildlife.ca.gov]; Davis, Ryan A [rdavis@usbr.gov]; Kundargi, Kenneth (Kenneth.Kundargi@wildlife.ca.gov) [Kenneth.Kundargi@wildlife.ca.gov]; Williams, Jonathan@Wildlife [Jonathan.Williams@wildlife.ca.gov]; Hendrick, Mike [mike.hendrick@icf.com]; Dekar, Melissa D [mdekar@usbr.gov]; Cordova, Daniel A [dcordova@usbr.gov]; Wilder, Rick [Rick.Wilder@icf.com]; La Luz, Felipe@Wildlife [felipe.laluz@wildlife.ca.gov]; Chris Fitzer (CFitzer@esassoc.com) [CFitzer@esassoc.com]; Hassrick, Jason (Jason.Hassrick@icf.com) [Jason.Hassrick@icf.com]; Greenwood, Marin [Marin.Greenwood@icf.com]; evan.sawyer [evan.sawyer@noaa.gov]; Lecky, Jim [jim.lecky@icf.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]; steve.micko@jacobs.com; Monique Briard (monique.briard@icf.com) [monique.briard@icf.com]; Cathy Marcinkevage - NOAA Federal [cathy.marcinkevage@noaa.gov]; Perry, Russell W [rperry@usgs.gov]; ebuttermore@usbr.gov; mbeakes@usbr.gov; smanugian@usbr.gov; Alicia Forsythe [aforsythe@sitesproject.org]; Schoenberg, Steven [steven_schoenberg@fws.gov]; cyril.michel@noaa.gov; Bauer, Nick@Wildlife [Nick.Bauer@Wildlife.ca.gov]; Huneycutt, Andrew@Wildlife [Andrew.Huneycutt@Wildlife.ca.gov]; Johnson, Matt@Wildlife [Matt.Johnson@wildlife.ca.gov]; Sherrick, Robert@Wildlife [robert.sherrick@wildlife.ca.gov]; Nelson, Jonathan@Wildlife [Jonathan.Nelson@wildlife.ca.gov]; Meyers, Erica@Wildlife [Erica.Meyers@wildlife.ca.gov]; annmarie.ore@waterboards.ca.gov; Biondi, Oscar@Waterboards [Oscar.Biondi@waterboards.ca.gov]; Kurth, Ryon@Wildlife [Ryon.Kurth@Wildlife.ca.gov]; gordon.stephanieS@epa.gov
CC: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]; Kevin Spesert [kspesert@sitesproject.org]; Jerry Brown [jbrown@sitesproject.org]; Marcia Kivett [MKivett@sitesproject.org]; Noble Hendrix [noble@qedaconsulting.com]; Steve Zeug [stevez@fishsciences.net]; King, Vanessa M [vking@usbr.gov]; Lee Bergfeld [Bergfeld@mbkengineers.com]; Paccassi, Michael@Wildlife [Michael.Paccassi@Wildlife.ca.gov]; stephen.maurano@noaa.gov
Subject: Sites Project Joint Aquatic Workshop #2
Attachments: Aquatics Joint Workshop 20210409_Final.pptx

Hello,

Thank you for attending our second Joint Agency Aquatics Workshop yesterday. I wanted to follow up and provide the presentation for your review and address the items and questions brought up during our workshop.

The following Action Items will be addressed in a separate email, please let me know if you have any additions:

1. Distribute Sites Daily Divertible & Storable Flow Tool once the modeling team has documented the assumptions used.
2. Discuss with the Sites team the inclusion of a post-pulse ramping regime and include results in next workshop.
3. Provide a rational and documentation of each bypass criteria in the environmental documentation and permit applications.
4. Clarify the diversion screen function as it related to increasing diversion volume with increasing river stage.

Lastly, the following are future agenda topics that were identified during our meeting:

- Provide additional detail on the temperature effects through egg emergence.
- Include a discussion of a net temperature benefit.
- Include a discussion of effects to Osmeriformes.
- Include a discussion of rearing habitat.

Please let me know if you have any questions or additions to the above.

Regards,

John

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

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Sites Project Joint Aquatic Workshop

PULSE FLOWS FOR SALMON:
SITES RESERVOIR PROJECT DIVERSION CRITERIA

April 9, 2021 Workshop

Agenda

- Introductions and objective
- Review of baseline for CalSim analysis
- Overview of proposed diversion criteria
- Discussion of Pulse Flow
 - Pulse flow vs. Wilkins Slough
 - Review of preliminary effect analysis
 - Implementation of pulse flow
- Group discussion
- Next steps

Purpose/Objectives

- Review development of and rationale for proposed operating criteria
- Discuss variability in flows and operations
- Review preliminary effects analysis
- Discuss proposed operating criteria

CalSim II Baseline



CALSIM II: Baseline Assumptions

- Baseline used for Revised Draft EIR/Supplemental Draft EIS modeling: CalSim 2020 Benchmark
- Baseline includes actions from SWP ITP and ROC on LTO
- Developed by Reclamation in coordination with DWR and CDFW
- Includes more ITP actions than DCR 2019 model and DWR ITP Alternative 2b model
- All baseline actions preserved in alternatives evaluated

Erin Heydinger to review modeling assumptions

CALSIM II: Baseline Key Actions

- Sacramento River:
 - Shasta Cold Water Pool Tiered Strategy (ROC on LTO)
 - Spring Pulse Flow (ROC on LTO)
- American River:
 - 2017 Flow Management Standard (ROC on LTO)
- Delta:
 - Delta Smelt Summer-Fall Habitat
 - X2 requirement (ROC on LTO and SWP ITP)
 - SMSCG operations (ROC on LTO and SWP ITP)
 - Summer Outflow Block (SWP ITP)
 - Spring Outflow Block – SWP export curtailment (SWP ITP)

Draft - Preliminary Working Document - For Discussion Purposes Only

6

SMSCG = Suisun Marsh Salinity Control Gates

CALSIM II: Baseline Key Actions

- Delta Old and Middle River (OMR) Flow Requirements:
 - Early winter pulse protection (ROC on LTO and SWP ITP)
 - Turbidity bridge avoidance (ROC on LTO and SWP ITP)
 - Storm-related OMR flexibility (ROC on LTO and SWP ITP)
 - Species-specific cumulative salvage or loss threshold (ROC on LTO and SWP ITP)
- Specifics of modeling approach for each of these actions and operations is available in a memo distributed February 23, 2021

SMSCG = Suisun Marsh Salinity Control Gates

Overview of Diversion Criteria and Pulse Flow



Purpose/Goals

- Review development of and rationale for proposed diversion criteria
- Discuss the value of variability in flows and operating consistent with “real time” hydrology to facilitate survival of out-migrating smolts
- Review preliminary effects analysis
- Discussion of proposed diversion criteria

Why pulse flow protection is an appropriate approach?

- Recent studies have focused more on the role of the river in driving salmon population levels
- Generally, smolt survival is higher in wetter years
- Variability in flow is important, particularly in drier years.
- Variability can be ensured by establishing diversion criteria tied to changes in the hydrograph resulting from storm events.

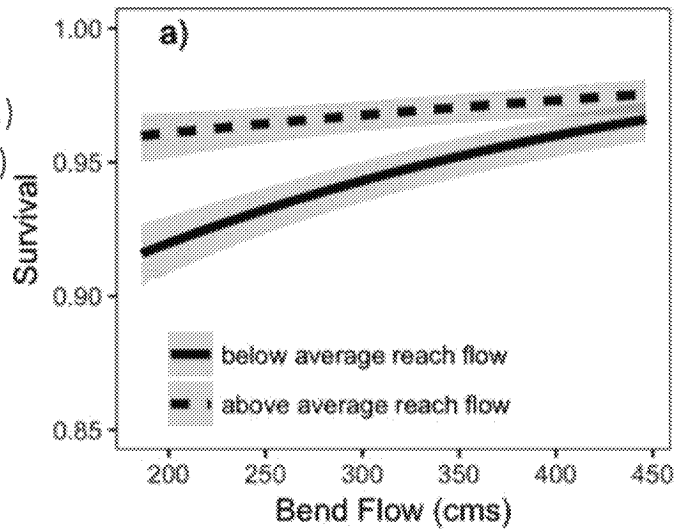
Sites Project Diversion Criteria

Sites Diversion Criteria	
Bend Bridge Pulse Protection Season	October - May
Bend Bridge Pulse Protection Initiation Criteria	3-day average Sacramento River must exceed 8,000 cfs; 3-day average tributary flow must exceed 2,500 cfs
Bend Bridge Pulse Protection Duration	7 days upon initiation
Bend Bridge Pulse Protection Re-setting Criteria	After completion of pulse protection period, resetting criteria must be met for another pulse protection period to commence: 3-day Sacramento River flow must go below 7,500 cfs for 7 consecutive days; 3-day moving average tributary flow must go below 2,500 cfs for 7 consecutive days
Wilkins Slough Bypass Flow	8,000 cfs April - May; all other times, 5,000 cfs
Fremont Weir Notch Criteria	Prioritize the Fremont Weir Notch, Yolo Bypass preferred alternative, flow over weir within 10% when spill range between 600 cfs and 6,000 cfs; First 600 cfs of spill are protected within 1%
Flows into the Sutter Bypass System	None
Freeport Bypass Flow	None
Surplus Delta Outflow	7 days of flow availability in February – March is required before diversions can be made in those months
SWP ITP Delta Outflow	44,500 cfs April - May

Riverscape Level – Henderson et al. (2018)

Reach x Year flow interaction

- Covariate response
 - High flow year (above ave.)
 - Low flow year (below ave.)

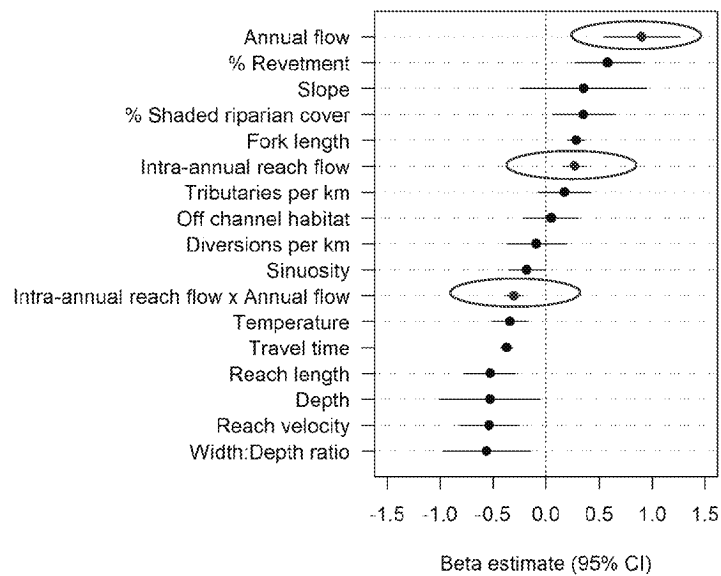


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If flow within a reach was well above the annual average, as it would be after a precipitation event, there was relatively little (1.6% per 10 km) difference between survival in low- and high-flow years. In contrast, below average flows within a reach resulted in large (5% per 10 km) differences in survival between low- and high-flow years.

Factors That Affect Winter Run Survival

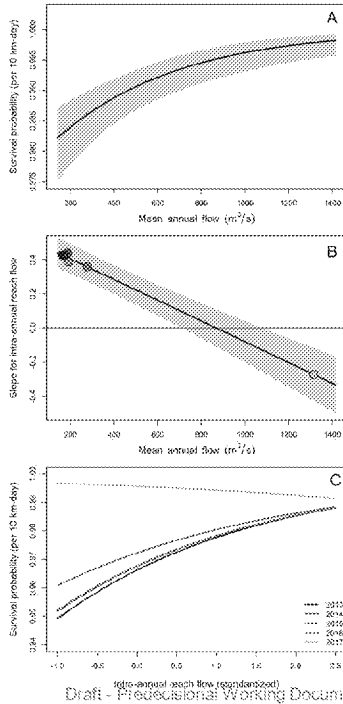


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Figure 6. Parameter estimates ($\pm$ 95% confidence intervals) of slope coefficients (i.e., beta estimates) for each covariate in the selected model. Confidence intervals that overlap zero indicate no detectable effect.

Riverscape Level – Hassrick et al. (in prep)



A. Survival as a function of mean annual flow

Shaded regions in panels A and B show 95% confidence intervals

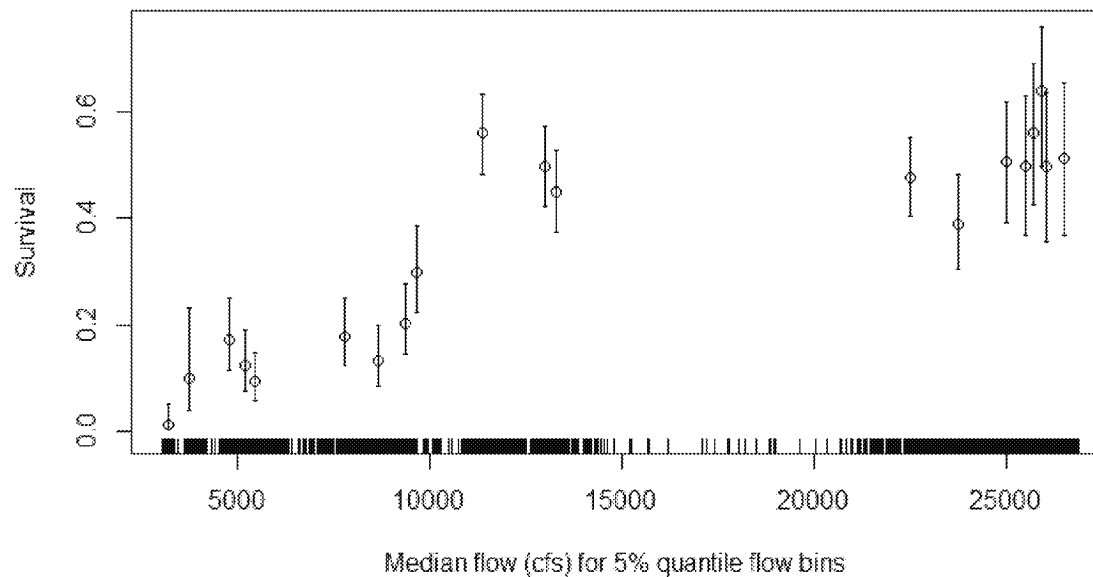
B. Slope coefficient for intra-annual reach flow as a function of mean annual flow.

C. Combined mean annual flow and intra-annual reach flow on predicted survival

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Effects of mean annual flow, interannual reach flow, and their interaction on predicted survival. Panel A shows predicted survival per 10 km per day as a function of mean annual flow with interannual reach flow and all other covariates set to mean values. Panel B illustrates the effect of the interaction between mean annual flow and interannual reach flow, showing the slope coefficient for interannual reach flow as a function of mean annual flow. Symbols in panel B show the slope for interannual reach flow for each value of mean annual flow (symbols jittered vertically slightly to reduce overlap). Panel C shows the 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 95% confidence intervals.

Nonlinear Flow-Survival - Michel et al. (2021)

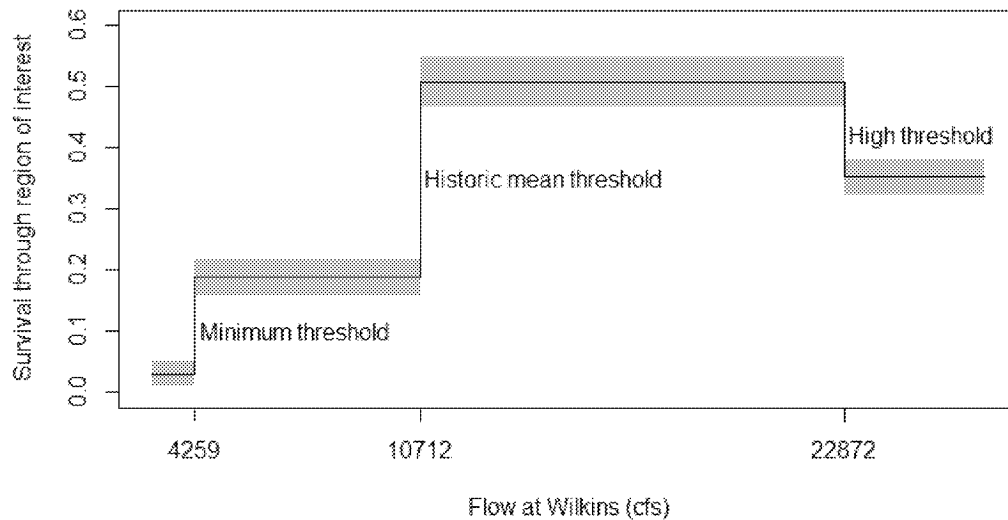


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Jim: Figure 3. Survival as a function of flow. Survival estimates (circles) with 95% confidence intervals (bars) for groups at 5% quantile bins of experienced flow, plotted at the median value of bins (in cfs) on the x-axis. Flow experienced per fish is indicated by vertical tick marks on x-axis.

Nonlinear Flow-Survival - Michel et al. (2021)



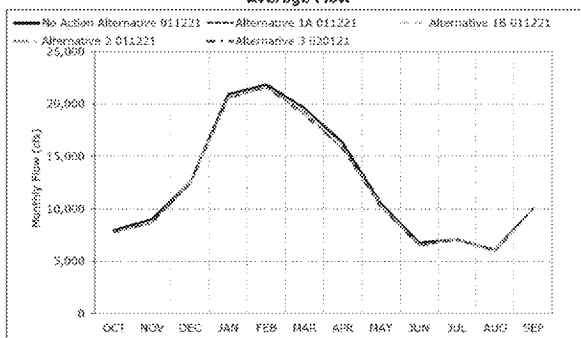
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Jim: Figure 6. Thresholds of predicted survival as a function of flow. Predictions are based on the model averaged parameters from the most parsimonious triple threshold models, with mean thresholds at 4,259 cfs, 10,712 cfs, and 22,872 cfs, with 95% confidence intervals (grey fill). Flow averaged from Wilkins Slough gauge through the region of interest (confluence with Deer Creek to confluence with Feather River).

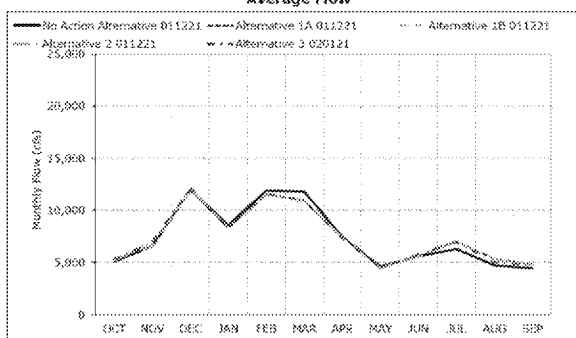
CalSim Average Annual Flow at Wilkins Slough Wet Year v. Dry Year

Figure 5B2-14-2. Sacramento River at Wilkins Slough Flow, Wet Year
Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCS D-1641, 1999).
*These results are displayed with calendar year - year type setting.

Figure 5B2-14-5. Sacramento River at Wilkins Slough Flow, Dry Year
Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCS D-1641, 1999).
*These results are displayed with calendar year - year type setting.

Jim: Base on the progress of investigation we think give the reduced size of the project the upstream location of the diversions, focusing on within year variability by protecting pulse flow events is a better approach to managing survival of emigrating Chinook salmon. We can't turn a dry year into a wet year with flow standards,

Sacramento River Flow at Wilkins Slough December - March

Figure SB2-14-9. Sacramento River at Wilkins Slough Flow, December

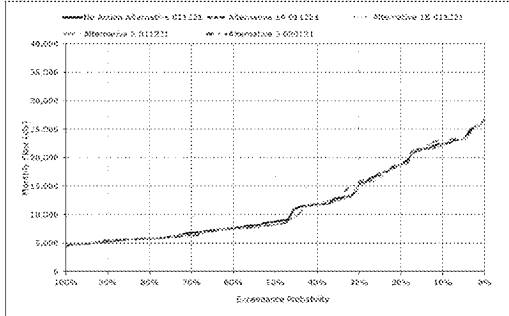


Figure SB2-14-10. Sacramento River at Wilkins Slough Flow, January

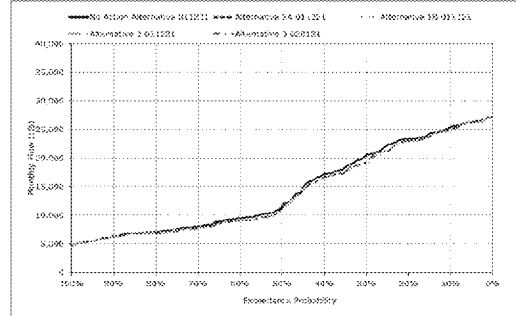


Figure SB2-14-11. Sacramento River at Wilkins Slough Flow, February

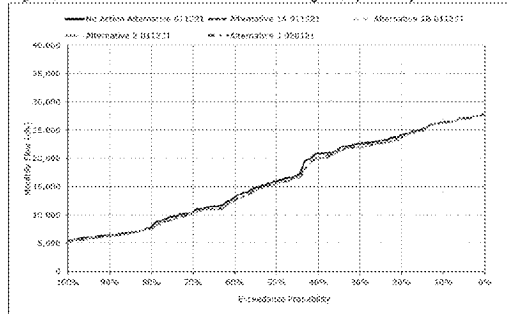
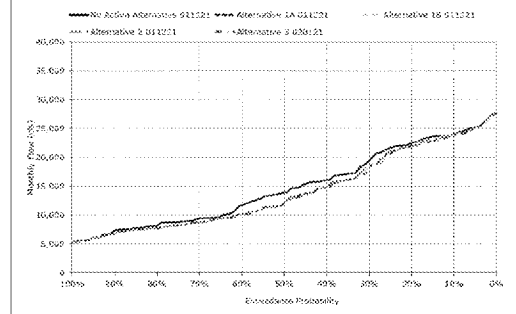


Figure SB2-14-12. Sacramento River at Wilkins Slough Flow, March



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Jim: For the most part CALSIM results deviate little from the NAA. The greatest deviation from the NAA occurs in March in below normal and

Potential Flow-Survival Effects



Potential Flow-Survival Effects

- Used Michel et al. (2021) flow thresholds
- Obtained R code from Cyril Michel
 - Applied the “pulse flows” portion of their analysis
 - But in Sites context used to illustrate the importance of accounting for daily (pulsed) movement of fish to assess potential diversion effects
- Input flow data (Sac. R. above Wilkins Slough) from Sites Daily Divertible & Storable Flow Tool (version 20210309) Excel workbook
 - Representation of historical flows (2009-2018)
 - Daily potential diversions of storable flow to Sites Reservoir

Marin: importance of pulse protection measures that are included in project

Potential Flow-Survival Effects

- Facility assumptions in Daily Divertible & Storable Flow Tool (version 20210309)

Sites Facilities	
Sites Storage Capacity	1.5 MAF
Initial Sites Storage	200 TAF
Sites Diversion Season	November - May
Red Bluff Diversion Capacity	2,100 CFS
Red Bluff Bypass Flow	3,250 CFS
TCC Minimum Pumping Level	125 CFS
Hamilton City Diversion Capacity	1,800 CFS
Hamilton City Bypass Flow	4,000 CFS
GCC Minimum Pumping Level	100 CFS
GCC Maintenance Window	January 25 – February 7
Facilities (Not Sites Specific)	
Fremont Weir	Fremont Weir Notch

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Potential Flow-Survival Effects

- Regulatory assumptions in Daily Divertible & Storable Flow Tool (version 20210309)

Regulatory Assumptions	
Bend Bridge Pulse Protection Season	October - May
Bend Bridge Pulse Protection Initiation Criteria	3-day average Sacramento River must exceed 8,000 cfs; 3-day average tributary flow must exceed 2,500 cfs
Bend Bridge Pulse Protection Duration	7 days upon initiation
Bend Bridge Pulse Protection Re-setting Criteria	After completion of pulse protection period, resetting criteria must be met for another pulse protection period to commence: 3-day Sacramento River flow must go below 7,500 cfs for 7 consecutive days; 3-day moving average tributary flow must go below 2,500 cfs for 7 consecutive days
Wilkins Slough Bypass Flow	8,000 cfs April - May; all other times, 5,000 cfs
Fremont Weir Notch Criteria	Prioritize the Fremont Weir Notch, Yolo Bypass preferred alternative, flow over weir within 10% when spill range between 600 cfs and 6,000 cfs; First 600 cfs of spill are protected within 1%
Flows into the Sutter Bypass System	None
Freeport Bypass Flow	None
Surplus Delta Outflow	7 days of flow availability in February - March is required before diversions can be made in those months
SWP ITP Delta Outflow	44,500 cfs April - May

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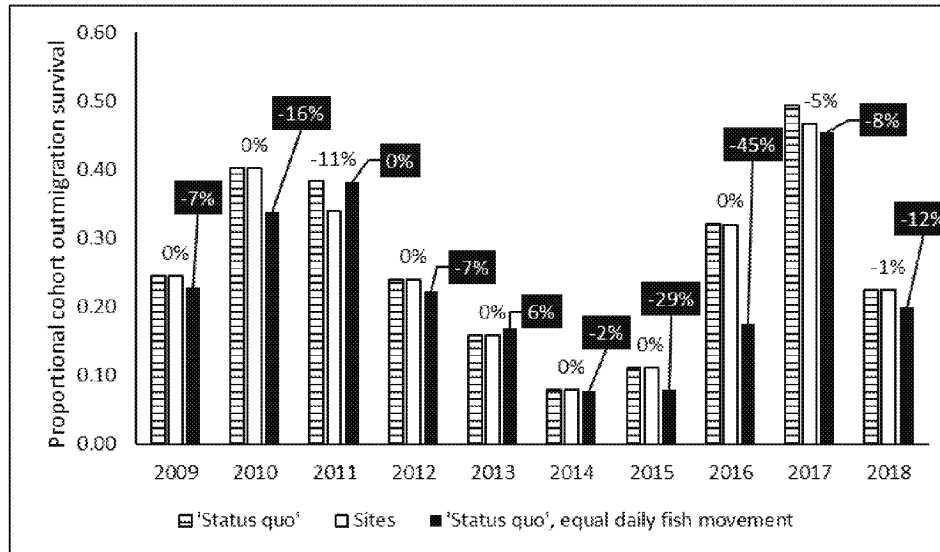
22

Potential Flow-Survival Effects

- Michel et al. (2021) flow threshold method
 - Refined window of analysis to January 1-May 31 (reflects input data provided by C. Michel + main period of Sites diversions)
 - (Original window was March 15-June 15)
- Applied method to three scenarios with flows
 - Historical movement of juvenile Chinook salmon at Red Bluff rotary screw traps
 - Sac. R at Wilkins Slough minus Red Bluff/Hamilton City diversions
 - Sac. R. at Wilkins Slough flow with Red Bluff + Hamilton City diversions added back in (~ 'status quo')
 - Equal number of fish moving each day
 - ~'Status quo' flows

Potential Flow-Survival Effects

- Results from Michel et al. (2021) flow threshold method
– Note: preliminary/draft, based on version 20210309 flow tool



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Marin

Potential Flow-Survival Effects

- Facility + regulatory assumptions from Daily Divertible & Storable Flow Tool (version 20210309) generally resulted in minimal survival differences compared to 'status quo' flows
- Regulatory assumptions capture pulse flows and associated fish movements well
 - Equal daily movement of fish scenario generally resulted in much lower modeled survival than status quo (and Sites potential diversions)
- Sites Project would also include real-time operations based on fish monitoring to minimize potential project impacts on survival

Marin: Summary of discussion of graph slide results.

Group Discussion

We welcome your thoughts and questions



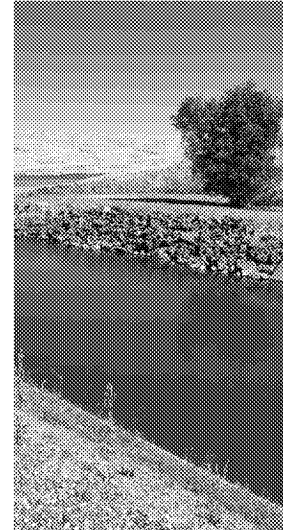
Potential Discussion Points

- How could Sites Reservoir be used to create or enhance pulses and improve temperatures, particularly in dry years?
- One approach is to try to time a pulse flow protection with pulses in tributary flows to achieve a more natural hydrograph. What are your thoughts on how Sites can create pulse flow conditions that can benefit salmon survival beyond what we have discussed?



Potential Discussion Points

- Temperature has been identified in several studies as a key driver of survival dynamics. What are your thoughts on how we can manage to keep temperatures low during low flow years, given that our ability to control temperature in the river is limited to the upper river?
- What additional analyses would help?



Next Steps

- Topics for next workshop
- Modeling output for review
- Schedule for next meeting





Prepared by Design for Distribution

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/12/2021 9:43:21 AM
To: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]; Risse, Danielle [Danielle.Risse@hdrinc.com]; Spranza, John [john.spranza@hdrinc.com]; Fisher, Linda [Linda.Fisher@hdrinc.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Permitting Matrix Update for Ad-Hoc

Hi John – I added a list of the cooperating and responsible agencies that are reviewing the project description but otherwise had no changes.

From: Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
Sent: Monday, April 12, 2021 9:41 AM
To: Risse, Danielle <Danielle.Risse@hdrinc.com>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Fisher, Linda <Linda.Fisher@hdrinc.com>
Cc: aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>
Subject: RE: Permitting Matrix Update for Ad-Hoc

Updated my info this morning.

One consideration is to add pre-application meeting for 404 and show it as completed (since it was a deliverable)

Jelica Arsenijevic
Environmental Project Manager

Due to COVID-19, I will be working from home. Please contact me via cell # listed below. Be safe out there!



2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916-679-8854
M 209-329-6897

Jelica.Arsenijevic@hdrinc.com

hdrinc.com/follow-us

From: Risse, Danielle <Danielle.Risse@hdrinc.com>
Sent: Sunday, April 11, 2021 2:49 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Fisher, Linda <Linda.Fisher@hdrinc.com>
Cc: aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>
Subject: RE: Permitting Matrix Update for Ad-Hoc

Hi John,
I've reviewed and updated for Section 106.

Thanks, Danielle

Danielle Risse, M.A.
Office 916-679-8796 Mobile 707-372-5007

hdrinc.com/follow-us

From: Spranza, John <John.Spranza@hdrinc.com>

Sent: Saturday, April 10, 2021 9:15 AM

To: Risse, Danielle <Danielle.Risse@hdrinc.com>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Fisher, Linda <Linda.Fisher@hdrinc.com>

Cc: aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>

Subject: Permitting Matrix Update for Ad-Hoc

Please take a moment to update the permitting matrix for our April Ad-Hoc meeting, I have created a file here:

<https://sitesreservoirproject.sharepoint.com/envpermitting/Meetings/Forms/AllItems.aspx?newTargetListUrl=%2Fenvpermitting%2FMeetings&viewpath=%2Fenvpermitting%2FMeetings%2FForms%2FAllItems%2Easpx&viewid=be7fc903%2Db9d5%2D4225%2D8bbc%2D57cabcffdcc5&id=%2Fenvpermitting%2FMeetings%2F3%2E%20Ad%2Dhoc%20Plan%20and%20Permit%20WG%2F2021%2FPermitting%20Dashboard>

Thanks.

John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

HDR

2379 Gateway Oaks Drive, Suite 200

Sacramento, CA 95833

D 916.679.8858 M 818.640.2487

john.spranza@hdrinc.com

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From: Micko, Steve/SAC [Steve.Micko@jacobs.com]
Sent: 4/12/2021 10:12:05 AM
To: Jerry Brown [jbrown@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Leaf, Rob/SAC [Rob.Lead@jacobs.com]
Subject: RE: Carriage Water and Delivery Schedule Strategy

Here's a list of talking points associated to Sites carriage water:

- Sites operational context (present a clear understanding of general operations):
 - Sites operations will modify Delta flows in most years by changing:
 - Sacramento River at Freeport flow
- Sites releases to the Sacramento River for South of Delta uses in Dry and Critically Dry years
 - Yolo Bypass flow
- Sites releases to the Yolo Bypass in most years
 - South of Delta exports
- South of Delta uses with Sites water released to the Sacramento River
 - Delta outflow
- Releases from Sites that are not exported from the Delta
 - Sites will consistently export water through the Delta on a long-term basis
 - Reliability of Sites is beneficial to SWP operations
 - Most notably San Luis storage in July and August
 - Should not bundle Sites with Non-Project Transfers
 - Sites may merit actions in Articles 6 and 7 of the 2018 COA Amendment
- Article 6: Conditions to commence a review process (revisions to Article 14a of 1986 COA)
- Article 7: Advisory Board process (new aspect of COA)
- Sites transfers:
 - One carriage water cost value per transfer window is not feasible
 - Significant operational effort required for Sites/SWP/CVP to calculate and agree upon carriage water cost each year
 - One value does not consider changing conditions in project storage and Delta water quality
 - One value yields more water quality benefits to SWP/CVP
 - Expansion of transfer window (from Jul – Sep to Jul to Nov) is novel
 - Delta WQ conditions in Oct and Nov are much different than those of Jul – Sep
- D1641 and Fall X2 are winding down (most controls cease in Sep)
- In some years, increased exports freshen Old River in Oct and Nov
 - How does DWR plan to approach this?
- “No harm” is too costly for Sites storage partners (Prop 1 SOD Refuges and SOD PWAs)
 - “No harm” carriage water costs are in the range of 30 – 35% each year

Apologies for the tardiness!
Steve

-----Original Appointment-----

From: Marcia Kivett <MKivett@sitesproject.org>
Sent: Tuesday, March 30, 2021 12:16 PM
To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Micko, Steve/SAC; Leaf, Rob/SAC
Subject: Carriage Water and Delivery Schedule Strategy
When: Thursday, April 8, 2021 4:00 PM-5:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Microsoft Teams Meeting

Steve/Rob – if this does not work with your schedule the only **other option is April 9 at 1:00.**

Microsoft Teams meeting

Join on your computer or mobile app

[Click here to join the meeting](#)

Or call in (audio only)

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[\(888\) 404-2493,72551967#](#) United States (Toll-free)

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A Brown and Caldwell Teams meeting has been created for this event.

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From: Lassell, Susan [Susan.Lassell@icf.com]
Sent: 4/12/2021 12:33:18 PM
To: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Williams, Nicole [Nicole.Williams@icf.com]; Risse, Danielle [Danielle.Risse@hdrinc.com]; Lloyd, John [John.Lloyd@hdrinc.com]
CC: Linda Fisher (linda.fisher@hdrinc.com) [linda.fisher@hdrinc.com]
Subject: RE: Sites - Cultural Resources

Thank you for the Reclamation examples, Ali, and your thoughts on applicability to our Cultural chapter. We'll take a closer look and consider these models as we address other comments discussed during our recent call.

I suspect that it will be cleaner to require compliance with the CRMP as the thing that mitigates the CEQA/NEPA impacts, rather than invoking the entire Section 106 process and the PA that results from that process. It's possible that somewhere down the line the PA could end up getting terminated, in which case there would no longer be anything for the Authority to comply with. However, if that were to happen the Authority could adopt the CRMP as its own management plan and still be fulfilling all CEQA commitments. In other words, we should aim to have the CEQA portion of the EIR/EIS fully enforceable by the Authority regardless of what Reclamation does in the future.

SUSAN LASSELL | +1.916.231.7612 direct | +1.415.238.9086 mobile

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Monday, April 12, 2021 7:56 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Lassell, Susan <Susan.Lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>
Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>
Subject: RE: Sites - Cultural Resources

Hi Ali, I think consistency with the PA is absolutely the appropriate (and only) path, I just want to make sure we are issuing a CEQA document that is not perceived to defer mitigation. The CEQA lead agency may have a higher bar than Reclamation in this regard. Obviously, just my opinion from a CEQA perspective.

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Monday, April 12, 2021 7:45 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Susan Lassell <susan.lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>
Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>
Subject: Re: Sites - Cultural Resources

Hi Laurie - please take a look at the example and the number of other recent Reclamation NEPA / CEQA documents that have done this. Also, the PA will be executed by the time we sign the CEQA decision docs. Reclamation will require a signed PA to sign the ROD. Based on the schedule, we should have a signed PA in early 2022, before issuing the Final EIR/EIS and signing the decision documents.

Ali

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

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Monday, April 12, 2021 6:50:49 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Susan Lassell <susan.lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>
Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>
Subject: RE: Sites - Cultural Resources

Hi Ali, my concern would be citing a PA as mitigation when it is not an executed agreement. Our CEQA mitigation needs to be able to stand alone if, for some reason, there is not a PA.

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Monday, April 12, 2021 5:45 AM
To: Susan Lassell <susan.lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>
Subject: Sites - Cultural Resources

Hi all – I just pulled up some examples of prior documents I worked on in Reclamation.

In all of these documents, Reclamation called the impacts LTS with implementation of Section 106 (these were joint CEQA documents). They also did this in the BF Sisk Raise document, which was a joint document.

This makes me think that we should likely modify the text of the CRMP to make it clear that it will comply with and implement the PA / Section 106. I wonder if we need an impact and the mitigation measures to require compliance with Section 106 – as the CRMP is only implementing the outcome of the PA.

Anyway, food for thought.

Ali

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

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Sent: 4/12/2021 12:38:46 PM
To: Lassell, Susan [Susan.Lassell@icf.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Williams, Nicole [Nicole.Williams@icf.com]; Risse, Danielle [Danielle.Risse@hdrinc.com]; Lloyd, John [John.Lloyd@hdrinc.com]
CC: Linda Fisher (linda.fisher@hdrinc.com) [linda.fisher@hdrinc.com]
Subject: RE: Sites - Cultural Resources

This all sounds good Susan. When you all talk with Marc with Reclamation, they may want compliance with Section 106 as their mitigation measure. Meaning, maybe we have different mitigation measures between CEQA and NEPA – which I think is fine as ultimately, they are really get at the same outcome. But in looking at a number of recent Reclamation documents, they all mitigated to less than significant with implementation of Section 106.

Ali

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

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From: Lassell, Susan <Susan.Lassell@icf.com>
Sent: Monday, April 12, 2021 12:33 PM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>
Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>
Subject: RE: Sites - Cultural Resources

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I suspect that it will be cleaner to require compliance with the CRMP as the thing that mitigates the CEQA/NEPA impacts, rather than invoking the entire Section 106 process and the PA that results from that process. It's possible that somewhere down the line the PA could end up getting terminated, in which case there would no longer be anything for the Authority to comply with. However, if that were to happen the Authority could adopt the CRMP as its own management plan and still be fulfilling all CEQA commitments. In other words, we should aim to have the CEQA portion of the EIR/EIS fully enforceable by the Authority regardless of what Reclamation does in the future.

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Sent: Monday, April 12, 2021 7:56 AM
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Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>
Subject: RE: Sites - Cultural Resources

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From: Alicia Forsythe <aforsythe@sitesproject.org>

Sent: Monday, April 12, 2021 7:45 AM

To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Susan Lassell <susan.lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>

Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>

Subject: Re: Sites - Cultural Resources

Hi Laurie - please take a look at the example and the number of other recent Reclamation NEPA / CEQA documents that have done this. Also, the PA will be executed by the time we sign the CEQA decision docs. Reclamation will require a signed PA to sign the ROD. Based on the schedule, we should have a signed PA in early 2022, before issuing the Final EIR/EIS and signing the decision documents.

Ali

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

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>

Sent: Monday, April 12, 2021 6:50:49 AM

To: Alicia Forsythe <aforsythe@sitesproject.org>; Susan Lassell <susan.lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>

Cc: Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>

Subject: RE: Sites - Cultural Resources

Hi Ali, my concern would be citing a PA as mitigation when it is not an executed agreement. Our CEQA mitigation needs to be able to stand alone if, for some reason, there is not a PA.

From: Alicia Forsythe <aforsythe@sitesproject.org>

Sent: Monday, April 12, 2021 5:45 AM

To: Susan Lassell <susan.lassell@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Lloyd, John <John.Lloyd@hdrinc.com>

Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Linda Fisher (linda.fisher@hdrinc.com) <linda.fisher@hdrinc.com>

Subject: Sites - Cultural Resources

Hi all – I just pulled up some examples of prior documents I worked on in Reclamation.

In all of these documents, Reclamation called the impacts LTS with implementation of Section 106 (these were joint CEQA documents). They also did this in the BF Sisk Raise document, which was a joint document.

This makes me think that we should likely modify the text of the CRMP to make it clear that it will comply with and implement the PA / Section 106. I wonder if we need an impact and the mitigation measures to require compliance with Section 106 – as the CRMP is only implementing the outcome of the PA.

Anyway, food for thought.

Ali

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

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Vegetation and Wildlife Mitigation Discussion - Agenda



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Our Commitment – To live up to these values in everything we do*

Meeting Information:

Date: April 13, 2021 **Location:** Webex
Start Time: 12:30 p.m. **Finish Time:** 2:00 p.m.
Purpose: Discuss EIR/EIS mitigation options for vegetation and wildlife.

Meeting Participants:

Ellen Berryman, ICF	Jennifer Haire, ICF	Ellen Unsworth, ICF
Monique Briard, ICF	Harry Oakes, ICF	Lisa Webber, ICF
David Duncan, ICF	Marieka Schrader, ICF	Laurie Warner Herson, Sites Integration
Linda Fisher, Sites Integration	John Spranza, Sites Integration	Nicole Williams, ICF
Ali Forsythe, Sites Authority		

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Welcome/Introductions	Linda/All	5 mins
2. CEQA/NEPA Analysis	ICF	60 mins
a. Project commitments/biological plan/mitigation measures		
b. Types of mitigation measures (on the ground vs. agency coordination/permits)		
c. Key Impacts		
3. Other Considerations	All	15 mins
a. Budgeting considerations		
4. Action Items	All	5 min

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/14/2021 8:00:05 AM
To: Greg Reis [reis@bayecotarium.org]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites Project Water Quality Group Discussion-Materials

Hi Greg,
I have passed your question along to the technical team and will circle back with you.

Hope you can make the next one.
John

John Spranza

D 916.679.8858 M 818.640.2487

From: Greg Reis <reis@bayecotarium.org>
Sent: Monday, April 12, 2021 11:09 AM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

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.

Thanks John, I'm sorry I missed the meeting. A quick question—is the Feb, May, Aug, Nov pattern of high concentrations evident for many constituents an effect of a quarterly sampling protocol? Or is this due to the timing of draining fields? These attachments show there are clear water quality problems due to agricultural drainage, and I'd hope that Sites operations wouldn't contribute to these (esp. by sending water to irrigate contaminated soils, or directing high-Diazinon water to Yolo Bypass without adequate dilution—examples where Sites operations could have a big negative effect).

I hope I'm able to make the next meeting.
Thanks,
Greg

Greg Reis
Staff Hydrologist, The Bay Institute



The Bay Institute | Aquarium of the Bay | EcoCenter at Heron's Head Park
Sea Lion Center | The Bay Academy | Bay Model Alliance

*Our mission is to protect, restore, and inspire conservation of San Francisco Bay
and its watershed, from the Sierra to the Sea™*

From: Spranza, John [<mailto:John.Spranza@hdrinc.com>]

Sent: Friday, April 9, 2021 2:56 PM

To: tstokely@att.net; jimb@aqualliance.net; dobegi@nrdc.org; Greg Reis <reis@bayecotarium.org>;
rzwillinger@defenders.org; DLucero@ButteCounty.net; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com;
regina@californiasalmon.org; Huber, Anne <Anne.Huber@icf.com>; Williams, Nicole (Nicole.Williams@icf.com)
<Nicole.Williams@icf.com>; Micko, Steve/SAC (Steve.Micko@jacobs.com) <Steve.Micko@jacobs.com>; David Zelinsky
<zelinsky.david@gmail.com>; asanchez@calwild.org; Ron Stork <RStork@friendsoftheriver.org>

Cc: [aforsythe \(aforsythe@sitesproject.org\)](mailto:aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Davis, Ryan A <rdavis@usbr.gov>; Dekar,
Melissa D <mdekar@usbr.gov>; King, Vanessa M <vking@usbr.gov>; Laurie Warner Herson
<laurie.warner.herson@phenixenv.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; Morgan, Joseph
<Morgan.Joseph@epa.gov>; Gordon, Stephanie (Skophammer) <GORDON.STEPHANIES@EPA.GOV>; Wolder, Natalie L
<nwolder@usbr.gov>; Deeds, Daniel A <ddeeds@usbr.gov>

Subject: Sites Project Water Quality Group Discussion-Materials

Hello,

Thank you for attending our Water Quality Discussion on Wednesday. I wanted to follow up and provide the presentation and the supplemental figures for Metals, Nutrients, and Pesticides that we discussed, they are attached.

I will follow up on the Action Items below in a separate email, please let me know if you have any additions.

1. Discussion of the Preferred Alternative selection
2. Provide a table with data details such as location, timing and number of data points
3. Schedule 90 minute meeting in May

Lastly, the following are future agenda topics that were identified during our meeting:

- Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of the reservoir.
- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

John

John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

HDR

2379 Gateway Oaks Drive, Suite 200

Sacramento, CA 95833

D 916.679.8858 M 818.640.2487

john.spranza@hdrinc.com

hdrinc.com/follow-us

hdrinc.com/follow-us

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/14/2021 9:02:34 AM
To: Micko, Steve/SAC [Steve.Micko@jacobs.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Leaf, Rob/SAC [Rob.Leaf@jacobs.com]
Subject: Re: Carriage Water and Delivery Schedule Strategy

Thanks for this list. It really helps to see this written down. For our small group technical meeting next Thursday 4/22 I propose we take the following approach. We only have 1 hour and we want to spend of majority of that time engaged in discussion, not one side or the other giving a lecture:

- Jerry/Erin kick off the discussion by saying that before we offer a written proposal we'd like to explore some topics to get a better idea of what kind of special considerations DWR might be willing to entertain for Sites flows.
- Steve/Rob walk through the Sites Operations, specifically pointing out the Sites operational context as noted below. The objective is to get a common understanding for discussion. Try to address what you know will be their apprehensions of giving Sites a special deal. Emphasize our best arguments (i. regular "Table A like" pattern of sites flows, and ii. yolo bypass return flows from Sites, stored water in Sites for balancing)
- Remaining time (hopefully 30-40 minutes) discussion time engaging in back and forth about technical concerns or issues.

I like that we identify San Luis possibilities, but since our analysis shows Sites flows bypassing San Luis, let's not bring this into the discussion right now.

I agree Article 6 of the 2018 COA amendment is relevant, but bringing up Article 7 seems a little heavy handed at this stage. The advisory board was meant to resolve disputes. I don't think we have a dispute yet.

Can we show some simple math that demonstrates our special circumstances? I heard some facts and figures in our call the other day that would help illustrate the points IMO.

Let's explore their consideration of using some of Sites stored water as a "true up" mechanism for over and under runs. I'm expecting they will want to backstop themselves so their contractors are not incurring any risk.

Let me know any questions/concerns/other thoughts.

From: "Micko, Steve/SAC" <Steve.Micko@jacobs.com>
Date: Monday, April 12, 2021 at 10:12 AM
To: Jerry Brown <jbrown@sitesproject.org>, Alicia Forsythe <aforsythe@sitesproject.org>, "Heydinger, Erin" <erin.heydinger@hdrinc.com>, "Leaf, Rob/SAC" <Rob.Leaf@jacobs.com>
Subject: RE: Carriage Water and Delivery Schedule Strategy

Here's a list of talking points associated to Sites carriage water:

- Sites operational context (present a clear understanding of general operations):
 - Sites operations will modify Delta flows in most years by changing:
 - Sacramento River at Freeport flow
- Sites releases to the Sacramento River for South of Delta uses in Dry and Critically Dry years
 - Yolo Bypass flow
- Sites releases to the Yolo Bypass in most years
 - South of Delta exports
- South of Delta uses with Sites water released to the Sacramento River
 - Delta outflow

- Releases from Sites that are not exported from the Delta
- Sites will consistently export water through the Delta on a long-term basis
- Reliability of Sites is beneficial to SWP operations
- Most notably San Luis storage in July and August
- Should not bundle Sites with Non-Project Transfers
- Sites may merit actions in Articles 6 and 7 of the 2018 COA Amendment
- Article 6: Conditions to commence a review process (revisions to Article 14a of 1986 COA)
- Article 7: Advisory Board process (new aspect of COA)
- Sites transfers:
- One carriage water cost value per transfer window is not feasible
- Significant operational effort required for Sites/SWP/CVP to calculate and agree upon carriage water cost each year
- One value does not consider changing conditions in project storage and Delta water quality
- One value yields more water quality benefits to SWP/CVP
- Expansion of transfer window (from Jul – Sep to Jul to Nov) is novel
- Delta WQ conditions in Oct and Nov are much different than those of Jul – Sep
- D1641 and Fall X2 are winding down (most controls cease in Sep)
- In some years, increased exports freshen Old River in Oct and Nov
- How does DWR plan to approach this?
- “No harm” is too costly for Sites storage partners (Prop 1 SOD Refuges and SOD PWAs)
- “No harm” carriage water costs are in the range of 30 – 35% each year

Apologies for the tardiness!
Steve

-----Original Appointment-----

From: Marcia Kivett <MKivett@sitesproject.org>

Sent: Tuesday, March 30, 2021 12:16 PM

To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Micko, Steve/SAC; Leaf, Rob/SAC

Subject: Carriage Water and Delivery Schedule Strategy

When: Thursday, April 8, 2021 4:00 PM-5:00 PM (UTC-08:00) Pacific Time (US & Canada).

Where: Microsoft Teams Meeting

Steve/Rob – if this does not work with your schedule the only **other option is April 9 at 1:00.**

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From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/14/2021 9:02:35 AM
To: steve.micko@jacobs.com; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Leaf, Rob/SAC [Rob.Leaf@jacobs.com]
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Let me know any questions/concerns/other thoughts.

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Date: Monday, April 12, 2021 at 10:12 AM
To: Jerry Brown <jbrown@sitesproject.org>, Alicia Forsythe <aforsythe@sitesproject.org>, "Heydinger, Erin" <erin.heydinger@hdrinc.com>, "Leaf, Rob/SAC" <Rob.Leaf@jacobs.com>
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Steve

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Sent: Tuesday, March 30, 2021 12:16 PM

To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Micko, Steve/SAC; Leaf, Rob/SAC

Subject: Carriage Water and Delivery Schedule Strategy

When: Thursday, April 8, 2021 4:00 PM-5:00 PM (UTC-08:00) Pacific Time (US & Canada).

Where: Microsoft Teams Meeting

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Microsoft Teams meeting

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From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/14/2021 1:13:03 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Huber, Anne [Anne.Huber@icf.com]
CC: Williams, Nicole [Nicole.Williams@icf.com]
Subject: RE: Sites Project Water Quality Group Discussion-Materials

I'll work something up and get it over to you.

John Spranza

D 916.679.8858 M 818.640.2487

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, April 14, 2021 1:03 PM
To: Huber, Anne <Anne.Huber@icf.com>; Spranza, John <John.Spranza@hdrinc.com>
Cc: Williams, Nicole <Nicole.Williams@icf.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

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John – I think we can massage Anne's response to get it to Greg. Maybe we ask him if there is a particular area he is concerned about with regard to irrigating contaminated soils?

Let me know if you'd like me to take a look at a response before you send it.

Ali

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

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From: Huber, Anne <Anne.Huber@icf.com>
Sent: Wednesday, April 14, 2021 8:40 AM
To: Spranza, John <john.spranza@hdrinc.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>; Williams, Nicole <Nicole.Williams@icf.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

Hi John,

I would say yes, the high values in February, May, August, and November are due to the sampling pattern, especially for CBD. It is correct that the habitat flows will put some of the CBD water on the Yolo Bypass, but Sites water will generally have the effect of diluting constituent concentrations in CBD. Diazinon is mostly a winter problem and Sites would not be increasing CBD flow to the Yolo Bypass during the winter.

I'm not sure about Greg's concern regarding irrigating contaminated soils. Sites may increase water for agriculture, but I doubt it would mean irrigation would newly extend into contaminated lands. Maybe he is concerned about increased

runoff from existing fields, but more water for agriculture doesn't necessarily mean increased contaminant load in runoff and runoff is regulated by the Irrigated Lands Regulatory Program.

I hope this helps,
-Anne

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Wednesday, April 14, 2021 8:01 AM
To: Huber, Anne <Anne.Huber@icf.com>
Cc: aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>
Subject: FW: Sites Project Water Quality Group Discussion-Materials

Hi Anne,
Any thoughts on Greg's questions?

John Spranza

D 916.679.8858 M 818.640.2487

From: Greg Reis <reis@bayecotarium.org>
Sent: Monday, April 12, 2021 11:09 AM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

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I hope I'm able to make the next meeting.
Thanks,
Greg

Greg Reis
Staff Hydrologist, The Bay Institute



The Bay Institute | Aquarium of the Bay | EcoCenter at Heron's Head Park
Sea Lion Center | The Bay Academy | Bay Model Alliance

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and its watershed, from the Sierra to the Sea™*

From: Spranza, John [<mailto:John.Spranza@hdrinc.com>]

Sent: Friday, April 9, 2021 2:56 PM

To: tstokely@att.net; jimb@aqualliance.net; dobegi@nrdc.org; Greg Reis <reis@bayecotarium.org>;
rzwillinger@defenders.org; DLucero@ButteCounty.net; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com;
regina@californiasalmon.org; Huber, Anne <Anne.Huber@icf.com>; Williams, Nicole (Nicole.Williams@icf.com)
<Nicole.Williams@icf.com>; Micko, Steve/SAC (Steve.Micko@jacobs.com) <Steve.Micko@jacobs.com>; David Zelinsky
<zelinsky.david@gmail.com>; asanchez@calwild.org; Ron Stork <RStork@friendsoftheriver.org>

Cc: [aforsythe \(aforsythe@sitesproject.org\)](mailto:aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Davis, Ryan A <rdavis@usbr.gov>; Dekar,
Melissa D <mdekar@usbr.gov>; King, Vanessa M <vking@usbr.gov>; Laurie Warner Herson
<laurie.warner.herson@phenixenv.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; Morgan, Joseph
<Morgan.Joseph@epa.gov>; Gordon, Stephanie (Skophammer) <GORDON.STEPHANIES@EPA.GOV>; Wolder, Natalie L
<nwolder@usbr.gov>; Deeds, Daniel A <ddeeds@usbr.gov>

Subject: Sites Project Water Quality Group Discussion-Materials

Hello,

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- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

John

John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

HDR

2379 Gateway Oaks Drive, Suite 200

Sacramento, CA 95833

D 916.679.8858 M 818.640.2487

john.spranza@hdrinc.com

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hdrinc.com/follow-us

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/14/2021 1:13:26 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites Project Water Quality Group Discussion-Materials

Yes, you know Bruce way better than I do. Thanks.

John Spranza

D 916.679.8858 M 818.640.2487

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, April 14, 2021 12:58 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

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.

Hey John – Lets engage Bruce Houdesheldt on this one. I think he could give us a sense of the magnitude of the concern and also help us reach out to the Rice Commission.

Should I reach out to Bruce and schedule an hour discussion in the next week or so?

Ali

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

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Sunday, April 11, 2021 8:38 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: FW: Sites Project Water Quality Group Discussion-Materials

Not sure how we want to address this whole topic.

John Spranza

D 916.679.8858 M 818.640.2487

From: David Zelinsky <zelinsky.david@gmail.com>
Sent: Saturday, April 10, 2021 12:22 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: tstokely@att.net; jimb@aqualliance.net; dobegi@nrhc.org; reis@bayecotarium.org; rzwilling@defenders.org; DLucero@ButteCounty.net; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com; regina@californiasalmon.org; Huber,

Anne <Anne.Huber@icf.com>; Williams, Nicole (Nicole.Williams@icf.com) <Nicole.Williams@icf.com>; Micko, Steve/SAC (Steve.Micko@jacobs.com) <Steve.Micko@jacobs.com>; asanchez@calwild.org; Ron Stork <RStork@friendsoftheriver.org>; aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Davis, Ryan A <rdavis@usbr.gov>; Dekar, Melissa D <mdekar@usbr.gov>; King, Vanessa M <vking@usbr.gov>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; Morgan, Joseph <Morgan.Joseph@epa.gov>; Gordon, Stephanie (Skophammer) <GORDON.STEPHANIES@epa.gov>; Wolder, Natalie L <nwolder@usbr.gov>; Deeds, Daniel A <ddeeds@usbr.gov>

Subject: Sites Project Water Quality Group Discussion-Materials

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.

You might reach out to Tim Johnson of the California Rice Commission. I suspect he will support Sites, but I want to hear what his comfort level is on the effect of Sites on metals in rice, such as arsenic, if any.

Perhaps they could be prevailed upon to help with water testing too.

Thank you.

David Zelinsky
530-417-6116

On Friday, April 9, 2021, Spranza, John <John.Spranza@hdrinc.com> wrote:

Hello,

Thank you for attending our Water Quality Discussion on Wednesday. I wanted to follow up and provide the presentation and the supplemental figures for Metals, Nutrients, and Pesticides that we discussed, they are attached.

I will follow up on the Action Items below in a separate email, please let me know if you have any additions.

1. Discussion of the Preferred Alternative selection
2. Provide a table with data details such as location, timing and number of data points
3. Schedule 90 minute meeting in May

Lastly, the following are future agenda topics that were identified during our meeting:

- Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of the reservoir.
- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

John

John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

HDR

2379 Gateway Oaks Drive, Suite 200

Sacramento, CA 95833

D 916.679.8858 M 818.640.2487

john.spranza@hdrinc.com

hdrinc.com/follow-us

hdrinc.com/follow-us

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/14/2021 2:44:23 PM
To: JP Robinette [jrobinette@brwnald.com]; Cheyanne Harris [CHarris@BrwnCald.com]
Subject: DPR Draft Regs
Attachments: Draft-DPR-Regulation-Overview.pdf

FYI - As we discussed yesterday, here is a slide deck that a water reuse panel used to describe what's in the draft regs. 2023 is when the SWRCB is scheduled to have the final DPR regs complete. Ambitious, but exciting because the regs are needed to know what facilities and operations are required to implement DPR in California. The final step, which might be the biggest hurdle to DPR being implemented far and wide, is public acceptance. I've been preaching to the bay area water and wastewater agencies for 5 years that the first DPR project cannot mis-step because any failure will have lasting negative financial effect for all 7M people in the region. For example, the ~1994 Clean Water Revival Project by DSRSD was last time a bay area water agency tried to inject advanced treated water into the groundwater basin for drinking purposes. (I can give details if you're interested, my hometown of Pleasanton killed the project).

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/14/2021 3:55:49 PM
To: Kevin Spesert [kspesert@sitesproject.org]; Sara M. Katz [skatz@katzandassociates.com]
Subject: Outreach Suggestions

Talked to Jerry Maltby today. Asked 2 questions and got the following responses:

- ,
1. "What are you hearing about drought and Sites?" – need to build it, taking too long, need it real bad in a year like this. When I shared with him that it would have 1MAF right now he immediately said you need to get that out in the next month to be widely consumed across the entire state. Suggested:
 - Getting an article in Family Water Alliance "Green Ribbon". The local papers and all of the other ag associations will pick it up from there.
 - California Certified Organic Farmers – he suggested this group as a possible NGO for the Op-Ed.
 2. "Hearing any concerns about southern Cal water grab on transfers?" – He's part of GCID and they are selling some water this year to the TC. They take care of the local area first and then where others have a real need. I think we should use a similar message when we talk about Sites project participant mix.

Kevin – Can you talk to Nadine?

Sara – possibly consider CCOF for the NGO Op-Ed.

2020 Water Transfers Carriage Water Costs

Ian Uecker, PE

Chief, Delta Compliance and Modeling Section
State Water Project Operations Control Office



Overview

- ▶ What is Carriage Water
- ▶ How is Carriage Water assessed by OCO
- ▶ 2020 Pre-Season and Post-Season Assessments

Definition of Carriage Water

- ▶ The marginal water cost needed to carry a unit of water across the Delta for export while maintaining a constant salinity level at a given location.
- ▶ Mathematically, carriage water may be expressed as,

$$CW = \Delta SAC - \Delta EXP, \text{ with } \Delta EC \approx 0$$

Where,

CW = carriage water,

ΔSAC = increase in SAC River flow

ΔEXP = increase in Delta exports

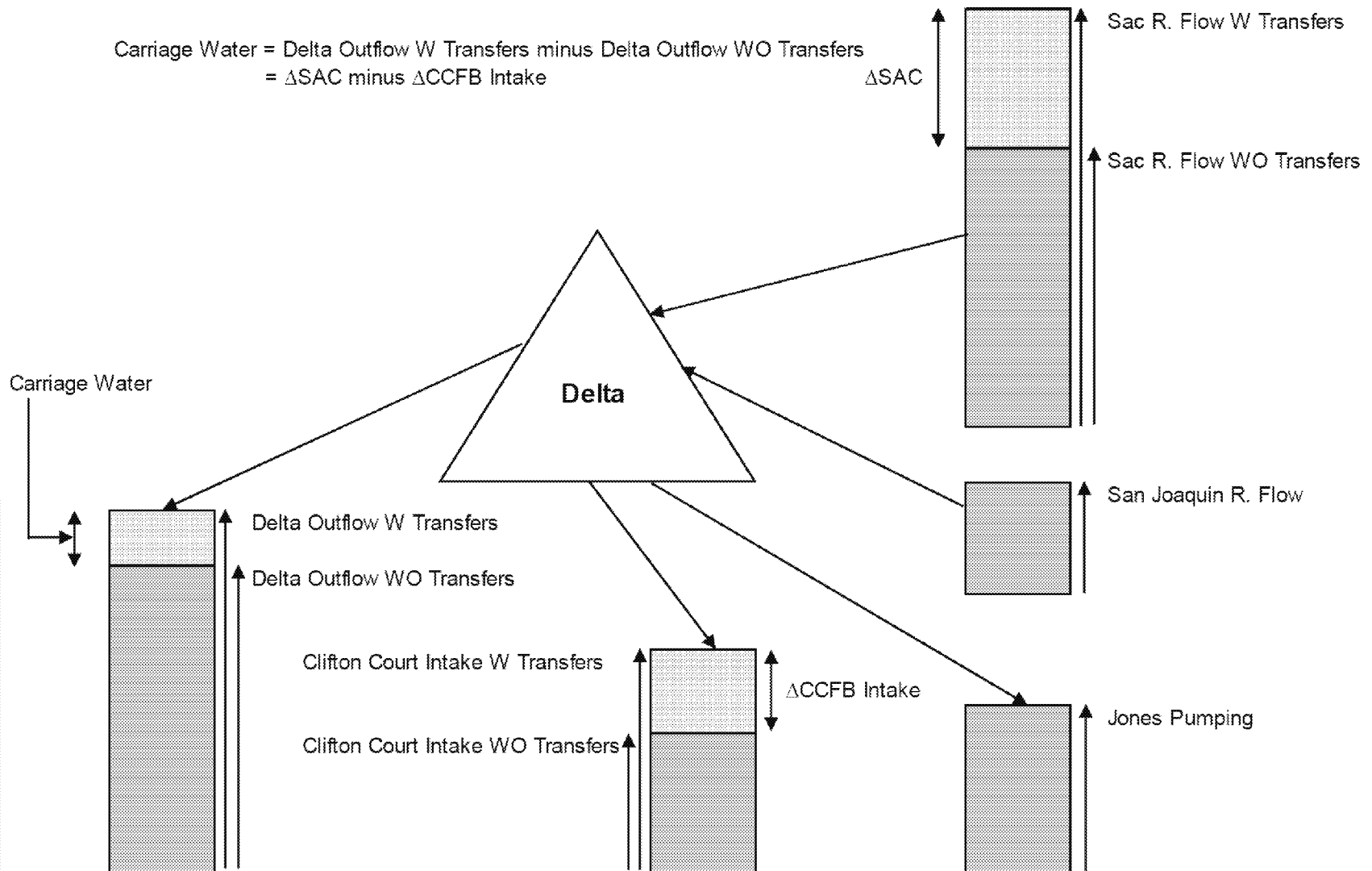
ΔEC = change in electrical conductivity level at a control point

Carriage Water Calculation

A= Without transfers condition; B = With transfers condtion, historical

EC or Chloride level remaining the same at control locations for both baseline and alternative

$$\begin{aligned}\text{Carriage Water} &= \text{Delta Outflow W Transfers} \text{ minus } \text{Delta Outflow WO Transfers} \\ &= \Delta \text{SAC} \text{ minus } \Delta \text{CCFB Intake}\end{aligned}$$



Controlling Locations

Jersey Point: D-1641 Ag standard and CCWD M/I indicator station

Bethel: CCWD M/I indicator station

Bacon Island: CCWD M/I indicator station

All three frequently control operations from July-September

The control location with the highest %CW is used

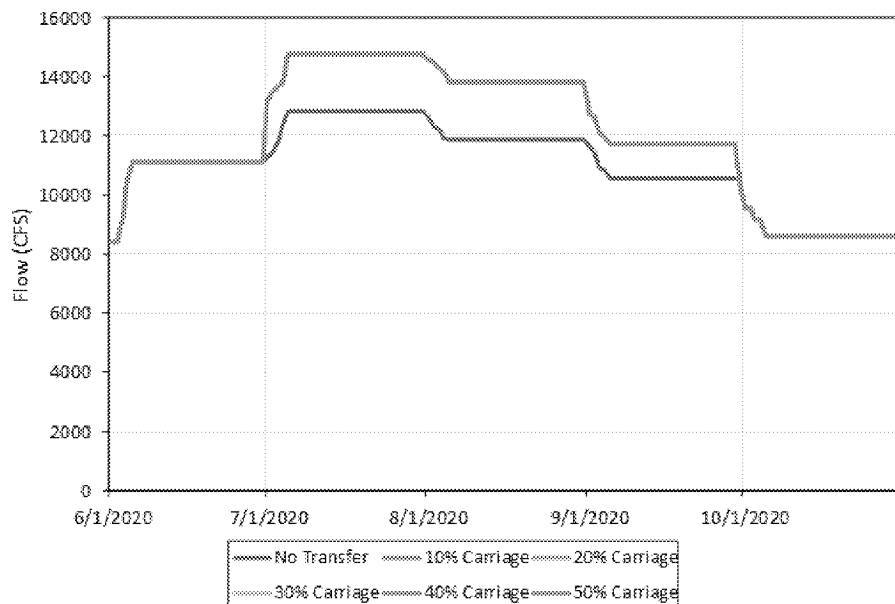
Pre-Season Assessment With DSM2

- ▶ DCO Allocation Study used to develop DSM2 Boundary Conditions
- ▶ Transfer Volumes Layered on top of Freeport and CCFB flows
- ▶ Multiple iterations with different assumptions of % CW are run
 - ▶ EX: a 10% CW iteration will add the transfer volume to Freeport and 90% of the transfer volume to Exports

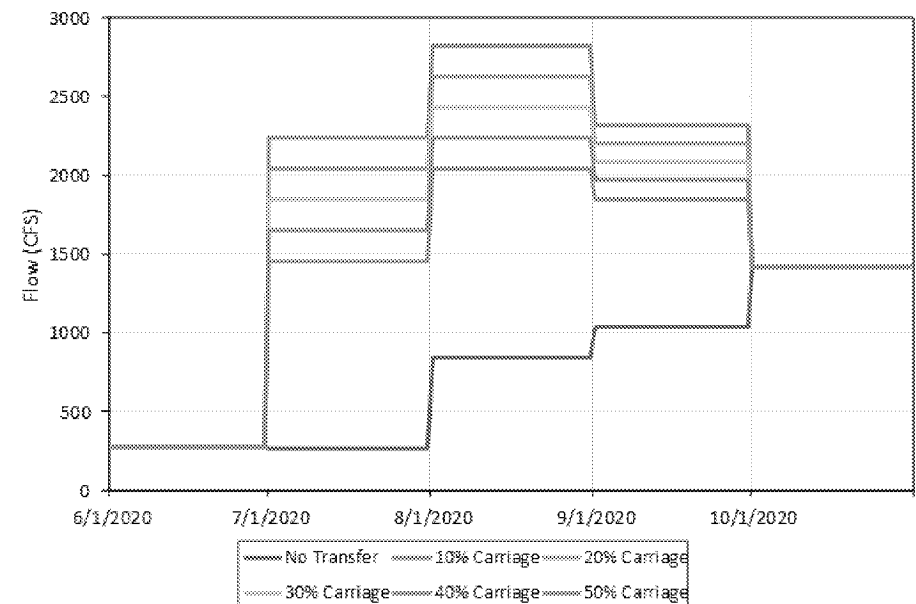
Pre-Season Assessment With DSM2

2020 Pre-Season Boundary Conditions for Freeport and Banks

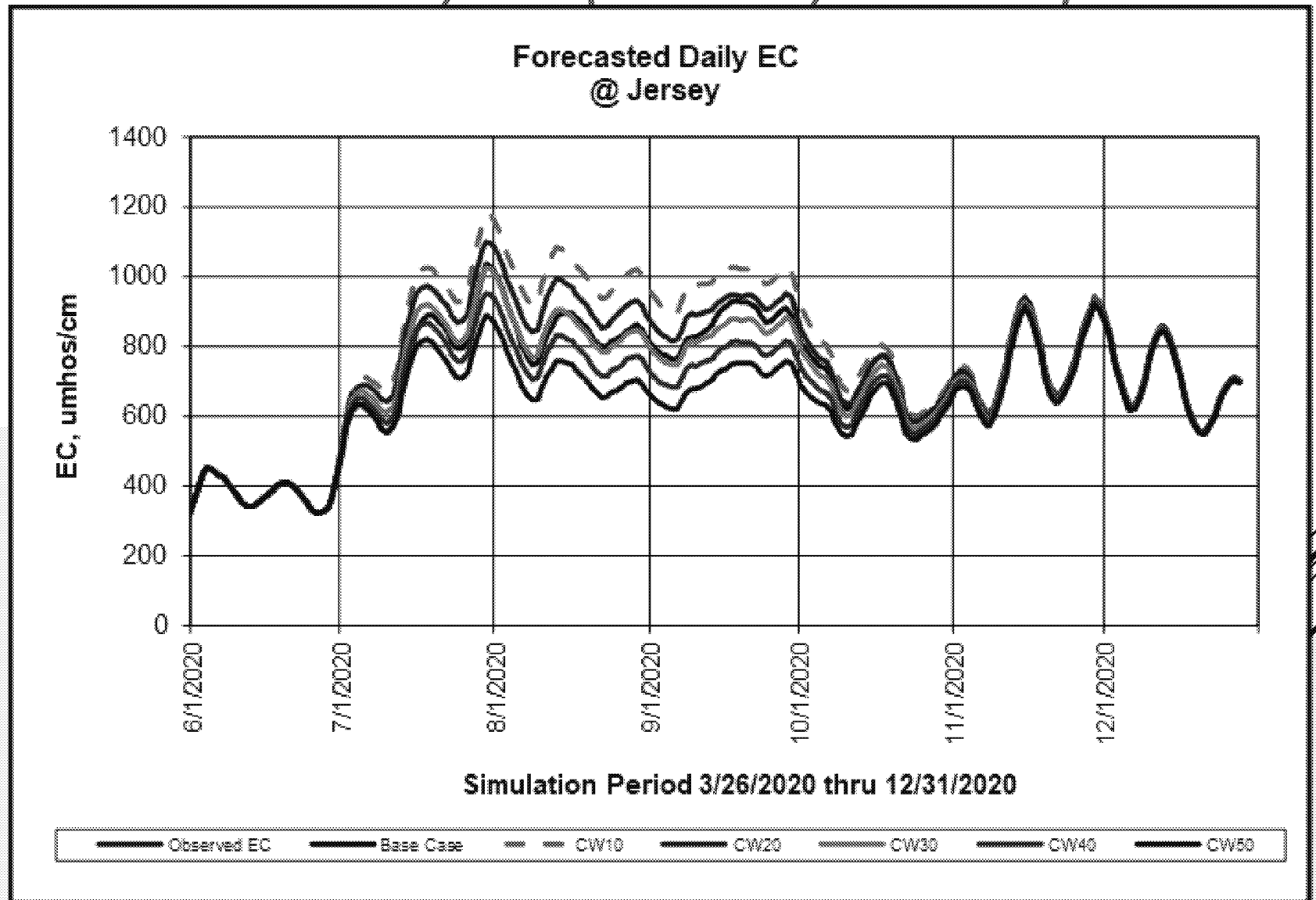
Sacramento River at Freeport



Banks Exports



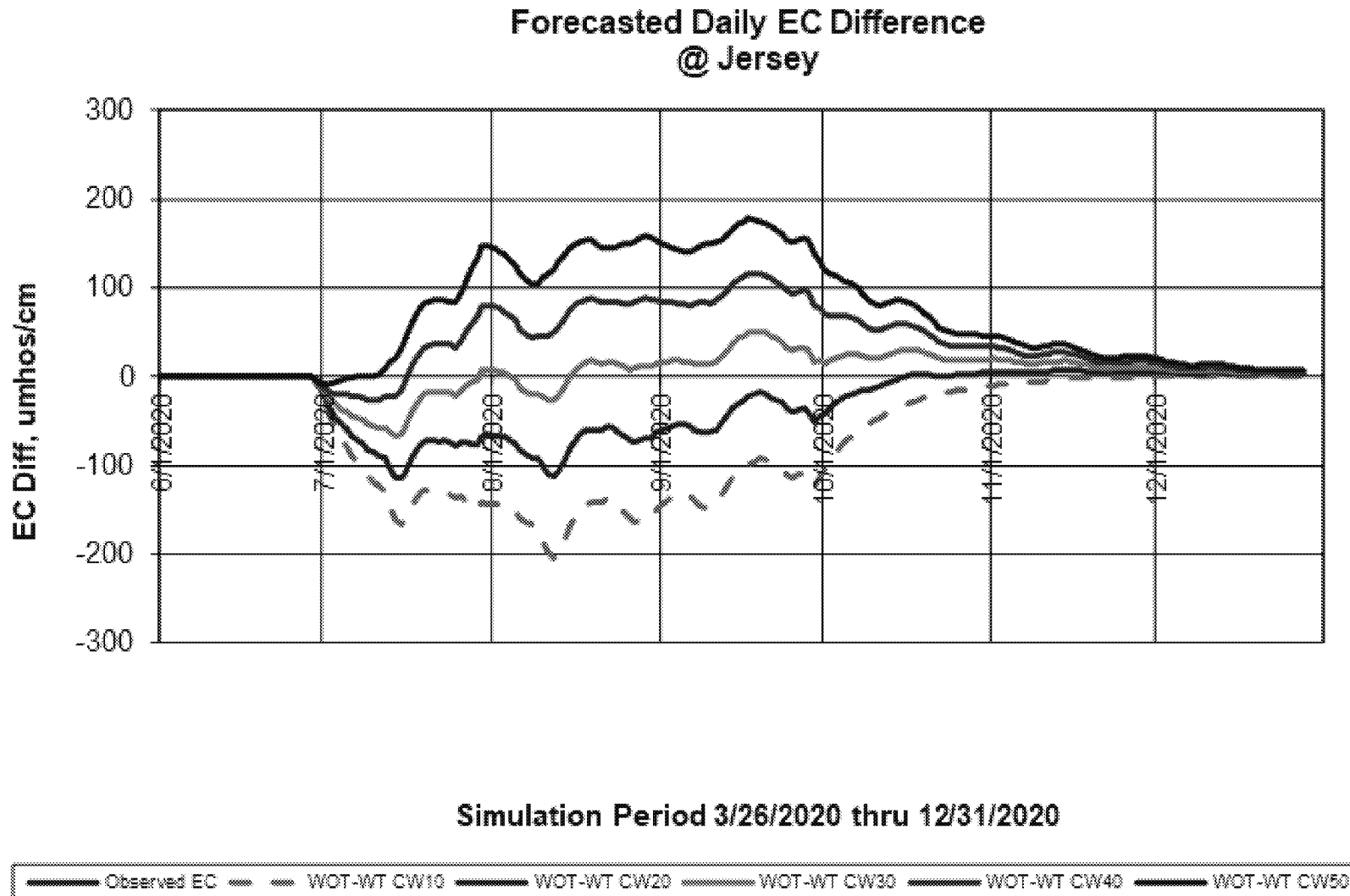
DSM2 Results For Preliminary 2020 Analysis (Jersey Point)



Post Processing Results to get Final %CW

- ▶ The average difference in salinity between the Without Transfer Base case and each With Transfer Iteration is calculated for the July-Sept Period
- ▶ Regressions of the %CW assumptions vs the average EC differences are developed
- ▶ The objective is to find the %CW that has an average EC difference of zero from July to September

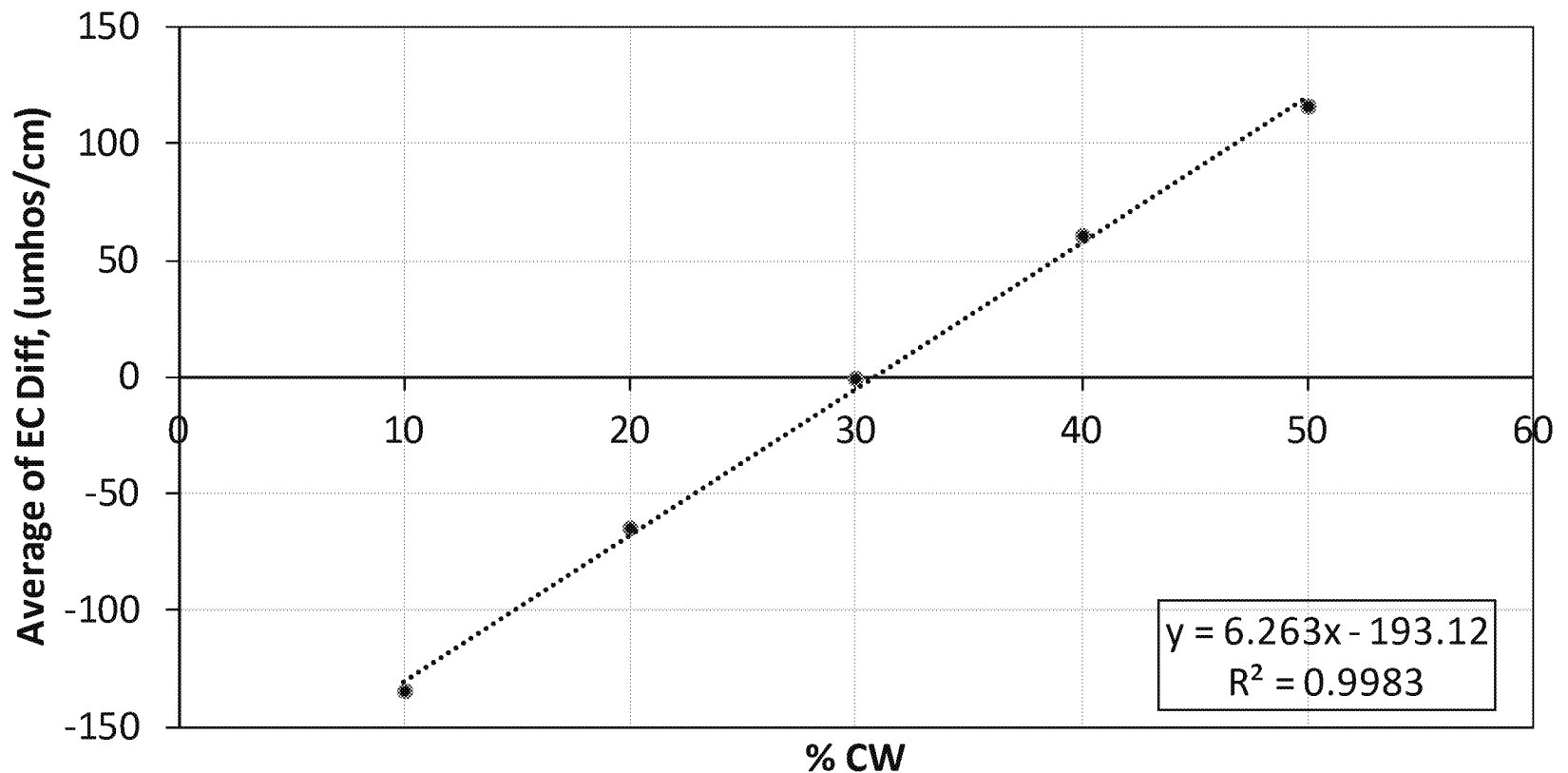
DSM2 Results For Preliminary 2020 Analysis (Jersey Point)



Final Solution

- ▶ The final step is to solve the regression for zero
- ▶ Final result is rounded to the nearest 5% (similar to the allocation)

Jersey Point



Pre-Season vs Post-Season

Transfer volumes are present in historical data, but are not represented in allocation studies

- ▶ **Pre-Season Assessment**

- ▶ Compares **Multiple With-Transfer Cases** to a **single Without Transfer Case**

- ▶ **Post-Season Assessment**

- ▶ Compares **Multiple Without-Transfer Cases** to a **single With Transfer Case**

Post-Season Assessment With DSM2

- ▶ Historical Data is used to develop DSM2 Boundary Conditions
- ▶ Transfer Volumes are subtracted from Freeport and CCFB flows
- ▶ Multiple iterations with different assumptions of % CW are run through the model
 - ▶ EX: a 10% CW iteration will subtract the transfer volume from Freeport and 90% of the transfer volume from Exports

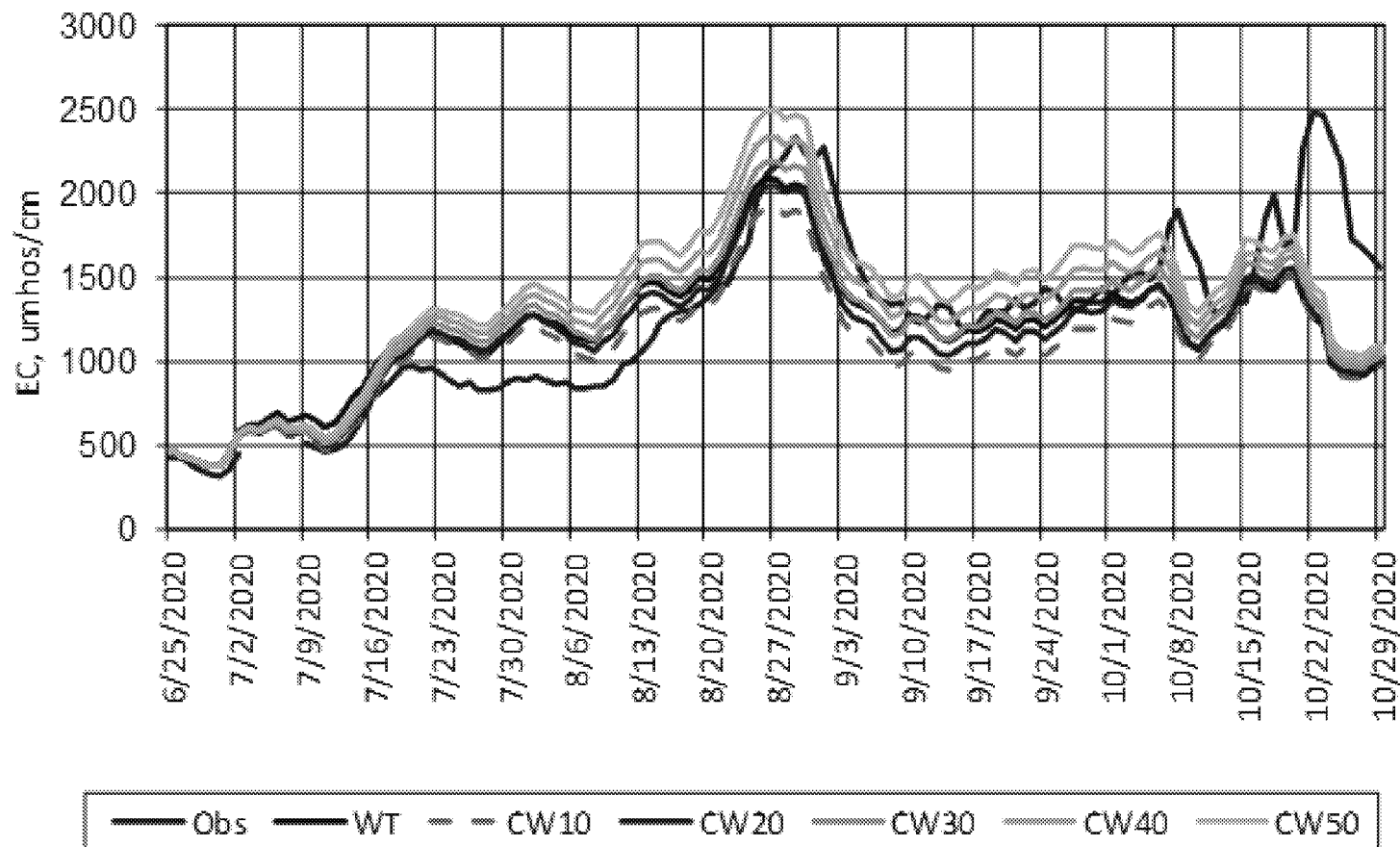
2020 Post-Season Assessment

**Pre-Season CW
Cost Estimate:
35%**

**Final Post-Season
CW Cost:
30%**

Post-Season DSM2 Results (Jersey Point)

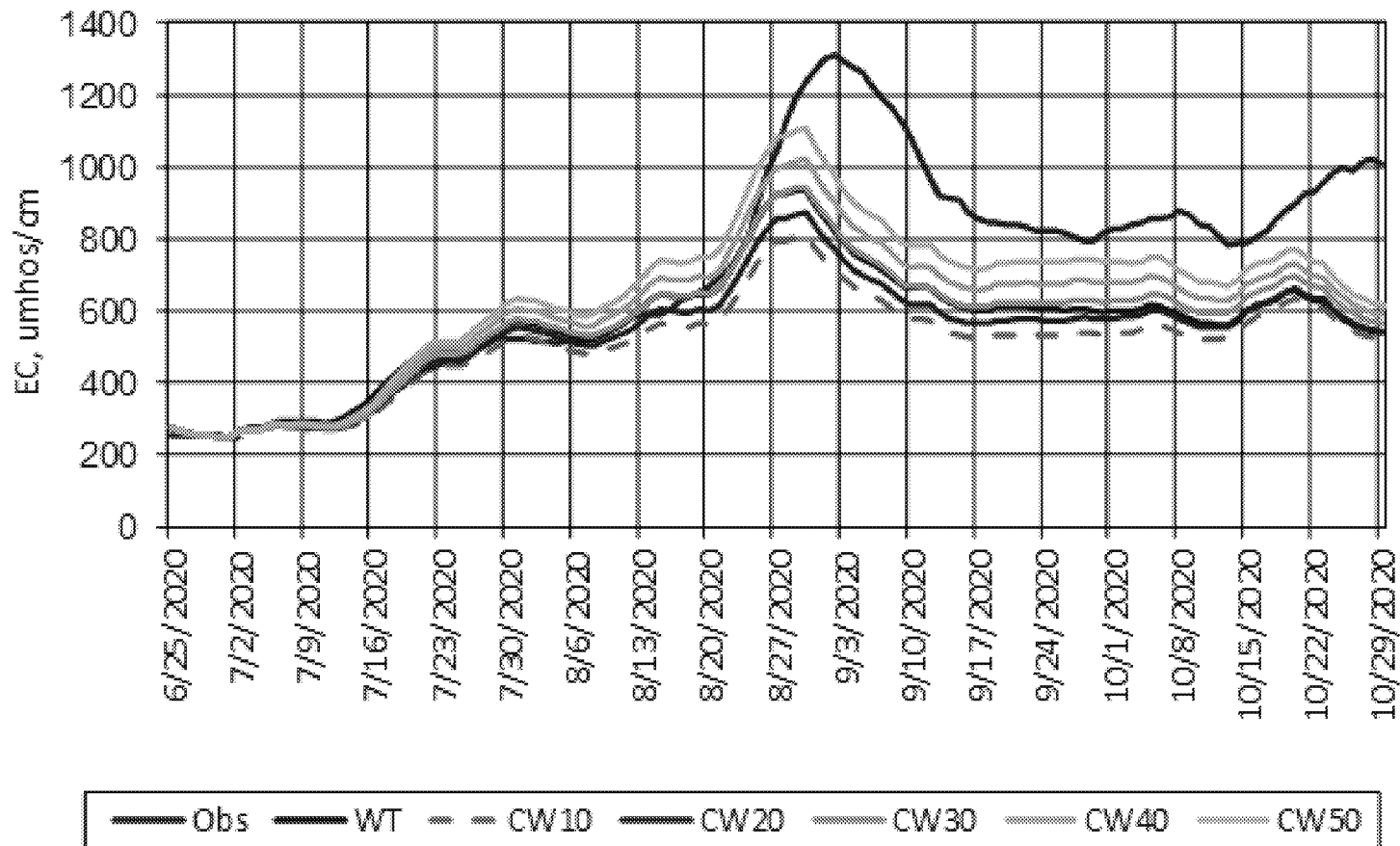
Forecasted Daily EC @Jersey Point



CW Jersey:
27%

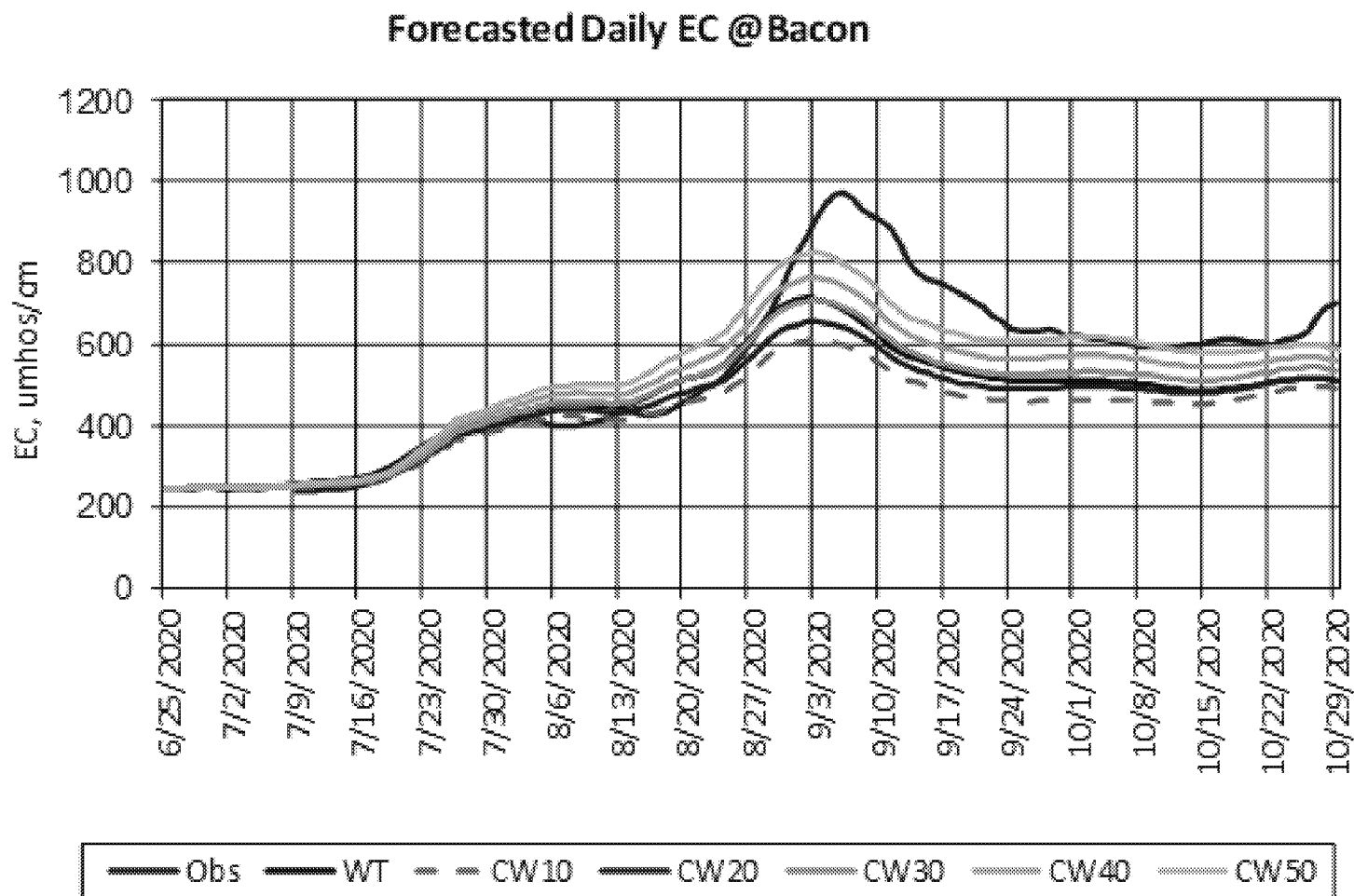
Post-Season DSM2 Results (Bethel)

Forecasted Daily EC @Bethel



CW Bethel:
29%

Post-Season DSM2 Results (Bacon Island)



CW Bacon:
29%

What About the Transfer Moved Oct and Nov?

- ▶ 97% of transfer water was moved from Jul to Sep
- ▶ An analysis covering Oct and Nov was completed and CW came out to 21%
- ▶ This result was pro-rated by the volume of transfer water along with the Jul-Sep CW and aggregated

$$.97*(29\%) + .03*(21\%) \approx 29\%$$

- ▶ Because so little water was moved Oct and Nov, this does not affect the final result when rounded to the nearest 1%

What Caused the 5% Decrease

- ▶ The pre-season studies significantly underpredicted the salinity at all controlling locations. CW is higher when conditions are fresher.
- ▶ The pre-season studies overpredicted Delta Outflow during the Jul-Sept Period. CW is higher when outflow is higher.
- ▶ A portion of the decrease was due to rounding to the nearest 5%

	Unrounded	Rounded
Pre-Season	33%	35%
Post-Season	29%	30%

Has Carriage Water Increased the Last Few Years?

	Final Analysis	Final CW
2008	22%	20%*
2009	25%	20%*
2010	37%	20%*
2011	No Transfer	No Transfer
2012	29%	30%
2013	28%	30%
2014	22%	20%
2015	22%	20%
2016	28%	30%
2017	No Transfer	No Transfer
2018	36%	35%
2019	No Transfer	No Transfer
2020	29%	30%

**Not based on analysis*

Questions?

Ian.Uecker@water.ca.gov

Governance

EXISTING AND FUTURE ROLES OF THE AB AND RC

April 2021

APPROVED DOCUMENTS ESTABLISHING ROLES

Fourth Amended and Restated Joint Exercise of Powers Agreement

- Mar-23-17 Approved

Reservoir Project Agreement

- Apr-1-19 Approved
- Oct-18-19 First Amendment Approved
- Apr-22-20 Second Amendment Approved

Bylaws

- Nov-21-16 Phase 1 Approved
- Nov-17-18 Phase 2 Approved

CURRENT ROLES OF THE AUTHORITY BOARD

Section 4.1 of the 2016 Bylaws and Section 10 of the 2018 Bylaws:

- **Environmental Review and Permitting**
 - CEQA lead agency and work with USBR for NEPA lead
 - Permit applicant, negotiation and acceptance of permit conditions, permit compliance
 - Commitment to mitigation
- **Project Design**
 - Dam safety compliance
 - Development of renewable power and pumped storage
- **Funding**
 - Proposition 1 grant compliance
 - Approve a financial plan
- **Agreements and Changes**
 - Review decisions at the Project Agreement level to ensure they are in the best interest of the State Reservoir Project
 - Establish decision making thresholds by specific topic areas to be addressed by the Reservoir Committee
 - Approve the Reservoir Project Agreement and amendments
 - Determination of Material Changes that affect cost and water supply benefits
- **Assets**
 - Acquire property and rights-of-way
 - Hold title to water rights
- **Outreach**
 - Outreach with elected officials, general public, NSO's and tribes
- **Oversight**
 - Oversight of employees and consultant contracts

CURRENT ROLES OF THE RESERVOIR COMMITTEE

Section 3 of the 2019 Reservoir Project Agreement:

- Setting policy for the RC
- Recommend actions for the AB to take
- Determine payments (and timing) per participation percentages each fiscal year
- Authorize payments consistent with adopted work plan and budget
- Approve all other actions needed to carry out the project development
- Material actions require both the Reservoir Committee approval and the AB approval

Questions for Today

Governance and Delegation

- Is current governance structure and delegation sufficient for future decisions?
- Does it need to evolve? If so, when?

Home Board Decision-making

- What do your home boards need to know about future governance and decision-making to sign the Amendment 3?

What We Heard from the Coordinating Committees

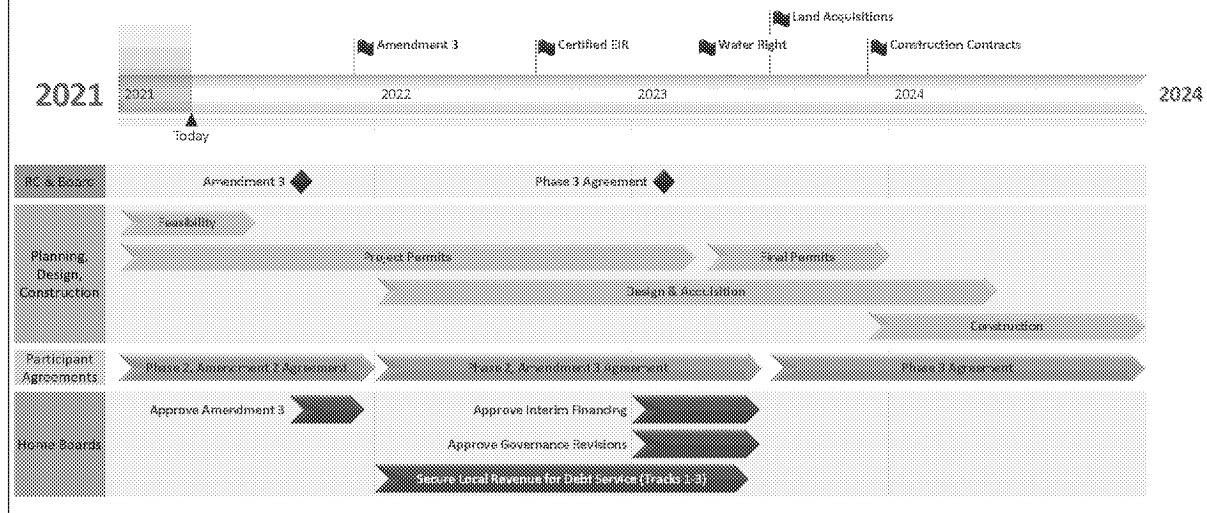
General Agreements and Observations

- The project and the Board/RC responsibilities will evolve substantially in future phases.
- The timing is good to begin discussion of these issues (before financing).
- Maintaining local representation through all phases is important for success.

Initial Areas for Attention

- Aligning liabilities, responsibilities, and decision-making
- Nimble decision-making
- Staffing to oversee design, construction, and operations
- Learn from good and bad of other programs
 - CVP, SWP, Diamond Valley, Delta Conveyance, High Speed Rail

Decision-making & Entitlement Milestones



Entitlement Milestone: EIR Certification

Certified EIR and Associated Commitments: Encumbers the Project with legal conditions

Obligations

- Design, construct, and operate the project in compliance with EIR and permitting commitments

Activities

- **Legal:** Resolve lawsuits (if any) related to adequacy of environmental compliance
- **Design:** Award design contracts and approve design contract changes
- **Permitting:** Certify compliance with Mitigation and Monitoring Plan and permits for this phase
- **Land Acquisition:** Secure access to all lands and right of way necessary to construct
- **Organization:** Establish the organization that will secure financing to fund and operate
- **Financing:** Secure financing for construction phase (state, federal and participant funds)
- **Communications:** Clearly communicate anticipated construction schedule (no surprises)

Entitlement Milestone: Acquisition of Assets & Liabilities

Lands, Water Right, and Loan Obligations: Creates long-term ownership responsibilities

Obligations

- Property deeds and land management responsibilities
- Water right compliance responsibilities
- Financing obligations for land acquisition and construction

Activities

- **Construction:** Award construction contracts and approve construction contract changes
- **Legal:** Resolve lawsuits (if any) from land acquisition
- **Permitting:** Certify compliance with Mitigation and Monitoring Plan and permits for this phase
- **Communications:** Communicate anticipated construction schedule
- **Operations:** Adopt operations rules and reporting for all partners
- **Funding:** Manage revenues and payments
- **Land Management:** Adopt public access plan and recreation plan
- **Risk Management:** Adopt a risk management strategy

Entitlement Milestone: Construction Oversight

Lands, Water Right, and Loan Obligations: Creates long-term ownership responsibilities

Obligations

- Property deeds and land management responsibilities
- Water right compliance responsibilities
- Financing obligations for land acquisition and construction
-

Activities

- **Construction:** Award construction contracts and approve construction contract changes
- **Legal:** Resolve lawsuits (if any) from construction claims
- **Permitting:** Certify compliance with Mitigation and Monitoring Plan and permits for this phase
- **Communications:** Communicate anticipated construction schedule (no surprises)
- **Operations:** Adopt operations rules and reporting for all partners
- **Funding:** Manage revenues and payments
- **Land Management:** Manage lands

Entitlement Milestone: Long-term Operations

Operations Phase: Operating the Project as an independent utility

Obligations

- Comply with water right, permits, operating agreements, and service agreements

Activities

- **Legal:** Resolve lawsuits (if any) from construction claims
- **Permitting:** Certify compliance with Mitigation and Monitoring Plan and permits for this phase
- **Operations:** Operate reservoir
- **Funding:** Manage revenues and payments
- **Land Management:** Manage public access and grazing leases (if any) and recreation plan

Governance Next Steps

- June Workshop:
 - Refined timeline for governance considerations
- August: Plan and timeline for governance issues in 2022

Workshop Discussion

Governance and Delegation

- Is current governance structure and delegation sufficient for future decisions?
- Does it need to evolve? If so, when?

Home Board Decision-making

- What do your home boards need to know about future governance and decision-making to sign the Amendment 3?

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/15/2021 7:24:47 AM
To: Jerry Johns [jjohnswater@gmail.com]
Subject: Re: Sites and COA Accounting Presentation

This is very helpful. Thanks.

From: Jerry Johns <jjohnswater@gmail.com>
Date: Wednesday, April 14, 2021 at 4:32 PM
To: Lee Bergfeld <Bergfeld@mbkengineers.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>, "Heydinger, Erin" <erin.heydinger@hdrinc.com>, "Spranza, John" <john.spranza@hdrinc.com>, Jerry Brown <jbrown@sitesproject.org>, Walter Bourez <Bourez@mbkengineers.com>, Anne Williams <williams@mbkengineers.com>, Marc VanCamp <Vancamp@mbkengineers.com>
Subject: Re: Sites and COA Accounting Presentation

Sites Folks,

I have a couple of comments after thinking about today's call that I want to pass along for your consideration.

First, while the main audience for this presentation is the operators of the SWP and CVP, there will be other folks from planning and management that will also be there and need to learn this. Many of this latter group have only a passing knowledge of Sites and the details of SWP and CVP operations let alone the COA. Also, I am guessing that you will run past the Reservoir Committee your proposed presentation before you give it DWR and USBR. While those in that group are very smart and quick studies, they too have not dealt with CVP and SWP operations in much detail. So my general suggestion is to go slow and add more pictures. Also, since nothing is secret, expect that whatever you do on this will get to the NGO community and SWRCB staff at some point and they know even less about any of this. I recommend that for examples you use something more of a schematic as a base map than what I used 2 years ago. I did not have good graphic capability, but you guys do. The numbers on my old sides are way too small to see in any PP slide or on a Zoom screen. So make them bigger.

For example, I would start simple with Stites water first being used to satisfy Sites participants with Sites water that is about their CVP water allocations. The show a picture of an example of how this would work on any given day under balanced conditions. Next, I would move to use of Sites water for Yolo Bypass with most of that water also going to Delta Outflow, and Sites water going to Level 4 refuges. Show a picture of both and note that there will be losses of the Yolo water that will need to be determined for appropriate credit for its contribution of Sites water going to Delta Outflow. Also, note that there will be carriage water losses for added Level 4 refuge water released from Sites. After that talk about Sites water going to Sites participants West and South of the Delta and show a picture of how that would work. Note that there will be no Carriage Water losses for America Canyon from NBA, but losses for SOD Sites participants that will need to be determined.

Then move to the concept of backing Sites water up into Shasta or Oroville or Folsom and show a picture of how that would work. Again use a schematic with larger numbers. Go into the COA accounting you have and how all that would work for each of the examples.

Second, Erin said something at the end of the call that I think is very important. When I was involved with Sites, the backing of Sites water into Shasta was a big part of the project planning with all the cold water pool benefits. That creates the water right issue of Shasta water right water going to SOD Sites participants that are not within the CVP place of use. You should know that the DWR planning Staff never recognized this water right issue and were surprised when I noted this issue to them in early 2017. We started working on how to address this issue back then and came up

the using the COA and State water in Shasta to meet some of the State In-Basin uses under the COA and retaining Oroville water that would have been used for that demand. This allows SWP water right water with a Sites tag on it to go to the Sites participants. The need to do this is driven by how much of the Sites tagged water held in Shasta actually goes to Sites SOD participants. In the past this was a large number, but what Erin indicated is that this occurs in only a few years and is not big number. If that is the case, we may not even need to bring the COA shift issue up.

The Sites Yolo water that does to Delta Outflow and the Level 4 refuge water both go to a CVP place of use. So any Sites tagged water held in Shasta can go to those uses with no water right issues at all. I am guessing that these uses could absorb all the Sites tagged water held in Shasta. If so, you don't even need to bring up the COA shift concept that I have been talking about. Also, If USBR actually becomes a Sites participant this issue becomes even less of a problem. It would be good to have someone run the numbers to see if the Yolo water and the level 4 water is enough to absorb and Sites tagged water in Shasta.

I would be more than happy to work with Walter on the presentation if you want.

Proposed Next Work Period Goals and Objectives

<i>Strategic Plan Goal Area</i>	<i>Work Period Objective</i>	<i>Optional Duration of activity (months)</i>
1. Affordability	a. Secure a final funding agreement with California Water Commission for the remainder of the MCED.	18 (assuming "lite" final approvals and permits)
	b. Execute final operations agreements with facility partners, federal and state agencies.	36
	c. Secure federal funding from the WIIN Act and other sources. Receive final federal commitments for project construction and execute Water Storage and Supply Services Contract with Reclamation.	18
	d. Complete loan applications including WIFIA, USDA Loan, and bank financing and related activities to immediately initiate bank financing at the start of the next phase.	18
	e. Complete and execute Water Supply and Storage Services Contracts with each Local Agency participating in the Project.	36
	f. Continue to refine affordability analysis based on updated capital and operating cost estimate, cost of capital, cost allocation and benefits analysis, and conduct value engineering studies, independent review boards, and design engineering constructability reviews as necessary.	36
2. Permittability	a. Complete Final EIR/EIS, Authority approves the Project, certifies the Final EIR, adopts the MMRP and issues the Notice of Determination, and Reclamation executes the Record of Decision.	18
	b. Complete and obtain all key environmental permits for WSIP final award and initiate secondary permits for construction and operations.	18 (key) 36 (secondary)
	c. Receive water right Order and Permit from the SWRCB.	18
	d. Develop draft and/or final all plans, as appropriate, identified in the EIR/EIS (such as the recreation management plan, traffic management plan, land management plan, operations plan, etc).	36

Proposed Next Work Period Goals and Objectives

	e. Complete and obtain local agency agreements and permits along with any required city or county actions necessary to support long lead activities necessary for the next Phase.	36
	f. Complete and execute benefit contracts with DWR (flood control and recreation benefits) and CDFW (environmental benefits) for public benefits.	18
	g. Develop a mitigation acquisition master plan and approach for mitigating the Project effects. Begin biological and cultural resources surveys to refine impacts and mitigation obligations on properties where willing land access can be obtained.	18 (related to key permits) 36 (for all other work)
	h. Initiate application for approval of permit to construct from DSOD for all jurisdictional facilities (dams) within the Project.	18 (for work related to WSIP final award) 36 (for all other work)
	i. Continue evaluation of operations parameters and support development of final operating agreements.	36
3. Buildability	a. Complete engineering design to 30% level and provide updated construction and operations cost estimates. Complete further facility designs as needed to get key permits and approvals required for WSIP funding.	18 (related to key permits) 36 (for all other work)
	b. Evaluate alternative project delivery methods, determine risks for project variances and recommended risk management strategies, finalize construction bid packages, and determine overall Project schedule.	36
	c. Develop land acquisition master plan and rights of way manual. Conduct preliminary landowner negotiations with willing sellers for potential acquisition of key parcels via options or fee title.	18 (for land acquisition master plan and ROW manual)

Proposed Next Work Period Goals and Objectives

		36 (for all other work)
	d. Perform geotechnical evaluations of all “willing seller” properties related to long-lead Project facilities (including permitting and monitoring).	18 (related to key permits) 36 (for all other work)
	e. Continue coordination with local community organizations and agencies to address Project effects during construction and operations.	36
4. Effectiveness	a. Develop and define the organizational culture, values and management approaches.	36
	b. Prepare Project controls and processes to ensure continued transparency and efficient operations through detailed design and construction.	36
	c. Determine the organization structure, insurance and organizational risk management approaches for the remainder of the Project and create the basic infrastructure to effectuate these changes at the start of the next work period.	18

Reservoir Committee Meeting

Agenda Item 3-1, CEQA Process, Status of
Introductory Chapters, Outreach to
Non-governmental Organizations

April 16, 2021



Draft - Preliminary Working Document - For Discussion Purposes Only

Agenda

- California Environmental Quality Act
 - CEQA Background
 - Authority Role as Lead Agency for CEQA
 - CEQA Process and Authority Decision
- Revised Draft EIR/Supplemental Draft EIS
 - Introductory Chapter Status
- NGO Outreach
 - Workshops
 - Small Group Meetings

California Environmental Quality Act (CEQA)



CEQA – What is it?

- CEQA is intended to provide decision makers and the public with information about a proposed project's **significant** effects on the environment and to:
 - Prevent significant, avoidable damage to the environment
 - Foster informed public decision making
 - Ensure transparency in governmental decision-making process
 - Encourage public participation
- CEQA Statutes (PRC § 21000) and Guidelines (CCR § 15000)
 - Periodically modified by Legislature
 - Interpreted by the Courts
- CEQA is a Process - Not a Permit

Draft - Predecisional Working Document - For Discussion Purposes Only

4

Speaker: Laurie

Draft - Predecisional Working Document - For Discussion Purposes Only

When Does CEQA Apply?

- California governmental agencies
- Discretionary approvals by an agency
 - Discretionary: “exercise of judgment or deliberation when the public agency or body decides to approve or disapprove a particular activity, as distinguished from situations where the public agency or body merely has to determine whether there has been conformity with applicable statutes, ordinances or regulations.”
- Applies to “projects”
 - An activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment
 - The activity approved by the public agency, not each individual permit or approval

Speaker: Laurie

Draft - Predecisional Working Document - For Discussion Purposes Only

Agency Roles under CEQA

- **Lead Agency – Authority**
 - Principle responsibility for carrying out or approving a project
 - Prepares CEQA document: Notice of Exemption, Negative Declaration, Environmental Impact Report (EIR)
- **Responsible Agency – Permitting Agencies, Reservoir Committee Members**
 - Discretionary approval authority over project
 - Typically relies on the CEQA document prepared by the Lead Agency
- **Trustee Agency**
 - State Agency with jurisdiction by law over natural resources held in trust for the people of California

Draft - Predecisional Working Document - For Discussion Purposes Only

6

Speaker: Laurie

Draft - Predecisional Working Document - For Discussion Purposes Only

Determination of Impacts

- Agency must consider direct and indirect effects
- Impacts determined by comparison to baseline physical conditions
- Impact determinations:
 - No impact – No change
 - Less-than-significant impact – No substantial adverse change
 - Less than significant with mitigation – Implementation of one or more mitigation measures would reduce the impact to a less-than-significant level
 - Significant and unavoidable impact – A potentially substantial adverse change in the physical conditions of the environment would result AND mitigation is not feasible or would not reduce impact to less than significant

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Speaker: Laurie

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Types of CEQA Documents

- Exemption
 - Statutory and Categorical Exemptions identified in CEQA Guidelines
 - Generally common activities that typically have no significant impacts associated with them
- Negative Declaration / Mitigated Negative Declaration
 - Projects with no significant impacts or all impacts can be mitigated to less than significant
- EIR
 - Prepared for projects that may or will have significant impacts that cannot be mitigated to less than significant

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Speaker: Laurie

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Environmental Impact Report Process

Typical EIR Process	Sites Reservoir Project EIR Process
Issue Notice of Preparation	Issue Notice of Preparation
Conduct Scoping	Conduct Scoping
Prepare Draft EIR	Prepare Draft EIR
Public and Agency Review	Public and Agency Review
Prepare Final EIR	Prepare and Recirculate Revised Draft EIR
Review by Commenting Agencies	Public and Agency Review
Authority Decision	Prepare Final EIR
Prepare Findings, Statement of Overriding Considerations, and Mitigation Monitoring Plan	Review by Commenting Agencies
File Notice of Determination	Authority Decision
	Prepare Findings, Statement of Overriding Considerations, and Mitigation Monitoring Plan
	File Notice of Determination

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Speaker: Laurie

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CEQA Process Leading to Decision

- Ongoing - Administrative RDEIR/SDEIS chapters and appendices currently being prepared
- May 2021 - All Administrative RDEIR/SDEIS chapters to be submitted to Authority in May
- June 2021 - Review by Authority and Reclamation
 - Select Chapters to CEQA Responsible and NEPA Cooperating Agencies for review
- July 2021 - Request approval from the Reservoir Committee and Authority Board for release of the public RDEIR in August
- August 2021 - Release of RDEIR
 - Schedule assumes parallel review and release of SDEIS as joint document
- June/July 2022 – Final EIR and NOD

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Speaker: Laurie

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Introductory Chapter Status



Introductory Chapter Status

- Introductory Chapters
 - Ch. 1, Introduction
 - Ch. 2, Project Description and Alternatives
 - Ch. 3, Environmental Analysis
 - Ch. 4, Regulatory and Environmental Compliance
- Chapter 2 posted to the Authority's website
 - Will be updated due to minor changes to the Project and other input
- Chapters 1-4 have been sent to CEQA Responsible and NEPA Cooperating Agencies
 - Any input will be considered when chapters are submitted with complete Administrative Draft RDEIR/SDEIS in May

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Speaker: Laurie

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Next Steps

- Ongoing Preparation of RDEIR/SDEIS
 - Key findings and outcomes will be presented to the Board in 2 additional parts at meetings in May and June
 - Final briefing and recommendation for release in July
- Public Draft release August 26, 2021

Speaker: Laurie

NGO Outreach



Outreach to NGOs

- Conducted General Workshops in December
 - Workshop 1 – December 14, 2020
 - Workshop 2 –December 16, 2020
- Conducted Survey
 - In January 2021, workshop participants were asked to participate in an online survey to identify topics to be addressed in technical small group meetings
- Formed 6 Technical Small Groups
 - More focused, technical discussions
 - Small groups were formed based on survey responses and workshops questions

Speaker: Ali

Technical Small Group Status

Technical Small Group	Key Topics Areas (examples, not intended to be all inclusive)	Meetings	Status
Fisheries Protections and Effects	1. Diversion criteria, bypass flows, minimum flows 2. Modeling approach, including baseline 3. Fisheries effects (Sacramento River and Delta) 4. Temperature of releases 5. Sites Operations Plan 6. Other topics as identified by the group	Currently scheduling first meeting	Currently scheduling first meeting
Project Benefits - Proposition 1 - WSIP Benefits	1. Timing, amount, and target species/activities 2. Management of benefit water 3. Ensuring benefits are realized 4. Other topics as identified by the group	March 11 and March 24	Completed
Terrestrial Species Effects	1. Impacts (species and acres) 2. Mitigation approach 3. Other topics as identified by the group	March 26	Scheduling follow on meeting

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Speaker: Ali

Technical Small Group Status

Technical Small Group	Key Topics Areas (examples, not intended to be all inclusive)	Meetings	Status
Trinity River Effects	1. CalSim modeling for the Trinity River 2. Next Steps for Trinity River considerations 3. Other topics as identified by the group	March 22	Scheduling follow on meeting
Water Quality	1. Source water quality (Sacramento River and local watersheds) 2. Reservoir water quality 3. Release water quality 4. Salt seepage in reservoir 5. Other topics as identified by the group	April 7	Scheduling follow on meeting
Water Rights	1. Water right approach and key application parameters 2. Water right schedule 3. Other topics as identified by the group	February 23 and March 23	Completed – Follow up in August timeframe

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Speaker: Ali

Key Areas of Feedback and Questions to Date

- Reclamation level of participation
 - How will Reclamation determine its preferred alternative
 - Potential for CVP water to be stored in Sites Reservoir
- Potential for Trinity River impacts
 - Consideration of the Humboldt County 1959 contract in the modeling and cumulative
 - Need for assurances/protection for the Trinity River system and Trinity River resources
- Request to expand Tribal consultation
- Need to consider area of origin water rights along with potential future instream flow requirements from the State Board and how those might affect the Project
- Changes to Prop 1 benefits allocation and amounts as a result of the final CWC award and due to changes to project
- Project flood control benefits and design considerations

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Speaker: Ali

Key Areas of Feedback and Questions to Date (cont)

- Lack of recent habitat and species surveys due to lack of property access
- Comparison of giant garter snake impacts from 2017 to 2021
- Gray Lodge Biological Opinion giant garter snake measures should be reviewed and considered for the Project
- Consider Sutter Buttes Land Trust for mitigation opportunities
- Water quality data is limited and may not have been collected during higher flow conditions when the Project would be diverting water
- Water quality analysis should be considering the higher concentrations and not using averages
- Mercury and arsenic could be important considerations for rice farmers and wildlife use of rice fields

Speaker: Ali

Next Steps

- Follow on meetings being scheduled
 - Trinity River
 - Terrestrial Biological Resources
 - Water Quality Considerations
- First meeting being scheduled for Fishery Protections and Effects

Speaker: Ali

Listed Species Considered in the RDEIR/SDEIS & BA/ITP



2017 vs 2021 Listed Terrestrial Species

Listed Species	Affected in 2017	Affected in 2021
Keck's checker-mallow	✓	✓
Palmate-bracted bird's beak	✓	✓
Vernal pool crustaceans	✓	✓
Valley elderberry longhorn beetle	✓	✓
California red-legged frog	✓	✓
Giant garter snake	✓	✓
Tricolored blackbird	✓	✓
Swainson's hawk	✓	✓
Western yellow-billed cuckoo	✓	TBD
Bank swallow	✓	TBD
Crotch and western bumblebees*		✓

Notes: *Not listed in 2017

Speaker: Ellen

2017 vs 2021 Listed Fish Species

Listed Species	Affected in 2017	Affected in 2021
Delta smelt	✓	✓
Longfin smelt	✓	✓
Green Sturgeon	✓	✓
Steelhead	✓	✓
Fall-run/Late Fall-run Chinook	**	**
Spring-run Chinook	✓	✓
Winter-run Chinook	✓	✓

Notes: *Not listed not listed, ESA consultation for the purposes of Essential Fish Habitat

Speaker: Ellen

Questions and Discussion





Subject: **Reservoir Committee Meeting**

9:00 AM – 12:00 PM

Location: [Click here to join the meeting](#)

Call in: **1-213-379-5743**

Code: **916 340 576#**

Chair: Jeff Davis (San Geronio Pass Water Agency)

Vice Chair: Bill Vanderwaal (Reclamation District 108 and Dunnigan Water District)

Treasurer: Jamie Traynham (Davis Water District)

AGENDA

Notice: Pursuant to Executive Orders N-25-20 and N-33-20, issued by Governor Newsom on March 12, 2020, and guidance by the California Department of Public Health dated March 11, 2020, this meeting will be conducted by teleconference. The public may attend the meeting and offer public comments by phone, using the call-in number above. Members of the Committee will participate by teleconference from other locations.

ROLL CALL & CALL TO ORDER:

- Introductions.
- Pledge of Allegiance.
- Approval of April 16, 2021 Agenda.
- Announcement of Closed Session.
- Period for Public Comment.

1. Consent Agenda:

Approximate start time 9:10 am

The Executive Director reviewed the following items. To his knowledge, there is no opposition to the action. The items can be acted on in one consolidated motion as recommended or may be removed from the Consent Calendar and separately considered at the request of any person.

- 1.1 Approve the March 18, 2021 Reservoir Committee Meeting Minutes. **(Attachments A & B)**
- 1.2 Accept the Sites Project Authority Treasurer's Report. **(Attachment A)**
- 1.3 Approve the Payment of Claims. **(Attachments A, B & C)**

2. Action Items:

Approximate start time 9:15 am

- 2.1 Approve the Principles for the Storage, Delivery and Sale of Sites Reservoir Project Water (formerly referred to as the Storage Policy). **(Attachments A, B & C)**

- 2.2 Approve the recommended methodology for allocating storage space in Sites Reservoir to each local Storage Partner using the final proposed formulaic approach of 1 acre-foot Amendment 2 participation to 6.234 acre-feet of storage space. **(Attachment A)**

3. Discussion and Information Items: Approximate start time 9:30

- 3.1 Review and comment on the CEQA process, the status of the RDEIR/SDEIS introductory chapters, and the status of outreach efforts to non-governmental organizations.
- 3.2 Review and comment on the Financing Action Plan progress including updated financing alternatives, an outline of the Water Storage and Supply Services Contract (Contract) Guiding Principles and Preliminary Terms, and updated Road Map. **(Attachments A, B & C)**
- 3.3 Review and comment on the Amendment 3 working draft Organization Chart, updated objectives and timeline being used to prepare the work plan. **(Attachments A, B & C)**

4. Reports: Approximate start time 10:15 am

4.1 Member's Reports:

4.1.1 Chairpersons' Report:

This time is set aside to allow the Chair/Co-Chair an opportunity to disclose/discuss items related to the Sites Project.

4.1.2 Workgroup Chairpersons' Report:

This time is set aside to allow the Workgroup Chairpersons' an opportunity to disclose/discuss items related to the Sites Project.

4.1.3 Reservoir Committee Participant Reports:

This time is set aside to allow Representatives or their Alternates an opportunity to disclose/discuss items related to the Sites Project.

4.2 Executive Director's Reports:

- Monthly status report. **(Attachment A)**
- Work Plan Key Deliverables Report. **(Attachment B)**
- Meetings Action Items Summary. **(Attachment C)**

5. **Closed Session:** Approximate start time 10:30 am
- 5.1 Negotiations Concerning Sites Project operation terms, conditions, and agreements with the State of California, Department of Fish and Wildlife (Govt. Code §§54956.9(c) and 54956.9(d)(4))
- 5.2 Conference with Real Property Negotiators (Govt. Code §§54956.8)
Property: Glenn Colusa Irrigation District Canal, Tehama Colusa Canal rights of way and associated conveyance facilities.
Agency Negotiator: Jerry Brown, Kevin Spesert, JP Robinette; Negotiating parties: Glenn-Colusa Irrigation District, Tehama Colusa Canal Authority and Bureau of Reclamation.
Under Negotiation: Price and terms of payment for facilities lease/common use agreement.
- 5.3 Negotiations Concerning Sites Project operation terms, conditions and agreements with the State of California, Department of Water Resources and the United States Bureau of Reclamation (Govt. Code 54956.9(c) and 54956.9(d)(4)).
6. **Report from Closed Session** Approximate start time 11:55 am
7. **Recap:** Approximate start time 12:00 pm
- 7.1 Suggested Future Agenda Items.
- 7.2 Upcoming Meetings:
Authority Board:
Wednesday, April 21, 2021 – 1:30 to 4:00 PM
Finance & Governance Alternatives Joint Workshop:
Friday, April 23, 2021, 9:30 AM – 12:00 PM
Reservoir Committee:
Thursday, May 20, 2021, 1:30 PM – 4:00 PM

Virtual Information will be provided prior to all meetings at [Sitesproject.org](https://sitesproject.org).

ADJOURN

PERIOD OF PUBLIC COMMENT: Any person may speak about any subject of concern, provided it is within the jurisdiction of the Reservoir Committee and is not already on today's agenda. The total amount of time allotted for receiving such public communication shall be limited to a total of 10 minutes per issue and each individual or group will be limited to no more than 3 minutes each within the 10 minutes allocated per issue. **Note:** No action shall be taken on comments made under this comment period.

ADA COMPLIANCE: Upon request, agendas will be made available in alternative formats to accommodate persons with disabilities. In addition, any person with a disability who requires a modification or accommodation to participate or attend this meeting may request necessary accommodation. Please make your request to the Board Clerk, specifying your disability, the format in which you would like to receive this Agenda and any other accommodation required no later than 24 hours prior to the start of the meeting.

This meeting will be recorded.

File Provided Natively

From: Unger, Sophie [Sophie.Unger@icf.com]
Sent: 4/16/2021 12:36:16 PM
To: Spranza, John [john.spranza@hdrinc.com]; Lecky, Jim [Jim.Lecky@icf.com]; Hendrick, Mike [Mike.Hendrick@icf.com]; Wilder, Rick [Rick.Wilder@icf.com]; Hassrick, Jason [Jason.Hassrick@icf.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: RE: Alt 3 American River and Feather River Redds

Hi All,

Regarding the Feather River redd dewatering results, one thing I should have noted when I was presenting my results is that the great majority of salmon and steelhead spawning occurs in the Low Flow Channel, i.e., upstream of the Thermalito Afterbay outlet, while the results I presented were for the High Flow Channel. I did not run a redd dewatering analysis for the Low Flow Channel because none of the Alternatives has much if any effect flow in that section of the river. I apologize if I cranked up anxiety more than necessary.

Thanks,
Sophie

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, April 15, 2021 12:48 PM
To: Lecky, Jim <Jim.Lecky@icf.com>; Unger, Sophie <Sophie.Unger@icf.com>; Hendrick, Mike <Mike.Hendrick@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Hassrick, Jason <Jason.Hassrick@icf.com>; aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: Alt 3 American River and Feather River Redds

Hi All,

We'd like to have a meeting early next week to discuss the Alt 3 American River results and the potential for Feather River redd dewatering. Please let me know your availability below. Thanks.

Monday 19th

10:30-11:30

3-4

4-5

Tuesday 20th

10-11

11-12

3-4

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8858 M 818.640.2487
john.spranza@hdrinc.com

hdrinc.com/follow-us
hdrinc.com/follow-us

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/18/2021 2:34:11 PM
To: Unger, Sophie [Sophie.Unger@icf.com]; Lecky, Jim [jim.lecky@icf.com]; Hendrick, Mike [mike.hendrick@icf.com]; Wilder, Rick [Rick.Wilder@icf.com]; Hassrick, Jason [Jason.Hassrick@icf.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: RE: Alt 3 American River and Feather River Redds

Okay, thanks for the clarification. I have briefed the Authority on our discussion from last Wednesday so please be prepared to speak to how this changes that brief.

Thanks.

John Spranza

D 916.679.8858 M 818.640.2487

From: Unger, Sophie <Sophie.Unger@icf.com>
Sent: Friday, April 16, 2021 12:36 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Lecky, Jim <jim.lecky@icf.com>; Hendrick, Mike <mike.hendrick@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Hassrick, Jason <Jason.Hassrick@icf.com>; aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>
Subject: RE: Alt 3 American River and Feather River Redds

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.

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John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

HDR

2379 Gateway Oaks Drive, Suite 200

Sacramento, CA 95833

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john.spranza@hdrinc.com

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Sites Modeling

Delta and South-of-Delta Modeling Review

April 13, 2021



Introductions

Rob Kunde



Agenda

- Purpose of modeling and work done to date
- Data available to participants
- Conveyance of water through the Delta
- Exchanges with Oroville
- Use of San Luis
- Next Steps
- Action Item Recap

Purpose of Modeling and Work Done to Date

Erin Heydinger



Work Done to Date: Baseline

Updated modeling baseline to shift to CalSim 2020
Benchmark:

- Baseline includes actions from SWP ITP and ROC on LTO
 - Key actions incorporated on Sacramento River, American River, and Delta Old and Middle River
- Developed by Reclamation in coordination with DWR and CDFW
- Includes more ITP actions than other recent state-focused models
- All baseline actions preserved in alternatives evaluated in Draft EIR/Supplemental EIS
- A draft memo is available identifying specific actions and modeling approach

Work Done to Date: EIR/EIS

Modeled all alternatives for RDEIR/SDEIS:

- Alternative 1:
 - 1.5 MAF Reservoir
 - Release pipeline to the Colusa Basin Drain
 - Reclamation investment of up to 7%
 - Reclamation has storage in Sites of 0-91 TAF
- Alternative 2:
 - 1.3 MAF Reservoir
 - Release pipeline to the Sacramento River
 - Partial release to Colusa Basin Drain
 - No Reclamation investment
- Alternative 3:
 - Same facilities as Alternative 1
 - Federal investment up to 25%
 - Reclamation has storage in Sites of up to 345 TAF

Work Done to Date: Climate Change

- Sensitivity-level climate change modeling performed for all RDEIR/SDIES alternatives
 - Uses 2035 Central Tendency (2035 CT)
 - 2035 CT was used in the analysis for the SWP ITP and ROC on LTO
- 2030 and 2070 climate change hydrology is required for the WSIP Feasibility Study and is under development

Questions?



Data Currently Available

Erin Heydinger



Data Available: CalSim Output

CalSim output at a monthly timestep for many metrics:

- Reservoir storage levels by participant “type”
- Reservoir releases by participant “type”
- Flows compared to the baseline in many locations between Shasta and Jones/Banks pumping plants along the Sacramento River and in the Delta
- All results are based on current operating assumptions
- Data is available for all RDEIR/SDEIS alternatives

Data Available: CalSim Output

- Summary data is available for key parameters:
 - Diversions, releases, etc.
 - Includes estimated water transferred from NOD to SOD participants each year
- Model itself is also available if desired

Data Available: Deliveries

- Post-processed deliveries available by participant by year
 - Has been distributed to Ad Hoc O&E Workgroup
- Summary metrics as well as year-by-year data available

How do I get all of these results?

- Email Erin at erin.heydinger@hdrinc.com
- Specify type of information needed
 - Summary-level
 - Specific parameter/location
 - CalSim model

Questions?



Conveyance of Water Through the Delta

Steve Micko



Demand and Export

- Demand
 - Assume storage partner wants water stored in Sites delivered every year
- Sites export window: July through November
 - July through November is an operational assumption, not a contractual assumption
 - Subject to available capacity:
 - Allowable exports under regulation minus SWP use of capacity
 - No assumed deliveries in Wet and Above Normal years
 - CalSim models all South of Delta PWAs as one “bin”; South of Delta PWA delivery values are post-processed

Delivery Pattern

- Delivery Pattern
 - Based upon export
 - Model does not consider delivery separate from export
 - Presume most deliveries would occur on-pattern with a portion off-pattern
 - Difference between on- and off-pattern is difference between pattern used by constituencies versus storage for later use

Carriage Water

- Model assumptions:
 - Only account for compliance with Delta water quality standards
 - No impact to SWP/CVP operations for meeting water quality standards
 - However, compliance is affected by antecedent conditions, influenced by all Sites operations
 - Compliance costs for Sites export operations are estimated at 18%
- Working with DWR regarding Sites exports through Delta
 - Non-project carriage water can be up to 30-35%

Questions?

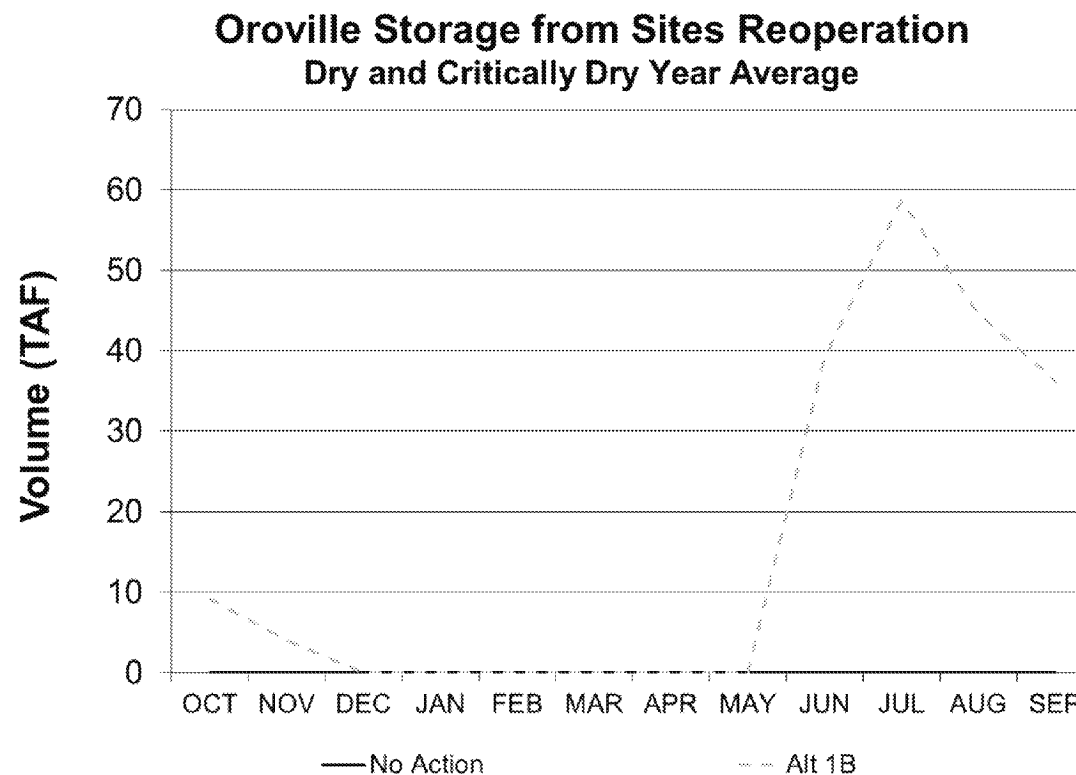


Exchanges with Oroville



Exchanges with Oroville: Purpose and Summary

- Increase flexibility of Sites release operation
- Augment Sites release capacity in drier water years



Exchanges with Oroville: Exchange Period

- Timing:
 - June and July
- Water year types:
 - Below Normal, Dry and Critically Dry years
- Volume:
 - Limited to minimize potential for spills of Sites water from Oroville

Exchanges with Oroville: Release Period

- Timing:
 - August through November
- Release capacity:
 - Considers capacity based on:
 - Feather River, Sacramento River and Delta regulatory requirements
 - Banks Pumping Plant capacity
- Maximum Feather River flow:
 - Feather River fall stability flow requirements are considered
- Spills:
 - Unused Sites water in Oroville is subject to spill
 - Average of 2 TAF, five spill events over CalSim period

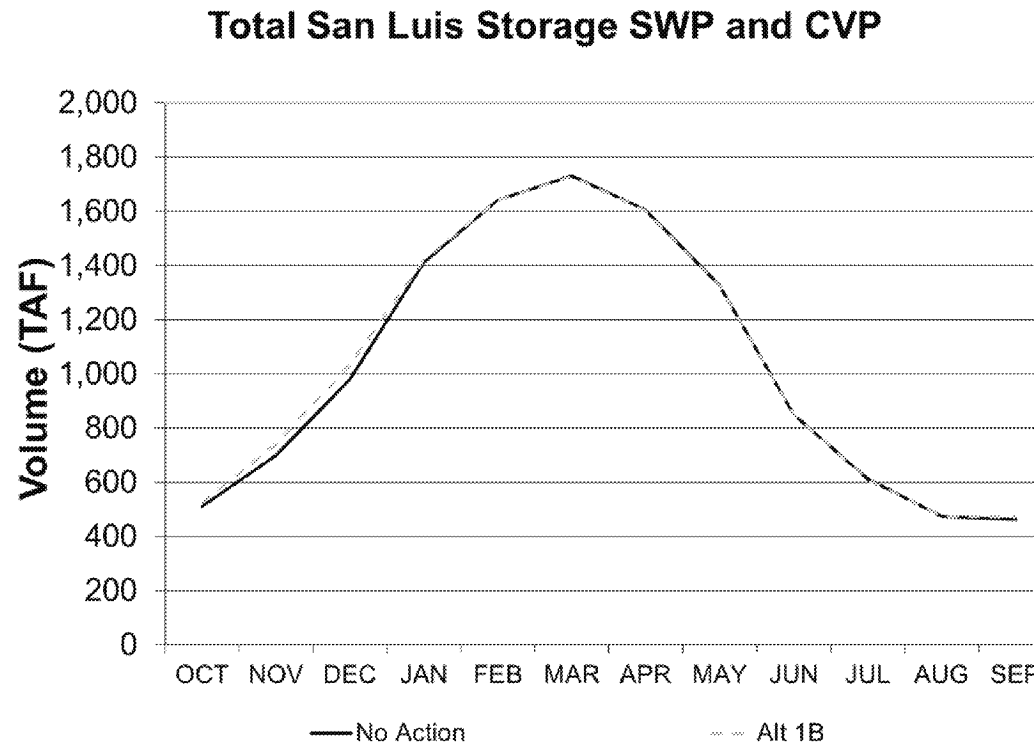
Questions?



Use of San Luis Reservoir and Carryover



Use of San Luis Reservoir and Carryover



- Model assumption: South of Delta Storage Partner water is not stored in San Luis

Use of San Luis Reservoir and Carryover

- Next steps:
 - Considering ability to re-operate San Luis storage to facilitate exports to on-pattern delivery
 - Likely to increase San Luis storage in July and August
 - Beneficial to SWP contractors
 - Coordinate with DWR and Reclamation regarding San Luis storage

Questions?



Deliveries



Deliveries: Model Assumptions

- Sites releases
 - Sacramento River through Dunnigan Pipeline
 - “In-river” exchanges with Sacramento River at Hamilton City
 - Oroville exchange
 - Shasta exchange
- Transfers from NoD to SoD storage partners may occur in Above Normal or Below Normal years
- Difference between release and deliveries are due to:
 - Carriage water costs
 - Losses in canals
- All South of Delta storage partners proportionally share exported water regardless of export pattern

Deliveries: Next Steps

- Work with DWR and South of Delta storage partners regarding South of Delta storage
- Conduct refined analysis of South of Delta deliveries
 - Treat each storage partner uniquely

Questions?



Next Steps

Erin Heydinger



Next Steps

1. Proforma
 - a) Evaluate other operational assumptions for NoD and SoD participants
 - b) Provide broader range of possible releases/deliveries
2. Operations Plan
 - a) Specific processes for annual water requests, coordination with SWP and CVP
3. Participant-specific modeling
 - a) Potential Amendment 3 activity

Action Items





From: Heydinger, Erin [Erin.Heydinger@hdrinc.com]
Sent: 4/19/2021 10:11:42 AM
To: Rob Kunde [rkunde@wrnwsd.com]; Eric Leitterman [ELeitterman@valleywater.org]; CWang (cwang@mwdh2o.com) [cwang@mwdh2o.com]
CC: steve.micko@jacobs.com; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Modeling Meeting Follow Up - Oroville & Baseline Memos
Attachments: Sites_Baseline_TM_20210127_rev01_DRAFT.pdf; SPJPA_Sites_OrovilleExchange_rev03_20210323.pdf

Good morning,

The three of you requested draft memos describing the baseline and Oroville exchanges. The attached memos are in draft form and describe how these two operations are built into the model for the purposes of the Revised Draft EIR/Supplemental Draft EIS. As noted last week, these are the modeling assumptions and, particularly for the Oroville exchange, are not intended to a comprehensive representation of how Sites might operate in coordination with Oroville and the SWP.

Thanks!
Erin

Erin Heydinger, PE, PMP
Project Manager
Water/Wastewater

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D 916.679.8863 M 651.307.9758

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Draft – Subject to Revision

Sites Project: Lake Oroville Exchange Modeling Assumptions

This document summarizes Sites Reservoir exchange operations with Lake Oroville. Then, details and tabulates modeling assumptions.

Summary of Oroville Exchange Operation

The Oroville exchange is designed to support cold water pool management of Oroville and augment delivery of Sites water to Delta Participants during the transfer window. In June and July of Oroville exchange years, a portion of SWP obligated releases would come from Sites in lieu of Oroville, reducing releases from Oroville. Therefore, Oroville storage and cold water pool would be preserved through the end of July.

At the end of July, Sites has released SWP water instead of Oroville. The volume of released water is equivalent to the exchange volume preserved in Oroville. In the late-Summer and Fall (August – November), the exchange volume augments Oroville releases, provides deliveries to Sites participants, and supports Oroville cold water pool management.

Oroville Exchange Operational Criteria

Assumptions of Oroville exchange operational criteria are detailed below. These criteria are also summarized in Table 1.

Exchange Period

In terms of physical Oroville storage capacity for an exchange, there is no assumed limit. Instead, the Oroville exchange volume is estimated in June and July based on Sites' forecasted transfer volume to south of Delta Storage Partners in August through November. If the Oroville exchange volume overestimates Sites' ability to transfer water south of the Delta, a portion of Sites exchange water remains in Oroville. This remaining exchange water is subject to spill.

The Oroville exchange period is limited to June and July. The Oroville exchange period starts in June due to the high degree of uncertainty in forecasting south of Delta transfers. Forecasting south of Delta transfers any earlier than June would pose a significant risk to losing Sites water, via spills from Oroville. Additionally, to protect Green Sturgeon habitat, Feather River flows must not decrease in August.

In Wet and Above Normal water years, Sites transfers to south of Delta Storage Partners are limited. As such, Oroville exchanges occur in Below Normal, Dry and Critically Dry water year types.

Release Period

The majority of exchange water is released in August and September, as October and November must consider Feather River fall stability flow targets. Per fall stability flow requirements, total Oroville releases are limited to 2,500 cfs from October 16th through November.

All exchange water must be released in the August through November period. If exchange water is not released by the end of November, it is subject to spill.

Table 1. Oroville Exchange Criteria

	Modeled Criteria	Notes
Exchange Period	June – July	Estimating volume of exchange water before June poses risk of losing Sites water to spill; Per Green Sturgeon requirements, Sites may not decrease Feather River flows in August
Exchange Constraints		
Water year types	Below Normal, Dry and Critically Dry water years	Oroville exchange not necessary in Wet and Above Normal water year types
Exchange Volume		Limited to minimize potential for spills of Sites water from Oroville
Release Period	August – November	
Release Constraints		
Delta Export Capacity		Considers conveyance capacity based on Feather River, Sacramento River and Delta regulatory requirements, and Banks Pumping Plant capacity
Max Feather River Flow	Oct: 4,000 cfs Nov: 2,250 cfs	Feather River fall stability flow requirements. October average flow of 4,000 cfs assumes flow requirement of 2,500 cfs for the 16 th through 31 st . November average of 2,250 cfs to protect fall stability flow requirement.
Spills	Spill Sites water in December	Unused Sites water in Oroville is subject to spill

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CC: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: Site Records for Yocha Dehe

Hi, Kevin and Ali

A while back we discussed the issue of providing the 2003 site records to the Yocha Dehe (and Colusa), but acknowledged the confidentiality problem given the restrictions agreed upon between DWR and the land owners. We all agreed that this would have to be taken up with the Authority about how to proceed with regard to providing the Yocha Dehe copies of the site records.

Over the years we have, at least twice, supplied the tribes with all of our GIS information about the sites, as well as the draft archaeological report from the early 2000s that describes each of the sites recorded. So, although they technically have all the pertinent site information available, Yocha Dehe has been asking for the site records to be electronically linked to the GIS. It is on ICF's radar, but has not been a top priority. This is partly due to the uncertainty of being able to pass on the site records in that format. (Note that we very recently provided them with all of the recent record search information collected for the geotechnical studies and the expanded project footprint.)

The Yocha Dehe GIS person is insisting that they cannot do their analysis for Tribal Cultural Resources without the site record information. And because we really need to get them to have the discussion about TRCs and mitigation for the EIR, we need to make a decision about how to proceed. Since they have all of the basic site information from the GIS and report, the site records will add little information that they don't already have, other than site-specific details. With this in mind, I would recommend that we move forward and have ICF make it a priority to link the GIS with the site records. They still will not be part of the CHRIS system, per the agreement with DWR.

I know this may warrant some further consideration and discussion. Please let me know if we need to discuss.

Thanks
janis

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CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: CDFW Concerns Regarding The Yolo Bypass Pulse Flows Benefit
Attachments: CDFWContract_Report_2019_NDFA_120519.pdf; 2019 Report North Delta Food Subsidies Study.pdf; 2020_orlando_et_al.pdf

Hi,
We had a WSIP benefits call with CDFW today and the first half was dedicated to Sites' ecosystem water's effects on Yolo and smelt. This will be in their comments they send over but I wanted to get this over to you for review.

Happy to set up a call to discuss.
John

John Spranza

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Subject: CDFW Concerns Regarding The Yolo Bypass Pulse Flows Benefit

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.

Hi John,

Thanks for taking the time to meet with us today. As requested, I listed out CDFW's concerns regarding Sites' Yolo Bypass Pulse Flows benefit. I have also attached three documents that discuss findings from the North Delta Flow Action (NDFA). Please, let me know if you have any questions.

Yolo Bypass Pulse Flow impacts of concern:

- Increased stray rates into the Yolo Bypass of fall-run Chinook and Steelhead. This is primarily a concern when pulses are provided in September and October.
- Temperature impacts, due to reservoir releases to the Yolo Bypass. Temperature is likely a significant driver of the lethal and sub-lethal impacts to fish that we observe in the Yolo Bypass.
- Water quality impacts, associated with delivering water through the Colusa Basin Drain. Samples collected as part of the NDFA have consistently detected concentrations of certain pesticides that exceed EPA's chronic invertebrate toxicity benchmarks. The study is currently looking into how contaminants may be affecting fish health.
- Capacity limitations in moving water through the Yolo Bypass, during the late-summer and fall period. Is there sufficient capacity to move the volumes of water that Sites is proposing, through the Yolo Bypass, given that agricultural drainage is often taking place at around the same time?

Thanks,

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State of California
California Natural Resources Agency

DEPARTMENT OF WATER RESOURCES
Division of Environmental Services
Office of Water Quality and Estuarine Ecology
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Special Studies Section

CDFW Contract Agreement D1683001 00 Report: Investigating Yolo Bypass as a Fall Food Web Subsidy for the Delta

Completed and Submitted: 12/5/2019



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Acronyms and Abbreviations

AB70	Assembly Bill 70
BDCP	Bay Delta Conservation Plan
BL5	Prospect Slough
BO	Biological Opinion
°C	Degrees Celsius
CDFW	California Department of Fish and Wildlife
CDEC	California Data Exchange Center
CFS	Cubic Feet per Second
Chl <i>a</i>	Chlorophyll <i>a</i>
CSC	Cache Slough Complex
DO	dissolved oxygen
DOC	Dissolved Organic Carbon
DOP	Drought Operation Plan
DSRS	Delta Smelt Resiliency Strategy
DWR	California Department of Water Resources
EC	Electrical Conductivity
I80	Toe Drain at I80 Bridge
LIB	Base of Liberty Island
LIS	Toe Drain below Lisbon Weir
mgL ⁻¹	milligrams per liter
NCRO	North Central Region Office
NH ₄	Ammonium
NO ₃	Nitrate
NO ₃ +NO ₂	Nitrate + Nitrite
NTU	Nephelometric Turbidity Unit
PO ₄	Ortho-phosphate
QAQC	Quality Assurance Quality Control
RCS	Ridge Cut Slough at Highway 113 Bridge
RD22	Toe Drain at Road 22
RVB	Sacramento River at Rio Vista Bridge
RYI	Cache Slough at Ryer Island
SDI	Sacramento River at Decker Island
SFE	San Francisco Estuary
Si(OH ₄)	Silica
SpCnd	Specific Conductance
STTD	Screw Trap at Toe Drain
µScm ⁻¹	micro siemens per centimeter
USGS	U. S. Geological Survey
WY	Water Year
YBFMP	Yolo Bypass Fish Monitoring Program
YSI	Yellow Springs Instruments

Project Title: Investigating Yolo Bypass as a Fall Food Web Subsidy for the Delta

I. Introduction

Funding Source:

January 17, 2014 Governor Brown issued proclamation declaring a state of emergency due to prolonged drought conditions – this resulted in the passage of Assembly Bill 92, including Section 11(AB 92). AB 92 directs the CDFW to take action relating to evaluate and manage the changing impacts of drought on threatened and endangered species. In addition, CDFW is required to conduct specific monitoring actions in the April 8, 2014 Drought Operations Plan (DOP). Furthermore, Biological Opinions covering Delta smelt and Chinook salmon requires actions to be taken in the Yolo Bypass and the Cache Slough Complex.

- Assembly Bill 92 (AB 92) – Emergency Drought Proclamation
- Drought Operation Plan (DOP)
- Biological Opinions

Purpose:

Inform future restoration efforts that are planned for the Yolo Bypass, with intent of enhancing food web benefits. Secondary objectives are to investigate associated effects of increasing fall flows through the Yolo Bypass on contaminants in downstream Cache Slough Complex and effects on residence time and movement of adult Chinook salmon.

- Food web benefits
- Contaminants
- Adult Chinook Salmon straying

Study Objective:

Monitor and manage summer and fall agricultural flows through the Yolo Bypass, and examine these flow effects on food web for Delta smelt, contaminants, and Chinook salmon.

- Execute managed flow action
- Monitor flow effects on:
 - Food web
 - Contaminants
 - Adult Chinook salmon migratory behavior

Study Background:

Previous studies from 2011-2015 indicate that fall flows through the Yolo Bypass have the potential to increase food supply for Delta Smelt in the Sacramento San Joaquin Delta (Frantzich 2017; Frantzich et al. 2018). Fall flows come through the Yolo Bypass Toe Drain when rice fields are drained. This water source also contains contaminants and the flow may attract adult Chinook salmon up into the Yolo Bypass.

Conceptual model:

Floodplains are known globally as vital sources of organic matter and centers of biodiversity in freshwater systems, despite having their extent and range decimated from the historical landscape worldwide (Tockner and Stanford, 2002). Floodplains are not only key locations for primary and secondary productivity, but also subsidize productivity outside of their boundaries via an intermittent connection with neighboring river systems. Known as the ‘flood pulse concept’ (Junk et al. 1989) this model postulates that long residence time when the river is disconnected from the flood plain allows for high *in situ* primary productivity, while river-floodplain connection during periods of high flow allow for export of high-productivity waters. In the Sacramento-San Joaquin Delta, this process has been demonstrated in the existing floodplains of the North Delta: in the Consumes River floodplain, periodic connectivity is essential for allowing the floodplain to supply suspended algal biomass to downstream systems (Ahearn et al. 2006). In the Yolo Bypass, phytoplankton biomass increases with residence time (Sommer et al. 2004), and peaks during drainage from inundation events (Schemel et al. 2004).

We use the flood pulse concept (Junk et al. 1989), as well as previous research and observations in the Yolo Bypass, as our conceptual model for developing predictions for the effect of fall agricultural drainage and other elevated flow events on the distribution of phytoplankton biomass. Previous research has already suggested that Yolo Bypass acts as a productivity subsidy for the Delta (Jassby and Cloern 2000; Schemel et al. 2004); however, export mechanisms have not yet been explicitly investigated. Beyond understanding how the Yolo Bypass may serve as a productivity subsidy for the Delta in general, a key motivator for this study is evidence from 2011 and 2012 that an algal bloom in the lower Sacramento River was based largely off contributions from the Yolo Bypass. This bloom was composed largely of chain-forming diatoms that are beneficial for secondary production and now rare in the western Delta during fall (F. Wilkerson, 2012 IEP Workshop presentation); thus, it is essential to understand the processes behind the formation of such a bloom. Six pieces of evidence suggest that the bloom occurred at least in part after agricultural drainage from Yolo Bypass produced a flow pulse that exported water rich in Chl a, a measure that closely tracks phytoplankton biomass (Jassby and Cloern 2000):

- (1) Water isotopic chemistry (“fingerprinting tools”) showed that the algal bloom in the lower Sacramento River was derived from contributions from the North Delta, and in particular the Yolo Bypass (C. Kendall, 2012 IEP Workshop presentation)
- (2) In September and October 2011, 2012 and 2013, elevated Chl a concentration was observed in Yolo Bypass (Figure 6), C. Kendall, 2012 IEP Workshop presentation, Frantzich, 2014 IEP Workshop presentation).
- (3) In all fall seasons since 2005, the Yolo Bypass experiences elevated flow levels from large-scale rice field drainage. Note that Yolo Bypass net flows in summer and fall are primarily negative (i.e. upstream transport), except during agricultural flow events such as that observed in fall 2011 and 2012, when positive flows occur.
- (4) In 2011 and 2012, DWR continuous chlorophyll data (collected with YSI sondes) and lab samples analyzed for Chl a concentration at Rio Vista Bridge, captured elevated values post Yolo Bypass agricultural flow pulse in summer and fall, suggesting an algal bloom (Frantzich et al. 2018).
- (5) In fall 2011 and 2012, low values of chlorophyll relative fluoresces were measured at the continuous water quality station at Sacramento River at Hood prior to the observed bloom event captured by the Rio Vista Bridge water quality station. To the contrary, elevated values of Chl a were captured by discrete water samples collected in the Yolo Bypass and Cache Slough Complex during the same time period, suggesting this region to be the primary source (Frantzich et al. 2018).

In 2013, a much more intense and collaborative study with DWR, UCD, CVWRCB, and USBR provided enough evidence that a phytoplankton bloom is occurring in the Yolo Bypass during the summer and fall agricultural drainage period, but there seems to be a significant role in water volume and discharge flows in the intensity and transport of this bloom downstream past Rio Vista. Given the above observations, we predict that in the summer of 2016 and falls of 2017 and 2018: 1) There will once again be relatively high Chl a concentration in the Yolo Bypass; and 2) high Chl a level will shift downstream, into the Cache Slough Complex and the lower Sacramento River, after the annual fall agricultural drainage event. These predictions will be evaluated much like they were in 2013-2015, through the collection of discrete Chl a samples before, during and after fall flow pulses at a series of site locations within the Toe Drain and at various downstream site locations within the Cache Slough corridor (Figure 1), ending at Rio Vista.

In 2016-2018, there will be intensified sampling efforts to determine the ecosystem response to managed North Delta Flow Actions in summer 2016 and fall 2017 as part of the Delta Smelt Resiliency Strategy (DSRS). Data will be collected within five identified regions that extend from the Colusa Basin Drain at Ridge Cut Slough south to the Sacramento River at Rio Vista. The focus of this study is on identifying the flux of nutrients and phytoplankton between each of these regions through the Toe Drain of the Yolo Bypass during the fall rice discharge period in each year. If possible, the rice discharge pulse will be augmented through management actions in order to enhance transport downstream to the estuary. There will be monitoring of various constituents within these fluxes, including: flow, continuous water quality measurements (temperature, SpCnd, Chl a, turbidity, pH, DO), light attenuation, nutrients, phytoplankton, and grazing (zooplankton and benthic sampling). The goal will be to model these fluxes to determine the relative effects (sources and sinks) of each region in the development and transport of phytoplankton downstream into the Lower Estuary.

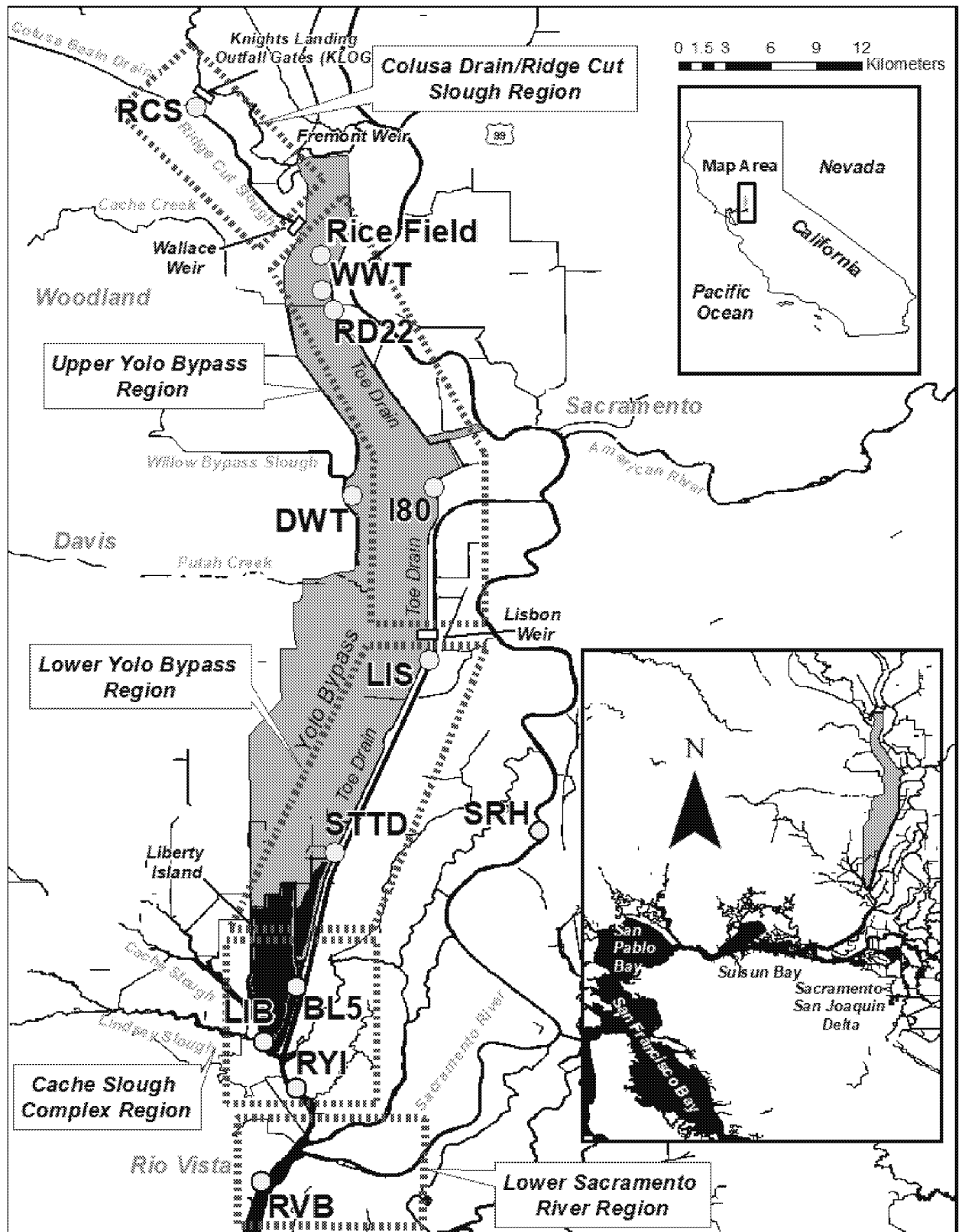
The Yolo Bypass presents a passage issue for migratory fishes in the Central Valley, especially during the low flow time-periods of summer and fall, and little is known about migrating Chinook in the lower Yolo Bypass attracts migratory Chinook salmon but fall flows may have an important effect on how far up the Yolo Bypass, Chinook Salmon migrate.

Due to this study's use of agricultural drainage flows to improve the food web downstream, there is an interest in identifying the timing, concentrations, and spatial distributions of agricultural contaminants over the study period. From water management perspective, knowing more about the timing of higher concentrations of pesticides can help in future management strategies in the timing of flow pulses and effects of discharge volume on contaminant concentration dilution and transport.

Study Regions:

1. Colusa Drain/Knights Landing Ridge Cut
2. Upper Yolo Bypass
3. Lower Yolo Bypass
4. Cache Slough Complex
5. Sacramento River at Rio Vista

Figure 1. Map of Yolo Bypass, Cache Slough Complex, and Sacramento River sampling sites



Primary Study Questions:

1. Can the Yolo Bypass be a significant source of fall phytoplankton to the Cache Slough Complex and the lower Estuary?
2. What the major fluxes of phytoplankton within the study regions (Colusa Drain/Knights Landing Ridge Cut, Central Yolo Bypass, Lower Yolo Bypass, Cache Slough Complex, and Sacramento River at Rio Vista)?
3. How do levels of flow, nutrients, and grazing (e.g. benthic, zooplankton) in each study region influence fluxes and the development of downstream bloom events?
4. Do increased fall flows affect the residence time and movement of adult fall-run Chinook salmon in the Yolo Bypass?

Addressing these questions will help inform future restoration efforts that are planned for the Yolo Bypass with the intent of enhancing food web benefits. These restoration efforts include the Bay Delta Conservation Plan (BDCP) and fish restoration

Study Tasks:

Task 1: Investigate the changes in chlorophyll-a distribution and water quality during summer/fall flow pulses

Task 2: Analyze the concentrations, distributions, and sources of various nutrients

Task 3: Determine the species composition and densities of phytoplankton

Task 4: Determine the agricultural flow pulse timing and the velocities of flow associated within the five Study Regions

Task 5: Measure zooplankton densities, grazing impacts, and production within each sampling region

Task 6: Modeling of plankton growth, transport, and losses in the Yolo Bypass

Task 7: Analyze the concentrations, distributions, and sources of various contaminants

Task 8: Adult fall-run Chinook Salmon acoustic telemetry to investigate residence time and movement in the Yolo Bypass

II. Task 1: (Chlorophyll *a*) Investigate the changes in chlorophyll *a* distribution and water quality during summer/fall flow pulses

Contributing authors:

Jared Frantzich, DWR Division of Environmental Services

Task 1. Background:

Phytoplankton (chlorophyll *a* is a surrogate for phytoplankton biomass) can affect various water quality parameters, including: pH, dissolved oxygen, color, taste and odor, and certain species can result in toxic blooms (Brown 2009; Carmichael 1981). They are a very important part of the pelagic food web in the Delta and are recognized as a preferred and dominant food source for much of the higher trophic levels (Brown 2009; Jassby et al. 1993; Muller-Solger et al. 2002; Sobczak et al. 2002). Further, phytoplankton biomass and primary productivity have exhibited a long-term trend since the mid-1970s (Jassby et al. 2002). Historical data from the DWR Yolo Bypass Fisheries Monitoring Program (YBFMP) shows periodic events of exceptionally high Chl *a* concentration (Frantzich 2017). However, these data are only collected at a single location on a biweekly basis, and primarily during winter and spring. Hence, higher-resolution seasonal data are needed to determine the duration and spatial extent of these flow pulse events, and whether they co-vary with high flow events or changes in water quality parameters.

Task 1. Research Questions:

1. Is there evidence that the summer/fall flow pulses in the Yolo Bypass Toe Drain help to transport algal biomass downstream?
2. Are summer/fall levels of chlorophyll *a* in the Yolo Bypass (and areas immediately downstream during the summer/fall flow pulses) relatively high as compared to other Delta locations?
3. How do chlorophyll *a* concentration and other water quality measurements (DO, EC, pH, WT) change temporally throughout the study regions?

Task 1. Methods:

*Chlorophyll *a* (Chl *a*) Discrete Sampling*

Chl *a* distribution during summer/fall flow pulses was determined by collecting discrete water samples for Chl *a* analysis by land and by boat using a Van Dorn sampler or Nasco 12' Extendible Swing Sampler at a total of twelve site locations: one in Ridge Cut Slough, six in the Toe Drain (includes Woodland and Davis wastewater discharge locations), three in Prospect and Cache Sloughs, and two in the lower Sacramento River (Figure 1). Note, sample collection was not performed at Woodland and Davis wastewater discharge points in 2013. Samples were typically collected during the months of August-October on a weekly basis, but sampling months changed to June-September in 2016-2017 to overlap with the timing of the summer 2016 Delta Smelt Resiliency Strategy North Delta managed flow action. Additional discrete IEP EMP data was used to evaluate whether Chl *a* concentration in Yolo Bypass and immediately downstream was relatively high compared to other regions in the Delta. Sample collection procedures followed established methods by IEP Bay-Delta Monitoring and Analysis Section. During each day of sampling one Chl *a* sample was duplicated on a rotating basis to ensure quality control in collection and lab procedures. Samples were typically collected on an ebb tide and a depth of 3 ft. using a Van Dorn sampler or Extendible Swing Sampler. The DWR Bryte laboratory was responsible for all sample analysis. Chlorophyll *a* concentrations and the degradation product phaeophytin *a* was

determined from the extraction of pigments on glass-fiber filters with 90% aqueous acetone and spectrophotometry (Standard Method 10200H, (APHA 2012).

Continuous Water Quality Sampling

To gain higher resolution data on how Chl *a* concentrations vary in the Yolo Bypass spatially and temporally, one continuous water quality station was placed in Ridge Cut Slough at the site of the flow gauge RCS, and three additional stations within the Toe Drain of the Bypass (Figure 1). The three Toe Drain sites are located (progressing southward) at Rd. 22 bridge (Rd. 22), I80 bridge (I80), and the site of the Yolo Bypass Fisheries Program rotary screw trap (STTD). This site location is approximately three miles north of the terminus of the Toe Drain and allow us to capture a signal of phytoplankton biomass movement downstream. The DWR also maintains a long-term continuous water quality stations: in the Toe Drain below Lisbon Weir (LIS), Sacramento River at Rio Vista Bridge (RVB), and Sacramento River at Hood (SRH) (<http://cdec.water.ca.gov/index.html>). In addition, continuous total chlorophyll fluorescence data was also acquired from USGS operated Yellow Springs Instruments (YSI) EXO2 sonde at Base of Liberty Island (LIB).

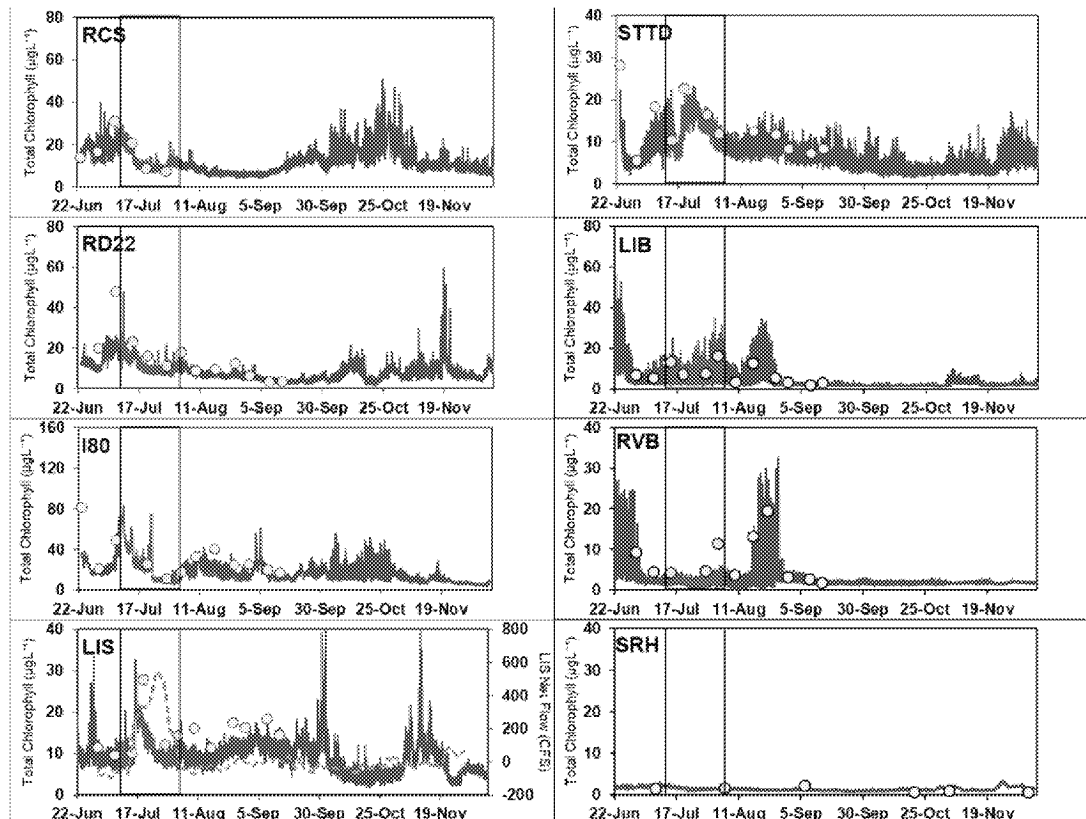
Each DWR continuous water quality station collected time-series data at 15-minute intervals with a YSI 6600EDS V2-4 internal data logging sonde. Each station recorded a single measurement of water temperature, dissolved oxygen, pH, specific conductance, turbidity, and total chlorophyll, within each 15-minute interval. All these parameters provide important information regarding the physical chemistry of the water that is flowing through the Toe Drain of the Yolo Bypass seasonally, and several of these parameters (e.g., turbidity) apply directly to the expected concentration of Chl *a*. Each station was visited every three weeks to perform calibrations of the sondes to ensure data accuracy. Upon each site visit, YSI handheld field instruments were used to sample current water conditions to confirm and compare water quality measurements with those recorded by the YSI 6600 V2-4 sondes. The calibration accuracy of each sonde was checked during post-deployments using the calibration standards described in the USGS technical report describing standard operating procedures for continuous station operation (Wagner et al., 2006). Data then underwent further QA/QC procedures established by Water Quality Evaluations Staff through the screening and flagging of unreliable data through the North Central Region Offices Hydstra database.

Task 1. Results and Discussion:

2016

In 2016, the summer managed flow pulse on July 14-August 1 through the Yolo Bypass Toe Drain helped to transport higher chlorophyll *a* (Chl *a*) concentrations (Task 1 Question 1) from the Ridge Cut Slough (site RCS) and upper Yolo Bypass (site RD22 and I80) regions into the lower Yolo Bypass (Task 1 Figures 1 and 2). The Ridge Cut Slough region had high Chl *a* concentration leading up to the managed flow pulse, with concentrations $>30 \mu\text{gL}^{-1}$ during the sampling week 2 on July 7 (Task 1 Figures 1 and 2). The Chl *a* concentration did drop 3-4-fold during the peak flows, as residence time was reduced, and Sacramento River water source was pumped into the Colusa Basin Drain (Task 1 Figures 1 and 2). The upper Yolo Bypass did have significantly different (ANOVA $p < 0.05$) concentrations throughout managed flow pulse, with higher ($>40 \mu\text{gL}^{-1}$) concentrations before (Tukey test $p < 0.05$) the flow pulse than during (Task 1 Figure 1 and 2). Although Chl *a* concentration did drop during peak flows in the upper Yolo Bypass region those concentrations did return to high levels at the I80 site ranging from 25-40 μgL^{-1} after flows subsided (Task 1 Figure 1 and 2).

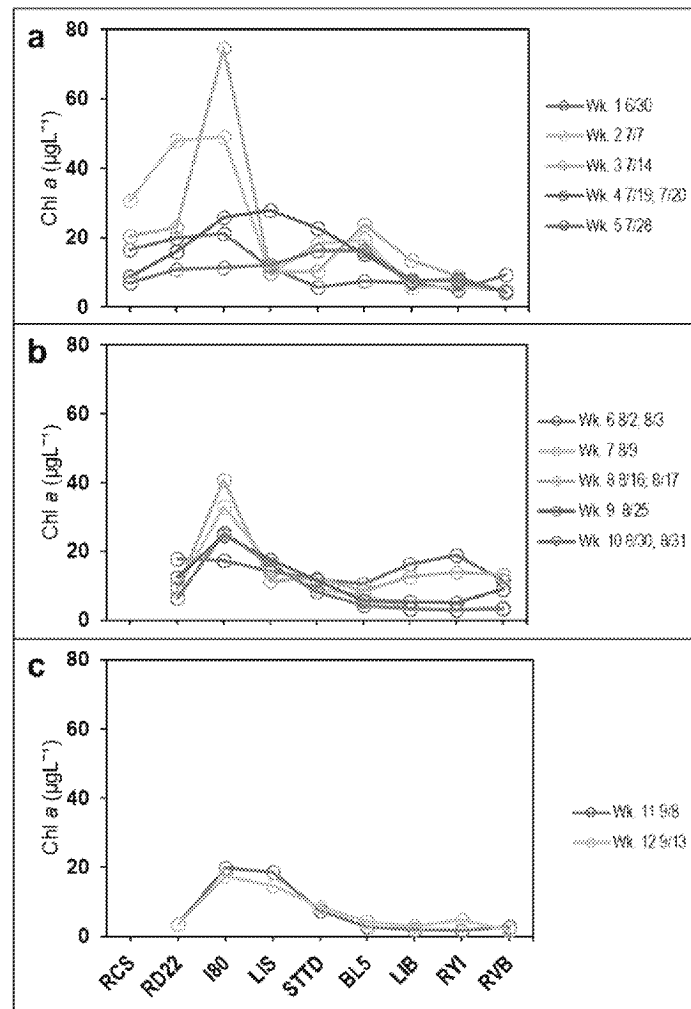
The lower Yolo Bypass region at site STTD had increasing Chl *a* concentration during the sampling weeks leading up to the flow pulse (Task 1 Question 1) as concentrations increased 3-fold from 6-18 $\mu\text{g L}^{-1}$ (Task 1 Figure 1 and 2), suggesting that there was a local phytoplankton bloom. The Chl *a* concentration at both sites within the region increased 2-fold during peak net flows, with measured concentrations $> 20\mu\text{g L}^{-1}$ (Task 1 Figures 1 and 2). The mean Chl *a* concentration remained high in this region ($\geq 10\mu\text{g L}^{-1}$) through the month of August after the managed flow pulse ended (Task 1 Figures 1 and 2). There was no significant difference in Chl *a* concentration before, during or after the managed flow pulse (ANOVA $p = 0.66$).



Task 1 Figure 1. 2016 continuous 15-min. time series total chlorophyll fluorescence data ($\mu\text{g L}^{-1}$) collected during the summer and fall months. Yellow dots represent discrete chlorophyll *a* extracted values ($\mu\text{g L}^{-1}$). Shaded region represents the 2016 flow pulse period. Sites RCS, RD22, I80, LIS, STTD, RVB, and SRH are maintained by DWR. LIB station is maintained by USGS. Blue-dotted line represents daily net flows at LIS gauging station.

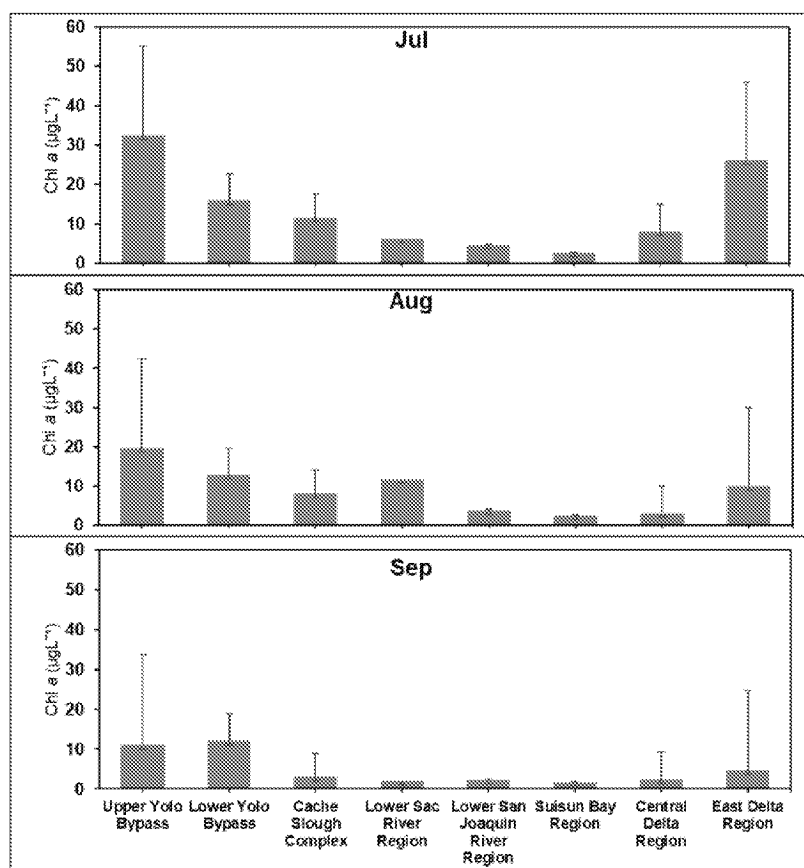
The Cache Slough Complex region (sites BL5, LIB, RYI) similar to the lower Yolo Bypass (site STTD) had increasing Chl *a* concentration at the upper most sites BL5 and LIB leading up to the managed flow pulse (Task 1 Figures 1 and 2), with concentrations on July 14 at $23.8\mu\text{g L}^{-1}$ and $13.4\mu\text{g L}^{-1}$ respectively. The Chl *a* concentration during the peak flows remained high at the BL5 site ($> 15\mu\text{g L}^{-1}$), but at all other sites the concentrations were $< 8\mu\text{g L}^{-1}$ (Task 1 Figures 1 and 2). The Chl *a* concentration peaked at sites LIB at $16.4\mu\text{g L}^{-1}$ and RYI at $18.9\mu\text{g L}^{-1}$ on August 2 after two weeks of net positive flow (Task 1 Question 1) through the Yolo Bypass (Task 2 Figure 1 and 2). The Chl *a* concentration in the lower Sacramento River at site RVB also increase 2-fold on August 2 and again on August 16. The continuous chlorophyll fluorescence data at the RVB site started to sustain higher readings ($\geq 20\mu\text{g L}^{-1}$) on August 19 (Task 1 Figure 1), so to validate the readings a Chl *a* grab sample was collected on August 22 and the

concentration was $19.5 \mu\text{gL}^{-1}$. These were the highest late summer Chl *a* values that have been measured in the lower Sacramento River at RVB in over a decade (Task 1 Figure 1).



Task 1 Figure 2. 2016 weekly discrete chlorophyll *a* (μgL^{-1}) concentration collected along north to south transect. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). a) June-July sampling events; b) August sampling events; c) September sampling events

In 2016, the Chl *a* concentration in the upper Yolo Bypass region was higher than all other Delta regions (Task 1 Figure 3). Both the upper and lower Yolo Bypass regions maintained higher Chl *a* levels than all other Delta regions (Task 1 Question 2) from July-Aug, with only the East Delta having greater Chl *a* concentration in July than the lower Yolo Bypass (Task 1 Figure 3). The measured Chl *a* concentration in the lower Sacramento River in August were higher than all other sampling years (Task 1 Figures 3, 7, and 11).

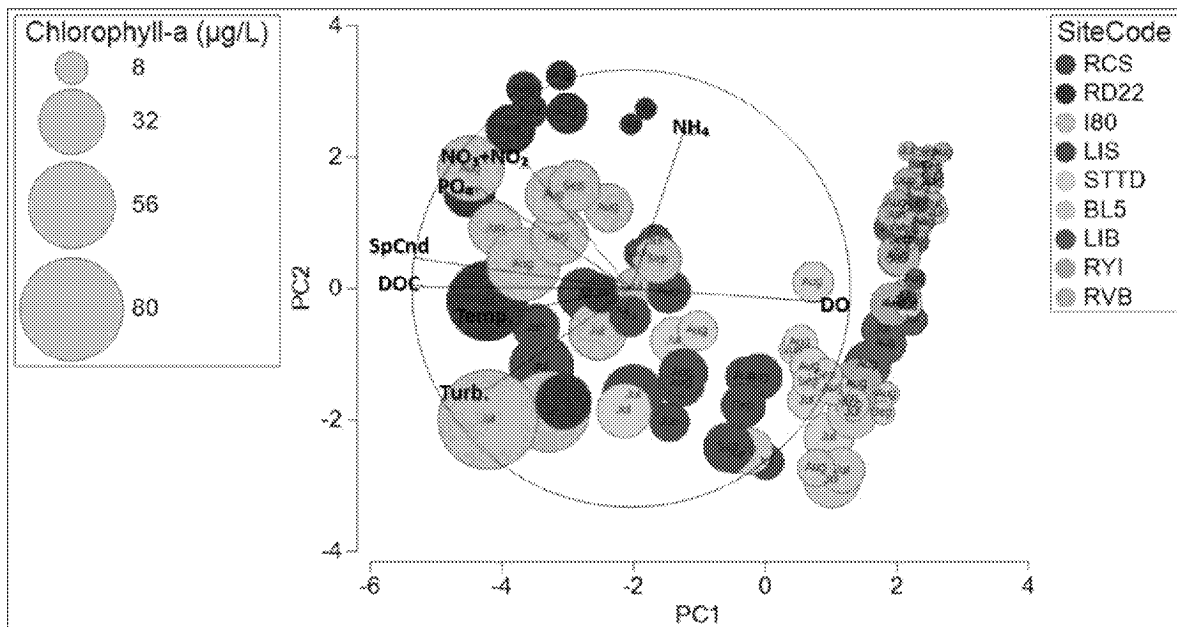


Task 1 Figure 3. 2016 monthly (July, August, and September) mean chlorophyll a (μgL^{-1}) concentration by Delta region. Upper Yolo Bypass (sites: RD22 and I80); Lower Yolo Bypass (sites: LIS and STTD); Cache Slough Complex (sites: BL5, LIB, RYI). IEP EMP monitoring data from: Lower Sacramento River (sites: D22); Lower San Joaquin River Region (sites: D12, D16); Suisun Bay (sites: D6, D7, D8); Central Delta (sites: D26, D19, D28A); East Delta (sites: MD10A, P8). Error bars represent one standard deviation of the mean.

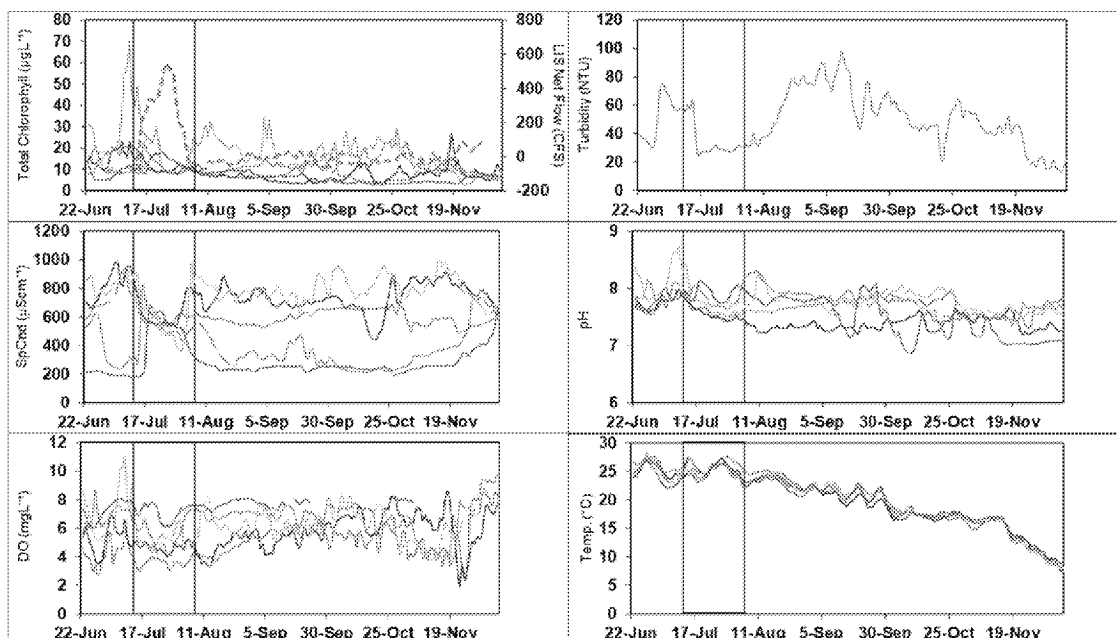
In 2016, the Colusa Basin-Ridge Cut Slough and upper Yolo Bypass region water sources were characterized by (Task 1 Question 3) high specific conductivity, warmer water temperatures, higher turbidity and lower dissolved oxygen concentrations (Task 1 Figure 4 and 5). In addition, these regions had high nutrient concentrations, specifically nitrate + nitrite ($\text{NO}_3 + \text{NO}_2$) and orthophosphate (PO_4) (Task 2 Figure 4). These regions also had higher dissolved organic carbon (DOC) concentrations.

The lower Yolo Bypass region water source was characterized as a transition zone (Task 1 Question 3), where during early summer before the managed flow pulse this region had water quality conditions equivalent to the downstream Cache Slough Complex, but during the managed flow pulse water conditions were more representative of the upper Yolo Bypass (Task 1 Figure 4). During the managed flow pulse as upstream water sources moved downstream into this region, we measured higher specific conductivity, higher turbidity, and lower dissolved oxygen concentrations (Task 1 Figure 5). The water temperatures were stable throughout the flow pulse period and temperatures were ideal ($>20^\circ\text{C}$) for phytoplankton growth. Although turbidities increased during the start of the flow pulse, the turbidity was significantly lower during the flow pulse. Based on observations in the field the water that comes off rice fields prior to harvest is very clear as the rice plant structure acts as a filter for suspending particulates. The fields are flow through and gravity fed, so during the drainage phase the water must filter through the entire field prior to returning to the primary irrigation channel (i.e. Colusa Basin Drain, Ridge Cut Slough

and Toe Drain). The Cache Slough Complex and lower Sacramento River were characterized as having much lower specific conductivity, higher dissolved oxygen, lower turbidities, and high ammonium concentration (Task 1 Figures 4 and 5).



Task 1 Figure 4 2016 PCA ordination diagrams. Circles are colored by site and represent water samples (n=102) collected during the study period and are proportional to chlorophyll a concentration. The vectors point in the direction of maximal variation between environmental variables by sampling sites, and lengths are proportional to the total contribution to the variance.

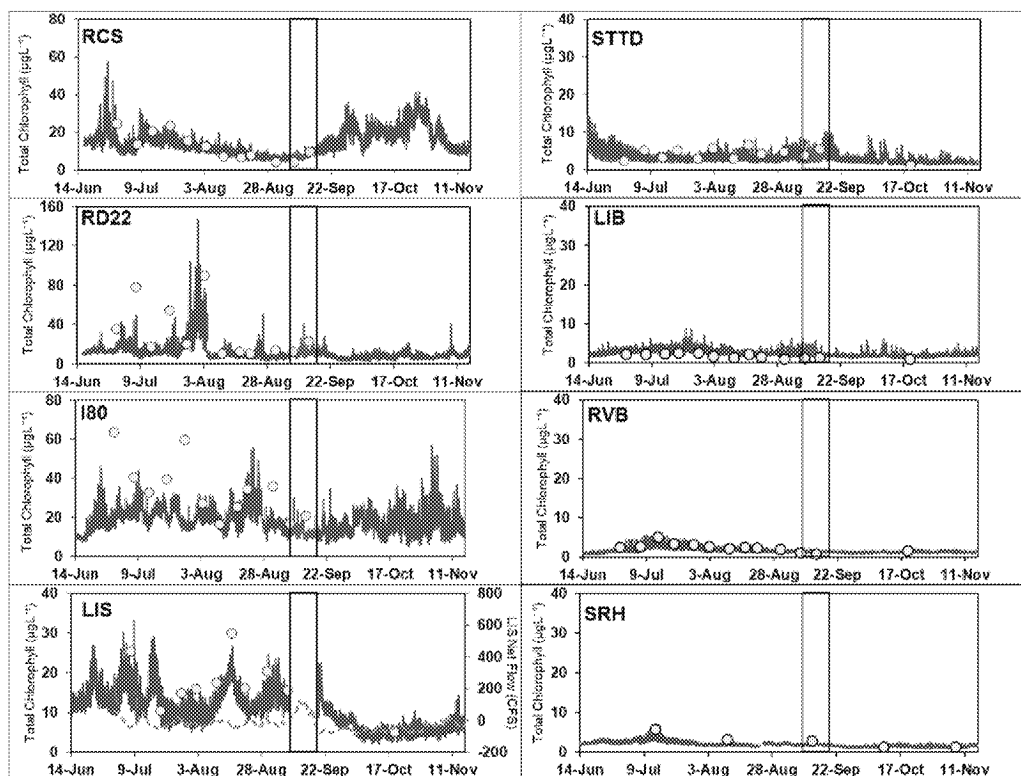


Task 1 Figure 5. 2016 daily mean time series data for total chlorophyll ($\mu\text{g/L}^{-1}$), SpCnd (μScm^{-1}), DO (mg/L^{-1}), Turbidity (NTU), pH, and water temperature ($^{\circ}\text{C}$). Orange line represents site RCS. Purple line represents site RD22. Yellow line represents site I80. Green line represents site LIS. Blue line represents site STTD. Light dashed line represents LIS daily net flow.

The PCA results for PC axes 1, explaining the total variation of physical variables between regions (Task 1 Question 3) for 2016 (Task 1 Figure 4), found strong positive correlations with specific conductance (PC1: 0.427), dissolved oxygen (PC1: 0.357), turbidity (PC1: 0.317), PO₄ (PC1: 0.365), and DOC (PC1: 0.428). In addition, the PCA results for PC axes 1 and 2, explaining the total variation of biological conditions between regions, found strong positive correlation with Chl a concentration (PC1: 0.309 PC2: 0.281).

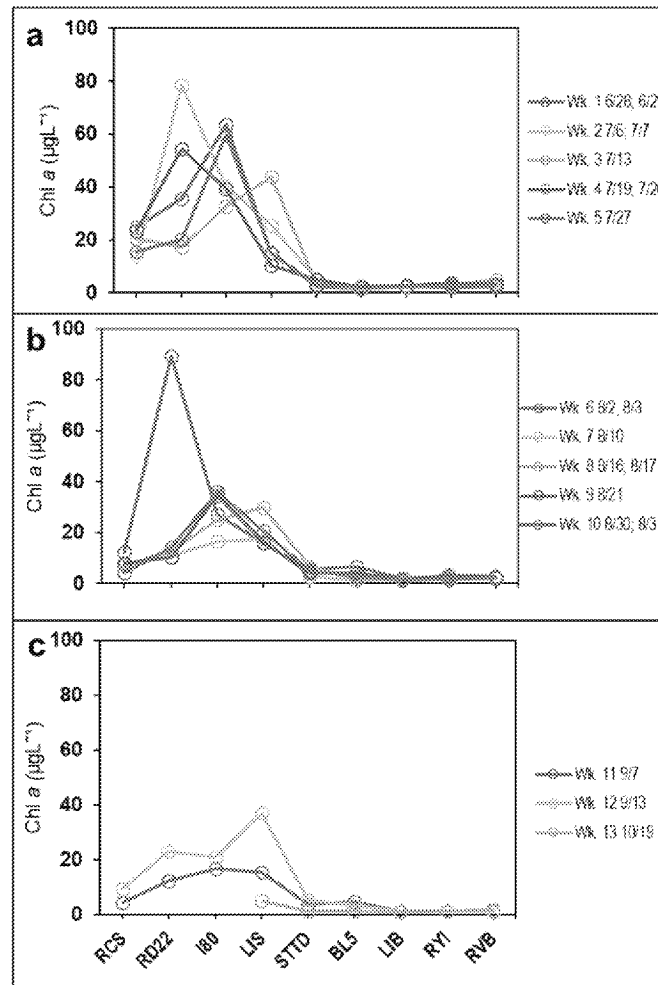
2017

In 2017, with no managed flow action there was no evidence of any phytoplankton biomass transport from the Ridge Cut Slough and upper Yolo Bypass regions into the Cache Slough Complex and lower Sacramento River regions (Task 1 Question 1). However, the Chl a concentration in both regions were high throughout the summer and fall (Task 1 Figures 6 and 7). The lower Yolo Bypass site LIS had periodic peaks ($>20 \mu\text{gL}^{-1}$) in Chl a concentration throughout the summer months, increased inflows into the Yolo Bypass due to record wet year in 2017, this improves water source exchange with upstream regions and below Lisbon Weir. Many of the side tributaries that feed into the Yolo Bypass (i.e. Ridge Cut Slough, Cache Creek, and Putah Creek) are known to be important nutrient and phytoplankton biomass inputs, especially in higher flow years (Schemel et al. 2004). There was a short period of net positive outflow in the Yolo Bypass in mid-September during local rice harvest period, there was some increases captured in the continuous chlorophyll fluorescence collected at both LIS and downstream at STTD (Task 1 Figure 6).



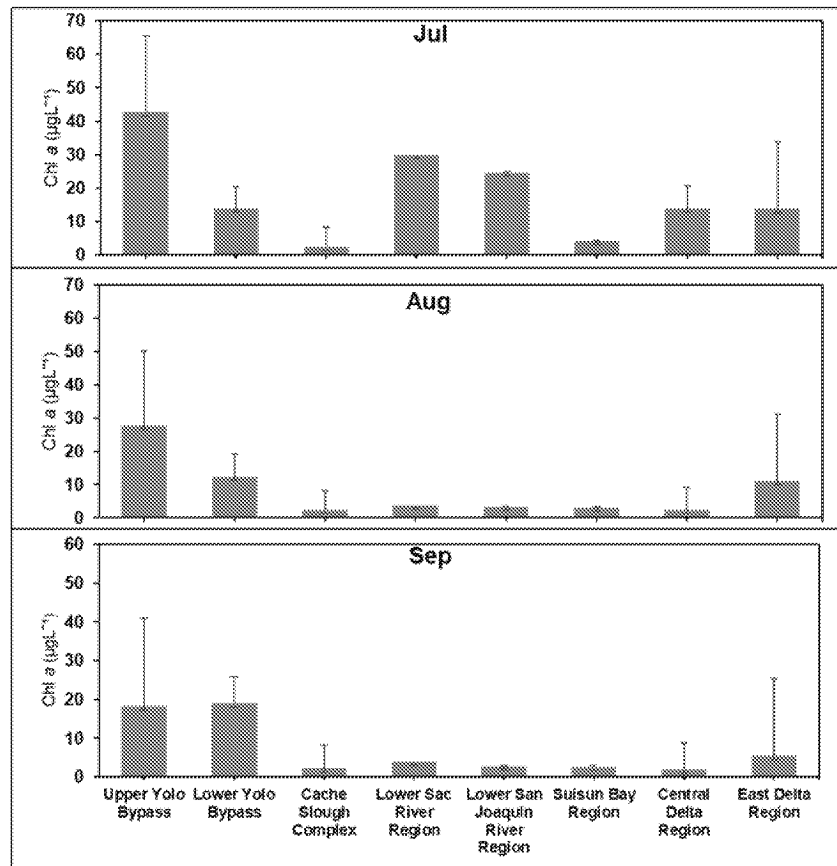
Task 1 Figure 6. 2017 continuous 15-min. time series total chlorophyll fluorescence data (μgL^{-1}) collected during the summer and fall months. Yellow dots represent discrete chlorophyll *a* extracted values (μgL^{-1}). Shaded region represents the 2016 flow pulse period. Sites RCS, RD22, I80, LIS, STTD, RVB, and SRH are maintained by DWR. LIB station is maintained by USGS. Blue-dotted line represents daily net flows at LIS gauging station

The Cache Slough complex and lower Sacramento River regions maintained low Chl *a* level throughout the study period (Task 1 Question 1), with concentrations ranging from 1-4 μgL^{-1} (Task 1 Figure 6 and 7). The Chl *a* concentration in the upper Sacramento River at Hood (site SRH) were also low (Task 1 Figure 6).



Task 1 Figure 7. 2017 weekly discrete chlorophyll *a* (μgL^{-1}) concentration collected along north to south transect. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RY1); Lower Sacramento River Region (site: RVB). a) June-July sampling events; b) August sampling events; c) September-October sampling events.

The upper and lower Yolo Bypass regions maintain high Chl *a* concentration when compared to other Delta regions (Task 1 Question 2) throughout the months of Jul-Sep. However, in July there was a large bloom in the lower Sacramento River and lower San Joaquin River that was also observed in the Central and East Delta regions. The Chl *a* concentration in the lower Sacramento River and lower San Joaquin River were $> 20\mu\text{gL}^{-1}$.



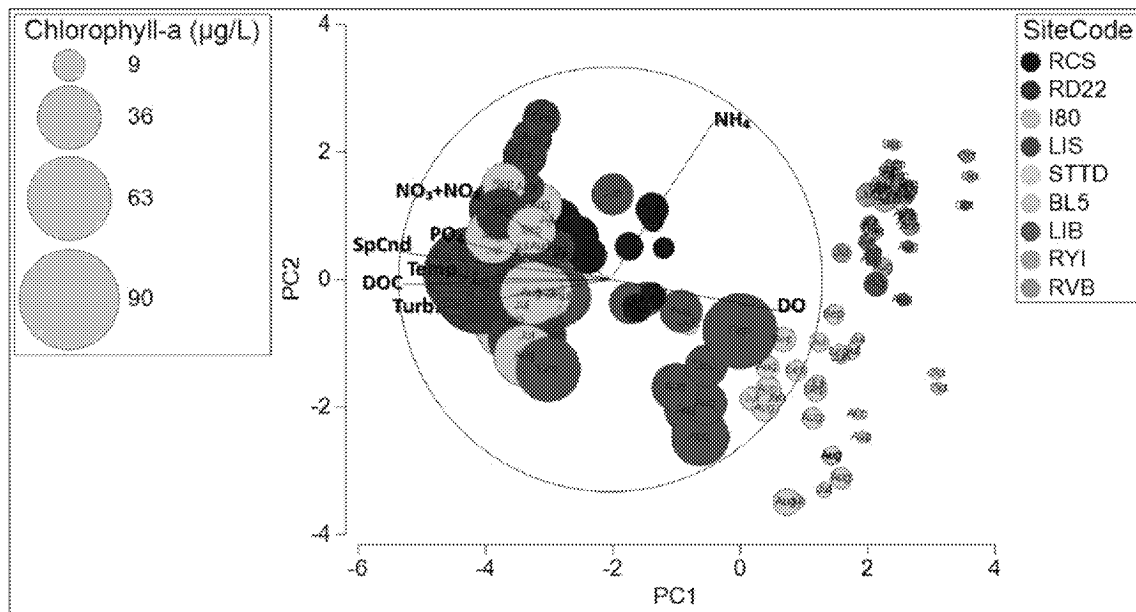
Task 1 Figure 8. 2017 monthly (July, August, and September) mean chlorophyll a (μgL^{-1}) concentration by Delta region. Upper Yolo Bypass (sites: RD22 and I80); Lower Yolo Bypass (sites: LIS and STTD); Cache Slough Complex (sites: BL5, LIB, RYI). IEP EMP monitoring data from: Lower Sacramento River (sites: D22); Lower San Joaquin River Region (sites: D12, D16); Suisun Bay (sites: D6, D7, D8); Central Delta (sites: D26, D19, D28A); East Delta (sites: MD10A, P8). Error bars represent one standard deviation of the mean.

In 2017, the Colusa Basin Drain-Ridge Cut Slough region and Upper Yolo Bypass regions water quality conditions were characterized as (Task 1 Question 3) having high specific conductivity, warmer water temperatures, lower dissolved oxygen, higher turbidity, and high Chl a (Task 1 Figure 9 and 10). The NO_3+NO_2 and PO_4 concentrations were also high in this region similar to 2016.

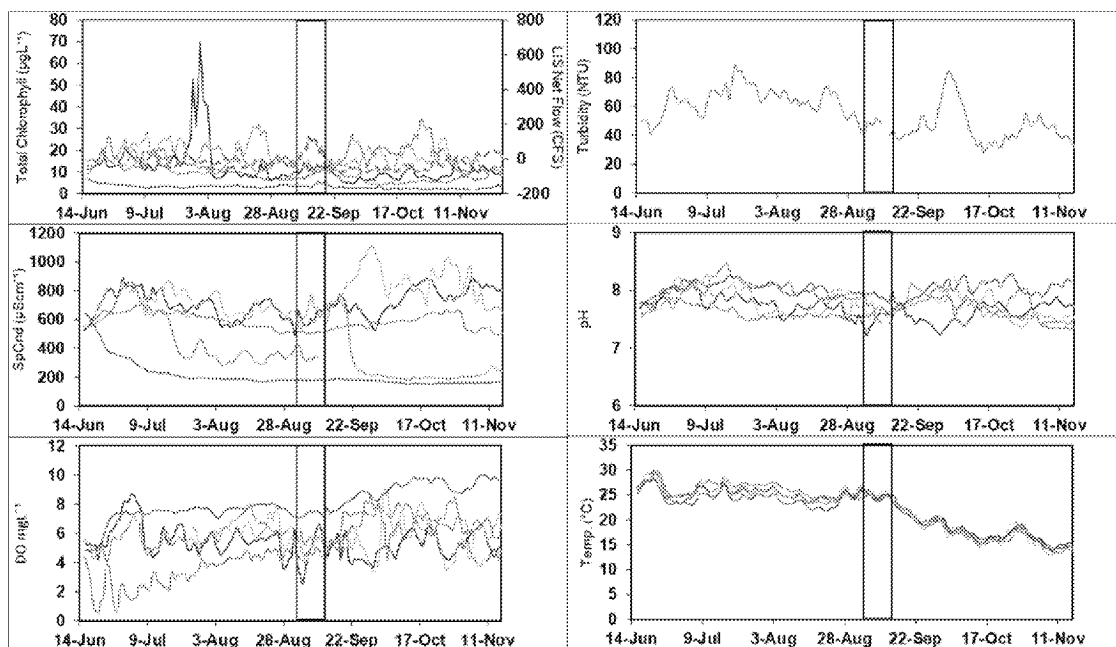
The Lower Yolo Bypass region water sources were very different between the two site locations (Task 1 Figure 9 and 10). The minimal positive outflow conditions in 2017 kept these two sites disconnected, with the lower STTD site being affected more by the landward tidal movement of Sacramento River water sources into the Cache Slough Complex and lower Yolo Bypass Toe Drain. The STTD site was characterized as having lower specific conductance, higher dissolved oxygen, lower water temperatures, lower turbidity, and lower Chl a as compared to the upper LIS site. During the small flow pulse in September there was an increase in specific conductance, drop in dissolved oxygen and turbidity as upstream water sources from Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass moved downstream.

The PCA results for PC axes 1, explaining the total variation of physical variables between regions (Task 1 Question 3) for 2017 (Task 1 Figure 9), found similar strong positive correlations with specific conductance (PC1: 0.396), dissolved oxygen (PC1: 0.312), turbidity (PC1: 0.348), PO_4 (PC1: 0.325), and

DOC (PC1: 0.381) as in 2016. In addition, the PCA results for PC axes 1 and 2, explaining the total variation of biological conditions between regions, found strong positive correlation with Chl a concentration for PC1 at 0.364 but not for at PC2 at 0.051.



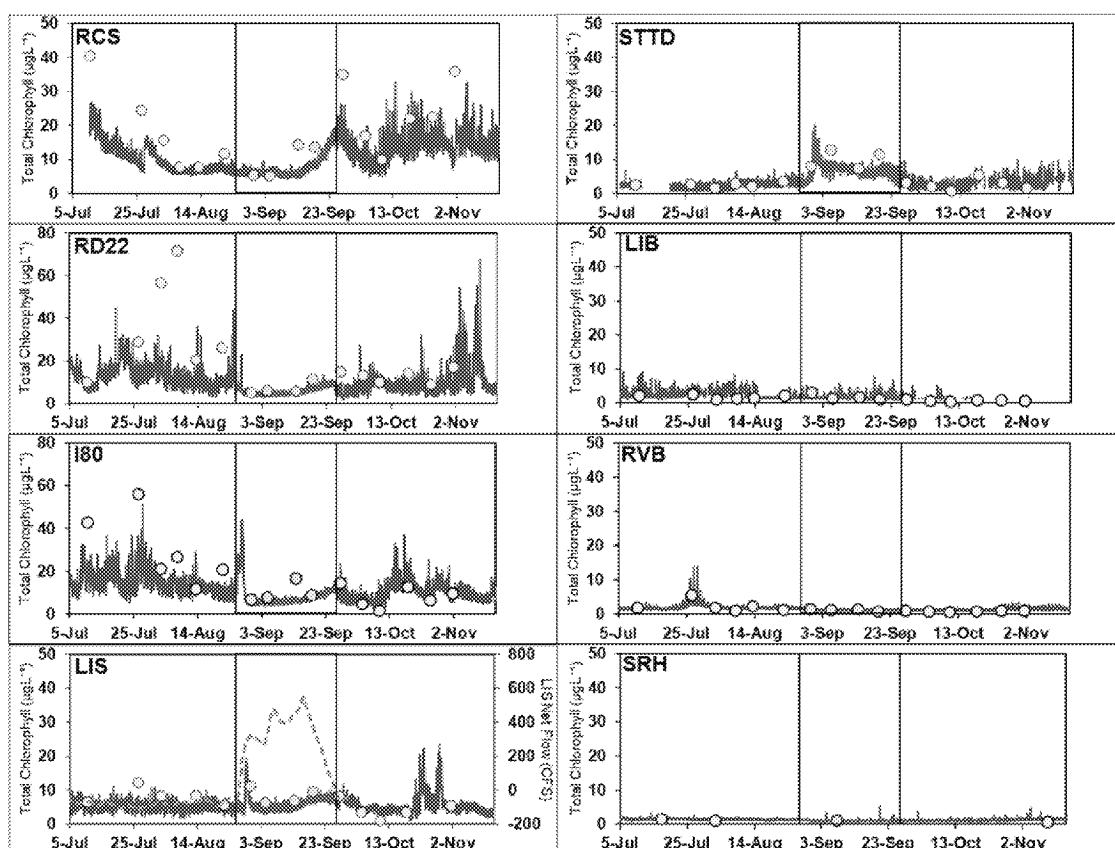
Task 1 Figure 9 2017 PCA ordination diagrams. Circles are colored by site and represent water samples (n=114) collected during the study period and are proportional to chlorophyll a concentration. The vectors point in the direction of maximal variation between environmental variables by sampling sites, and lengths are proportional to the total contribution to the variance.



Task 1 Figure 10. 2017 daily mean time series data for total chlorophyll (μgL^{-1}), SpCnd (μScm^{-1}), DO (mgL^{-1}), Turbidity (NTU), pH, and water temperature ($^{\circ}\text{C}$). Orange line represents site RCS. Purple line represents site RD22. Yellow line represents site I80. Green line represents site LIS. Blue line represents site STTD. Light dashed line represents LIS daily net flow.

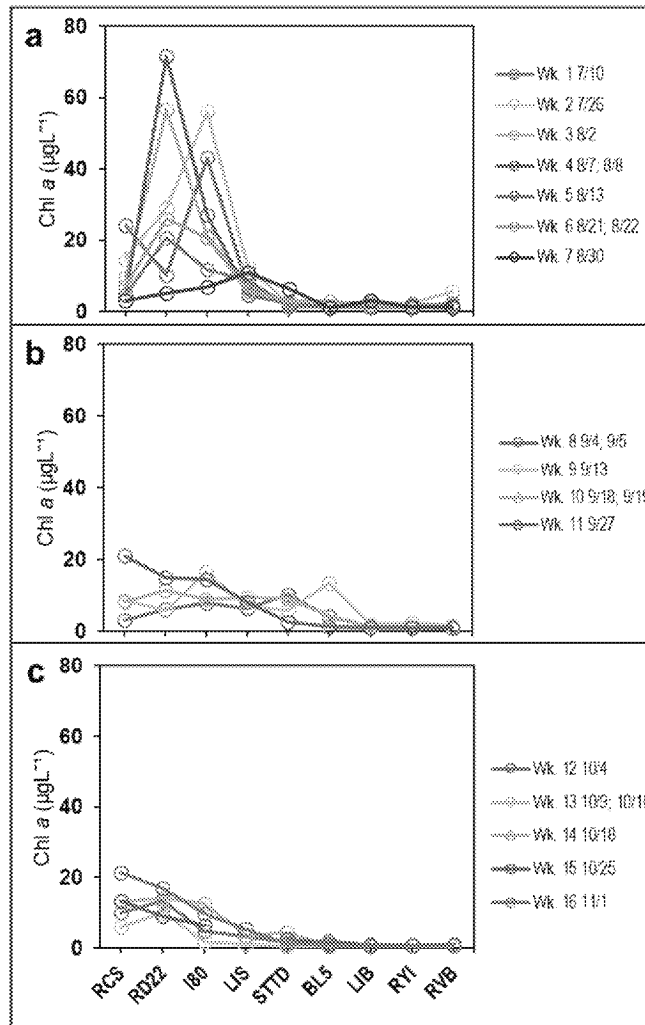
2018

In 2018, with a managed flow pulse in the fall, there was an observed transport of increased phytoplankton biomass (Task 1 Question 1) from the Ridge Cut Slough and upper Yolo Bypass region into the lower Yolo Bypass (Task 1 Figures 11 and 12). However, the Chl *a* concentration did seem lower in Ridge Cut Slough compared to prior years, with concentrations in August ranging from 3.2 - 9.4 μgL^{-1} (Task 1 Figure 9 and 10). The Chl *a* concentrations in the upper Yolo Bypass were elevated prior to the flow pulse and significantly higher (Tukey test $p < 0.05$) than during and after the peak flows. There were some measured increases in Chl *a* in the lower Yolo Bypass (Task 1 Question 2), but the increases were for short duration and there was no significant difference between mean concentrations before and during the managed flow pulse.



Task 1 - Figure 11. 2018 continuous 15-min. time series total chlorophyll fluorescence data (μgL^{-1}) collected during the summer and fall months. Yellow dots represent discrete chlorophyll *a* extracted values (μgL^{-1}). Shaded region represents the 2016 flow pulse period. Sites RCS, RD22, I80, LIS, STTD, RVB, and SRH are maintained by DWR. LIB station is maintained by USGS. Blue-dotted line represents daily net flows at LIS gauging station.

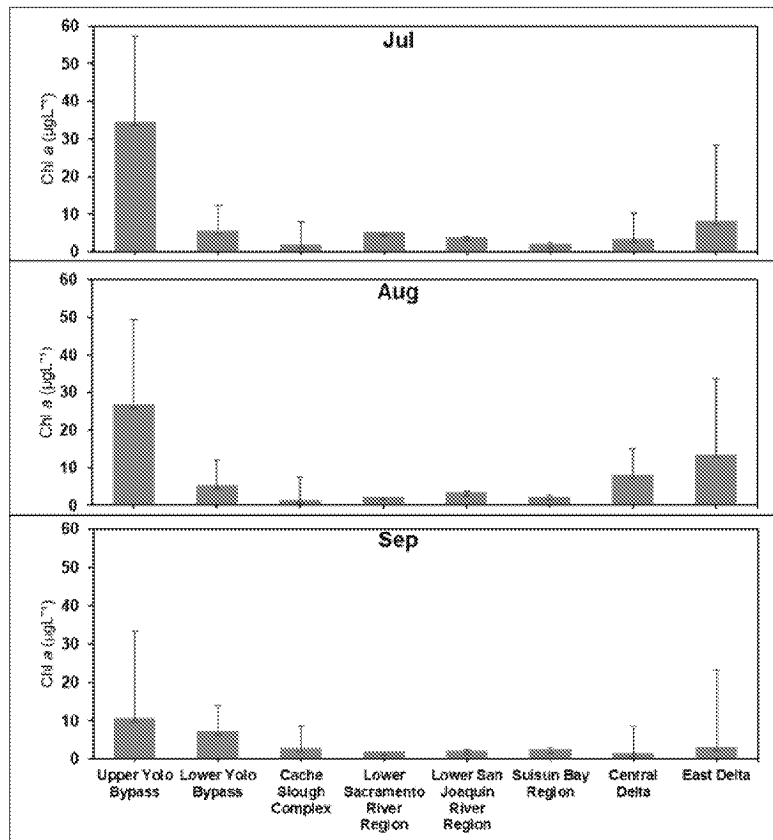
The Cache Slough Complex also saw evidence of phytoplankton transport from the flow pulse (Task 1 Question 1), but only to site BL5 in the upper part of the region on September 13 (Task 1 Figures 11 and 12). The other Cache Slough Complex sampling sites (LIB and RYI) and the lower Sacramento River region maintained low Chl *a* concentration (Task 1 Question 1) through August and September ranging from 0.74 – 3.12 μgL^{-1} (Task 1 Figures 11 and 12). The lower Sacramento River region had significantly (Tukey test $p < 0.05$) higher Chl *a* concentration before than after the managed flow pulse.



Task 1 Figure 12. 2018 weekly discrete chlorophyll a ($\mu\text{g/L}$) concentration collected along north to south transect. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB).

The Chl a concentration in the upper Yolo Bypass, like previous sampling years, remained higher than other Delta regions (Task 1 Question 2) in July-September (Task 1 Figure 13). The lower Yolo Bypass had a much lower mean concentration compared to prior years (Task 1 Figures 3, 8, 13). The East Delta was the only other region with Chl a concentration above $10 \mu\text{g/L}$. The lower Sacramento River, lower San Joaquin and Suisun Marsh regions had consistently low concentrations of Chl a, with no observed summer or fall blooms events (Task 1 Figure 13).

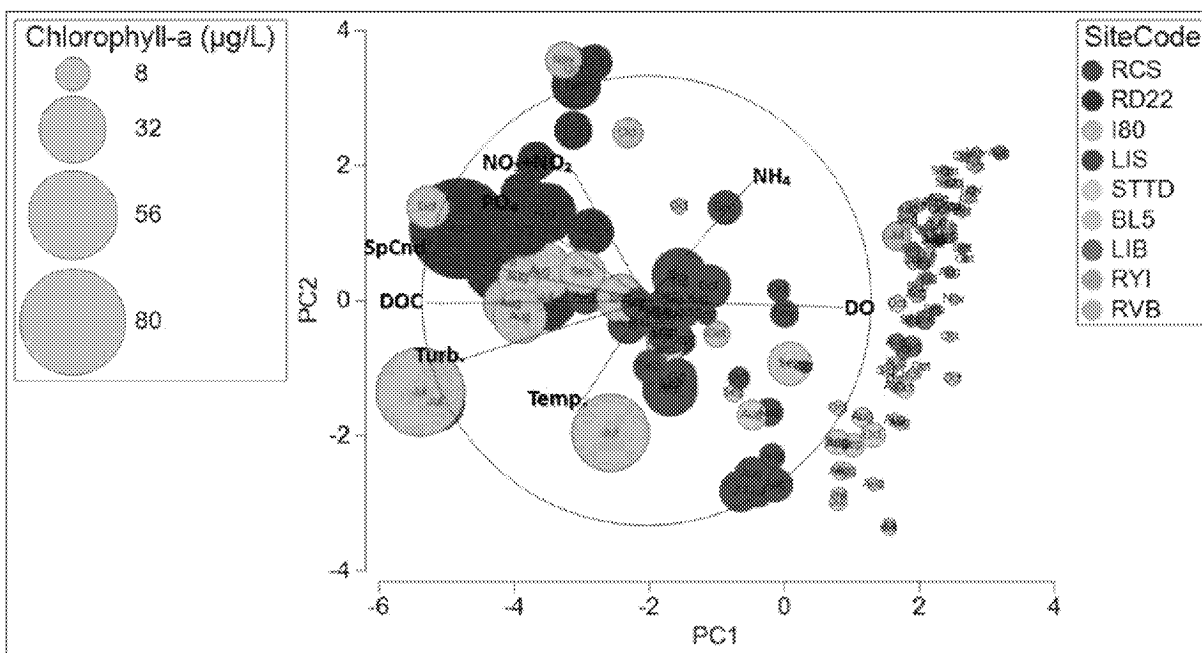
In 2018, the Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass regions water quality conditions were characterized similar to prior years 2016 and 2017 (Task 1 Question 3), with high specific conductivity, lower dissolved oxygen concentrations, and periodically higher water temperatures (Task 1 Figure 14 and 15). During the managed flow pulse the specific conductivity, dissolved oxygen and pH decreased as rice discharge water sources moved downstream. These regions did exhibit higher nutrients concentrations, especially higher NO_3+NO_2 and PO_4 throughout the flow pulse. These regions also had high dissolved organic matter concentrations.



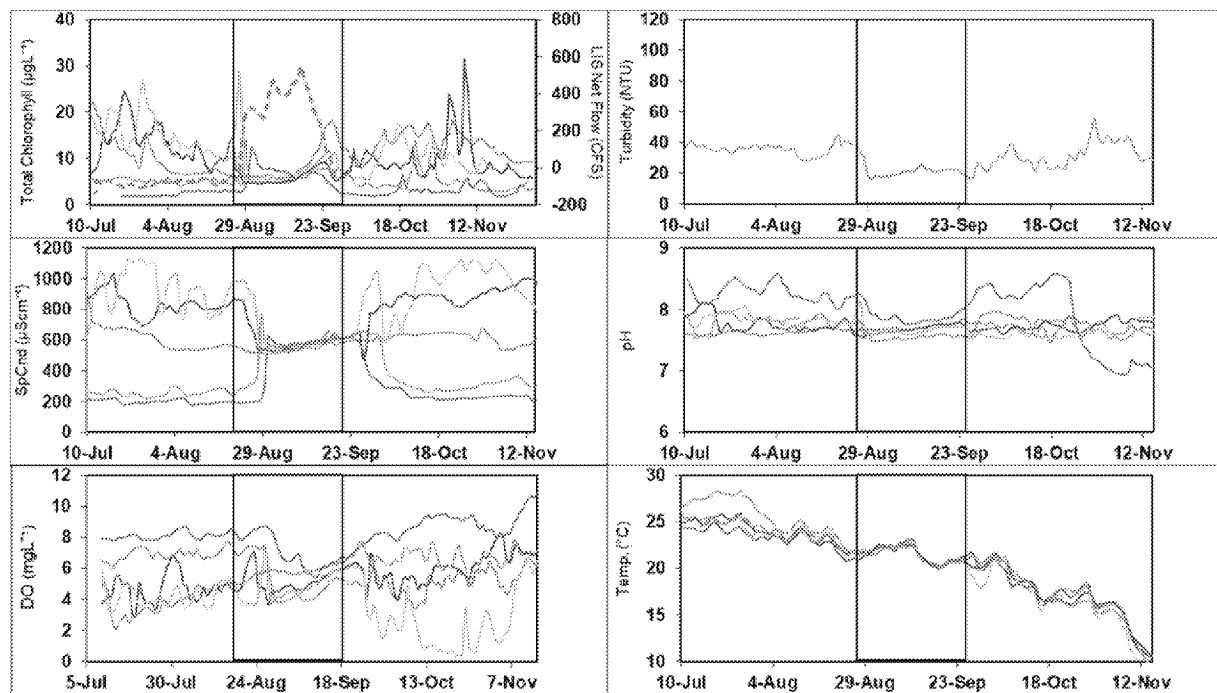
Task 1 Figure 13. 2018 monthly (July, August, and September) mean chlorophyll a (μgL^{-1}) concentration by Delta region. Upper Yolo Bypass (sites: RD22 and I80); Lower Yolo Bypass (sites: LIS and STTD); Cache Slough Complex (sites: BL5, LIB, RYI). IEP EMP monitoring data from: Lower Sacramento River (sites: D22); Lower San Joaquin River Region (sites: D12, D16); Suisun Bay (sites: D6, D7, D8); Central Delta (sites: D26, D19, D28A); East Delta (sites: MD10A, P8). Error bars represent one standard deviation of the mean.

The Lower Yolo Bypass region water quality conditions at both sites (LIS and STTD) had similar specific conductance, dissolved oxygen and water temperature conditions (Task 1 Question 3) prior to the flow pulse (Task 1 Figure 14 and 15). The specific conductivity increased, dissolved oxygen concentrations dropped, and turbidity decreased as upstream rice-discharge water sources from the Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass moved downstream. The water quality conditions quickly deviated once the net positive flow conditions stopped, with conditions returning to prior specific conductance, dissolved oxygen, pH and turbidity levels. This region had much lower nitrogen concentrations throughout the flow pulse period.

The PCA results for PC axes 1, explaining the total variation of physical variables between regions (Task 1 Question 3) for 2018 (Task 1 Figure 4), found strong positive correlations with specific conductance (PC1: 0.414), dissolved oxygen (PC1: 0.361), turbidity (PC1: 0.364), PO_4 (PC1: 0.278), and DOC (PC1: 0.412). In addition, the PCA results for PC axes 1 and 2, explaining the total variation of biological conditions between regions, found strong positive correlation with Chl a concentration for PC1 at 0.386 but not for at PC2 at 0.029.



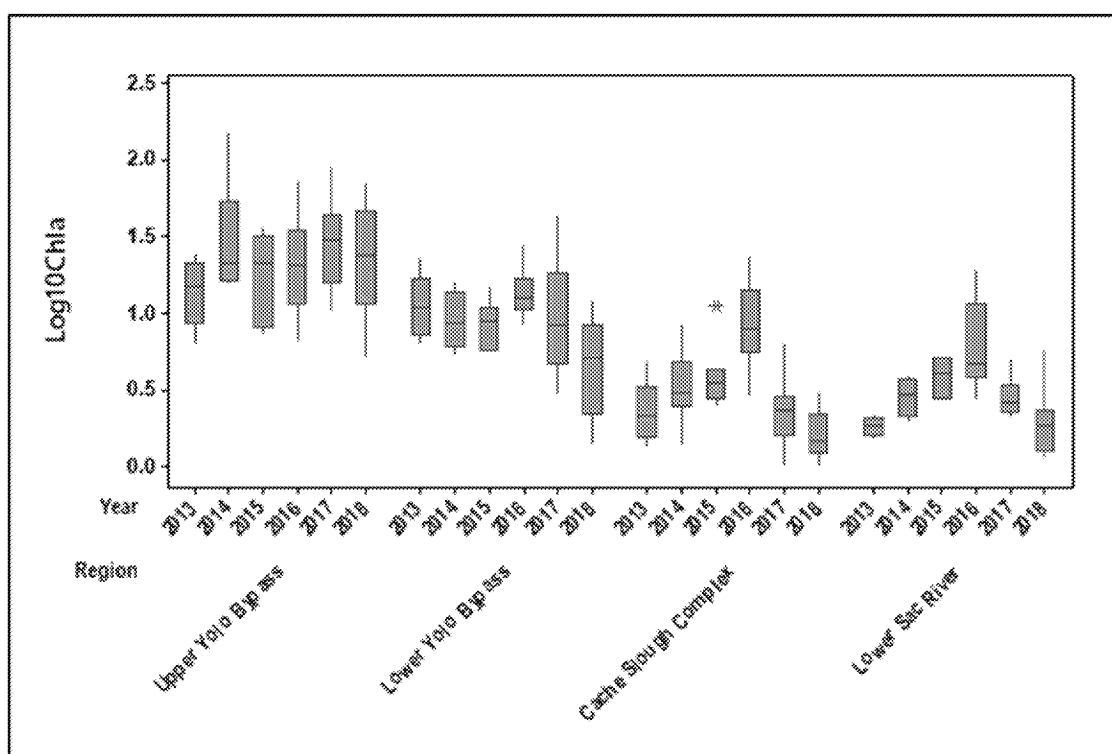
Task 1 Figure 14 2018 PCA ordination diagrams. Circles are colored by site and represent water samples ($n=143$) collected during the study period and are proportional to chlorophyll a concentration. The vectors point in the direction of maximal variation between environmental variables by sampling sites, and lengths are proportional to the total contribution to the variance.



Task 1 Figure 15. 2018 daily mean time series data for total chlorophyll ($\mu\text{g/L}^{-1}$), SpCnd (μScm^{-1}), DO (mg/L^{-1}), Turbidity (NTU), pH, and water temperature ($^{\circ}\text{C}$). Orange line represents site RCS. Purple line represents site RD22. Yellow line represents site I80. Green line represents site LIS. Blue line represents site STTD. Light dashed line represents LIS daily net flow.

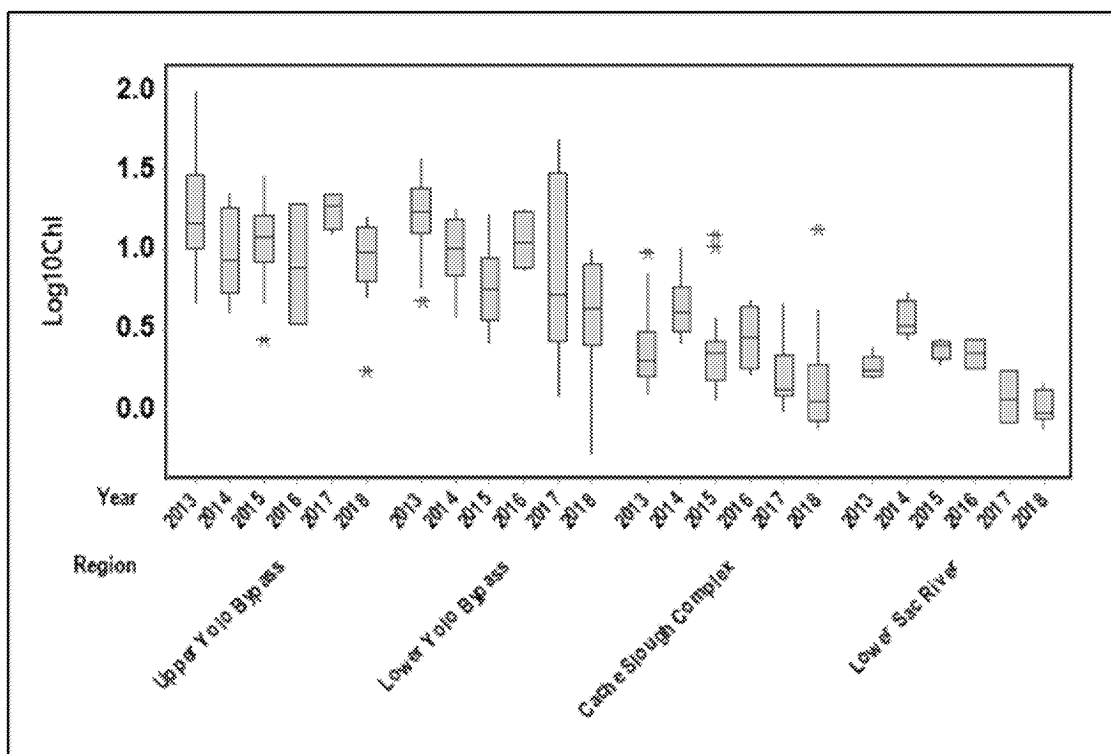
2013-2018

The Chl *a* concentrations for all sampling years (2013-2018) in the upper Yolo Bypass region during the summer months of July and August had similar measured concentrations, with no significant difference (ANOVA $p = 0.16$) in mean concentration between years (Task 1 Figure 16). In the fall, we observed the highest Chl *a* concentrations in 2017 in the upper Yolo Bypass. In 2017, there was substantial flow restrictions in the upper Yolo Bypass due to construction in Ridge Cut Slough that contributed to much higher water residence time throughout the summer and fall, which is an important factor in promoting phytoplankton growth (Lopez et al. 2006; Lucas et al. 2009). The high water year in 2017 also increased local land and tributary runoff, which is known to increase nutrient inputs (Schemel et al. 2004) into the Yolo Bypass in high outflow years.



Task 1 Figure 16. 2013-2018 boxplots of weekly summer July-August discrete samples collected for chlorophyll *a* (Chl *a*) analysis. Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB).

In 2018, the lower Yolo Bypass region had significantly (Tukey test $p < 0.05$) lower summer Chl *a* concentrations than all other sampling years (Task 1 Figure 16). The mean Chl *a* concentrations were also low throughout the Cache Slough Complex and lower Sacramento River regions in the summer and fall of 2018 compared to other years (Task 1 Figure 16 and 17). The lower Yolo Bypass region also had the lowest mean Chl *a* concentrations in the fall sampling months, with sampling year 2013 having significantly (Tukey test $p < 0.05$) higher mean concentrations. The 2016 summer Chl *a* concentrations in the Cache Slough Complex were significantly higher (Tukey test $p < 0.05$) than all other study years (Task 1 Figure 16). The lower Sacramento River region mean summer Chl *a* concentration was also higher in 2016 than all other sampling years, with significantly greater mean (Tukey test $p < 0.05$) concentrations than years 2013, 2017, and 2018 (Task 1 Figure 16).



Task 1 Figure 17. 2013-2018 boxplots of weekly fall September-October discrete samples collected for chlorophyll a (Chl a) analysis. Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB).

Task 1. Conclusion:

Our results show that periods of net positive outflow from summer and fall flow pulses in the Yolo Bypass do help transport phytoplankton biomass downstream. In all years, during periods of net positive outflow there were increases in the measured Chl a within the Upper and Lower Yolo Bypass. In 2016 and 2018, continuous total chlorophyll fluorescence data showed a wave of higher phytoplankton biomass move from the Colusa Basin-Ridge Cut Slough and Upper Yolo Bypass regions into the Lower Yolo Bypass. These upper study regions in all years had high Chl a concentration often $\geq 20 \mu\text{gL}^{-1}$ before flow pulses. The Chl a in the Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass in all years was often 2-3-fold higher than other regions in the Delta during the summer and fall.

In 2016, the Chl a was higher than the other study years in all regions before, during and after the summer managed flow pulse. The Chl a in the CSC was elevated leading up to the flow pulse and there was an observed increase in Lower Sacramento River Chl a about 3-weeks after the positive outflows in the Yolo Bypass. Chl a concentration was measured at $19.5 \mu\text{gL}^{-1}$ on August 22 in the Lower Sacramento River at site RVB during peak continuous total chlorophyll fluorescence measurements. It has been well over a decade since the Delta has seen Chl a concentration this high in the late summer months.

The 2018 fall flow pulse was anticipated to see the same Chl a increase in the Lower Sacramento River as observed in 2011, 2012 and 2016, but concentrations remained low. The Chl a did elevate in the Lower Yolo Bypass and at the northern most CSC region sites. Overall, the Chl a was lower in the Yolo Bypass and CSC leading up to the 2018 flow pulse and therefore resulted in minimal transport into downstream habitats.

The physical water quality conditions (i.e. water temperature, specific conductance, pH and DO) in all regions were similar between study years. There were strong correlations between Chl a concentration and associated specific conductance, dissolved oxygen, turbidity, PO₄, and DOC measurements. The increase in specific conductance was a good predictor of upstream water sources from the Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass movement into downstream habitats of the Lower Yolo Bypass and CSC regions during managed flow pulses. These upper regions also had high concentrations of DOC, an indicator that these upper regions may also provide lower food web support through the detrital pathway as well.

III. Task 2: (Nutrients) Analyze the concentrations, distributions, and sources of various nutrients

Contributing authors:

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Task 2. Background:

The types of nutrients and concentrations of those nutrients are highly influential in the timing and magnitude of primary production in ecosystems such as the Delta. The availability of various nutrient concentrations for assimilation by phytoplankton is an essential factor in controlling overall growth rate (Glibert et al. 2011; Reynolds 1999). There has been a long-term shift in nutrient concentrations and ratios within the Delta and a key contributing factor is the increased influx of ammonium, primarily through the discharge by waste water treatment plants (Dugdale et al. 2007; Glibert et al. 2011; Wilkerson et al. 2006). More importantly, high ammonium concentrations tend to inhibit phytoplankton growth especially in the formation of diatoms, while periods of higher nitrate concentrations result in much higher growth rates (Cloern and Dufford 2005; Dugdale et al. 2007; Wilkerson et al. 2006). Due to the reduction in phytoplankton blooms and a changing in species composition to predominately flagellates and cyanobacteria (Brown 2009; Glibert et al. 2010) throughout the Delta, the bloom events seen in 2012 and 2013 (which were dominated by diatoms *Aulacoseira granulata* and *Cyclotella sp.*), were extremely rare and of significant importance to the entire Delta pelagic food web. The further investigation of nutrients in the Yolo Bypass, specifically the concentrations of nitrate and phosphorus seem essential in determining the intensity of a bloom and ultimately the species composition, which all have implications on its assimilation into the higher trophic levels (i.e. zooplankton and fish).

The Yolo Bypass is an engineered flood control system that is also managed for agricultural diversion and as a waste water discharge for the cities of Woodland and Davis. These various inputs add a complexity to understanding the fluxes of nutrients and how they contribute to the biomass and composition of the lower trophic levels. In 2013, initial results showed that the rice field discharge water was nitrogen limited and the Yolo Bypass and Cache Slough Complex had an N:P ratio >8, implying that nitrogen not phosphorus will become limiting as nutrients are drawn down (Frantzich et al. 2018). In addition, nutrient concentrations were measured at Woodland discharge location in summer/fall 2014 and resulted in substantially high values (Figure 5) of both nitrate nitrite (≥ 60 mg/L) and orthophosphate (>30 mg/L) (Frantzich et al. 2018).

Task 2. Research Questions:

1. Is rice field drainage water a significant source of nutrients to the Yolo Bypass, contributing to the summer/fall phytoplankton blooms?
2. What are the available concentration of nutrients (i.e. nitrogen, phosphorus, silica) for phytoplankton assimilation in the Yolo Bypass and south to Rio Vista during summer/fall flow pulses?
3. What are the spatial differences in nutrient concentrations and are there regions that are sources (e.g. Woodland Davis wastewater treatment discharge) and/or sinks during elevated fall summer/fall flows?
4. What are the regional N:P ratios and is there evidence that nutrients reach limiting levels during the summer and fall algal bloom period?

Task 2. Methods:

The concentrations of various nutrients (i.e. Dissolved Ammonia, Dissolved Nitrate Nitrite, Dissolved Ortho-Phosphate, Dissolved Silica, and Dissolved Organic Carbon) were determined by the collection of water samples by boat or land at twelve sites: 1.) Ridge Cut Slough (RCS); 2.) Woodland Wastewater Discharge (WWT); 3.) Toe Drain at Rd. 22 (RD22); 4.) Davis Wastewater Discharge (DWT); 5.) Toe Drain at I80 (I80); 6.) Lisbon Weir (LIS); 7.) Toe Drain at Screw Trap (STTD); 8.) Prospect Slough (BL5); 9.) Cache Slough at Liberty Island (LIB); 10.) Cache Slough at Ryer Island (RYI); 11.) Sacramento River at Rio Vista (RVB), and Sacramento River at Decker Island (SDI) (Figure 1) in conjunction with Chl a sample using a Van Dorn sampler or Nasco 12' Extendible Swing Sampler. Samples were collected weekly typically during the months of June through October based on the historical occurrence of flow pulses recorded at the existing Lisbon flow station.

Sample collection procedures followed established methods by IEP Bay-Delta Monitoring and Analysis Section. For each batch of samples for analysis a blank sample was analyzed as a control in collection and lab procedures. All samples were typically collected on ebb tide and a depth of 3 ft. using a Van Dorn sampler. Samples were collected in required containers, using proper preservation techniques, and holding times as required by Standard Methods for the Examination of Water and Waste Water (APHA 2012). The ambient nutrient concentrations were analyzed using various established U.S. EPA and APHA analysis methods: NO_3+NO_2 (Std. Method 4500- $\text{NO}_3\text{-F}$ Modified), NH_4 (EPA 350.1), PO_4 (EPA 365.1), and Si(OH)_2 (EPA 200.7D).

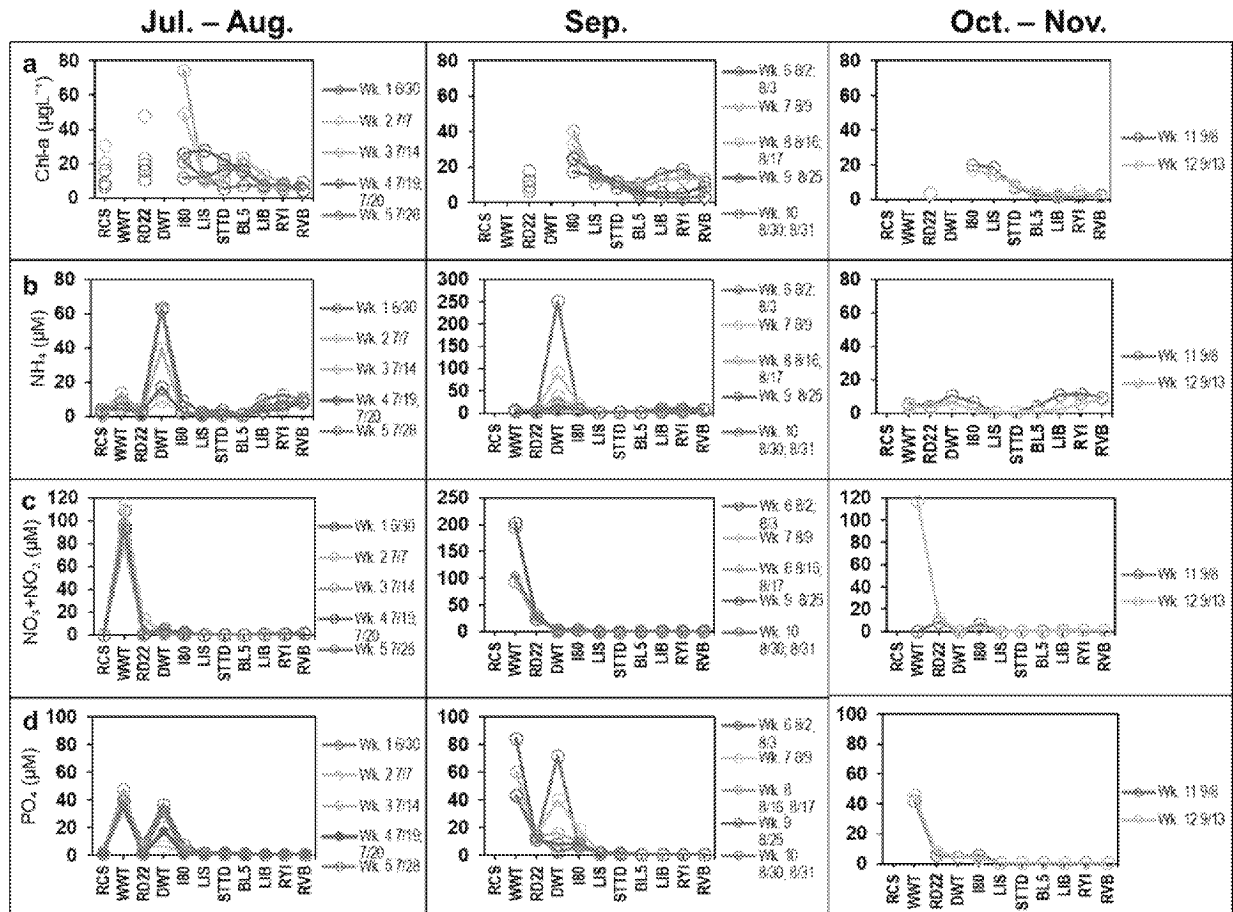
Task 2. Results and Discussion:

2016

In 2016, the managed flow pulse occurred in the summer from mid-July-August 1, which was well before the rice field discharge period in the Northern Sacramento Valley. This managed flow pulse required the additional pumping of Sacramento River water into the Colusa Basin Drain and Toe Drain of the Yolo Bypass., due to the high consumptive use of water from these sloughs for irrigation at this time of year. Despite the direct use of Sacramento River water, the adjacent landscape and connecting tributaries and drains into the Yolo Bypass are constantly providing nutrient input as local farmers and wastewater effluent release return water into the system.

The nitrogen concentrations in the upper most extent of our sampling within the Colusa Basin Drain-Ridge Cut Slough region (site RCS) was low during the sampling weeks prior to the flow pulse (Task 2 Question 3), with NH_4 concentrations $<1.40 \mu\text{Mol}$ and $\text{NO}_3+\text{NO}_2 < 0.20 \mu\text{Mol}$ (Task 2 Figure 1b, 1c, 1d). The nitrogen concentrations did increase during the managed flow pulse (Task 2 Question 1 and 2), but this region did maintain some of the lowest concentrations of nitrogen and concentrations were limiting based on N:P ratios (Task 2 Question 4) throughout the flow pulse sampling period (Task 2 Figure 2d). One factor leading to the lower nitrogen concentration is likely the assimilation by the high phytoplankton biomass in this region (Task 2 Figure 1a), especially during those sampling weeks leading up to the flow pulse. The RCS site was a source of PO_4 , Si(OH)_2 and DOC, as this region maintained high concentrations of all three nutrients (Task 2 Figure 1d, 2a, 2b), throughout the sampling period (Task 2 Question 2 and 3). The upper Yolo Bypass (sites RD22 and I80) had the highest measured concentrations of nitrogen. These two sites are both located below wastewater effluent release points (Task 2 Question 1), with the RD22 site below the city of Woodland's and I80 below the city of Davis's (Figure 1). The RD22 site had the highest measured concentrations of NO_3+NO_2 , while site I80 had higher concentrations of NH_4 (Task 2 Figure 1b, 1c). The form of nitrogen as it's released from these facilities differs as the

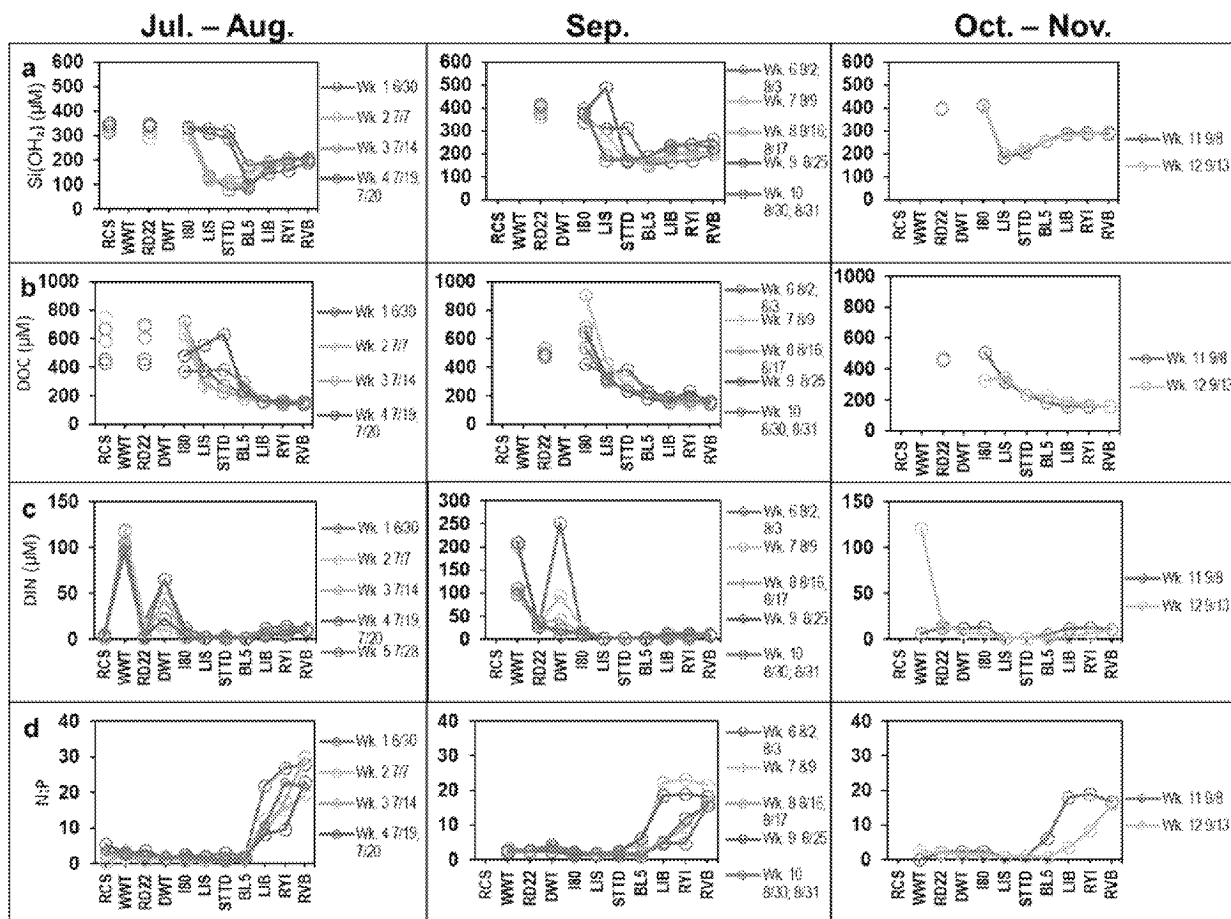
Woodland plant undergoes secondary tertiary treatment, causing nitrogen to be released as NO_3 (Frantzieh et al. 2018). This region was an important source to downstream regions for nitrogen (NH_4 and NO_3), PO_4 , $\text{Si}(\text{OH})_2$, and DOC (Task 2 Question 2 and 3) throughout the flow pulse period (Task 2 Figure 1b, 1c, 1d, 2a, 2b). There was a significant increase (ANOVA $p < 0.01$) in the PO_4 concentration in the upper Yolo Bypass during the flow pulse, suggesting that upstream water sources from the Colusa Basin Drain and Ridge Cut slough regions may have contributed.



Task 2 Figure 1. 2016 weekly discrete a) chlorophyll *a* ($\mu\text{g L}^{-1}$), b) ammonium ($\mu\text{M-N}$), c) nitrate + nitrite ($\mu\text{M-N}$), and d) orthophosphate ($\mu\text{M-P}$) concentration collected along north to south transect for months July–November. Colusa Basin Drain–Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). Woodland wastewater discharge site WWT and Davis wastewater discharge site DWT.

The lower Yolo Bypass (sites LIS and STTD) maintained low concentrations of nitrogen (Task 2 Question 2 and 3), but those concentrations were closely tied to the changing chlorophyll *a* (Task 2 Figure 1a, 1b, 1c). The nitrogen concentration in the form of $\text{NO}_3 + \text{NO}_2$ did increase in this region at site LIS during the managed flow pulse, but concentrations remained low at site STTD (Task 2 Figure 1c). This region maintained a low N:P ratio (1–3) throughout the sampling period (Task 2 Question 4), suggesting this region is primarily nitrogen limited (Task 2 Figure 2d). The net positive flow through the upper Yolo Bypass seems to be an important physical process to provide ample nutrients for phytoplankton production in the lower extent of the Toe Drain.

The Cache Slough Complex (sites BL5, LIB, RYI) is large and dynamic region that is strongly affected by the daily tidal movement patterns, which drive the physical and chemical processes within its many tidal slough and island habitats. The nutrient dynamics within the CSC are tied closely to the net movement of water either upstream or downstream. In 2016, like most years, the net movement of water is upstream in the summer due to consumptive use. This causes this region to be influenced by the downstream water source inputs from the adjacent Sacramento River that receives high nitrogen loading from the city of Sacramento wastewater discharge (Task 2 Question 1), which are high in NH_4 concentration. This causes the region to have a gradient of higher NH_4 and NO_3 as you move downstream (Task 2 Figure 1b and 1c). This causes the upper site BL5 to have very different nitrogen concentrations (Task 2 Question 2 and 3) than the lower sites of LIB and RYI (Task 2 Figure 1b and 1c).

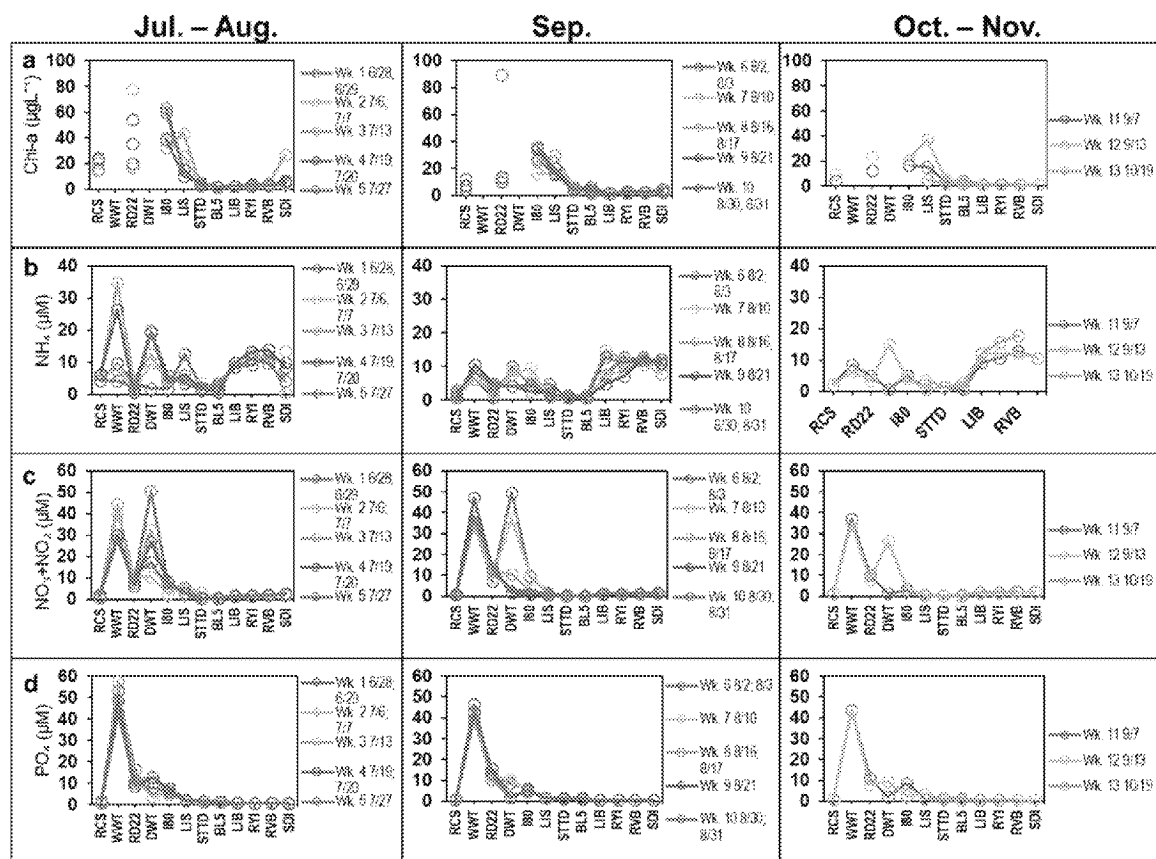


Task 2 Figure 2. 2016 weekly discrete a) silica ($\mu\text{M-Si}$), b) dissolved organic carbon ($\mu\text{M-C}$), c) dissolved inorganic nitrogen ($\mu\text{M-N}$) concentration, and d) N:P ratio from samples collected along north to south transect for months July-November. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). Woodland wastewater discharge site WWT and Davis wastewater discharge site DWT.

In addition, the N:P ratio at the upper BL5 site is low (1-2) and similar to the lower Yolo Bypass sites (Task 2 Question 4), but the lower CSC sites have high N:P ratios (8-27) due to the high surplus of nitrogen. During the flow pulse there was some reduction the NH_4 and NO_3 concentration in the upper CSC sites of BL5 and LIB, this was likely contributed to increased assimilation by phytoplankton, as

increased Chl *a* concentration was often observed on the same sampling dates (Task 2 Figure 1b and 1c). The concentrations of PO₄ and DOC followed a decreasing gradient (Task 2 Question 2 and 3) from BL5 moving downstream (Task 2 Figure 1d and 2b)

The lower Sacramento River (site RVB) had the highest concentrations of NH₄ (Task 2 Question 2 and 3) and maintained higher NO₃+NO₂ concentrations than the Cache Slough Complex and lower Yolo Bypass throughout the flow pulse (Task 2 Figure 1b and 1c). The lower Sacramento River region had the highest N:P ratio (19-28), which was as a result of the high NH₄ concentration (Task 2 Question 4) and lower PO₄ (Task 2 Figure 1b, 1d, 2d). The Si(OH)₂ and DOC concentrations in the lower Sacramento River region were similar to the lower CSC sites LIB and RYI (Task 2 Figure 2a and 2b). There were no significant differences in any of the nutrient constituents at RVB before, during or after the managed flow pulse.



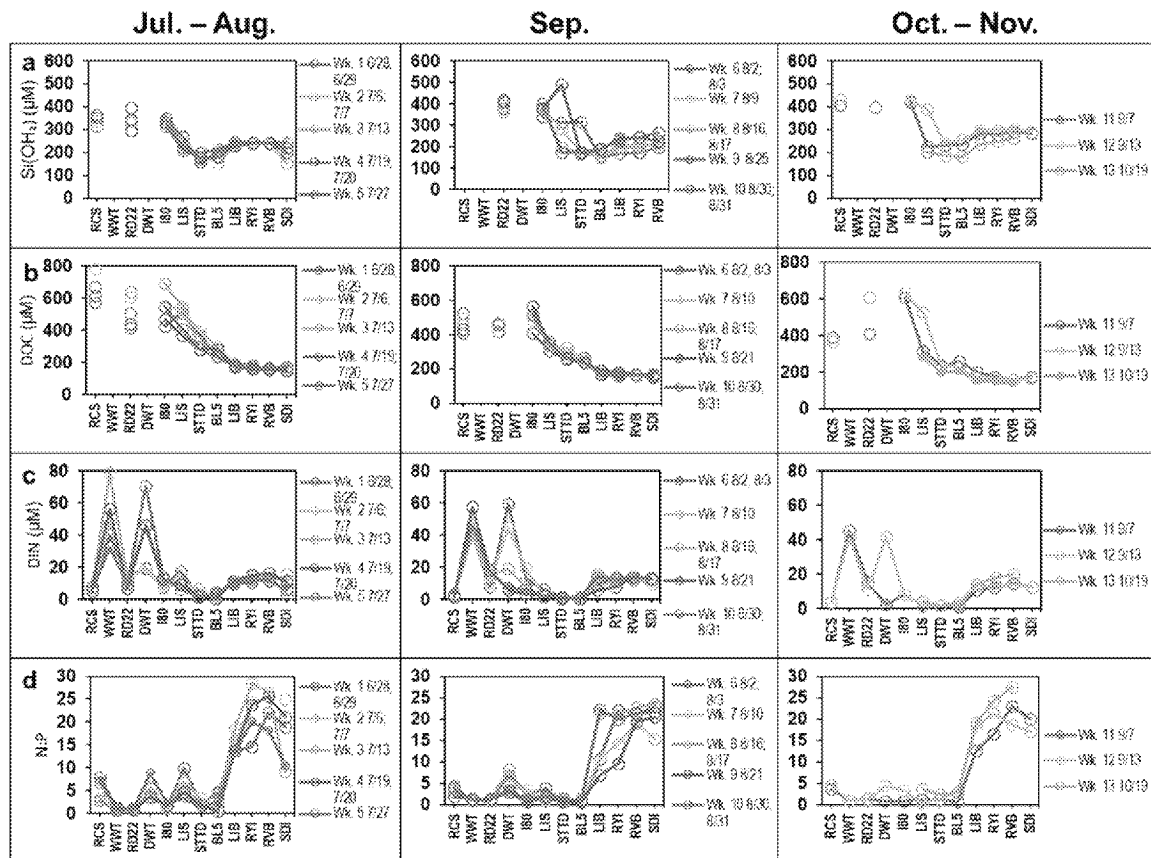
Task 2 Figure 3. 2017 weekly discrete a) chlorophyll *a* (µg/L⁻¹), b) ammonium (µM-N), c) nitrate + nitrite (µM-N), and d) orthophosphate (µM-P) concentration collected along north to south transect for months July-November. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). Woodland wastewater discharge site WWT and Davis wastewater discharge site DWT.

2017

In 2017, there was no managed flow pulse and in channel construction in Ridge Cut Slough from July – October, caused a drastic reduction in downstream flows from the Colusa Basin Drain into the Yolo Bypass Toe Drain. Much like 2016, the nitrogen concentration in the Colusa Basin Drain and Ridge Cut Slough region (site RCS) was low (Task 2 Question 1, 2 and 3) compared to the upper Yolo Bypass

region (Task 2 Figure 3b and 3c). Although, July concentrations in 2017 were 2-3-fold higher than 2016 for both NH_4 and NO_3+NO_2 , this may have been a result of the wetter year, causing more nutrients to enter the Colusa Basin Drain and Ridge Cut Sloughs from overland run off. The N:P ratio at site RCS was higher (Task 2 Question 4) than 2016 at 2-4 (Task 2 Figure 4d). This region had high Si(OH)_2 and DOC throughout the sampling period (Task 2 Figure 4a and 4b).

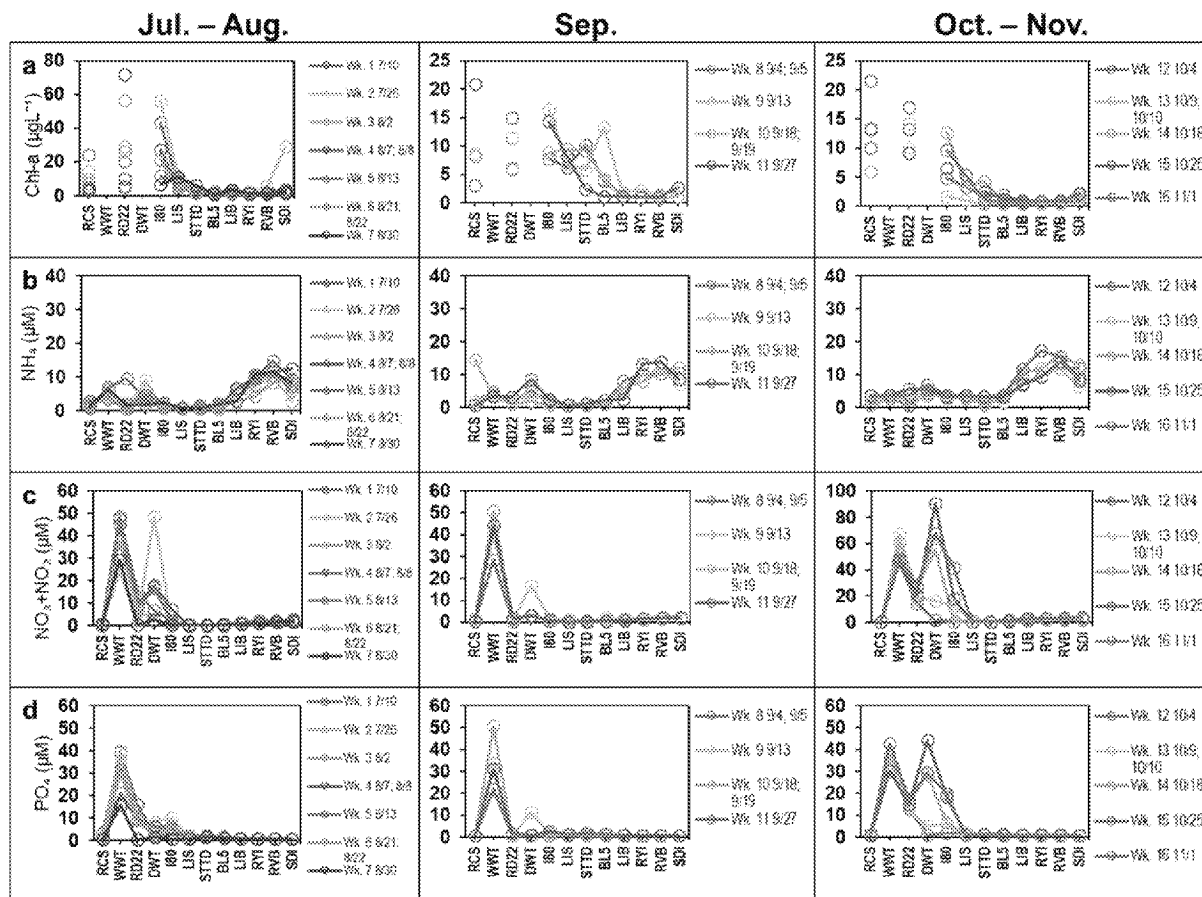
The upper Yolo Bypass (sites RD22 and I80) had the highest nitrogen concentrations (Task 2 Question 2 and 3). The NO_3+NO_2 at site RD22 below the city of Woodland's wastewater effluent release point, had concentrations ranging from 7.16-14.26 $\mu\text{M-N}$ throughout the sampling period (Task 2 Figure 3c). The NO_3+NO_2 concentrations collected at the wastewater effluent release channel site WWT were often >30 $\mu\text{M-N}$ (Task 2 Figure 3c). The nitrogen concentrations at site I80 were also high throughout the sampling period (Task 2 Question 2 and 3), with higher inputs of NO_3+NO_2 than 2016 (Task 2 Figure 1c and 3c). This shift of higher nitrogen in the form of NO_3+NO_2 , at site DWT may be a result of changes to the wastewater treatment processes by the city of Davis, as they are working towards upgrading to secondary tertiary process. This region was also a source of high PO_4 , Si(OH)_2 and DOC, often with the highest concentrations during the study period (Task 2 Question 2 and 3). The N:P ratio remained low at 1-3, suggesting nitrogen as the limiting nutrient (Task 2 Question 4).



Task 2 Figure 4. 2017 weekly discrete a) silica ($\mu\text{M-Si}$), b) dissolved organic carbon ($\mu\text{M-C}$), c) dissolved inorganic nitrogen ($\mu\text{M-N}$) concentration, and d) N:P ratio from samples collected along north to south transect for months July-November. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). Woodland wastewater discharge site WWT and Davis wastewater discharge site DWT.

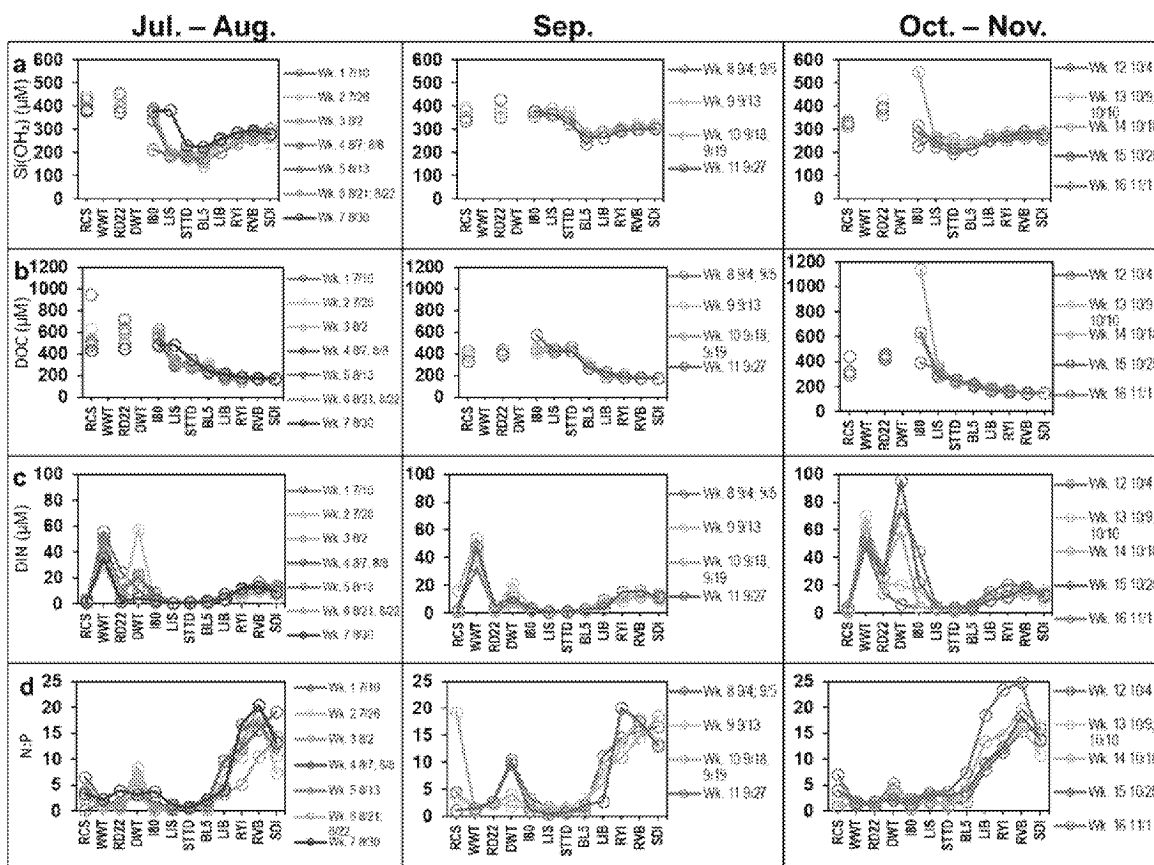
The lower Yolo Bypass (site LIS and STTD) maintained higher nitrogen concentrations through July (Task 2 Question 2 and 3), but concentrations dropped substantially into August (Task 2 Figure 3b and 3c). This is likely contributed to the sustained outflows from some side tributaries (i.e. Ridge Cut Slough, Cache Creek and Putah Creek), as well as nutrient inputs from increased land run off from the wet water year (Figure 1). The upstream construction starting in mid-July in Ridge Cut Slough, caused a dramatic decrease in water source exchange from the high nutrient upper Yolo Bypass region and the lower region sites. The STTD site maintain low $\text{NO}_3 + \text{NO}_2$ levels ($<0.70 \mu\text{M-N}$) throughout July-September (Task 2 Question 2 and 3) and N:P ratio was low at 1-2 (Task 2 Question 4), suggesting this region was nitrogen limited at times (Task 2 Figure 3c and 4d). The PO_4 , $\text{Si}(\text{OH})_2$, and DOC concentrations were equivalent to previous monitoring years (Task 2 Figure 3d, 4a, 4b).

The Cache Slough Complex (sites BL5, LIB, RYI) and lower Sacramento River (site RVB) regions had much higher concentrations of nitrogen in the form of NH_4 throughout the sampling period (Task 2 Figure 3b) as compared to 2016 (Task 2 Question 2 and 3). This resulted in high N:P ratio (Task 2 Question 4) at sites LIB, RYI and RVB (Task 2 Figure 4d). The PO_4 , $\text{Si}(\text{OH})_2$, and DOC concentrations were similar to 2016, with minimal changes during the study period (Task 2 Figure 3d, 4a, 4b).



Task 2 Figure 5. 2018 weekly discrete a) chlorophyll a ($\mu\text{g/L}$), b) ammonium ($\mu\text{M-N}$), c) nitrate + nitrite ($\mu\text{M-N}$), and d) orthophosphate ($\mu\text{M-P}$) concentration collected along north to south transect for months July-November. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). Woodland wastewater discharge site WWT and Davis wastewater discharge site DWT

In 2018, the managed flow pulse occurred in the late summer and early fall (August 26 – September 24) and used entirely agricultural return water from the Colusa Basin Drain during the seasonal rice-field harvest period. In the Colusa Basin Drain-Ridge Cut Slough region (site RCS), the nitrogen concentrations were low (Task 2 Question 1, 2 and 3), similar to prior years of 2016-2017, with NH_4 concentrations ranging from 0.70–2.89 $\mu\text{M-N}$ and NO_3+NO_2 0.09-1.74 $\mu\text{M-N}$ from July-October (Task 2 Figures 5b and 5c). The N:P ratio was low (Task 2 Question 4) at 1-6 (Task 2 Figure 6d). The PO_4 , $\text{Si}(\text{OH})_2$, and DOC concentrations were similar to the two prior study years 2016 and 2017 (Task 2 Figures 5d, 6a, 6b).



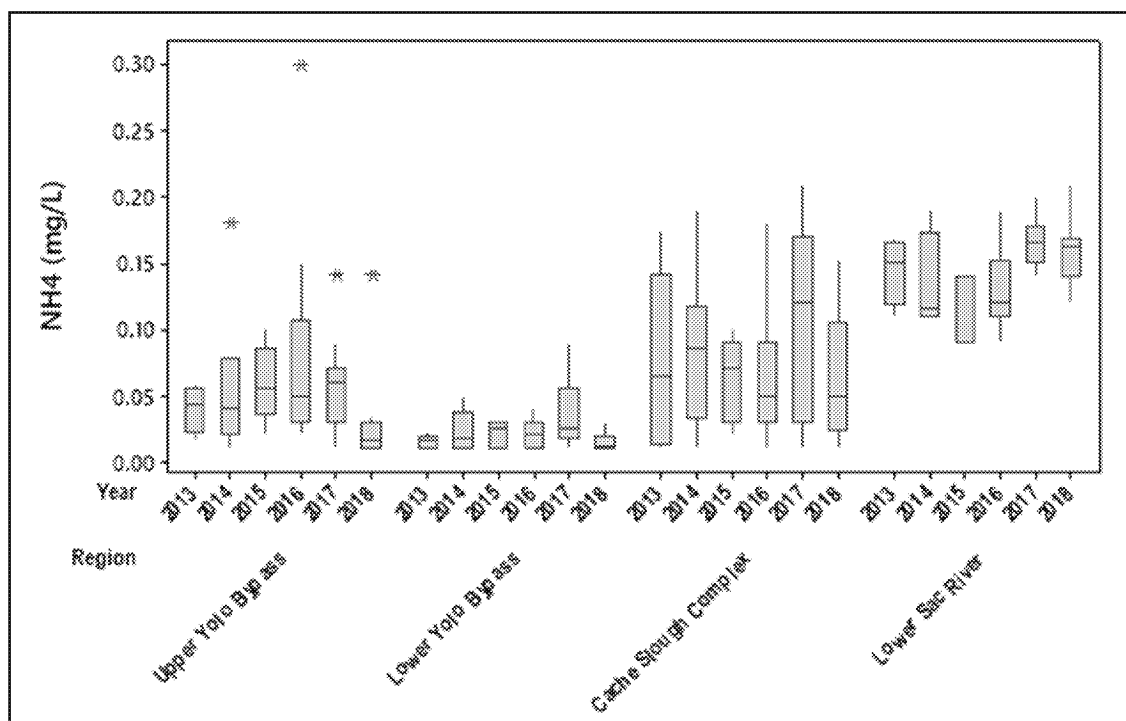
Task 2 Figure 6. 2018 weekly discrete a) silica ($\mu\text{M-Si}$), b) dissolved organic carbon ($\mu\text{M-C}$), c) dissolved inorganic nitrogen ($\mu\text{M-N}$) concentration, and d) N:P ratio from samples collected along north to south transect for months July-November. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). Woodland wastewater discharge site WWT and Davis wastewater discharge site DWT

The upper Yolo Bypass (sites RD22 and I80) had the highest nitrogen concentrations, especially in the form of NO_3+NO_2 (Task 2 Figures 5b and 5c). Both the city of Woodland site WWT and city of Davis site DWT had high NO_3+NO_2 concentrations (Task 2 Question 1, 2 and 3), with some concentrations in July that were 40-50 $\mu\text{M-N}$ (Task 2 Figure 5c). The concentrations of NH_4 at DWT were much lower than the two prior sampling years (Task 2 Figures 1b, 3b, 5b), and this is likely a result of updates in the wastewater treatment process that started in 2017. The N:P ratio in this region remained low (Task 2

Question 4) at 1-5 (Task 2 Figure 6d). The PO_4 concentrations were high 2.95-16.22 $\mu\text{M-N}$ in this region prior to the managed flow pulse but were much lower during at 0.63-1.77 $\mu\text{M-N}$ (Task 2 Figure 5d). The Si(OH)_2 and DOC concentrations were high in this region as in previous sampling years (Task 2 Figures 6a and 6b).

The lower Yolo Bypass (sites LIS and STTD) had low nitrogen concentrations before, during and after the flow pulse (Task 2 Question 2 and 3), with NH_4 concentration ranging between 0.66-3.54 μM and NO_3+NO_2 concentrations 0.09-1.47 $\mu\text{M-N}$ (Task 2 Figure 5b and 5a). The N:P ratio remained low (Task 2 Question 4) at 1-3 (Task 2 Figure 6d). The PO_4 and Si(OH)_2 concentrations were similar to prior years, with no significant increases during the flow pulse period (Task 2 Figure 5d and 6a). There was an increase in the DOC concentrations during the flow pulse in the lower Yolo Bypass (Task 2 Figure 6b), this suggests that using agricultural return water may also provide food-web benefits for lower trophic community through the organic detrital pathway.

The Cache Slough Complex (sites BL5, LIB, RYI) and lower Sacramento River (site RVB) followed a similar NH_4 and NO_3+NO_2 gradient of lower concentrations at the upper most site BL5 (Task 2 Question 2 and 3) and increasing concentrations as you move downstream to RVB (Task 2 Figure 5b). The NH_4 concentrations were reduced during the flow pulse at site BL5, with concentrations dropping from a mean of 1.19 $\mu\text{M-N}$ before to 1.00 $\mu\text{M-N}$ during (Task 2 Figure 5b). The PO_4 concentrations in the upper Cache Slough Complex at sites BL5 and LIB were higher than previous sampling years (Task 2 Figure 5d). The Si(OH)_2 concentrations were similar to prior years, but DOC concentrations were higher during the flow pulse at upper CSC sites BL5 and LIB (Task 2 Figure 6a and 6b).



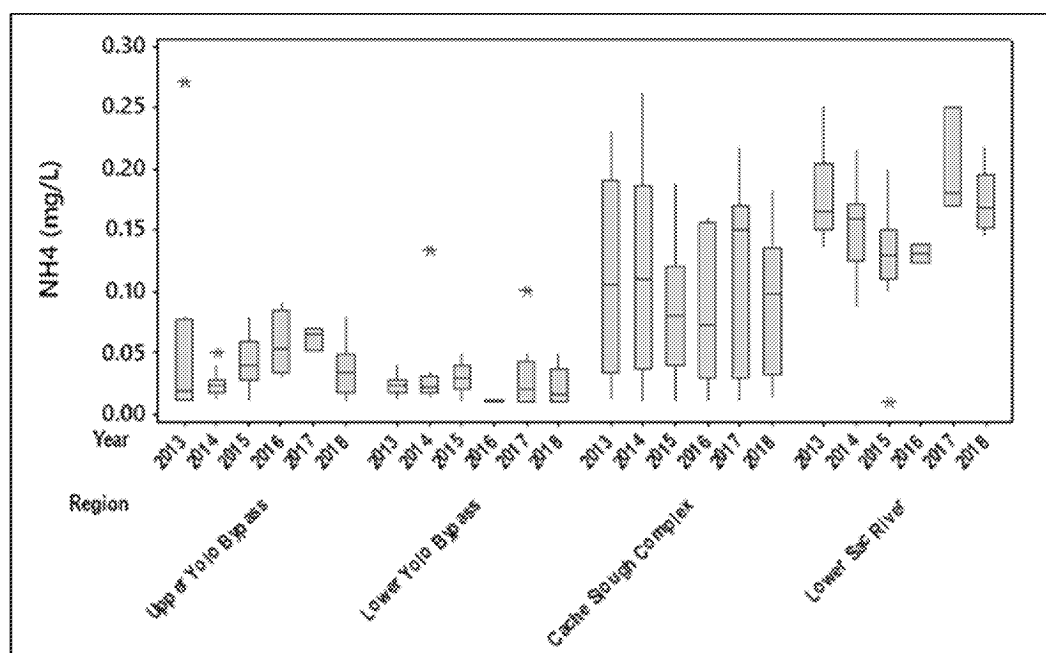
Task 2 Figure 7. 2013-2018 boxplots of weekly summer July-August discrete samples collected for ammonium (NH_4) analysis. Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB).

2013-2018

To identify differences in the regional nutrient concentrations (i.e. NH_4 , NO_3+NO_2 and PO_4) between different water years and managed flow pulse events, we compared all years (2013-2018) of data collection in the summer months of July-August and fall months of September-October. We determined significant differences in mean concentrations using an ANOVA and Tukey pairwise comparison test.

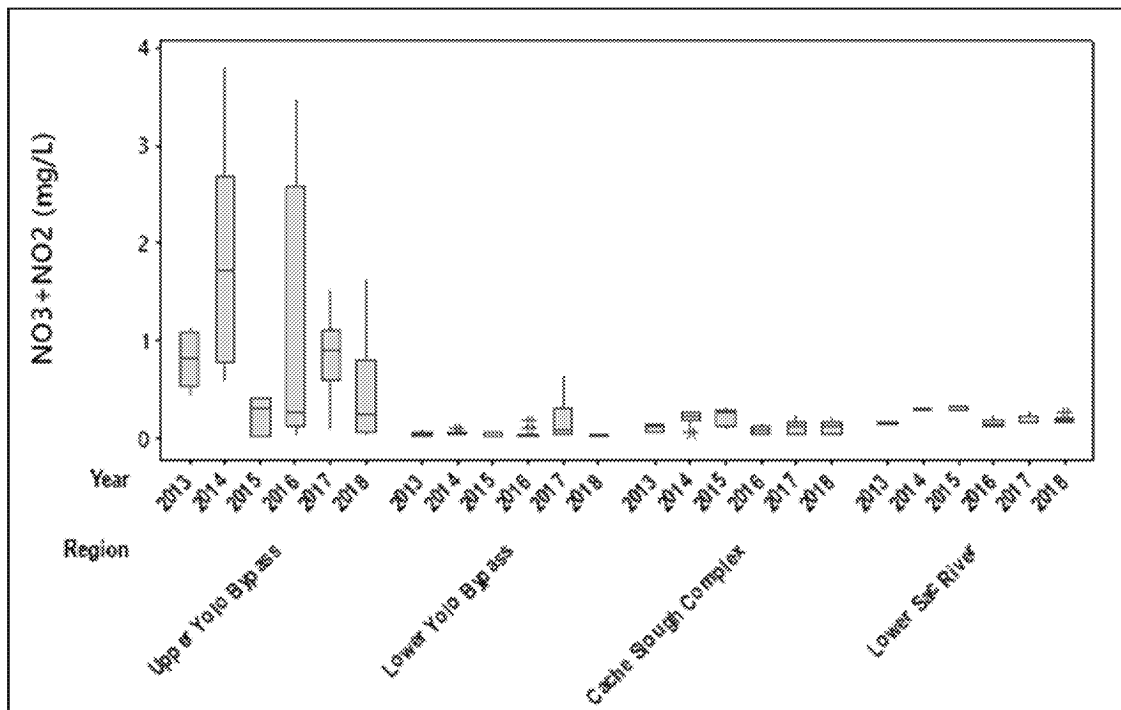
Ammonium (NH_4)

In 2018, the upper Yolo Bypass region had lower NH_4 concentrations than all other sampling years during the summer, with significantly lower concentrations (Tukey test $p < 0.05$) than 2016 and 2017 (Task 2 Figure 7). The reduced effluent inputs of NH_4 from DWT in 2018 are likely a primary contributor, but there is also evidence that differences in inflow and outflow conditions in the Yolo Bypass between these years are also a key driver in nitrogen inputs. There were however no significant differences in the NH_4 concentrations between the upper Yolo Bypass regions in the fall between sampling years. The NH_4 concentration in the lower Yolo Bypass region was similar between most years, with only the record wet year of 2017 having significantly higher concentrations (Tukey test $p < 0.05$) than the drought year of 2015 in the summer months (Task 2 Figure 7). The summer managed flow pulse year of 2016 had the lowest concentrations of NH_4 in the lower Yolo Bypass in the fall (Task 2 Figure 8). In 2016, the phytoplankton biomass was high throughout the summer months in the lower Yolo Bypass and with outflow conditions being drastically reduced in the fall due to construction in Ridge Cut Slough, the increased assimilation by phytoplankton likely depleted the available nitrogen. This region has shown a consistently low N:P ratio and total dissolved inorganic nitrogen (DIN) concentrations (Task 2 Figure 2d, 4d, 6d) are often near limiting levels for phytoplankton growth (Frantzich et al. 2018).



Task 2 Figure 8. 2013-2018 boxplots of weekly fall September-October discrete samples collected for ammonium (NH_4) analysis. Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB).

In 2016, the Cache Slough Complex region had the lowest NH_4 concentrations in the summer and fall compared to all other years (Task 2 Figures 7 and 8). With the high phytoplankton biomass in the region throughout 2016, there was likely higher nitrogen uptake than other years. There was higher NH_4 concentrations in the lower Sacramento River region in 2017 and 2018 compared to other years, with significantly (Tukey test $p < 0.05$) higher summer concentrations in the wet and high outflow year of 2017 than the drought year 2015 (Task 2 Figure 7). The record high inflows and land run-off in 2017 likely added to increased nutrient inputs. The higher flows can also contribute to lower residence time and reductions in phytoplankton nutrient uptake for growth.

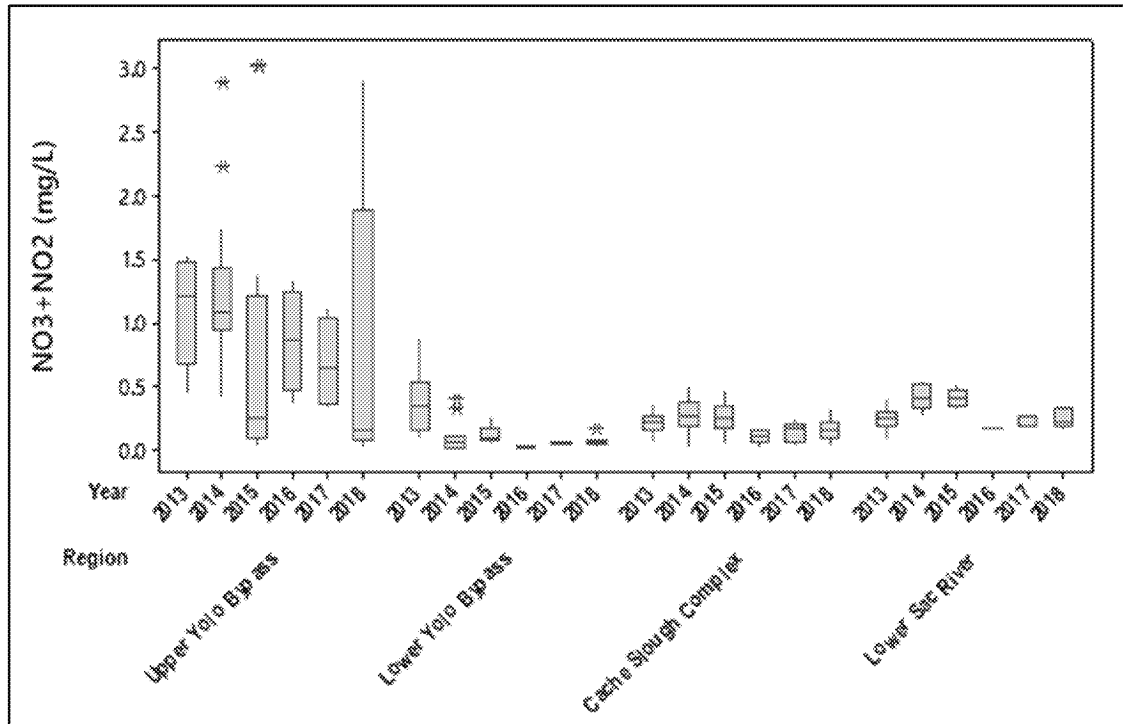


Task 2 Figure 9. 2013-2018 boxplots of weekly summer July-August discrete samples collected for nitrate nitrite (NO_3+NO_2) analysis. Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB)

Nitrate + Nitrite (NO_3+NO_2)

The NO_3+NO_2 concentrations in the upper Yolo Bypass were highly variable in the summer months (Task 2 Figure 9). In 2014, the NO_3+NO_2 concentrations were higher than all years in both summer and fall, with concentrations being significantly (Tukey test $p < 0.05$) higher than sampling years 2015 and 2018 (Task 2 Figure 9 and 10). The variability in NO_3+NO_2 in this region is caused primarily by wastewater inputs, especially the WWT site (Frantzich et al. 2018). In addition, side tributary inputs can also be important seasonal contributors of nutrients in the upper reaches of the Yolo Bypass (Schemel et al. 2004). The lower Yolo Bypass had the highest summer NO_3+NO_2 concentrations in the record wet year of 2017 (Task 2 Figure 9), this is likely as a result of increase inflows from nutrient rich side-tributaries (Schemel et al. 2004). In the fall sampling period, the dryer water years of 2013-2015 had the higher concentrations of NO_3+NO_2 (Task 2 Figure 10), with 2013 being significantly higher (Tukey test $p < 0.05$) than all other years.

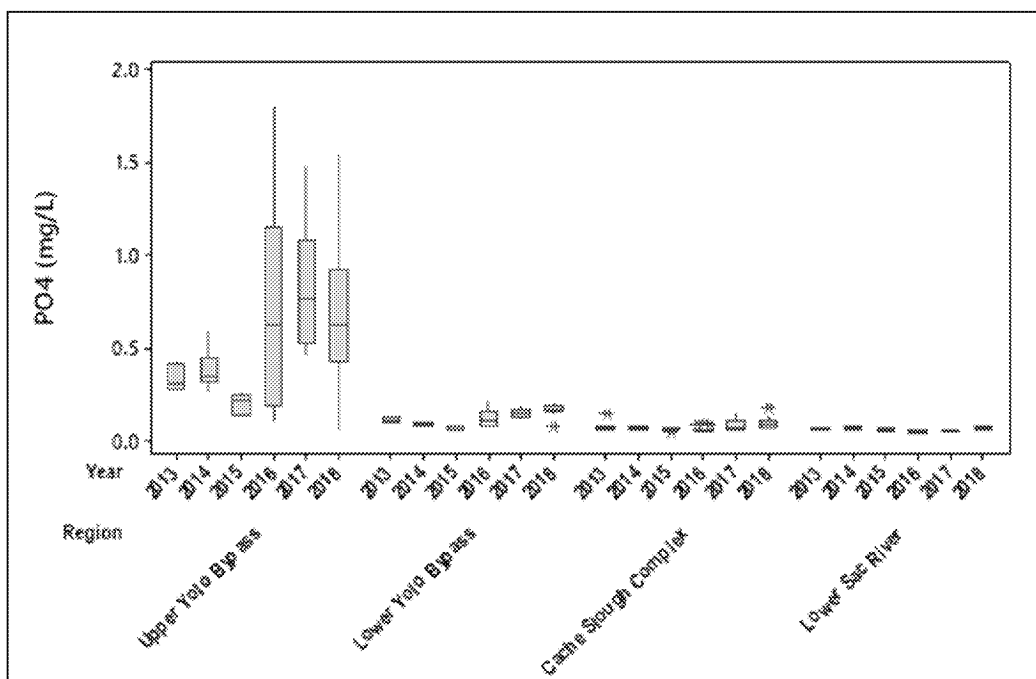
The Cache Slough Complex and lower Sacramento River had the lower NO_3+NO_2 concentrations in the higher outflow years of 2016-2018 and higher concentrations in the drought years 2013-2015 (Task 2 Figure 9 and 10). The higher values in the Cache Slough Complex are likely contributed to the strong landward tidal flows advecting higher nitrogen loads from the Sacramento River Wastewater treatment plant back upstream into the channel and tidal slough habitats. In 2016, with the summer managed flow pulse the NO_3+NO_2 concentrations were significantly lower than the two low outflow years of 2014 and 2015 (Task 2 Figure 9). The net landward movement of Sacramento River water up into the Cache Slough Complex was reduced in 2016 and added higher phytoplankton biomass in the region likely reduced the NO_3+NO_2 concentration.



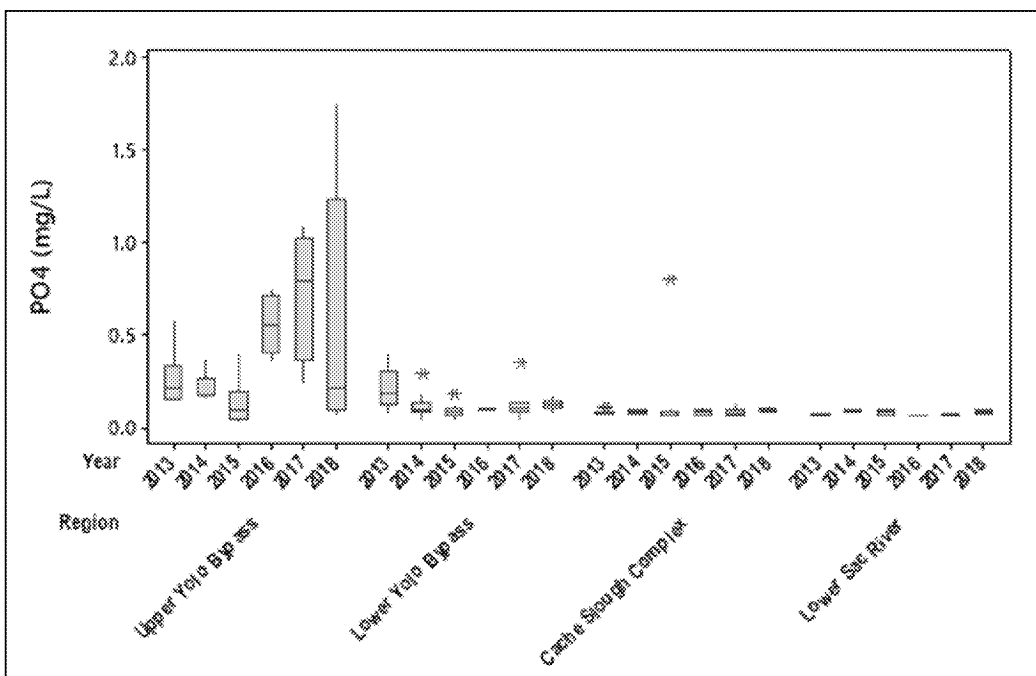
Task 2 Figure 10. 2013-2018 boxplots of weekly fall September-October discrete samples collected for nitrate nitrite (NO_3+NO_2) analysis. Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB)

Ortho-phosphate (PO_4)

The upper Yolo Bypass region had the highest concentrations of PO_4 in all years and regions (Task 2 Figure 11 and 12). In more recent sampling years 2016-2018, the PO_4 concentrations have been higher. There is some evidence that the PO_4 inputs from the Woodland wastewater discharge (site WWT) may be increasing in recent years (Task 2 Figure 3d and 5d). The lower Yolo Bypass and Cache Slough Complex regions were also seeing an increase in the PO_4 concentrations in more recent years (Task 2 Figure 11) at least during the summer months. Overall, the lower Yolo Bypass, Cache Slough Complex and lower Sacramento River saw very little change in concentrations between years (Task 2 Figures 11 and 12).



Task 2 Figure 11. 2013-2018 boxplots of weekly summer July-August discrete samples collected for orthophosphate (PO₄) analysis. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB)



Task 2 Figure 12. 2013-2018 boxplots of weekly fall September-October discrete samples collected orthophosphate (PO₄) for analysis. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB)

Task 2. Conclusion:

Our results suggest that rice field discharge water is not as important of a nutrient source to the Yolo Bypass, but rather Woodland and Davis wastewater discharge is a much more important contributor in the summer and fall. In all years, the nitrogen concentrations in Colusa Basin Drain-Ridge Cut Slough were low and at or near limiting concentrations before, during and after managed flow pulses. The Upper Yolo Bypass maintained high nitrogen concentrations, with high contributions of $\text{NO}_3 + \text{NO}_2$ from the Woodland wastewater treatment plant. The Davis wastewater treatment plant had lower $\text{NO}_3 + \text{NO}_2$ contribution to the Upper Yolo Bypass, but was an important nitrogen and phosphorus source in all years.

The Lower Yolo Bypass was a dynamic zone for nitrogen concentration and conditions changed with managed flow pulses. The stations within this region also varied due to their proximity to the high nutrient sources in the Upper Yolo Bypass. The LIS site at the northern end of the region maintained higher nutrient concentrations due to periodic tidal and outflow exchange with the upper Toe Drain. The STTD site at the lower end of the region often had low to limiting nitrogen concentrations in the summer and fall. The net negative outflow in the Toe Drain during the summer and early fall months likely contributes to high residence time and limited exchange of higher nutrient sources in the upper Bypass. Both sites observed increases in nitrogen and phosphorus concentrations during the flow pulses in 2016 and 2018, which is likely an important mechanism in the increase of Chl a. The NH_4 concentrations were often elevated at the STTD site and had similar levels to CSC, as strong landward tidal exchange with high NH_4 water sources from the Sacramento River.

The CSC and Lower Sacramento River regions maintained high nitrogen concentrations in all study years. These regions had elevated NH_4 concentrations and much of this nitrogen source is from the Sacramento Regional Wastewater Treatment Plant discharge into the Sacramento River. The NH_4 concentration increased from north to south in these lower study regions and strong landward tidal movement in the summer and fall months contributed to elevated concentrations in the CSC as Sacramento River water sources were tidally forced upstream. The elevated NH_4 in the Sacramento River has been attributed to inhibition of phytoplankton growth (Wilkerson et al. 2016) and the higher concentrations in 2018 may be an important factor in the low Chl a.

Our results further suggest that positive flow pulses in the Yolo Bypass may be important in contributing to nutrient transport to downstream regions. These flow pulses may alter nutrient ratios and contribute to changes in the primary forms of nitrogen available for phytoplankton uptake. The increase in $\text{NO}_3 + \text{NO}_2$ and reduction in NH_4 may aid in phytoplankton growth, as access to a higher NO_3 pool has shown to be an important factor in diatom blooms in the SFE.

IV. Task 3: (Phytoplankton) Determine the species composition and densities of phytoplankton

Contributing Authors:

Jared Frantzich, DWR Division of Environmental Services

Task 3. Background:

The San Francisco Estuary when compared to other estuaries throughout the world has a poor pelagic phytoplankton biomass and primary productivity (Cloern and Jassby 2008). The decline in phytoplankton biomass and primary productivity has been a long-term trend since the mid-1970s (Jassby 2008). The Yolo Bypass has been identified as a significant source of phytoplankton biomass to the Delta during the winter and spring times during floodplain inundation (Lehman et al. 2008; Sommer et al. 2004), but little has been known about its contribution to the food web during the dryer summer and fall months. Since the observed bloom events in 2011 and 2012, we have realized the potential of the Yolo Bypass as a source of valuable phytoplankton to the Cache Slough Complex and as far south as Antioch. This has direct positive implications for the zooplankton and pelagic fish community, which has also been on the decline. Initial study results from 2012, 2013, and 2012 have shown that the phytoplankton species composition during the fall flow pulse is dominated by the higher nutritional quality diatoms (Frantzich et al. 2018), which are a primary food for copepods (Brown 2009; Lehman 1992; Orsi 1995). Copepods are a very important diet item for many Delta larval and juvenile fishes (Cloern et al. 1983; Obreski et al. 1992; Orsi 1995).

Task 3. Research Questions:

1. How do the densities of phytoplankton change along the sampling transect before, during and after the summer/fall flow pulse?
2. What is the phytoplankton species composition within the Yolo Bypass, Prospect Slough, Cache Slough Complex and lower Sacramento River before, during and after the summer/fall flow pulse?
3. How does the phytoplankton composition and biomass change throughout the summer/fall flow pulse as it relates to variable water quality, nutrients, light attenuation and flow data?

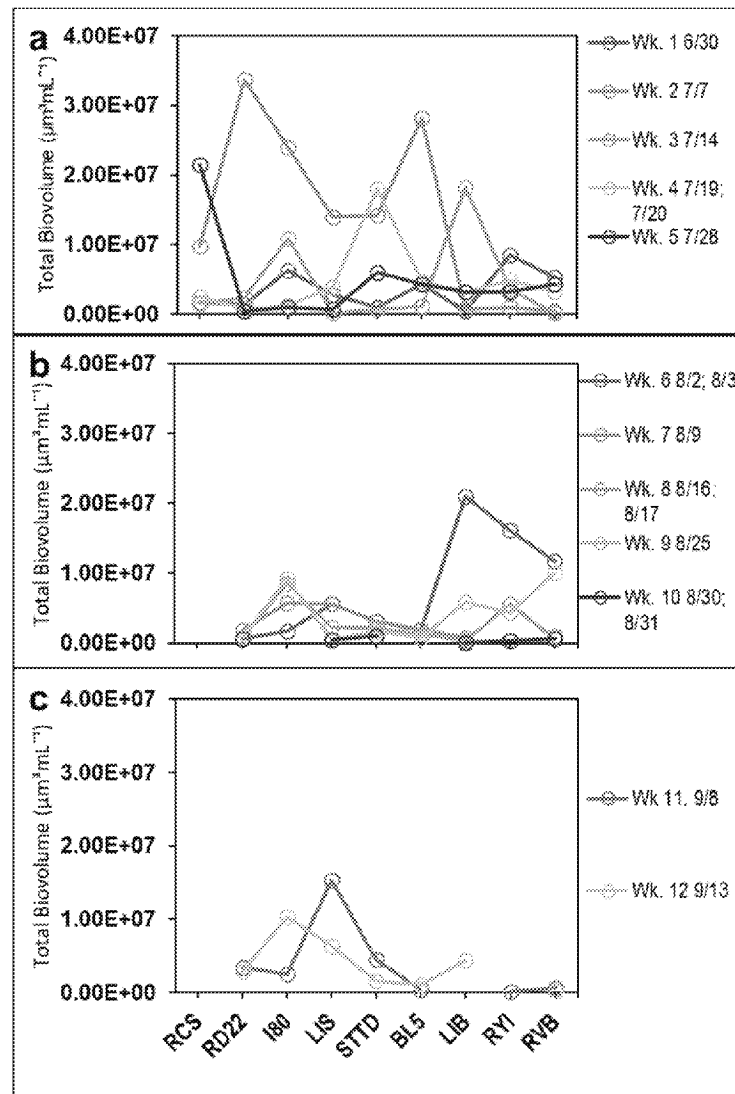
Task 3. Methods:

The species composition and densities of phytoplankton were determined from the collection of water samples by boat or land at ten sites: 1.) Ridge Cut Slough (RCS); 2.) Toe Drain at Rd. 22 (RD22); 3.) Toe Drain at I80 (I80); 4.) Toe Drain below Lisbon Weir (LIS); 5.) Toe Drain at Screw Trap (STTD); 6.) Prospect Slough (BL5); 7.) Cache Slough at Liberty Island (LIB); 8.) Cache Slough at Ryer Island (RYI); 9.) Sacramento River at Rio Vista (RVB); 10) Sacramento River at Decker Island (SDI) (Figure 1) in conjunction with Chl a sample using a Van Dorn sampler or Nasco 12' Extendible Swing Sampler. Samples were collected during the months of June through October on a weekly basis based on the historical occurrence of flow pulses recorded at the existing Lisbon flow station (LIS, Figure 1). In addition, light attenuation measurements using a LI-COR LI-193SA were collected at all sites to characterize the photosynthetically active radiation (PAR) before, during and after the summer/fall flow pulse event.

Sample collection procedures followed those established methods by IEP Bay-Delta Monitoring and Analysis Section. All samples were typically collected on ebb tide and a depth of 3 ft. using a Van Dorn sampler or Nasco 12' Extendible Swing Sampler. Samples were collected in required containers (50 mL

amber glass bottles) and using proper preservation techniques (Lugol's solution). The samples were analyzed by a contracted taxonomist and the biovolume was measured for each sample. The analysis specifications were based off the DWR Bay-Delta Monitoring and Analysis Section's current contract, so data is comparable for future analysis.

Phytoplankton composition was determined and enumerated to at least the genus level using the Utermöhl microscope method (Utermöhl 1958) for all samples. Phytoplankton samples were counted for at least four hundred total algal units, with one hundred units of the dominant taxa. Length measurements were recorded in micrometers (μm) on the first twenty-five units of major phytoplankton taxa and first five units of minor taxa to calculate biovolume ($\mu\text{m}^3 \text{L}^{-1}$) from formulas given for different algal shapes by Keller et al. (1980).

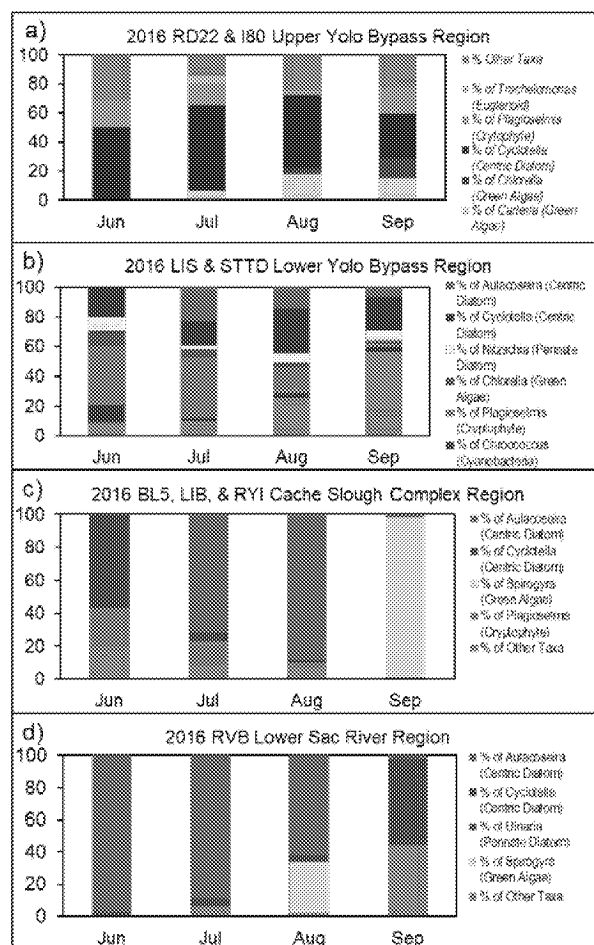


Task 3 Figure 1. 2016 weekly phytoplankton biovolume ($\mu\text{m}^3\text{mL}^{-1}$) collected along north to south transect. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). a) June-July sampling weeks; b) August sampling weeks; c) September sampling weeks.

Task 3. Results and Discussion:

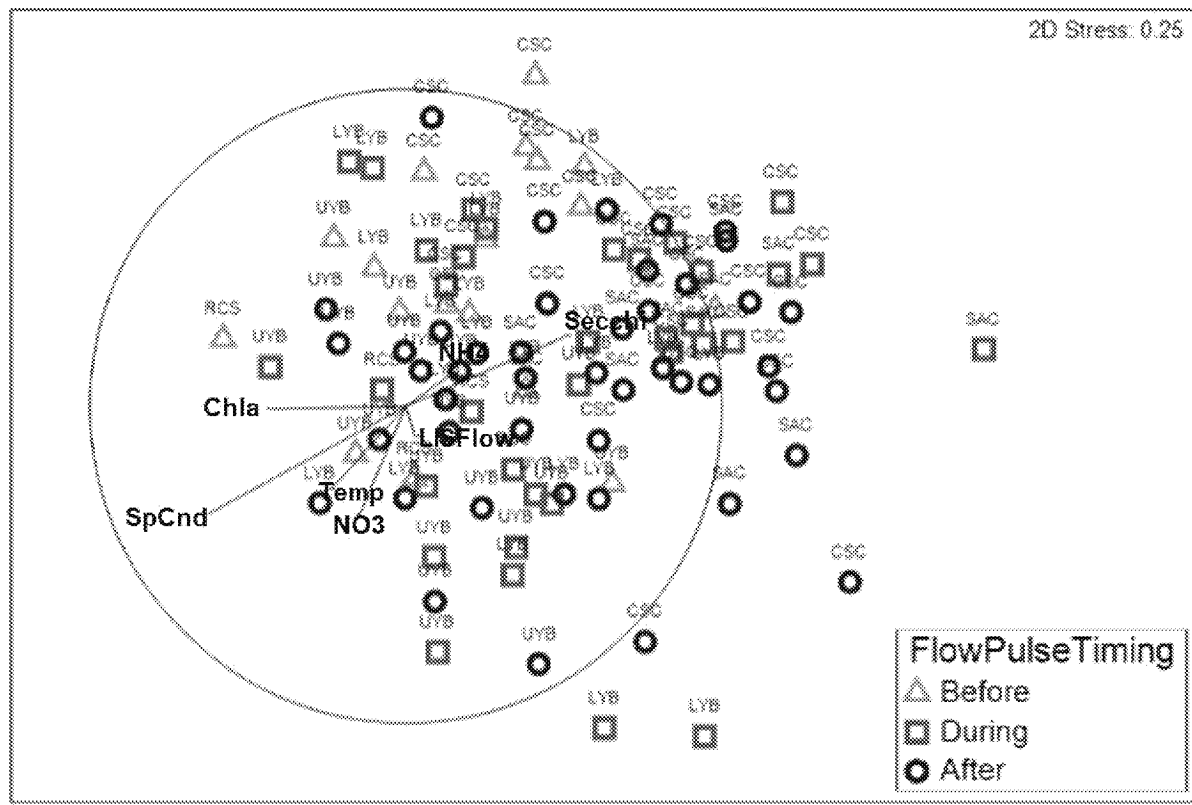
2016

In 2016, the total phytoplankton biovolume ($\mu\text{m}^3\text{mL}^{-1}$) was high (Task 3 Question 1) in Colusa Basin Drain-Ridge Cut Slough (site RCS), the Upper Yolo Bypass (sites RD22, I80), Lower Yolo Bypass regions (sites STTD and LIS), and the Cache Slough Complex site BL5 during the second sampling week 2 on July 7 (Task 3 Figure 1a). This was the week just prior to the managed flow pulse that started on July 14 (Task 4 Figure 2 and Table 1). During the increased flows during sampling week 3 on July 14 total phytoplankton biovolume in the Cache Slough Complex at site LIB just downstream of BL5 increased by 20-fold from the prior sampling week (Task 3 Figure 1a), suggesting export of phytoplankton biomass from upper Cache Slough into the lower reaches near the base of Liberty Island (Figure 1). In addition, the lower Yolo Bypass site STTD also observed a 40-fold increase (Task 3 Question 1) in total phytoplankton biovolume from sampling week 3 to week 4 as higher phytoplankton biomass from the upper reaches of the Yolo Bypass was exported downstream during net positive outflows (Task 3 Figure 1a). As the flow pulse progressed over time and water residence time was reduced in Colusa Basin Drain-Ridge Cut Slough, Upper Yolo Bypass and Lower Yolo Bypass regions the phytoplankton biovolume also decreased (Task 3 Figure 1a and 1b).



Task 3 Figure 2. 2016 region monthly phytoplankton taxa total biovolume by group and % of taxa making up $\geq 3\%$ of total biovolume. Regions: a) Upper Yolo Bypass, b) Lower Yolo Bypass, c) Cache Slough Complex, and d) Lower Sacramento River

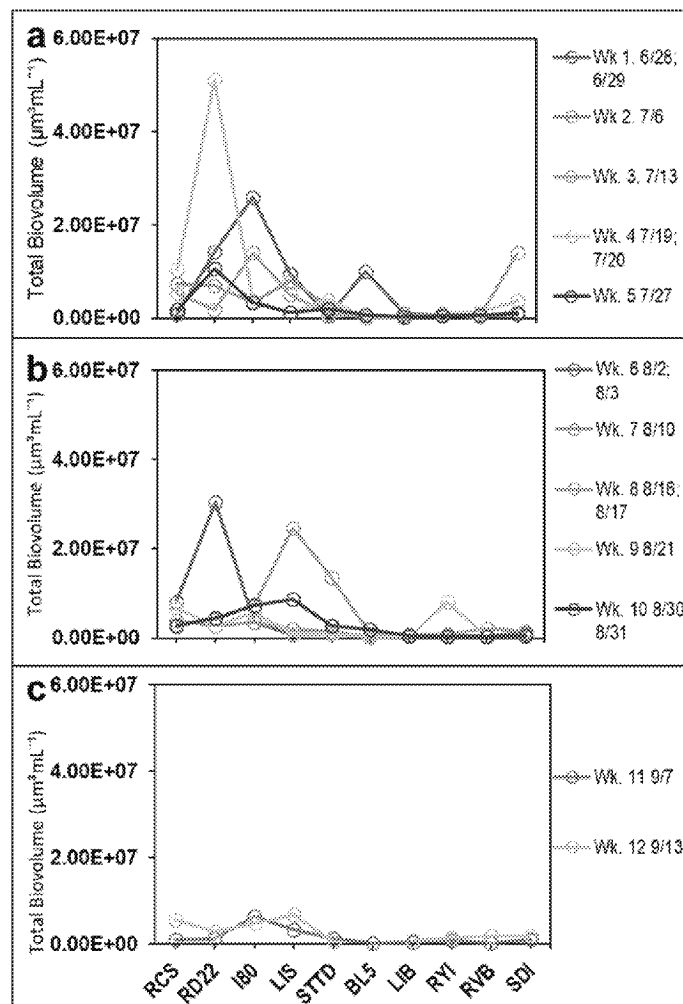
In sampling week 6 on August 3, shortly after the managed flow pulse ended, the lower Cache Slough Complex region (sites LIB and RYI) and lower Sacramento River site RVB all increased by 3-fold or more in total phytoplankton biovolume (Task 3 Question 1). Then again approximately 3-weeks after the flow pulse we observed a substantial increase in the phytoplankton biovolume (Task 3 Question 1) at the lower Sacramento River site RVB (Task 3 Figure 1b). This delayed response of several weeks and a sudden increase in phytoplankton biomass was the same response that was observed in both 2011 and 2012 after sustained net positive flows occurred through the Yolo Bypass (Task 4 Figure 2).



Task 3 Figure 3. 2016 Non-metric MDS plot of phytoplankton biovolume ($\mu\text{m}^3\text{mL}^{-1}$) taxa group data forth root transformed for Colusa Basin Drain-Ridge Cut Slough Region (RCS); Upper Yolo Bypass Region (UYB); Lower Yolo Bypass Region (LYB); Cache Slough Complex Region (CSC); Lower Sacramento River Region (SAC). Bray Curtis similarity matrix was performed on taxa data and environmental variables: Lisbon flow (LISFlow), chlorophyll a (Chla), water temperature (Temp), specific conductance (SpCnd), ammonium (NH_4), nitrate nitrite (NO_3), and Secchi depth (Secchi) were selected as overlay vectors

The phytoplankton composition in the upper Yolo Bypass (sites RD22 and I80) was composed primarily of the centric diatom *Cyclotella* sp. (Task 3 Question 2) at over 40% of the total phytoplankton biovolume throughout the sampling weeks in June-August (Task 3 Figure 2a). In the Lower Yolo Bypass (sites STTD and LIS) the composition was also composed of the centric diatom *Cyclotella* sp., but a much smaller percentage (~20%) during the same sampling weeks. The cryptophyte *Plagioselmis* sp. made up a much larger percentage of the overall total phytoplankton biovolume in the Lower Yolo Bypass region (Task 3 Question 2) at over 50 % in June-July and the centric diatom *Aulacoseira* sp. made up over 20% of the total biovolume in July and September (Task 3 Figure 2b). In the Cache Slough Complex region (sites BL5, LIB, RYI) and the lower Sacramento River region site RVB the composition was largely dominated by the single centric diatom taxa *Aulacoseira* sp. making up 60-90% of the total biovolume

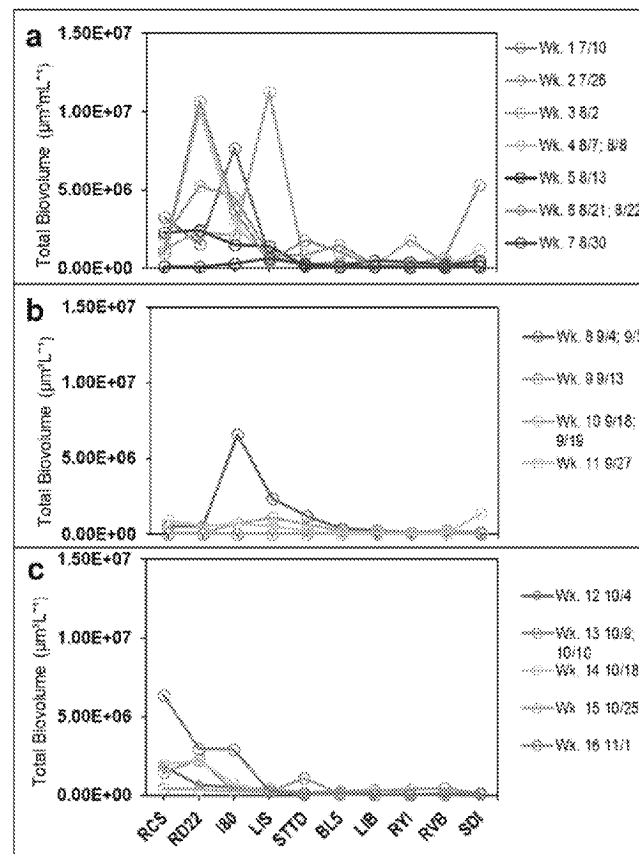
(Task 3 Question 2) in the months of July and August during the managed flow pulse (Task 3 Figure 2c, 2d).



Task 3 Figure 4. 2017 weekly phytoplankton biovolume ($\mu\text{m}^3\text{mL}^{-1}$) collected along north to south transect. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). a) June-July sampling weeks; b) August sampling weeks; c) September sampling weeks.

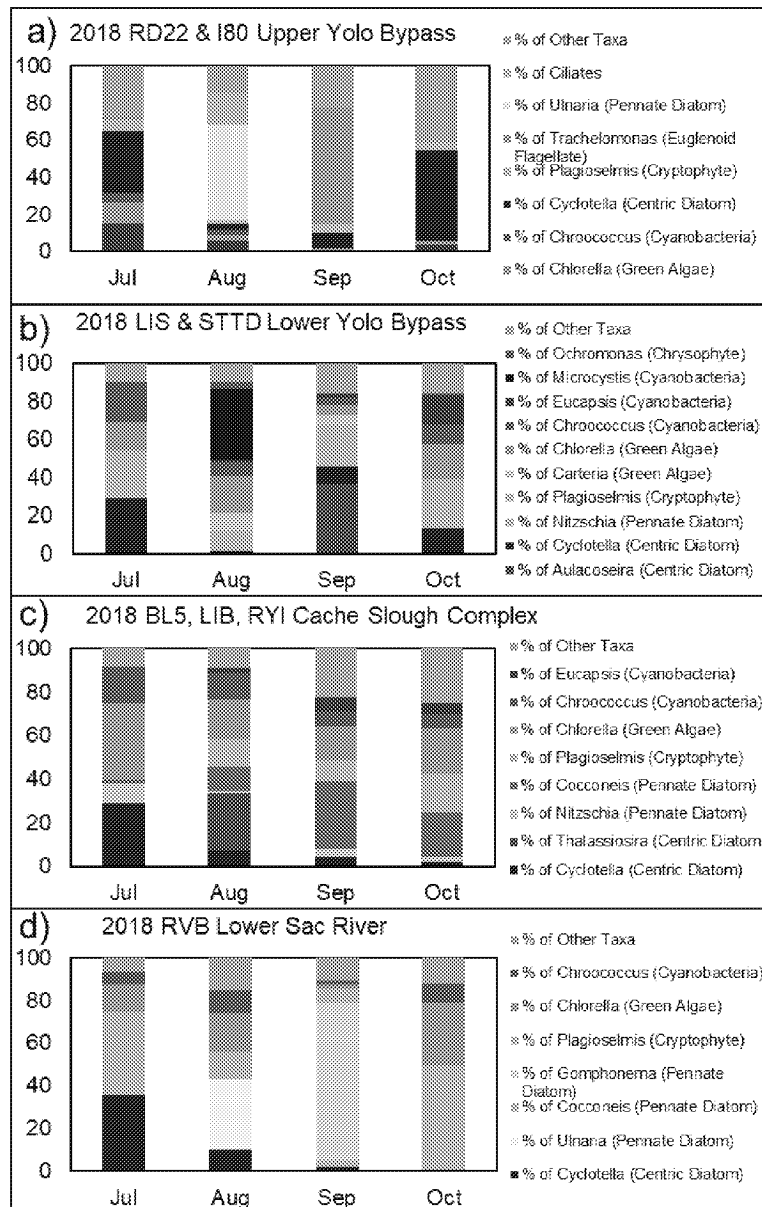
In 2016, the managed flow pulse occurred during the summer starting on July 14 through August 1. The phytoplankton biovolume in the lower Yolo Bypass region increased dramatically at the STTD site, as phytoplankton biomass from the upper reaches of the Yolo Bypass were exported downstream. The positive flows measured at LIS flow gauge during the managed action were positively correlated with subsequent increases in NO_3+NO_2 concentration, specific conductivity, and water temperature at the lower Yolo Bypass sites (Task 3 Question 3), as upstream water sources moved into lower reaches of the Toe Drain (Task 3 Figure 3). The Cache Slough Complex and lower Sacramento River regions phytoplankton biovolume were strongly correlated with higher Secchi depth and NH_4 concentration. There was increased dissimilarity between the Cache Slough Complex region before, during and after the flow pulse (Task 3 Question 4) suggesting that the managed flow pulse caused changes in phytoplankton biovolume, nutrient, and water quality conditions (Task 3 Figure 3). In all, as shown by the non-metric

The phytoplankton composition in the upper Yolo Bypass (sites RD22 and I80) during the early summer months of Jun-July was less dominated by diatoms (Task 3 Question 2) when compared to 2016 (Task 3 Figure 1a), with the euglenoid flagellates *Strombomonas* sp. and *Euglena* sp. making up 40-50% of the total phytoplankton biovolume (Task 3 Figure 5a). The centric diatom *Cyclotella* sp. and cryptophyte *Plagioselmis* sp. were also prevalent species, but both taxa composed only 20% or less of the total phytoplankton biovolume throughout the sampling period of June-September (Task 3 Figure 5a). The Lower Yolo Bypass region (sites LIS and STTD) was composed primarily by the centric diatom *Cyclotella* sp. (Task 3 Question 2) at 40-60% of the total phytoplankton biovolume (Task 3 Figure 5b). In the Cache Slough Complex region, the centric diatom *Cyclotella* sp. composed 7-20% of the total phytoplankton biovolume during the summer months of June-August (Task 3 Question 2). The cyanobacteria *Chroococcus* sp. was also a prevalent taxon in this region during the months of July and August, making up 40% and 30% of the total phytoplankton biovolume respectively (Task 3 Figure 5c). The centric diatom *Aulacoseira* sp. that was so dominant in the Lower Yolo Bypass and Cache Slough Complex regions in 2016, was only a small contributor at 9% of the total phytoplankton biovolume in the Lower Sacramento River region (site RVB) in the month of July (Task 3 Figure 5d). The Lower Sacramento River region was primarily composed of the centric diatom *Cyclotella* sp. (Task 3 Question 2) throughout the sampling period of June-September, making up 30-50% of the total phytoplankton biovolume (Task 3 Figure 5d).



Task 3 Figure 6. 2018 weekly phytoplankton biovolume ($\mu\text{m}^3\text{mL}^{-1}$) collected along north to south transect. Colusa Basin Drain-Ridge Cut Slough Region (Site: RCS); Upper Yolo Bypass Region (sites: RD22 and I80); Lower Yolo Bypass Region (sites: LIS and STTD); Cache Slough Complex Region (sites: BL5, LIB, RYI); Lower Sacramento River Region (site: RVB). a) July-August sampling weeks; b) September sampling weeks; c) October-November sampling weeks.

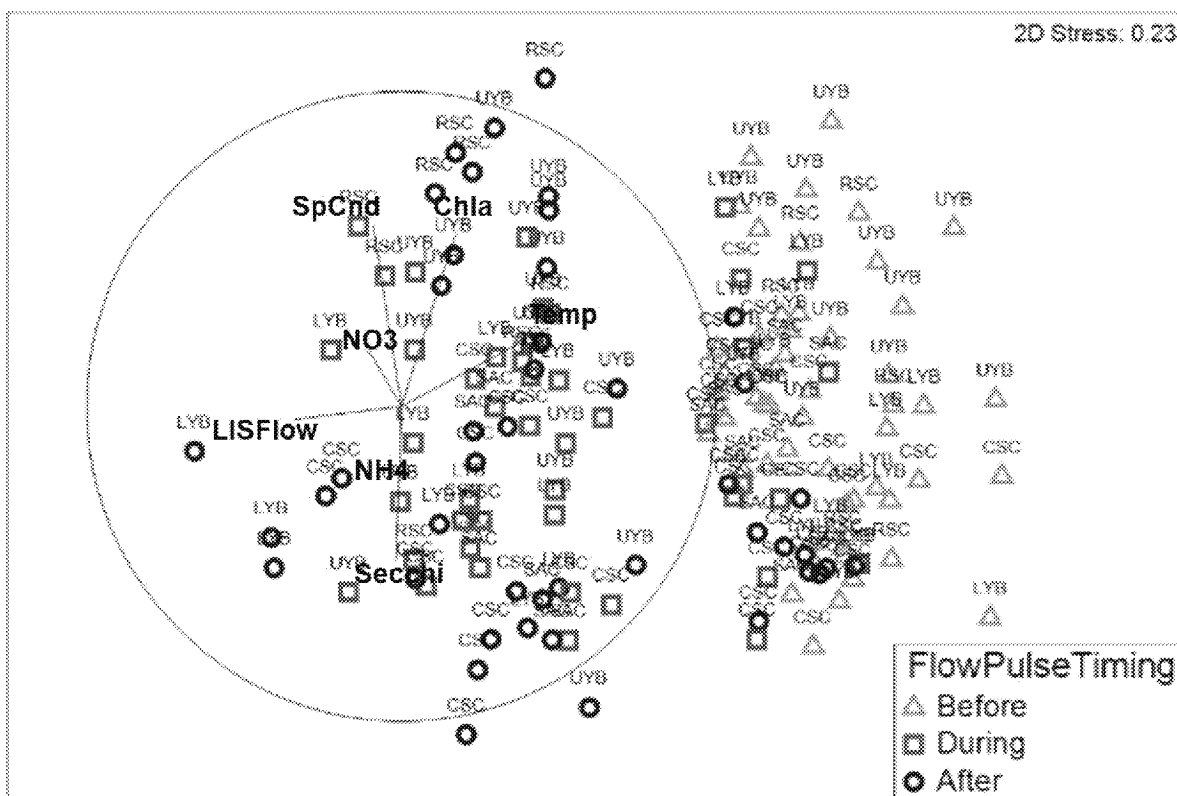
In 2017, there was no managed flow action in the Yolo Bypass and additional flow restrictions occurred in the Yolo Bypass Toe Drain due to construction at Wallace Weir that impeded Colusa Basin Drain and Ridge Cut Slough inflows (Task 3 Question 3). This reduced the channel connectivity of those Upper Yolo Bypass region with high phytoplankton biomass, with downstream sites in the Lower Yolo Bypass and Cache Slough Complex regions. The Lower Sacramento River region maintained low total phytoplankton biovolume throughout the sampling period (Task 4 Table 1 and Figure 3). There was a short period of net positive outflow in the Yolo Bypass in September, during routine local rice-field discharge, resulting an increase in total phytoplankton biovolume in the lower Yolo Bypass, with site LIS increasing 8-fold and site STTD 3-fold (Task 3 Figure 4b).



Task 3 Figure 7. 2018 region monthly phytoplankton taxa total biovolume by group and % of taxa making up $\geq 3\%$ of total biovolume. Regions: a) Upper Yolo Bypass, b) Lower Yolo Bypass, c) Cache Slough Complex, and d) Lower Sacramento River

2018

In 2018, the total phytoplankton biovolume in Colusa Basin Drain-Ridge Cut Slough (site RCS) and the Upper Yolo Bypass regions (sites RD22 and I80) were high (Task 3 Question 1) throughout the sampling weeks in July and early August (Task 3 Figure 6a). The high phytoplankton biomass in these upper regions was also observed in prior two sampling years of 2016 and 2017 (Task 3 Figures 1a and 4a). The Lower Yolo Bypass regional site LIS observed a peak in total phytoplankton biovolume in week 3 on August 2 (Task 3 Question 1) but maintained lower levels than sites in the Upper Yolo Bypass region throughout much of the July-August sampling period. Both lower Yolo Bypass region sites (LIS and STTD) observed an increase in total phytoplankton biovolume in week 8 (Task 3 Question 1) in early September (Task 3 Figure 6b), shortly after the managed flow action that started on August 28 (Task 4 Figure 2 and Table 1). The Cache Slough Complex (sites BL5, LIB, RYI) and Lower Sacramento River (site RVB) regions maintained low total phytoplankton biovolume throughout the study period (Task 3 Question 1), especially in those sampling weeks in late August and the throughout the month of September. There was no substantial increase in total phytoplankton biovolume in the lower Sacramento River at site RVB (Task 3 Question 1) in response to the 2018 managed flow pulse (Task 4 Figure 4 and Table 1).



Task 3 Figure 8. 2018 Non-metric MDS plot of phytoplankton biovolume ($\mu\text{m}^3\text{mL}^{-1}$) taxa group data forth root transformed for Colusa Basin Drain-Ridge Cut Slough Region (RCS); Upper Yolo Bypass Region (UYB); Lower Yolo Bypass Region (LYB); Cache Slough Complex Region (CSC); Lower Sacramento River Region (SAC). Bray Curtis similarity matrix was performed on taxa data and environmental variables: Lisbon flow (LISFlow), chlorophyll a (Chla), water temperature (Temp), specific conductance (SpCnd), ammonium (NH_4), nitrate nitrite (NO_3), and Secchi depth (Secchi) were selected as overlay vectors.

The phytoplankton composition in the Upper Yolo Bypass region (sites RD22 and I80) much like 2017 (Task 3 Question 2), was less dominated by centric diatoms than 2016 (Task 3 Figure 7a). Phytoplankton biovolume in July was dominated (>50%) by the pennate diatom *Ulnaria sp.* and August dominated by the euglenoid flagellate *Trachelomonas sp.* (Task 3 Figure 7a). Both these taxa were not prevalent in prior years, with *Ulnaria sp.* a common taxon in the Lower Sacramento River region. The Lower Yolo Bypass region (sites LIS and STTD) had an overall lower biovolume of centric diatoms and higher total biovolume of cyanobacteria (Task 3 Question 2), especially during the months of July and August with *Microcystis sp.* and *Chroococcus sp.* making up close to 50% of the total phytoplankton biomass as biovolume (Task 3 Figure 7b). The centric diatom *Aulacoseira sp.* was only a prevalent species in one sample collected at site STTD in mid-September (Task 3 Figure 7b). The Cache Slough Complex region was also composed of a higher total phytoplankton biovolume of cyanobacteria (Task 3 Question 2), with *Chroococcus sp.* and *Eucapsis sp.* making up the highest biomass (Task 3 Figure 7c). In 2018, there was an overall higher total biovolume of green algae compared to previous years and lower biovolume of higher food quality centric diatoms (Brett and Mueller-Navarra 1997, Winder et al. 2017) in both the Cache Slough Complex and Lower Sacramento River regions (Task 3 Figure 7c, 7d).

In 2018, there was high dissimilarity (Task 3 Question 3) between the total phytoplankton biovolume composition before and samples during and after the fall managed flow action (Task 3 Figure 8). This seemed to be driven primarily by the intensity and duration of the flow pulse. This flow pulse increased the specific conductance and NO₃ in the lower Yolo Bypass and Cache Slough Complex regions, as upstream high conductivity water was advected into the lower sloughs and channels (Task 3 Figure 8). These upstream source waters also had unique phytoplankton taxa that were exported downstream and likely contributing to the increased dissimilarities in the total phytoplankton biovolume composition over the flow pulse period (Task 3 Question 3). The non-metric MDS plot does suggest that there may have been less dissimilarity in the Lower Sacramento River region, suggesting that the flow pulse did not have substantial effects on the total phytoplankton biovolume composition (Task 3 Figure 8).

Task 3. Conclusion:

The phytoplankton biomass as biovolume was highest in the upper regions of the study area, with highest biovolumes in the Upper Yolo Bypass. This region had highest ambient nutrients, and this was attributed primarily to the constant influx of effluent release water from both Woodland and Davis wastewater treatment plants. The Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass regions had high phytoplankton biovolume in all years during the summer months leading up to managed flow pulses. Our results show that the phytoplankton biomass was highest in 2016 before, during, and after the summer managed flow action when compared to the other study years. This biomass was primarily composed of the centric diatom *Aulacoseira sp.* the same taxa that made up the large bloom in 2012. Both the 2016 and 2018 managed flow pulses observed in the transport of phytoplankton from north to south in the study area, but only the 2016 flow pulse resulted in increases in the lower Cache Slough Complex and Lower Sacramento regions. The 2016 flow pulse provided evidence that the Cache Slough Complex can also be an important source of phytoplankton biomass to downstream habitats and that these managed flow pulses are not just an export of phytoplankton from the Yolo Bypass.

The phytoplankton biomass in the Colusa Basin Drain-Ridge Cut Slough, Yolo Bypass, and Cache Slough Complex regions was composed primarily by centric diatoms. The composition and biomass did change between years, but the centric diatom *Cyclotella sp.* and the cryptophyte *Plagioselmios sp.* were dominant taxa in all study periods. These taxa were primarily what was observed during the managed flow pulses, except for 2016 when *Aulacoseira sp.* was a dominant taxon in the Lower Yolo Bypass at site STTD, Cache Slough Complex, and Lower Sacramento River. In 2018, the composition was very

different in the Lower Yolo Bypass, Cache Slough Complex, and Lower Sacramento River leading up to the flow pulse, as smaller celled and lower food-quality flagellates and cyanobacteria made up a much larger portion of the total phytoplankton biomass.

The water quality and water clarity conditions were similar between years and regions. The water temperature in all years were at or above 20 °C throughout the study period, an ideal temperature for phytoplankton growth. The Secchi depth as a determination of light availability had an increasing trend from north to south in the study region, with light conditions increasing in 2018. The nutrients were different between flow pulse years, with NH_4 concentrations being higher in the Cache Slough Complex and Lower Sacramento River and lower in the Upper Yolo Bypass. This lower nitrogen in the Upper Yolo Bypass may have reduced phytoplankton biomass prior to the flow pulse and the higher NH_4 concentrations in the downstream regions may have inhibited phytoplankton growth.

- V. **Task 4 (Flow):** Determine the agricultural flow pulse timing and the velocities of flow associated within the five Study Regions

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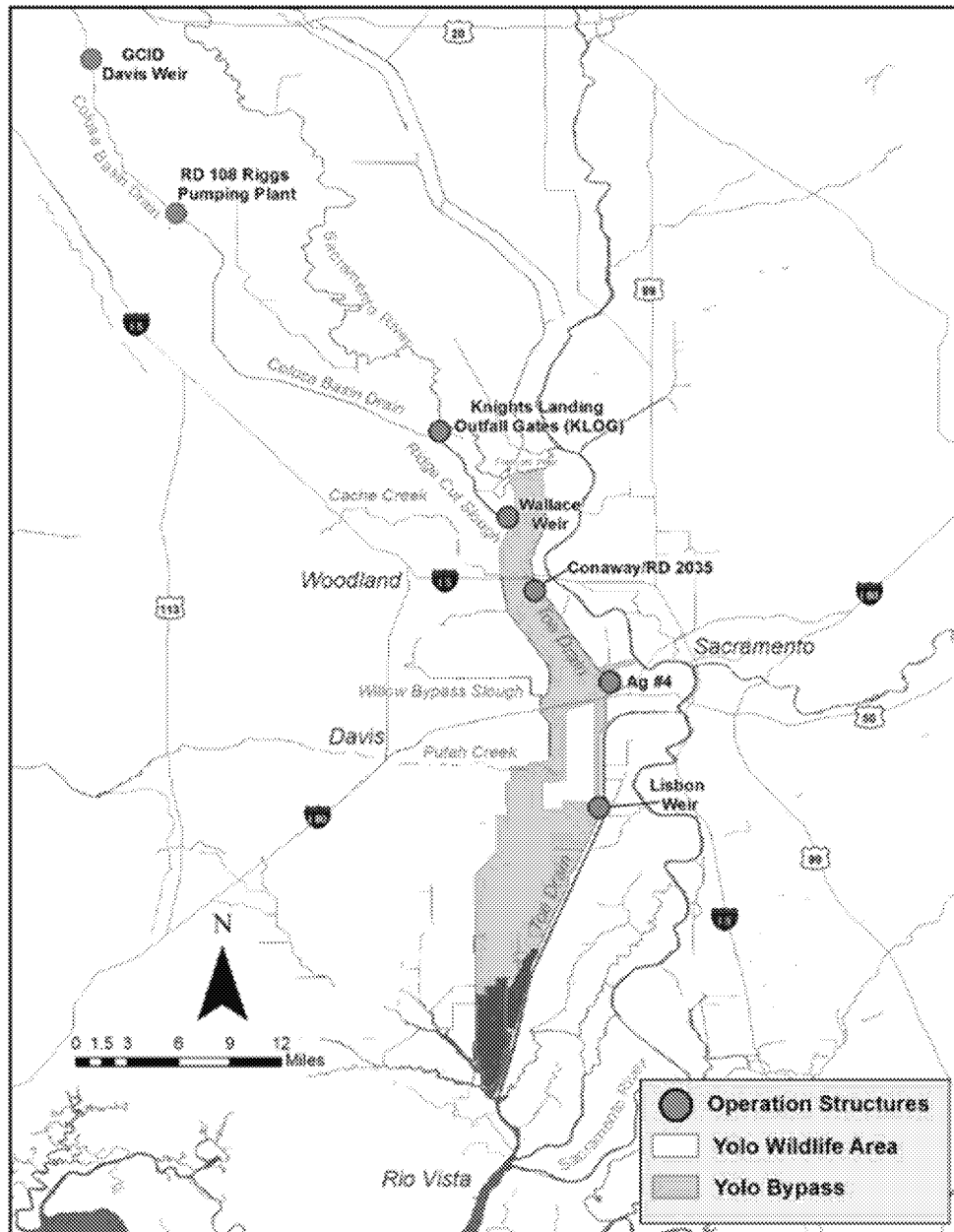
Task 4. Background:

The Yolo Bypass is the primary floodplain of the San Francisco Estuary and when fully inundated in the winter and spring it can double the wetted area of the Delta. Floodwaters from the Sacramento and Feather Rivers are conveyed through the spilling of Fremont Weir at the north and the Sacramento Weir on the north eastern side of the Bypass. In addition, there are contributing flows from four side tributaries: Ridge Cut Slough, Cache Creek, Putah Creek, and Willow Bypass Slough. During the dryer months of summer and early fall connectivity of the Bypass to the Delta is maintained through the perennial riparian channel called the Toe Drain, which flows along the east side of the leveed floodplain. During the summer and fall the floodplain of the Yolo Bypass is used heavily for agriculture and a large percentage is used for rice production. The downstream flow within the Toe Drain during this time period is maintained mostly by upstream inputs from agricultural diversion from the upper Colusa Basin Drain and those flows are controlled by elevation at the Knights Landing Outfall Gates and further downstream at Wallace Weir (Task 4 Figure 1). The Lisbon Weir, a permanent rock barrier that mutes tidal influence upstream, maintains water levels for water diversion upstream for agriculture and the Yolo Wildlife Area, during varying tidal cycles.

In the dry season of summer and fall the waters within the Yolo Bypass are confined to the Toe Drain, a perennial man-made channel that flows along the east-side of the leveed floodplain. In the late spring through the fall (late May-Oct) the Yolo Bypass is used heavily for agriculture and for waterfowl habitat management in the Yolo Wildlife Area (Task 4 Figure 1) This results in high consumptive use for local irrigation and managed wetland habitat. In most years, this causes water use to exceed outflows, causing water to move northward into the Yolo Bypass and Cache Slough Complex. This net flow becomes positive in the Toe Drain each year in late summer and early fall (late Aug.- mid Sept.) during periods of increased agricultural return water discharge from local and upstream rice-field harvest. In the fall (Oct-Nov) the Yolo Bypass Wildlife Area will begin pumping water from the Toe Drain to fill and maintain seasonal flooded wetland habitat for migratory waterfowl.

Agricultural Water Operation Structures

The Colusa Basin Drain is a man-made channel that interconnects a network of historical streams within the Colusa basin and operates as the primary irrigation canal for Northern Sacramento Valley counties and several counties within the Sacramento Metro region. The Colusa Basin Drain does not have a natural outlet to the Sacramento River, but maintains periodic connection based on operations at the Knights Landing Outfall Gates (KLOG) and through Knights Landing Ridge Cut Slough that joins the Yolo Bypass near the northern most extent of the Toe Drain (Task 4 Figure 1). Glenn Colusa Irrigation District (GCID), the largest irrigation district in the Sacramento Valley, is the primary water rights holder and conveyor of water throughout the Colusa Basin Drain and the complex network of interconnected canals and laterals. GCID operates a main pumping station that diverts from the Sacramento River near Hamilton City and maintains the Davis Weir as a downstream water control structure (Task 4 Figure 1).



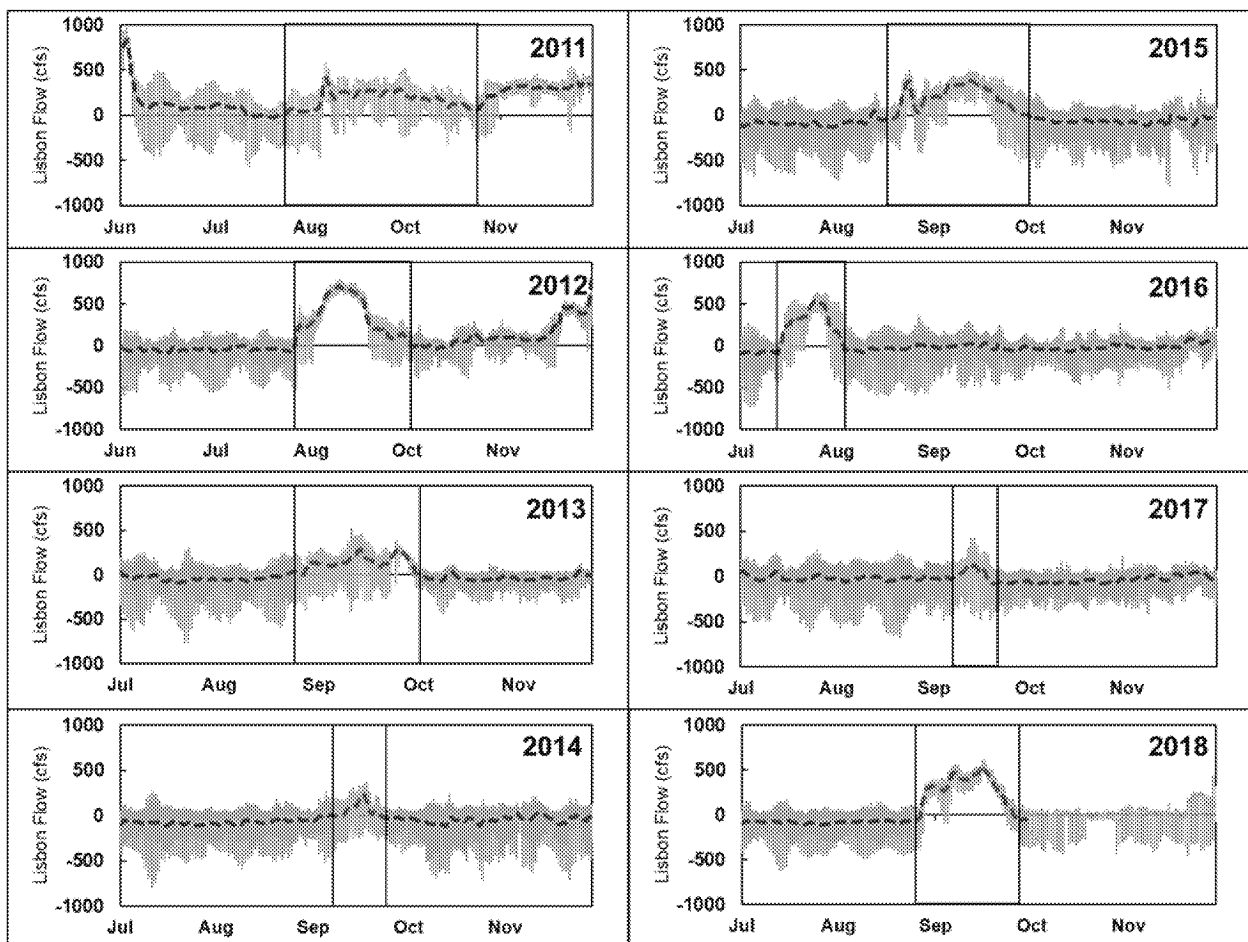
Task 4 Figure 1 Map of Yolo Bypass tributary inputs and primary operation structures

Reclamation District No. 108 (RD 108) is another water rights holder within the southern Colusa County and northern Yolo County, that pumps water into the Colusa Basin Drain from the Sacramento River through a series of river diversion pumping plants south of the city of Williams to the city of Woodland. RD 108 also operates several reuse pumping plants with the primary plant along the Colusa Basin Drain being the Ridge Ranch pumping plant (Task 4 Figure 1).

The Knights Landing Outfall Gates (KLOG) is a gate operated water control structure at the base of the Colusa Basin Drain (Task 4 Figure 1). It acts as a barrier to protect the lower Colusa Basin against backwater flooding from the Sacramento River and to control water elevations in the Colusa Basin Drain for irrigation and drainage during low flow periods. KLOG is currently operated by California Department of Water Resources (DWR) Division of Flood Management Office (DFM).

Wallace Weir was historically a mostly earthen berm with a series of manually operated slide gates to hold back water in Knights Landing Ridge Cut Slough and Colusa Basin Drain for irrigation by local farmers and Reclamation District 108 (RD 108) within the lower Colusa Basin and northern Yolo Bypass (Task 4 Figure 1). This weir structure is the primary flow control structure between Colusa Basin Drain flows and the Yolo Bypass Toe Drain during low flow periods of summer and fall. In 2016, DWR contracted with RD 108 to develop a new permanent and improved Obermeyer Weir structure as part of a larger habitat restoration and fish passage improvement project included in the 2009 NMFS BO, this would provide more year-round automated operational control and include a fish rescue facility. This structure is currently operated jointly by local landowners, RD108 and DWR.

Reclamation District 2035, Conaway Ranch and Woodland Davis Clean Water Agency operate and jointly own an intake on the Sacramento River just north of Interstate 5 (Task 4 Figure 1). This intake delivers water in separate pipelines to the cities of Woodland and Davis as well as for irrigation within the northern Yolo Bypass for Conaway Ranch farming operations. Conaway Ranch also operates a reuse pumping plant located just above I5 in the northern Toe Drain.



Task 4 Figure 2. 2011-2018 continuous 15-minute and daily average flow data (cfs) measured at Toe Drain below Lisbon Weir (LIS) from June-November

The Swanston Ranch within the central Yolo Bypass maintains a primarily earthen road crossing (Ag #4) with a manually operated central culvert and upstream slide gate (Task 4 Figure 1). This road crossing acts as both a transportation corridor and a weir to back water in the upper Toe Drain for irrigation by

local farmers in the central Yolo Bypass. This weir structure resides at the upper most extent of the tidal excursion from the lower Delta.

Lisbon Weir is the lowest weir structure within the Yolo Bypass Toe Drain and operates primarily as a tidal retention dam (Task 4 Figure 1). A series of one-way flap gates on the west side of the weir structure allow tidal flows to convey flood waters upstream but retain that water upstream to allow for upstream water users to continue pumping throughout tidal cycles. Primary water users include private landowners and largely the California Department of Fish and Wildlife managed Yolo Wildlife Area (YWA). The YWA is a 16,000-acre region of the Yolo Bypass that is managed and operated as: seasonal and perennial wetland wildlife habitat, riparian woodland, and for agriculture. The DWR operates a continuous and real-time telemetered stage, flow and water quality station below the weir that is a critical element to the monitoring and assessment of the flow action (CDEC site: LIS <http://cdec.water.ca.gov/dynamicapp/QueryF?s=lis>).

During late August and early September every year, the Northern Valley's estimated 500,000 acres of irrigated and flooded rice fields are drained for harvest. This drainage water has two fates: 1) to enter the Sacramento River at Knight's Landing through the Outfall Gates or 2) flow through Ridge Cut Slough and down into the Toe Drain of the Yolo Bypass and eventually into the North Delta. During these drainage events we see substantial increases in flow throughout the Toe Drain of the Yolo Bypass, as observed at the Lisbon Weir flow gage each September since 2005 (Task 4 Figure 2).

Preliminary evidence from the study suggests that there is a flow threshold required to move through the Toe Drain of the Yolo Bypass and CSC to facilitate a phytoplankton bloom downstream to the confluence of the Sacramento and San Joaquin rivers. The increased flow and volume of water through the Yolo Bypass in fall of 2011 and 2012 resulted in significant changes in the spatial extent of phytoplankton biomass throughout the CSC and was observed as far south as Antioch. Based on observations in 2012, flows through the Yolo Bypass were augmented due to gate repair at the Knights Landing Outfall Gates. This resulted in increasing the volume of rice field drainage flows that entered the Yolo Bypass from the Colusa Basin Drain. The fall flows that were observed at the Lisbon gauging station in 2012 were unprecedented compared to any flows measured since the gauge was installed in 2005 (Task 4 Figure 2). Based on these results, we hypothesize that a two-week fall flow pulse of at least 700 CFS during rice field drainage season (e.g. September) may be enough to generate downstream phytoplankton blooms. Since Knights Landing Outfall Gates are operable, it is possible that these flows could be achieved using adaptive management of Colusa Drain flows.

Task 4. Research Questions:

1. What are the flow velocities within each region of the conceptual model before, during and after the summer/fall flow pulses?
2. When do flows start to increase within each region of the conceptual model as a result of rice field drainage?
3. How does flow affect the flux of nutrients, phytoplankton, and other physical water quality parameters during the fall flow pulse?
4. What is the downstream fate of phytoplankton generated within the Yolo Bypass under variable annual summer/fall flows pulses (using UnTRIM Bay Delta model) in the Cache Slough Complex and lower Sacramento River?

Task 4 Methods:

Toe Drain Below Lisbon Weir ADCP Flow Data

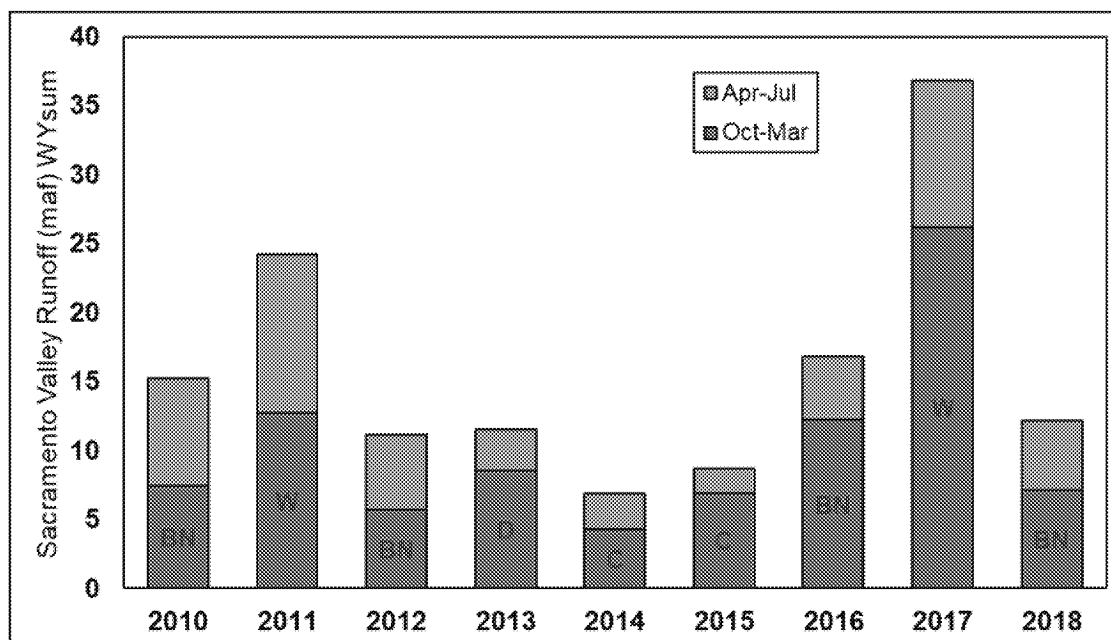
The changes in flow within the Yolo Bypass were determined using the continuous data collected at the Acoustic Doppler Current Profiler (ADCP) located at the Yolo Bypass at Lisbon (LIS) monitoring gauge. This flow data is maintained and calibrated by the DWR North Central Region Office Flow Monitoring and Special Studies Section. The flow monitoring stations within the lower reaches of the study include these additional site locations: 4.) Liberty Island at Approximately Center South End (LIB); 5.) Cache Slough at Ryer Island (RYI); 6.) Sacramento River at Rio Vista Bridge (RVB) and are operated and calibrated by USGS. USGS operates a large network of Acoustic Doppler Current Profilers throughout the Delta that monitor effects of water operations on the changing flow and sediment fluxes annually.

3-D Hydrodynamics Modeled Flow Data

Anchor QEA will perform a 3-D hydrodynamic modeling and particle tracking to gain an initial understanding of the transport and fate of phytoplankton generated within the Yolo Bypass. For this analysis, the UnTRIM Bay-Delta model developed for the San Francisco Bay and Sacramento-San Joaquin Delta will be used (MacWilliams, 2007, 2008, 2009, 2015). The UnTRIM Bay-Delta model takes advantage of the grid flexibility allowed in an unstructured mesh by gradually varying grid cell sizes, beginning with large grid cells in the Pacific Ocean and gradually transitioning to finer grid resolution in the smaller channels of the Sacramento-San Joaquin Delta. This approach offers significant advantages both in terms of numerical efficiency and accuracy and allows for local grid refinement for detailed analysis of local hydrodynamics, while still incorporating the overall hydrodynamics of the larger estuary in a single model. The model setup will include: update to model boundary conditions in Yolo Bypass for target years for the simulation 2011, 2012, 2016, 2017 and 2018, a 2- to 3-month analysis period will be used to represent baseline conditions for the mid-June to mid-August or mid-September period, depending on the year in question, release schedule for the scalar food sources from Yolo Bypass will be developed in coordination with DWR based on observed chlorophyll *a* trends at Rio Vista, and simulations will include salinity, and the food source, which will be simulated as a conservative passive scalar, but are not currently scoped to include simulation of sediment or temperature. The results from each simulation will be used to prepare time series, tabular summaries, and maps of the distribution of the food sources, such as chlorophyll, by zone within the CSC and downstream regions.

Task 4. Results and Discussion:

To determine variability in outflows between study years 2016-2018 and historical years 2011-2015 we used Toe Drain below Lisbon Weir (LIS) flow gauge continuous flow data, calculated net flow and discharge volume. Historically, the Yolo Bypass maintains net negative outflows in summer months as a result of consumptive use from primarily agriculture and the Cache Slough Complex through additional municipal exports from East Bay Aqueduct. Water Year (WY) conditions varied between both study years and historical data years summarized within this report (Task 4 Figure 3). WY's 2011 and 2017 were determined as wet years in the Sacramento Valley, 2012-2016 below normal, and 2013-15 were determined to be dry to critical. The drought that occurred over an approximate five-year period from 2012-2016 placed California into most severe drought since 1976-77 and the longest drought period since record keeping in 1895. This annual variability in precipitation and watershed inflow is a critical component in determining both the physical, chemical, and biological preceding conditions we observed within the Yolo Bypass, Cache Slough Complex, Lower Sacramento River regions and the larger downstream estuary.



Task 4 Figure 3. 2010-2018 Department of Water Resources water year hydrologic classification indices for Sacramento Valley in runoff as million-acre-feet (maf) for April-July (orange) and October-March (blue)

2016

In 2016, after three-years (2013-2015) of severe drought the Sacramento Valley observed a moderate increase in precipitation but was still classified as a below normal WY (Task 4 Figure 3). This resulted in the Yolo Bypass experiencing higher flows and an extended Fremont Weir overtop event in the spring for 16-days from Mar. 11- Mar. 26 that caused prolonged floodplain inundation.

In summer 2016, with support from the California Natural Resources Agency (CNRA) and the addition of a North Delta Flow Action (NDFA) as a Delta Smelt Resiliency Strategy, DWR executed the first managed flow action through the Yolo Bypass. Due to planned construction in Ridge Cut Slough at Wallace Weir in the fall this managed flow pulse was constrained to the summer month of July. This provided a unique opportunity to work with local landowners, irrigation and reclamation districts to generate a flow pulse by supplementing outflows with additional upstream pumping of water from the Sacramento River. Flows had to be supplemented due to the high consumptive rate in the summer for agriculture. To allow local irrigation districts and reclamation districts to have adequate water levels in the Sacramento River for pumping the DWR, CDFW, and CNRA worked with United States Bureau of Reclamation (USBR) to increase outflows from Keswick Dam at Shasta Reservoir to 10,500 CFS on July 7. This increased outflow was in support of a new 2016 proposal submitted by USBR to National Marine Fisheries Service (NMFS) as a temperature management plan for salmon that includes monthly average release flows at Keswick Dam as follows: July 10,500 CFS; August: 10,000 CFS; September: 9,000 CFS; October 6,500 CFS.

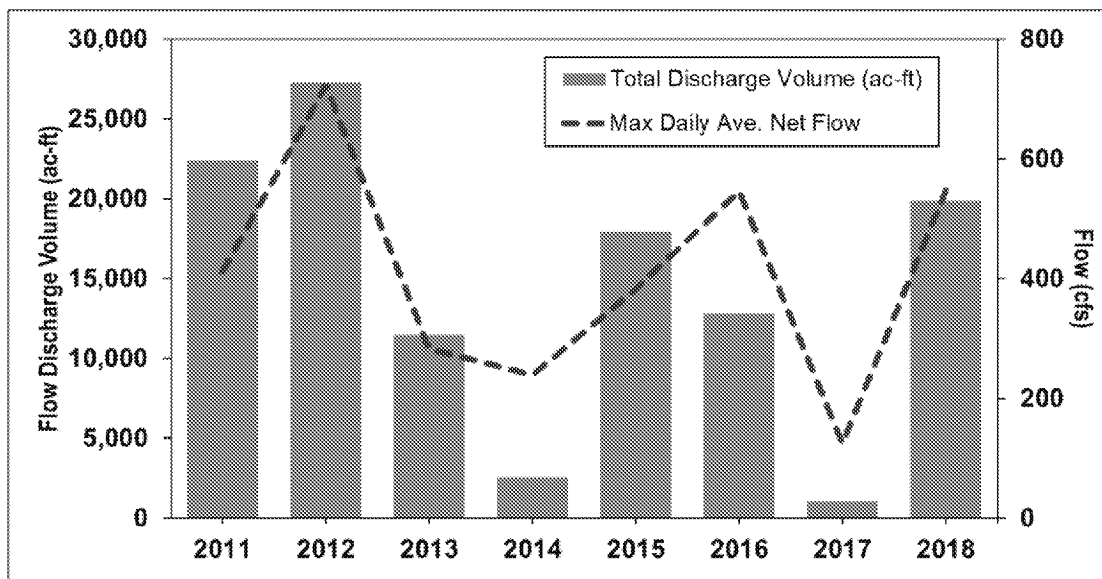
On July 11, with increased Keswick release flows into the Sacramento River the Glenn Colusa Irrigation District (GCID) started to supplement flows into the Colusa Basin Drain at no cost, pumping 200 CFS continuously from the T.C.C.A Wasteway until July 26 (Task 4 Figure 1). The total diversion rate for the flow action by GCID totaled 9,978 total acre feet (AF). Reclamation District 108 supplemented these outflows by pumping an additional 881 AF into the Colusa Basin Drain via the Riggs Pumping Plant (Task 4 Figure 1) through a resource agreement with CDFW. On July 23, Reclamation District

2035/Conaway Preservation Group (CPG) under a second resources agreement with CDFW added additional supplemental flows at the First Tule Canal Gate downstream of County Road 22 (Task 4 Figure 1). Reclamation 2035 estimated a total of 4,160 AF was diverted from July 23-Aug. 1 into the Toe Drain. This totaled 15,019 AF that was diverted to generate the managed flow pulse in 2016.

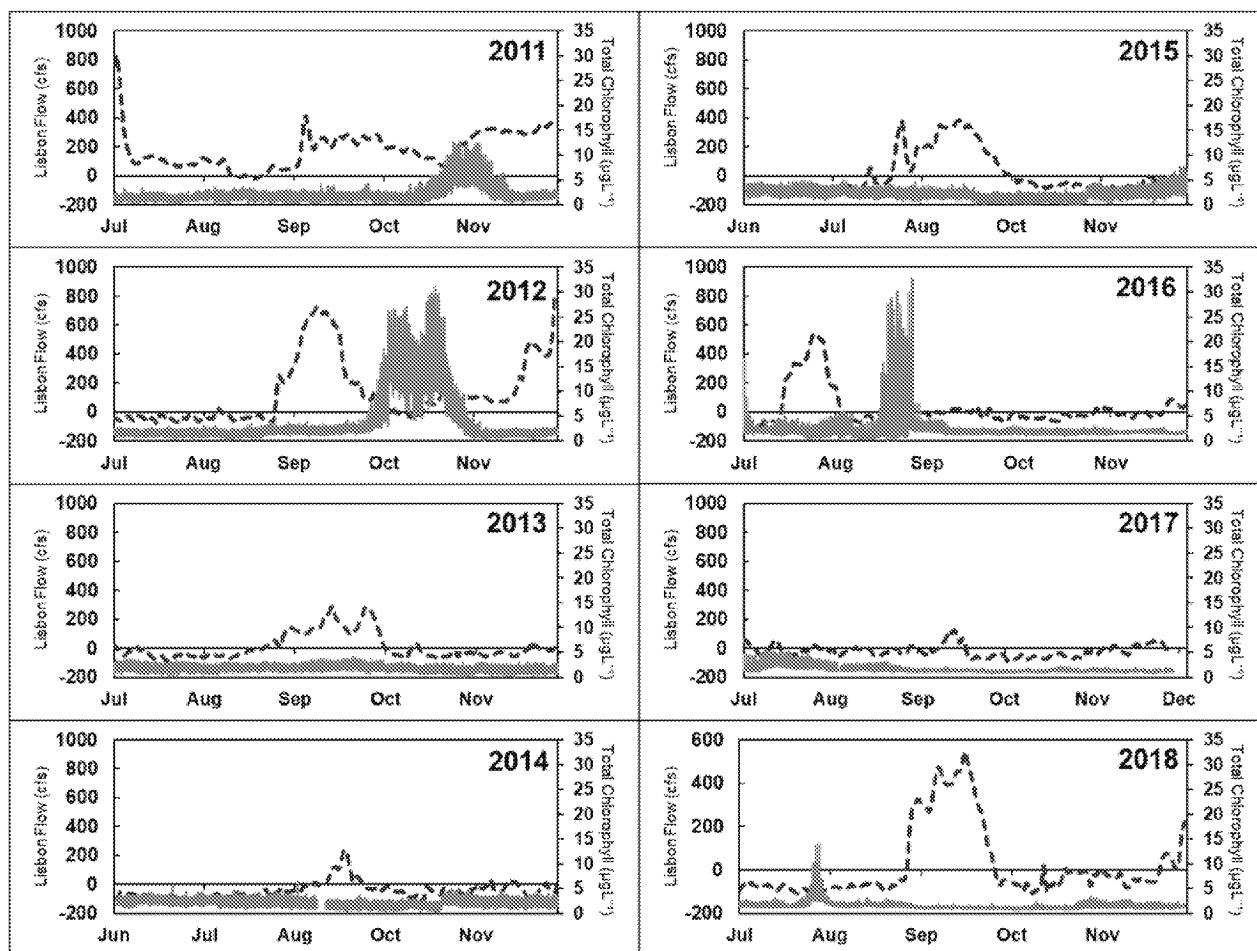
The action resulted in a substantial flow pulse (12,700 AF as measured at LIS) for over two weeks (Task 4 Question 1 and 2) from July 14 – Aug 1 (Task 4 Table 1 and Figure 4). Although flow was well below our target of 24,000AF, the action was followed by a significant increase in phytoplankton biomass (Task 4 Question 3 and 4) in the Cache Slough Complex and further downstream in the lower Sacramento River at Rio Vista (Task 4 Table 1 Figure 5). This successful action provided a template for future multi-agency action strategy and further support for continuing this action as a Delta Smelt Resiliency Strategy.

Year ^α	WY-Type ^β	Max-Daily-Ave-Net-Flow-(cfs) ^α	Total-Average-Net-Volume-(ac-ft) ^α	Total-Average-Net-Volume-(m ³) ^α	Net-Flow-Total-Days ^α	Date-Range ^α	Rio-Vista-Plankton-Response ^α
2011 ^α	W ^α	412 ^α	22,356 ^α	27,575,432 ^α	63 ^α	Aug-23--Oct-24 ^α	Yes ^α
2012 ^α	BN ^α	723 ^α	27,224 ^α	33,579,959 ^α	38 ^α	Aug-26--Oct-2 ^α	Yes ^α
2013 ^α	D ^α	283 ^α	11,437 ^α	14,107,235 ^α	42 ^α	Aug-22--Oct-2 ^α	No- ^α
2014 ^α	C ^α	239 ^α	2,503 ^α	3,087,097 ^α	15 ^α	Sep-9--Sep-23 ^α	No- ^α
2015 ^α	C ^α	383 ^α	17,909 ^α	22,090,187 ^α	42 ^α	Aug-21--Oct-1 ^α	No- ^α
2016 ^α	BN ^α	546 ^α	12,752 ^α	15,729,074 ^α	19 ^α	Jul-14--Aug-1 ^α	Yes ^α
2017 ^α	W ^α	125 ^α	1,022 ^α	1,260,724 ^α	12 ^α	Aug-29--Sep-18 ^α	No- ^α
2018 ^α	BN ^α	548 ^α	19,821 ^α	24,448,691 ^α	30 ^α	Aug-28--Sep-26 ^α	No- ^α

Task 4 Table 1. 2011-2018 max daily average flow (CFS), total average net volume (m³), net flow total days, and date range of net positive flow at Toe Drain below Lisbon Weir (LIS) flow gauge. Years with measured increase in total chlorophyll concentration after net positive flow at LIS are noted with “Yes”.



Task 4 Figure 4. 2011-2018 total discharge volume (ac-ft) and max daily average net flow (cfs) measured at Toe Drain below Lisbon Weir (LIS) flow gauge.



Task 4 Figure 5. 2011-2018 daily average net flow (cfs) at Toe Drain below Lisbon (LIS) as represented by the dashed blue line on primary y-axis. 2011-2018 total chlorophyll fluorescence ($\mu\text{g/L}$) continuous 15-minute data from Sacramento River at Rio Vista Bridge (RVB) as represented by the green line on the secondary y-axis.

2017

In 2017, after three-years (2013-2015) of severe drought and below normal WY 2016, the Sacramento Valley observed its second highest runoff year on record since 1983 (Task 4 Figure 3). This resulted in the Yolo Bypass experiencing prolonged high flows and multiple extended Fremont Weir overtop events during the months of December – early May. The four extended periods of Fremont Weir overtop included: 5-days from December 17-21, 61-days from January 9-March 10, 23-days from March 19-31, and 25-days from April 9-May 3.

In 2017, there was no managed flow pulse executed for DSRs NDFA. This was mainly contributed to the need to complete the final construction of the new Wallace Weir and associated Fish Collection Facility to meet project timelines (ICF International, 2016). The construction that started the prior year on August 18, 2016 once again started construction in July 2017 during the lower flow conditions in the Yolo Bypass. This construction requires the entire dewatering of the area in and around the weir structure, so flows were drastically decreased in Ridge Cut Slough and downstream Yolo Bypass Toe Drain (Task 4 Figure 1). Ridge Cut Slough flows were rerouted around the Wallace Weir structure through the Knaggs Ranch property irrigation canals, but the flows were still greatly reduced. In wet years (e.g. 2011), we

typically see higher and net positive flows on into the early summer months (Task 4 Figure 2) from east side tributaries, but this construction likely restricted that late outflow as Ridge Cut Slough is one of the primary west-side tributaries that provide perennial water supply to the Yolo Bypass Toe Drain.

Although outflows in the Yolo Bypass Toe Drain were highly modified in 2017, there was still a typical net positive outflow in early fall (Task 4 Question 1 and 2). This positive outflow coincided with local rice field harvest by growers within the confines of the Yolo Bypass. The unmanaged flow pulse lasted 10-days from September 9-18 and reached a daily net positive outflow of 125 CFS at the LIS flow gauge on September 14 (Task 4 Figure 2, 4 and Table 1). The 2017 total discharge volume (1,022 AF) within the Toe Drain during the summer and fall was lower than the drought year 2014, and as expected no increase in phytoplankton biomass (Task 4 Question 3 and 4) was observed in the lower Sacramento River at Rio Vista (Task 4 Table 1).

2018

In 2018, the Sacramento Valley observed a below normal WY, after its second highest runoff year on record in 2017 (Task 4 Figure 3). This resulted in the Yolo Bypass experiencing lower flows throughout the winter and spring. There was only one short period of Fremont Weir overtop of 4-days from April 8-11. Due to the dryer floodplain conditions this allowed local farmers within the Yolo Bypass to increase rice field planting and holdover water levels in state and federal water project reservoirs from 2017 allowed for ample water supply for northern Sacramento Valley rice farmers.

In fall 2018, with support from the CNRA, CDFW, USBR, local landowners, irrigation and reclamation districts, we executed the second managed DSRS NDFA through the Yolo Bypass. This was our first opportunity to try and replicate a managed fall flow pulse like the one observed in 2012. The flow targets for this action were for 20,000 AF and a max daily net flow of 700 CFS over a 4-week period. This flow pulse relied exclusively on rerouting fall rice harvest discharge water in the Colusa Basin Drain into Ridge Cut Slough and downstream into the Yolo Bypass Toe Drain through Wallace Weir. As in previous years, the Yolo Bypass observed net negative outflows in the 2018 summer months leading up to the flow pulse (Task 4 Figure 2). On August 23, the Glenn Colusa Irrigation District (GCID) reported substantial increases in flows ($>1,200$ CFS) at Davis Weir (Task 4 Figure 1) as northern Colusa Basin Drain water users started to drain their fields for rice-field harvest. This triggered the reoperation by DWR of the Knights Landing Outfall Gates (KLOG) on August 26 raising the elevation from 25.5 ft. to 26.5 ft., causing more Colusa Basin Drain water to reroute into Ridge Cut Slough and through Wallace Weir into the Yolo Bypass Toe Drain. On August 28, daily net positive flows were recorded at LIS flow gauge at 162 CFS and daily net flows continued to rise over the next 3-days to 325 CFS (Task 4 Question 1 and 2). These initial flows coincided with a peak in total chlorophyll fluorescence data recorded at LIS of $19 \mu\text{gL}^{-1}$ on August 29, as phytoplankton biomass (Task 4 Question 3 and 4) from the upper Yolo Bypass was advected downstream.

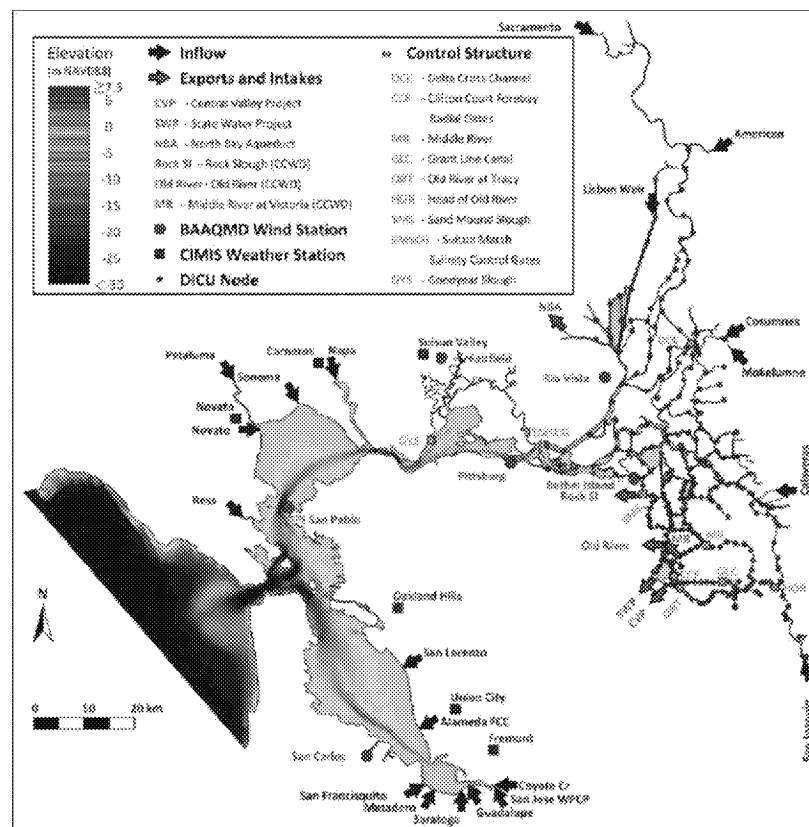
In 2018, as we observed the daily flow conditions over several days at LIS, we realized that the current operations of KLOG and the newly designed Wallace Weir were not resulting in our target net positive flow of 700 CFS. The daily net flows were only reaching near or below 300 CFS (Task 4 Figure 2). We talked with both local landowners and reclamation districts and they agreed that we should raise the KLOG elevation another .5 ft. to 27 ft. to try and increase the positive outflow in the Toe Drain. On September 4, DWR raised KLOG to 27 ft. and maintained that elevation throughout the remaining 24-days of the flow pulse. This reoperation resulted in daily net positive outflows averaging near 400 CFS and we reached a max daily net positive outflow of 548 CFS on September 16 (Task 4 Figure 2, 3 and Table 1). The net positive flows lasted 29-days from August 28-September 26. The total flow discharge in

2018 was 19,821 AF (Task 4 Question 1 and 2) and was the highest flow discharge since the 2012 flow pulse. Despite the high discharge flow volume, we did not observe an increase in phytoplankton biomass (Task 4 Question 3 and 4) in the lower Sacramento River near Rio Vista (Task 4 Figure 4).

3-D Hydrodynamics Modeled Flow Data

Introduction:

The goal of this project task was to evaluate how hydrodynamics influence the fate of water originating in the Cache Slough Complex (CSC) and water originating from the flow pulses by tracking the water through the CSC and further downstream and by examining similarities and differences in the hydrodynamics between years. This report documents the 3-D hydrodynamic model simulations conducted for DWR to examine the transport of water in the CSC and downstream in 5 years with varying flow pulse magnitudes and durations: 2011, 2012, 2016, 2017 and 2018. This study applied a 3-D hydrodynamic, salinity, and water temperature model to evaluate differences in the movement of water masses through the system during each of the 5 years analyzed. The hydrodynamics in each of the 5 years are described individually and then similarities and differences between the years are presented. A simulation of 2016 with the flow pulse removed from the freshwater inflow was used to directly evaluate the effects of the flow pulse in 2016 on hydrodynamics. The predicted hydrodynamics for each of the 5 years was compared to observed chlorophyll *a* concentration to explore potential relationships between hydrodynamics and chlorophyll *a* concentration in the vicinity of the CSC.



Task 4. Figure 6. High-resolution UnTRIM San Francisco Bay-Delta model domain, bathymetry, and locations of model boundary conditions which include inflows, export facilities, Contra Costa Water District (CCWD) intakes, wind stations from the Bay Area Air Quality Management District (BAAQMD) evaporation and precipitation from California Irrigation Management Information Systems (CIMIS) weather stations, Delta Island Consumptive Use (DICU), and flow control structures

Methods:

UnTRIM Bay-Delta Model Overview

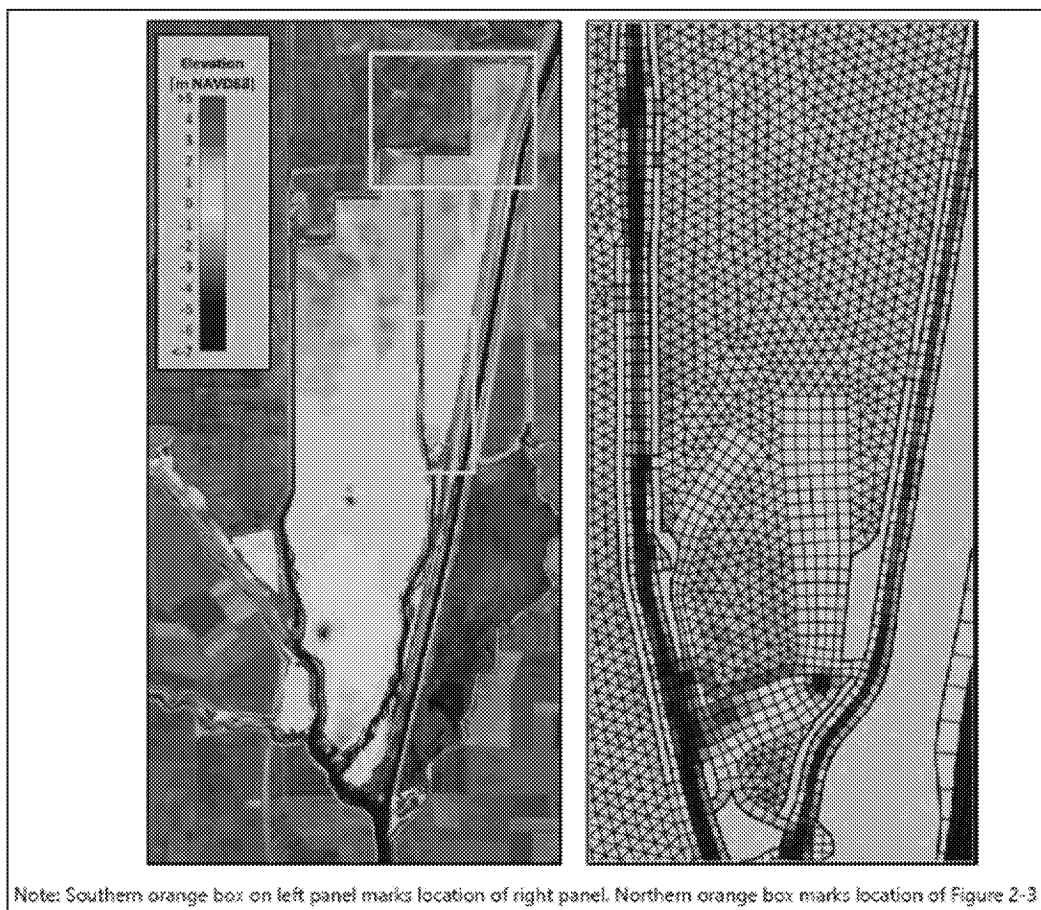
All the modeled high resolution 3-D hydrodynamics data for this task utilized the UnTRIM San Francisco Bay-Delta model (UnTRIM Bay-Delta model), which has been developed using the UnTRIM hydrodynamic model (MacWilliams et al. 2007, 2008, 2009, 2015). The UnTRIM Bay-Delta model extends from the Pacific Ocean through the entire Delta and takes advantage of the grid flexibility allowed in an unstructured mesh by gradually varying grid cell sizes, beginning with large grid cells in the Pacific Ocean and gradually transitioning to finer grid resolution in the smaller channels of the Delta. This approach offers significant advantages in terms of numerical efficiency and accuracy, and allows for local grid refinement for detailed analysis of local hydrodynamics, while still incorporating the overall hydrodynamics of the larger estuary in a single model. This task included the additional modeling of CSC and contains more than 180,000 horizontal grid cells and more than 1.4 million 3-D grid cells (Task 4 Figure 6).

The UnTRIM Bay-Delta model has previously been applied to evaluate potential effects of summer reoperation of the Suisun Marsh Salinity Control Gates (SMSCG) to better understand how summer operation of the SMSCG would affect salinity in Suisun Marsh and Suisun Bay during both above normal and below normal water years (Anchor QEA 2018a, 2019). The UnTRIM Bay-Delta model has also been applied to San Francisco Bay and the Delta as part of the Delta Risk Management Strategy (MacWilliams and Gross 2007), several studies to evaluate the mechanisms behind the Pelagic Organism Decline (e.g., MacWilliams et al. 2008), the Bay Delta Conservation Plan (MacWilliams and Gross 2010), and for examining X2 and the Low Salinity Zone (MacWilliams et al. 2015). The UnTRIM Bay-Delta model has also been applied for a range of studies by the U.S. Army Corps of Engineers (USACE), including the Hamilton Wetlands Restoration Project (MacWilliams and Cheng 2007), the Sacramento River Deep Water Ship Channel Deepening Study (MacWilliams et al. 2009), the San Francisco Bay to Stockton Navigation Project Deepening Study (MacWilliams et al. 2014), and the South San Francisco Bay Shoreline Study (MacWilliams et al. 2012).

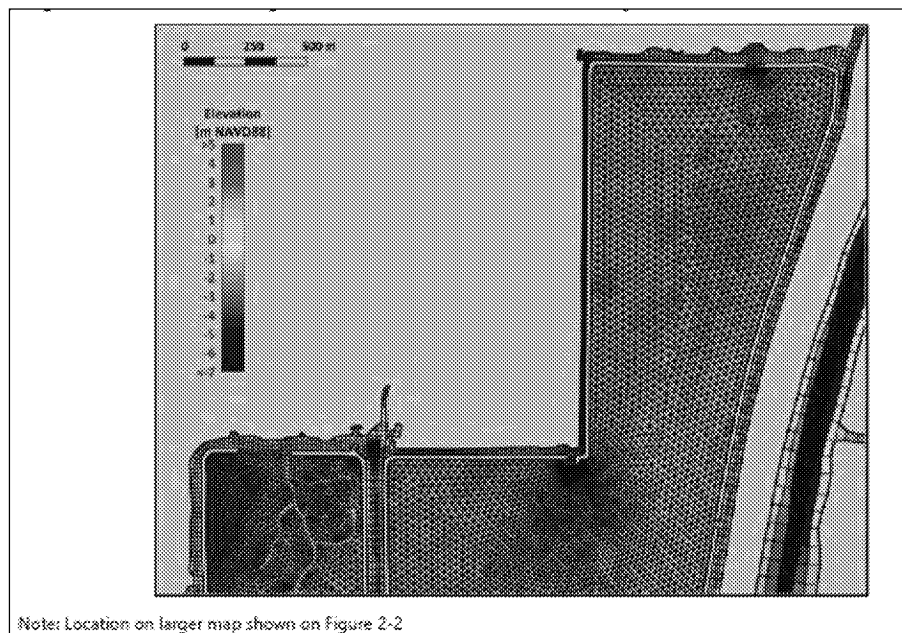
The UnTRIM Bay-Delta model has been calibrated using water level, flow, salinity, and water temperature data collected in San Francisco Bay and the Delta in numerous previous studies (e.g., MacWilliams et al. 2008, 2009; MacWilliams and Gross 2010; MacWilliams et al. 2015; MacWilliams et al. 2016; Anchor QEA 2018b). The model has been shown to accurately predict salinity, water temperature, tidal flows, and water levels throughout the San Francisco Bay and Delta under a wide range of conditions.

High Resolution Cache Slough Complex Model Grid

For this study task, the UnTRIM Bay-Delta Model grid was refined in the CSC to resolve the relevant bathymetric features necessary for the correct routing of water from Lisbon Weir through Liberty Island during low flow conditions (no overflow of Fremont Weir). This higher-resolution area extends from the Toe Drain at Lisbon Weir through the southern portion of Liberty Island and is used for this study in place of the standard grid which resolves the entire Yolo Bypass from Fremont Weir south at a lower resolution. The high-resolution CSC grid resolves levee breaches between Liberty Island and Little Holland Tract (Task 4 Figure 7) and the stair-step channels and the connection to the Toe Drain (Task 4 Figure 8). High resolution bathymetry for the Toe Drain was provided by DWR. Bathymetry for the CSC, including Liberty Island, Little Holland Tract, and the deeper channels, was derived from Wang and Ateljevich (2012) and supplemented with more recent data where available.



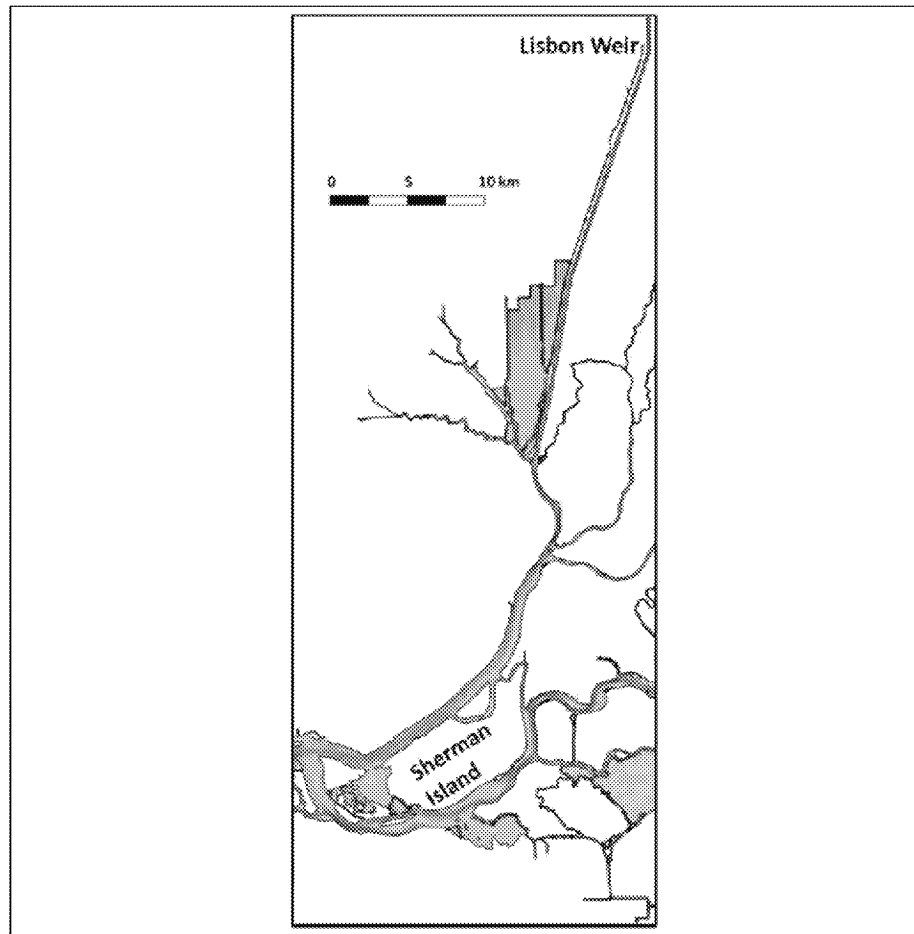
Task 4 Figure 7. UnTRIM San Francisco Bay-Delta high-resolution model grid in the vicinity of the Cache Slough Complex



Task 4 Figure 8. UnTRIM San Francisco Bay-Delta high-resolution model grid at the northern end of Liberty Island and Little Holland Tract

Model Simulation Periods, Scenarios, and Analyses

This study focuses on the Yolo Bypass and North Delta, extending from Lisbon Weir south through the CSC to the Sacramento River near Sherman Island (Task 4 Figure 9). Hydrodynamic model simulations were conducted for the low-flow summer period around flow pulses for 5 different years: 2011, 2012, 2016, 2017 and 2018. The wet water years of 2011 and 2017 generally had higher Delta outflow and X2 than the below normal water years 2012, 2016 and 2018 (Task 4 Figure 10). Model simulations included at least 1.5 months of spin up and then simulated 3 months around the flow pulse in each year.



Task 4 Figure 9. UnTRIM San Francisco Bay-Delta model region extent for the study task

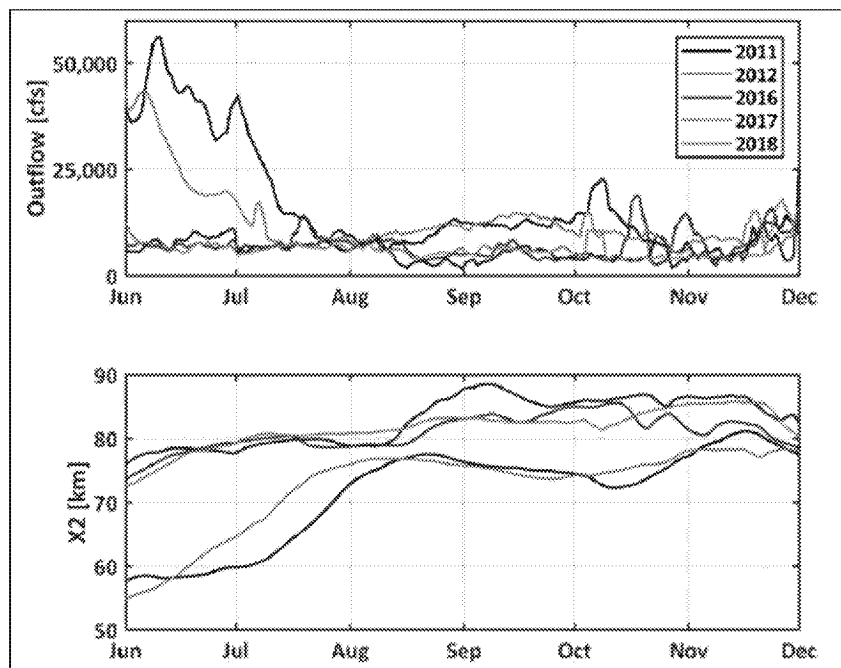
Five model simulations were used to examine the hydrodynamics around the CSC before, during, and after the flow pulses in the 5 years of interest (2011, 2012, 2016, 2017, and 2018). The five simulations represented hindcasts of historical conditions (Task 4 Table 2).

Freshwater inflow to the study area was based on the observed water flow past Lisbon Weir. Although flow pulse water has generally come through the Colusa Basin Drain and traveled down the Tule Canal north of the study area, not all this water reaches the Toe Drain due to diversions along the Tule Canal. In the model, the observed flow at Lisbon Weir was used to specify the inflow of water for the Toe Drain to eliminate assumptions that would have been necessary had the model boundary been specified at Wallace Weir. First, the water flow past Lisbon Weir is less than the water flow at Wallace Weir due to diversions within the Yolo Bypass. The exact timing and magnitude of

these diversions are not known. As a result, the observed flow at Lisbon Weir provides a better estimate of the timing and amount of flow pulse water reaching the CSC. Second, there is a gap in the flow data at Ridge Cut Slough during the 2016 flow pulse.

Year	Analysis Date Range	Flow Pulse Date Range	Flow Pulse Magnitude (TAF)	
			Relative to Zero Daily-Average Flow	Relative to No Flow Pulse
2011	August 15 to November 15	September 2 to October 23	NA	16.6
2012	August 15 to November 15	August 26 to October 10	27.4	31.4
2016	July 1 to October 1	July 14 to August 3	12.8	15.8
2017	August 15 to November 15	September 8 to September 19	1.4	2.6
2018	August 15 to November 15	August 27 to September 27	19.5	23.6

Task 4 Table 2. Flow pulse timing and magnitudes based on Lisbon Weir flow gauge data. Note: In 2011, the daily average flow was always positive; therefore, the flow pulse magnitude cannot be calculated relative to zero flow. The flow pulse magnitude relative to no flow was calculated by linearly interpolating from the start to the end of the flow pulse and determining the volume of water in excess of that linearly interpolated flow.



Task 4 Figure 10 Time series of outflow and X2 for 2011, 2012, 2016, 2017, and 2018 from Dayflow

The 15-minute water flow data at Lisbon Weir was averaged daily to provide the freshwater discharge boundary to the model (Task 4 Figure 2). However, due to water use upstream (north) of Lisbon Weir, the flow is not always positive (toward the south), that is, net flows past the Toe Drain are often toward the north during periods of low flow (Task 4 Figure 2). When the flow is negative at Lisbon Weir, the model boundary acts as a sink of water, resulting in a net outflow through the Toe Drain toward the north, as observed.

The value of the flow pulse was estimated in each year based on the observe flow at Lisbon Weir. The

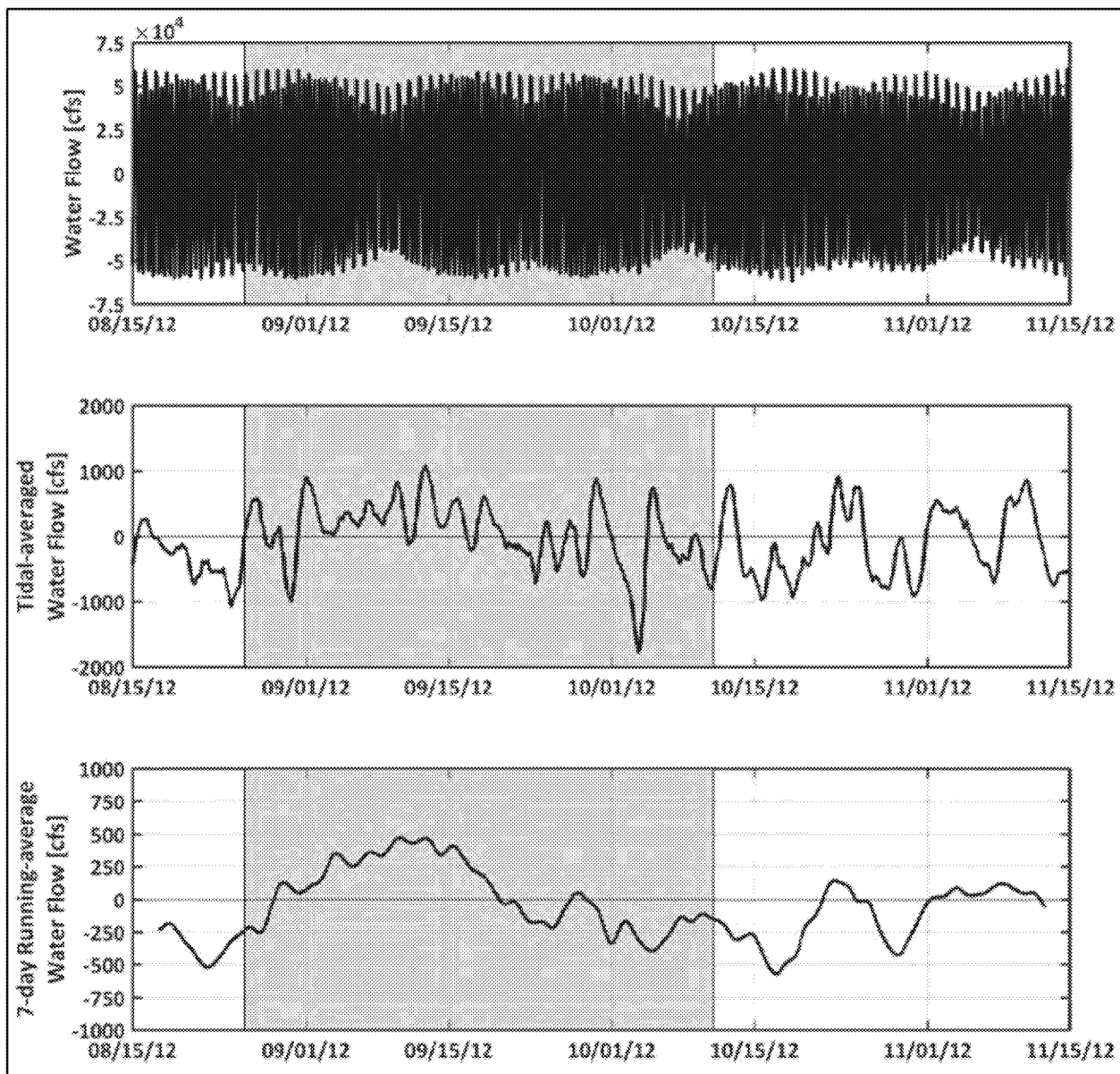
flow pulse in 2012 was the largest volume, while the flow pulse in 2017 was much smaller than the other years (Task 4 Figure 2). The flow pulse in 2011 had a lower peak flow rate than the other years with substantial flow pulses (excluding 2017) but was the longest duration flow pulse (Task 4 Table 2 and Figure 2). The estimated volumes of the flow pulse are influenced by assumptions on when the flow pulse starts and ends and where the data for calculating the flow pulse magnitude was collected. Changing the assumed start and end dates of the flow pulses will either increase or decrease the estimated volume of the flow pulse. Because these flow pulse volumes were calculated using observed flows at Lisbon Weir, they may differ from estimates of the flow pulse based on observed flows at either Ridge Cut Slough or Wallace Weir. Because the above assumptions affect the estimated flow pulse volume, the volumes in Task 4 Table 2 are intended to provide a relative comparison of the flows reaching the CSC between the 5 years simulated but are not necessarily representative of the water volume diverted further upstream.

Salinity and temperature of the model inflow was set using observed data at Lisbon Weir. For each of the 5 years, temperature was set to the daily average of the observed data, to match the daily averaged water discharge. For 2016, 2017 and 2018, salinity was set to the daily average of the observed data. Observed salinity data at Lisbon Weir were not available for 2011 and 2012. Salinity for 2011 and 2012 were set to the average value over the complete data record. The North Bay Aqueduct was also included as a water intake in the study area (Task 4 Figure 6). The intake rate for the North Bay Aqueduct was set based on daily values reported by DWR modeled DAYFLOW. The intake rate at the North Bay Aqueduct varied over the duration of the flow pulses, with the average intake rates between 86 and 106 cubic feet per second (CFS; Task 4 Table 3).

Year	Average Intake Rate (cfs)	Total Intake Volume (TAF)
2011	87	9.0
2012	106	9.6
2016	86	3.6
2017	100	2.4
2018	90	5.7

Task 4 Table 3. North Bay Aqueduct Intake during the annual flow pulse periods

Water flow in the study area varies on tidal, weekly, and longer time scales. The net flow of water over given time intervals can be calculated by time-averaging the instantaneous flow to determine the net transport of water through the study area. Within the study area, tidal flows are generally larger in magnitude than time-averaged flows. Task 4 Figure 11 shows the predicted water flow between the CSC and Cache Slough near Ryer Island during the 2012 analysis period. The instantaneous water flow (top panel) varies from about -50,000 to 50,000 CFS, with positive values indicating flow toward the south out of the CSC. Because the tidal flows are so large, it is impossible to visualize any effect of the flow pulse on this instantaneous flow. After tidal averaging, the flow varies from about -2000 to 1000 CFS and daily to weekly variation in the net flow is evident, but the effect of the flow pulse is not obvious (Task 4 Figure 11, middle panel). Applying a 7-day running average to the flow smooths much of the shorter duration variability in the flow and results in a flow time series that highlights longer than 7-day variations on the net flow (Task 4 Figure 11, bottom panel). These 7-day running-average flows are useful for visualizing net flows through time and estimating the effect of the flow pulse on net water flow.



Task 4 Figure 11. UnTRIM San Francisco Bay-Delta model predicted water flow south out of the Cache Slough Complex during the 2012 analysis period

Longer-duration averages were also used to understand the net transport of water through the study area in relation to the timing of the flow pulse. The 3-month analysis period for each simulation (Task 4 Table 4) was split into three periods for calculating the time-averaged water flows. These three periods represent before, during, and after each of the flow pulses and allow for an examination of net flow magnitude and direction during different portions of the simulations. Each of the three time periods were set to start and end when the predicted water level at the Liberty Island continuous monitoring time series location was at mean water level approaching the higher-high water level (Task 4 Table 4). Setting the start and end times based on a consistent water level ensures the net flows over a given time are most accurately estimated and minimally affected by tidal phase. However, some uncertainty in the magnitudes of the net flows can still be introduced when setting finite

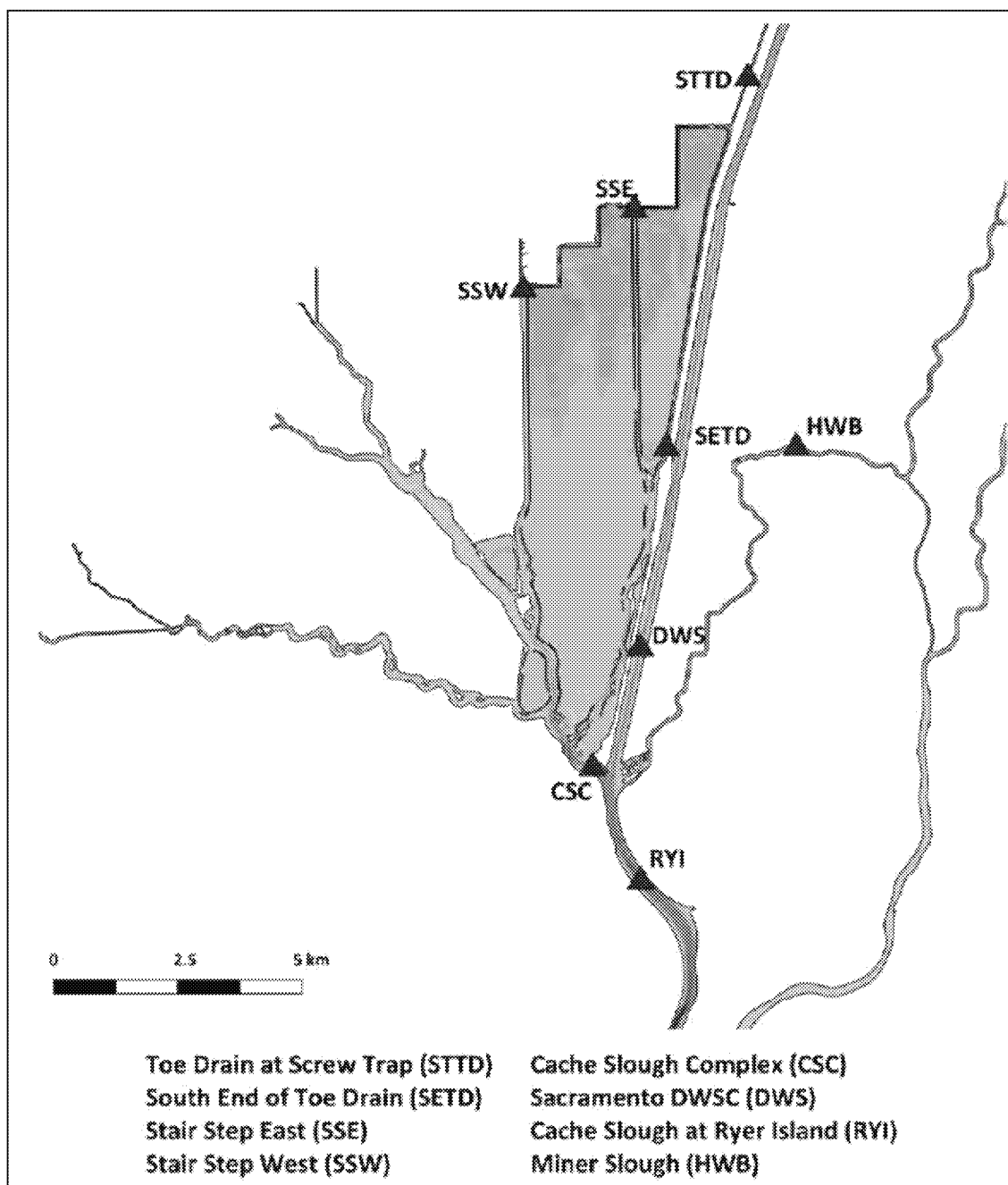
averaging periods, especially at cross sections with large tidal times-scale flows and small net flows. This uncertainty should be considered when making inferences on small net flows near zero cross sections with large tidal flows.

Year	Date Range		
	Before Flow Pulse	During Flow Pulse	After Flow Pulse
2011	August 15 01:42 to September 2 16:03	September 2 16:03 to October 23 11:18	October 23 11:18 to November 15 15:21
2012	August 15 22:45 to August 26 19:45	August 26 19:45 to October 10 21:15	October 10 21:15 to November 15 13:12
2016	July 1 21:36 to July 14 20:39	July 14 20:39 to August 3 00:03	August 3 00:03 to October 1 14:18
2017	August 15 18:09 to September 8 15:03	September 8 15:03 to September 20 01:09	September 20 01:09 to November 15 11:45
2018	August 15 17:06 to August 27 00:54	August 27 00:54 to September 27 14:51	September 27 14:51 to November 15 09:03

Task 4 Table 4. Date ranges for the time-averaged flow at cross sections

The net flows were calculated at eight cross sections that together provide an understanding of water flow through the Toe Drain, the stair steps, out of the CSC and southward through Cache Slough (Task 4 Figure 12). Net water intake at the North Bay Aqueduct during each of the three periods were also calculated. The net flows are shown on maps using block arrows to visualize the directions and magnitudes. The length of the arrows scale with the magnitude of the net flows. Three different colored arrows are used, because the magnitudes of the net flows vary widely. Dark blue arrows represent a net flow 10 times as large as a light blue arrow of the same length. Orange arrows represent a net flow 50 times as large as a light blue arrow of the same length and five times as large as a dark blue arrow of the same length.

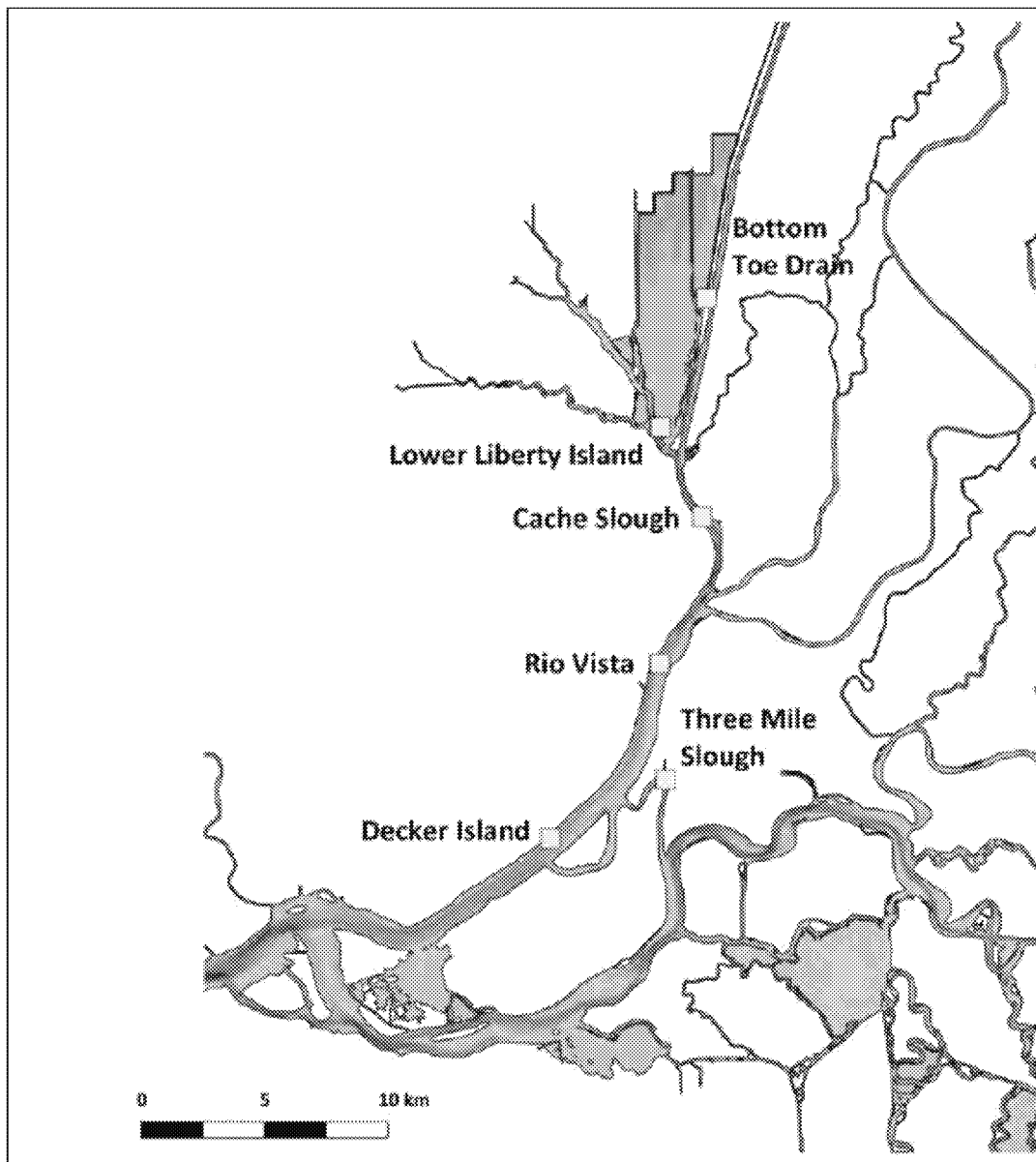
Calculating water age is a technique used to determine the average amount of time it has taken a parcel of water to reach a given location from a given starting point (Karna and Baptista 2016; Shen and Wang 2007). Water age is like residence time, except that while water age provides the average amount of time it has taken to reach a given location, residence time is the amount of time it will take a parcel of water to reach a future location. In this study, water age was used to determine the average amount of time it has taken flow pulse water to reach a given location as a metric for how long it takes water that passed Lisbon Weir to reach various locations in the study region.



Task 4 Figure 12. Map of UnTRIM San Francisco Bay-Delta modeled time-average flow cross section locations

Water age was used to determine the average amount of time it took flow pulse water to reach any given location at any time following the start of the flow pulse. Water from the flow pulse is given an age of zero when it enters the model domain at the northern boundary of the Toe Drain. Only the water that enters the domain during the time period of the flow pulses (Task 4 Table 2) was used to calculate the age of the flow pulse water, that is, any water that entered before or after the flow pulse was not included in the water age calculation. Water age was analyzed both as maps at discrete times and as time series at discrete locations. Time series of water age were analyzed at six discrete locations to investigate how the age of the flow pulse water varies at different locations

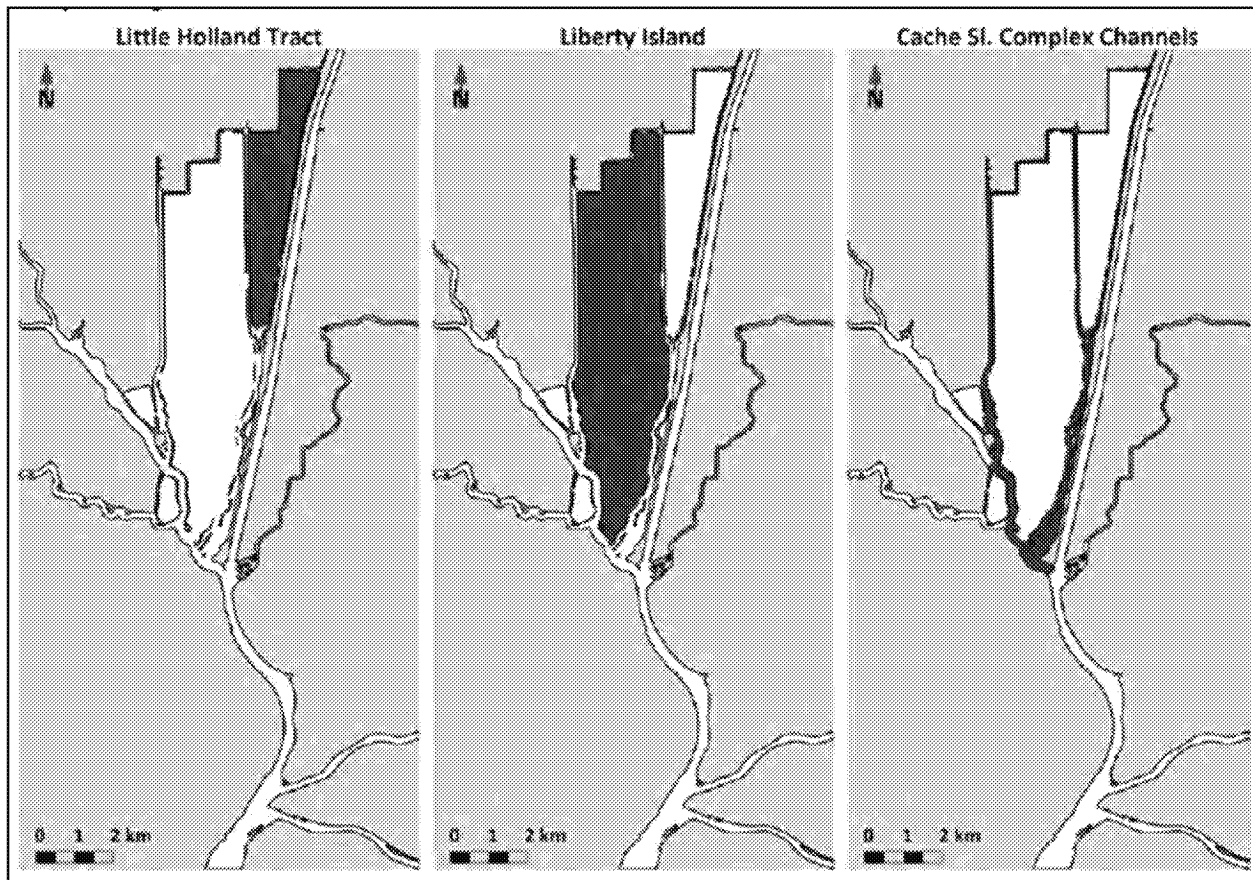
during and after the flow pulse (Task 4 Figure 13).



Task 4 Figure 13. Map of discrete locations where water age and tracers were analyzed as time series

A conservative tracer, like a dye, was used to track the flow pulse water and determine the percentage of the water that originated from the flow pulse at any given location and any given time. Only incoming water during the flow pulse was tagged with the tracer, the same as water age. The flow pulse water tracer was also analyzed both as maps at discrete times and as time series at six discrete locations (Task 4 Figure 13). The analysis of the tracer is shown as the percent of the flow pulse water that makes up the total water mass at a given location. The percent is shown on a log base 10 scale because the percent varies widely dependent on location and time in relation to the flow pulse. A lower limit of 0.01% was used in analyses, with water percent less than 0.01% assumed to be negligible. This 0.01% threshold was used to determine when flow pulse water reached a given location.

Four additional tracers were used to track other water masses during and following the flow pulse. From the start of the flow pulse to the end of the simulation, water flowing down Miner Slough toward Cache Slough was continuously tagged with a tracer. This allows for the determination of the percentage of the water at any location and time after the start of the flow pulse that is Sacramento River water origin that travelled down Miner Slough toward the CSC. Three tracers were used to tag water in Little Holland Tract, Liberty Island, and the deeper channels in the CSC (including the Toe Drain) (Task 4 Figure 14). The water in each of these three regions was tagged with a different tracer on the first day of the flow pulse when the predicted water level at the Liberty Island continuous monitoring time series location was at mean water level approaching the higher-high water level. Initializing the tracers at a consistent water level ensures similar volumes of water were tagged with a tracer in each year and provides for the best comparison of the transport of the water from these different regions between the 5 years simulated.



Task 4 Figure 14. Map of Little Holland Tract, Liberty Island, and Cache Slough Complex regions used for tracer initialization

The combination of the five tracers (flow pulse, Miner Slough and three CSC tracers) allows for a determination of where the water around the CSC originated from and for the tracking of these different water masses throughout the study area during and after the flow pulse. These tracers were also analyzed both as maps at discrete times and as time series at six discrete locations (Task 4 Figure 13). The analysis of the tracers is shown as the percent of the initial water tagged with the tracer that makes up the total water mass at a given location. The percent is shown on a log base 10 scale because the percent varies widely dependent on location and time in relation to the flow pulse. A

lower limit of 0.01% was used in analyses, with water percent less than 0.01% assumed to be negligible.

2016

Net water flow past Lisbon Weir was northward before the 2016 flow pulse but switched to southward during the flow pulse (Task 4 Figure 3). As the flow pulse trailed down the daily-averaged flow past Lisbon Weir neared zero and switched to northward (Task 4 Question 1 and 2). Then the daily-averaged flow increased to near zero for about two-thirds of the period after the flow pulse. This results in the flow at the Toe Drain at Screw Trap, just north of Little Holland Tract, being toward the north before the flow pulse, switching to toward the south during the flow pulse and returning to northward after the flow pulse (Task 4 Table 5; Figure 15). The net flow between the CSC and Cache Slough near Ryer Island was northward (Task 4 Question 1 and 2) into the CSC when averaged over the periods before, during, and after the flow pulse (Task 4 Table 4). The predicted net flow into the CSC during the flow pulse results from the magnitude of the flow pulse not being large enough to exceed the intakes and diversions to produce a net flow out of the CSC (Task 4 Question 1 and 2), when averaged over the entire duration of the 2016 flow pulse. However, there are short periods of predicted tidal-averaged flow out of the CSC and a short period of 7-day running-averaged net flow out of the CSC during the flow pulse (Task 4 Figure 16). The net flow in Cache Slough by Ryer Island, to the south of the CSC, is consistently directed toward the south and is much larger magnitude than flows in the CSC (Task 4 Table 7; Figure 16). This relatively large net flow through Cache Slough results from the flow of Sacramento River water down Miner Slough and down Cache Slough to the confluence of Cache Slough and the Sacramento River (Task 4 Table 8).

Year	Time-averaged Predicted Water Flow Rate (cfs)		
	Before Flow Pulse	During Flow Pulse	After Flow Pulse
2011	53	210	250
2012	-30	302	71
2016	-67	334	-20
2017	-16	54	-47
2018	-57	310	-44

Task 4 Table 5 Time-averaged predicted water flow rate south through the Toe Drain at Screw Trap

Year	Time-averaged Predicted Water Flow Rate (cfs)		
	Before Flow Pulse	During Flow Pulse	After Flow Pulse
2011	-321	-205	84
2012	-350	30	-131
2016	-535	-110	-263
2017	-319	-191	-214
2018	-518	-9	-221

Task 4 Table 6. Time-averaged predicted water flow rate south from the Cache Slough Complex

Year	Time-averaged Predicted Water Flow Rate (cfs)		
	Before Flow Pulse	During Flow Pulse	After Flow Pulse
2011	1728	2125	1329
2012	1290	1554	810
2016	1366	1930	1688
2017	2117	2476	1527
2018	1329	1811	823

Task 4 Table 7. Time-averaged predicted water flow rate south through Cache Slough

Year	Time-averaged Predicted Water Flow Rate (cfs)		
	Before Flow Pulse	During Flow Pulse	After Flow Pulse
2011	2082	2390	1212
2012	1670	1539	955
2016	1981	2087	1952
2017	2427	2632	1726
2018	1906	1860	1061

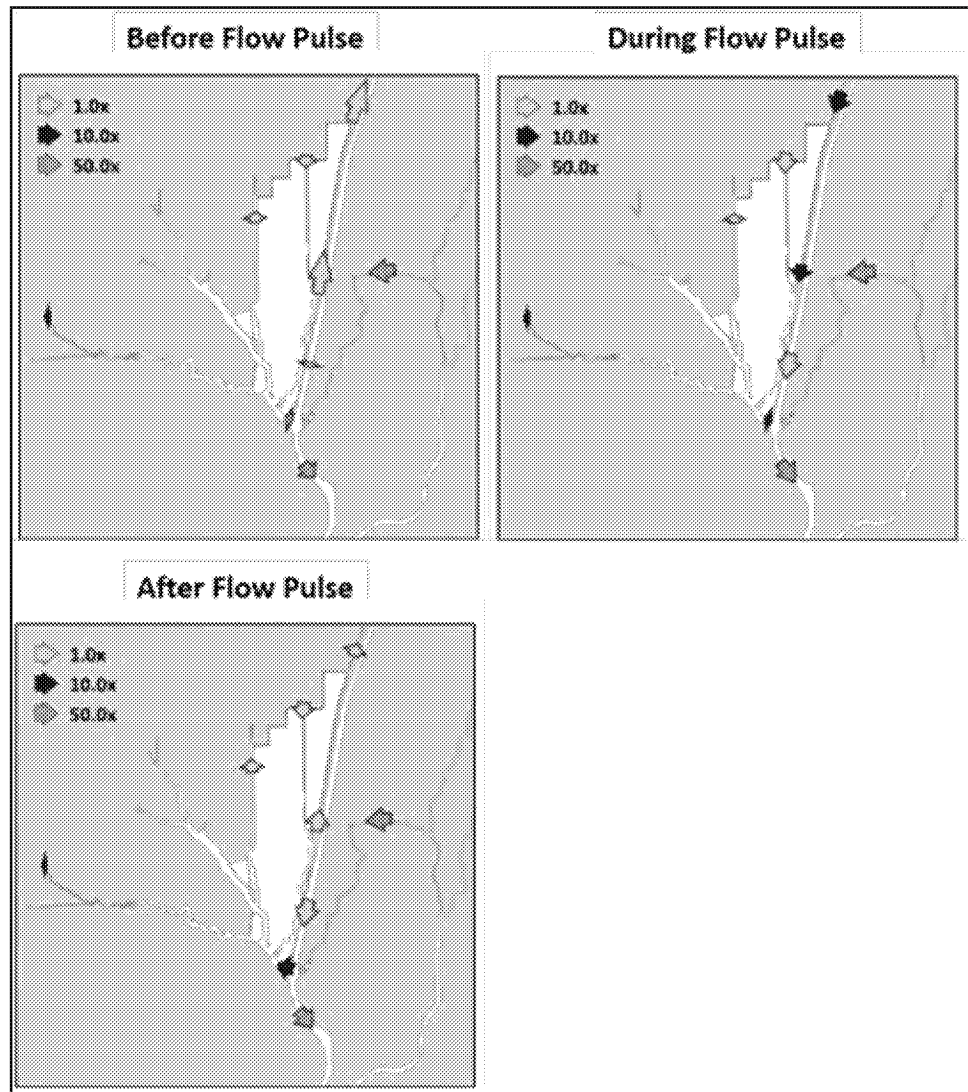
Task 4 Table 8. Time-averaged predicted water flow rate south through Miner Slough

Flow pulse water was predicted to reach the bottom of the Toe Drain about 3 days after the start of the flow pulse in 2016 (Task 4 Question 1 and 2). Flow pulse water is transported south on ebb tide and the percent of flow pulse water increases, while the percent of the flow pulse water decreases on flood tide. The average age of the flow pulse water, the average amount of time since the water passed Lisbon Weir, remains less than about 6 days until about 15 days after the start of the flow pulse, when the water age begins to gradually increase (Task 4 Question 2). This start of the gradual increase in the age corresponds to the start of the trailing down of the magnitude of the flow pulse (Task 4 Figure 2).

Flow pulse water was predicted to reach Lower Liberty Island about 5 days after the start of the flow pulse in 2016 (Task 4 Question 1 and 2). The flow pulse water percent then increases but has a large tidal variation. On ebb tide, the percent flow pulse water increases, and on flood tide, the relatively low percent water from Cache Slough is transported into the CSC and the percentage of flow pulse water at Lower Liberty Island decreases. The water age at Lower Liberty Island does not vary as much with the tides as at the bottom of the Toe Drain. The average age at Lower Liberty Island is also larger than at the bottom of the Toe Drain, indicating that the flow pulse water spends a significant amount of time transiting through Liberty Island (Task 4 Question 3).

Flow pulse water was predicted to reach Cache Slough about 5 days after the start of the flow pulse in 2016 (Task 4 Question 1 and 2). This is a similar amount of time predicted for the flow pulse water to reach Lower Liberty Island because the Cache Slough location is within a tidal excursion of Lower Liberty Island. Even though the percentage of flow pulse water is less than at Lower Liberty Island, the water age is similar to that at Lower Liberty Island. Flow pulse water was predicted to reach Rio Vista about 7 days after the start of the flow pulse in 2016 (Task 4 Question 1 and 2). This is a similar amount of time predicted for the flow pulse water to reach Lower Liberty Island and Cache Slough, because there is a large net flow through Cache Slough transporting water southward toward Rio Vista on every tidal

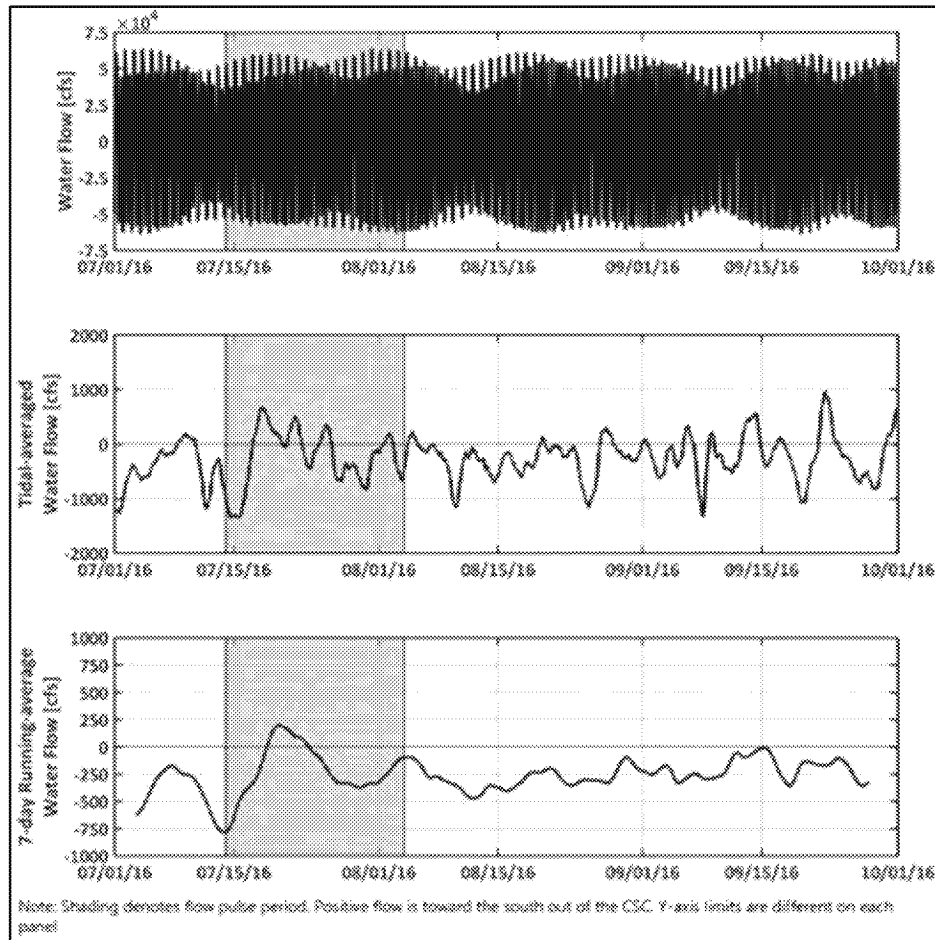
cycle. Even though the percentage of flow pulse water is less than at Cache Slough, the water age is similar to that at Lower Liberty Island and Cache Slough (Task 4 Question 3).



Task 4 Figure 15 UnTRIM San Francisco Bay-Delta modeled net water flow direction in the lower Yolo Bypass, Cache Slough Complex, lower Cache Slough and Miner Slough before, during, and after the 2016 summer managed flow pulse.

On every tidal cycle, the flow pulse water is transported southward on ebb tide and then back northward on flood tide, represented by the tidal-timescale variation in the time series figures. The spatial distribution of flow pulse water age and flow pulse water percent at the end of ebb and flood tides are shown on Task 4 Figures 17 and 18. Task 4 Figure 17 shows the distributions at the end of ebb tide near the end of the flow pulse, while Task 4 Figure 18 shows the distributions at the end of flood tide. These figures highlight the relatively small spatial variation in water age because of the short duration of the flow pulse (Task 4 Question 3). The figures also show the decrease in the proportion of flow pulse water toward the south. The southward transport of flow pulse water on ebb tide results in relatively low age flow pulse water on the eastern side of Liberty Island relative to at the end of flood tide, that is, the flow

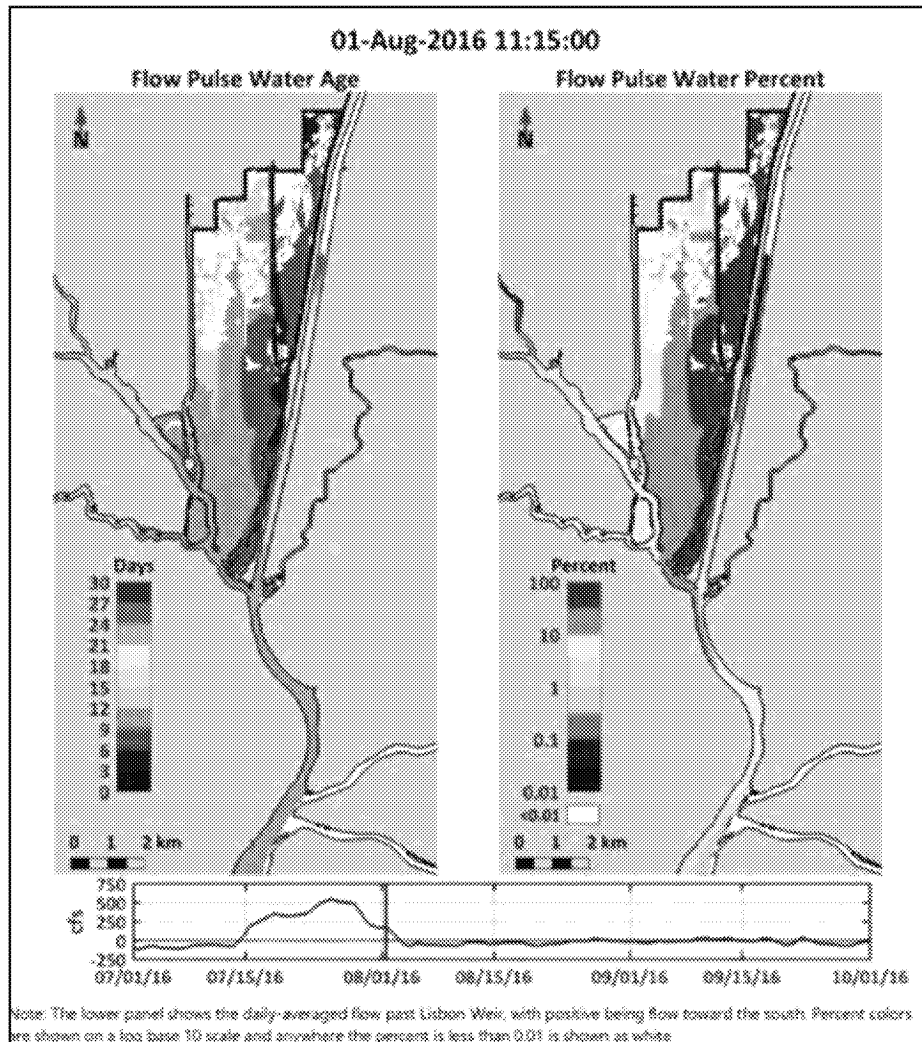
pulse water on the eastern side of Liberty Island at the end of ebb tide relatively recently passed Lisbon Weir, compared to the flow pulse water in Liberty Island at the end of flood tide. On ebb tide, the flow pulse water in the CSC is transported into Cache Slough near Ryer Island, resulting in an increase in the proportion of flow pulse water downstream at Cache Slough and Rio Vista (Task 4 Question 3). On flood tide, the water from Cache Slough is transported into the CSC and water in southern Liberty Island is composed of a relatively low proportion of flow pulse water.



Task 4 Figure 16. UnTRIM San Francisco Bay-Delta modeled water flow southward out of the Cache Slough Complex in 2016

Tidal-averaging the time series of water age and water percent at the discrete locations makes them easily comparable between locations (Task 4 Figure 19). Flow pulse water was predicted to reach the bottom of the Toe Drain relatively quickly in 2016, represented by low water age (Task 4 Question 1 and 2). Water age from Lower Liberty Island to the Sacramento River at Decker Island increases linearly until about 15 days after the start of the flow pulse and is representative of the water age trending toward equilibrium with the magnitude of the flow pulse (Task 4 Figure 3). At about 16 days after the start of the flow pulse, when the magnitude of the pulse has decreased, there is a relatively large spread in the water age between Lower Liberty Island and Rio Vista and Decker Island downstream. This large spread indicates that it is taking a noticeable amount of time for the flow pulse water to travel downstream from Lower Liberty Island to Rio Vista (Task 4 Question 3). At about 18 days after the start of the flow pulse, the age of water

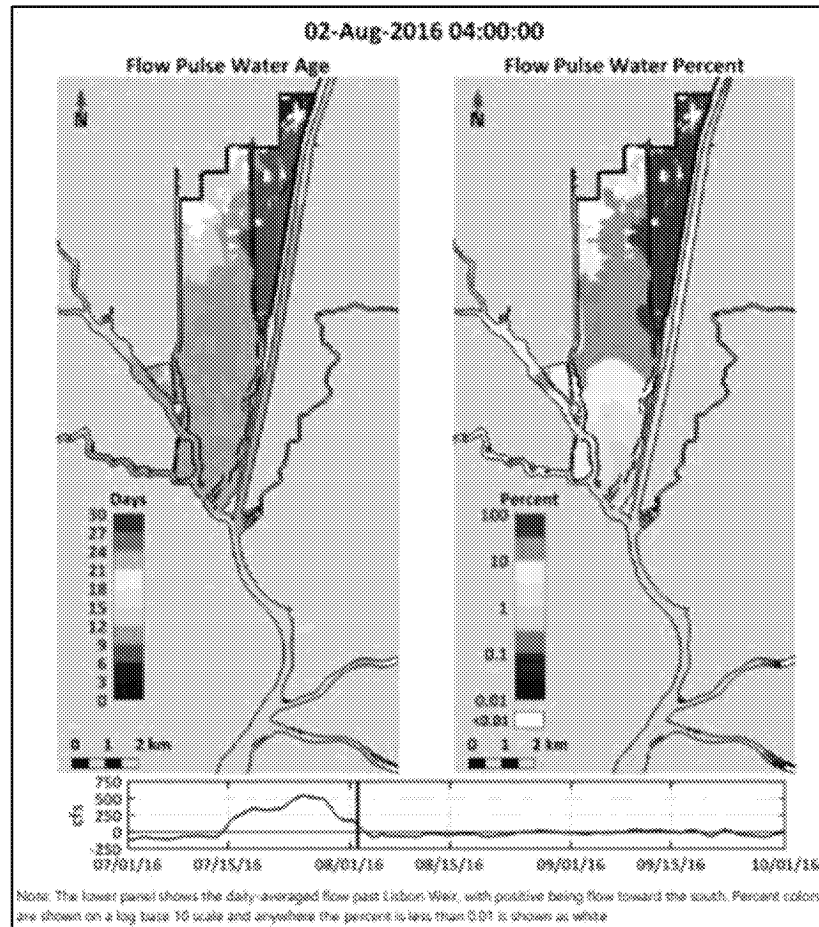
at Lower Liberty Island increases faster than at the downstream locations and the spread in the ages becomes smaller, that is, the water age at Lower Liberty Island becomes more similar to the water age at the downstream locations.



Task 4 Figure 17. Map of UnTRIM San Francisco Bay-Delta modeled managed flow pulse water age and percent at the end of ebb tide near the end of the flow pulse in 2016.

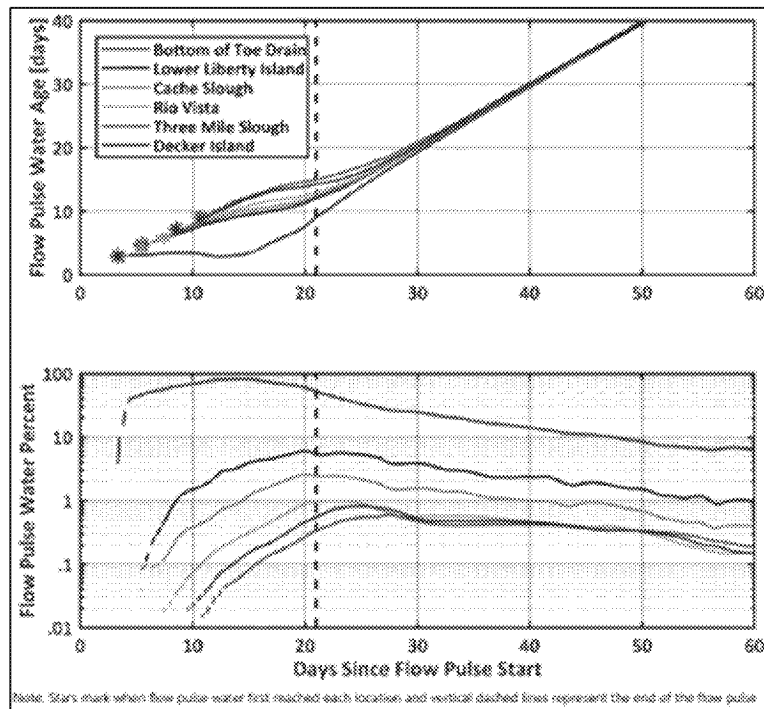
On the first day of the flow pulse, water in Little Holland Tract, Liberty Island, and the CSC channels is tagged with a tracer to investigate the transport of those water masses through the study area (Task 4 Figure 14). Water moving down Miner Slough is continuously tagged from the start of the flow pulse to the end of the simulation. The percent of the water composed of Little Holland Tract, Liberty Island, and CSC channel water is often the highest at the bottom of the Toe Drain and decreases toward Decker Island and Three Mile Slough (Task 4 Figure 19). However, when the magnitude of the flow pulse is relatively large, between about 10 and 15 days after the start of the flow pulse (Task 4 Figure 3), the flow pulse water makes up a large percentage of the water at the bottom of the Toe Drain and the percentage composed of the other water masses decreases. Throughout the flow pulse, the proportion of the water composed of Miner Slough water is the highest at Lower Liberty Island and decreases toward Decker Island and Three Mile Slough. The proportion decreases toward the south because distributaries of the

Sacramento River converge and dilute the water coming down Miner Slough. During the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is relatively low, because the southward net flow of water through the Toe Drain restricts the mixing of Miner Slough water northward into the Toe Drain (Task 4 Question 3). Following the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is similar to the percentage at Lower Liberty Island.

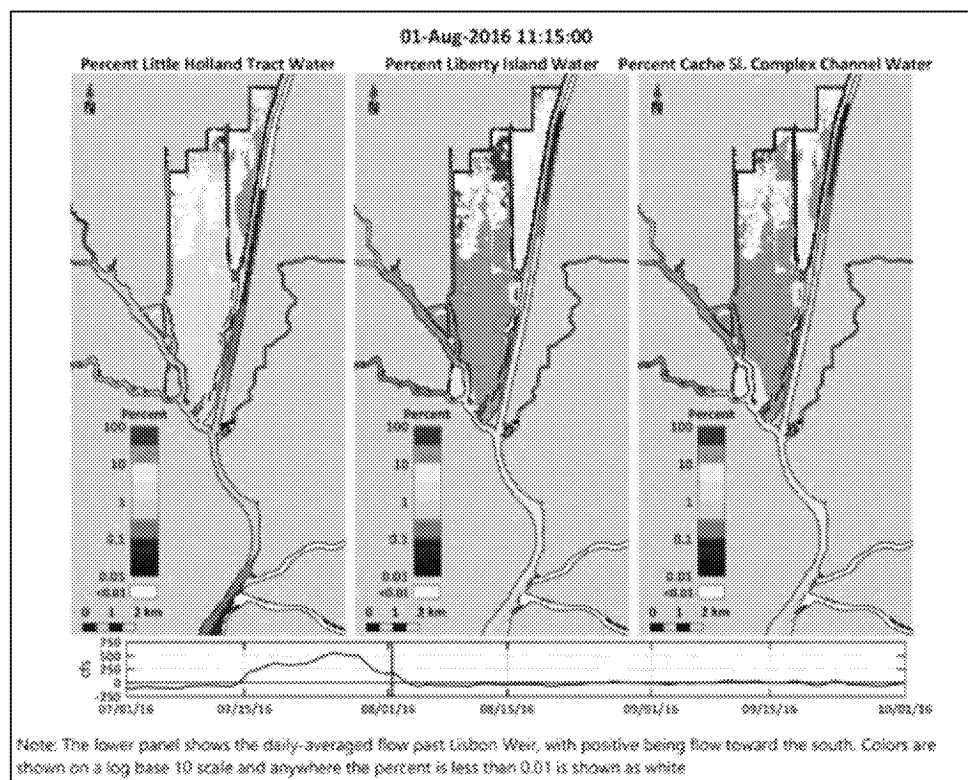


Task 4 Figure 18. Map of UnTRIM San Francisco Bay-Delta modeled managed flow pulse water age and percent at the end of the flood tide near the end of the flow pulse in 2016.

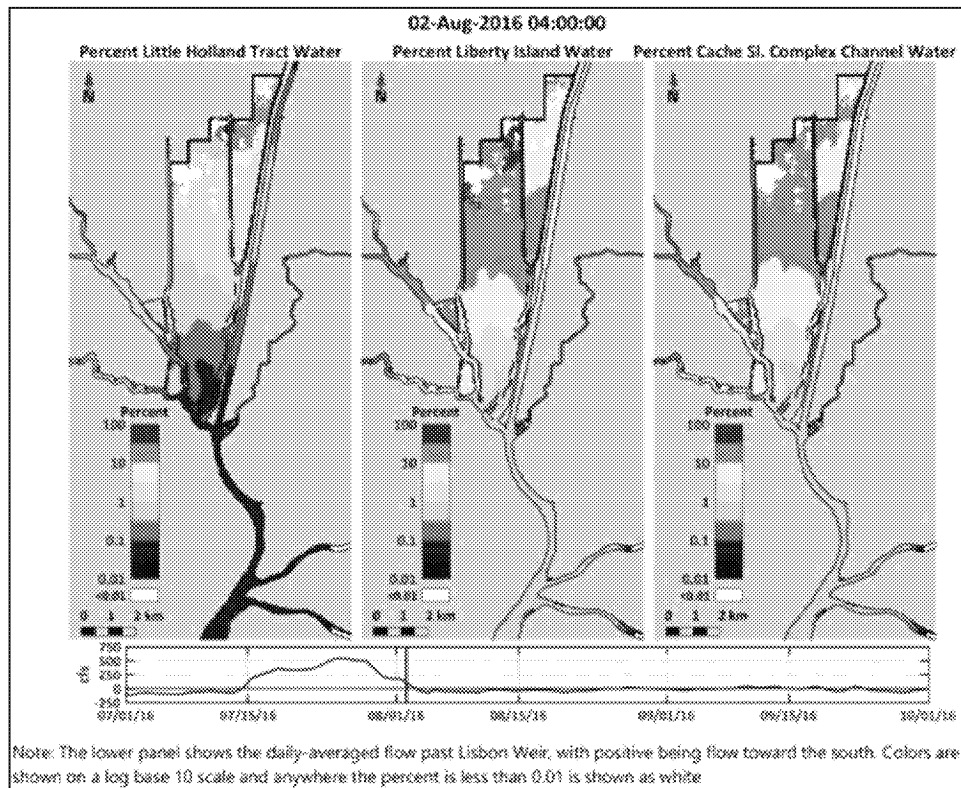
The spatial distributions of water initially in the CSC on the first day of the flow pulse are shown at the end of ebb tide (Task 4 Figure 18) and flood tide (Task 4 Figure 19). These maps show the distributions near the end of the flow pulse. These figures highlight the decrease in the proportion of water from the CSC toward the south and that water initially in Little Holland Tract makes up a smaller proportion outside of Little Holland Tract than the water initially in Liberty Island or the CSC channels. The southward transport of water on ebb tide (Task 4 Question 3) results in relatively high proportions of water from the CSC downstream at Cache Slough and Rio Vista (Task 4 Figure 18). However, on flood tide, water from Cache Slough, which is composed of a large percentage of water from Miner Slough (Task 4 Figure 17), is transported into the CSC (Task 4 Figure 19).



Task 4 Figure 19. UnTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at each location in 2016



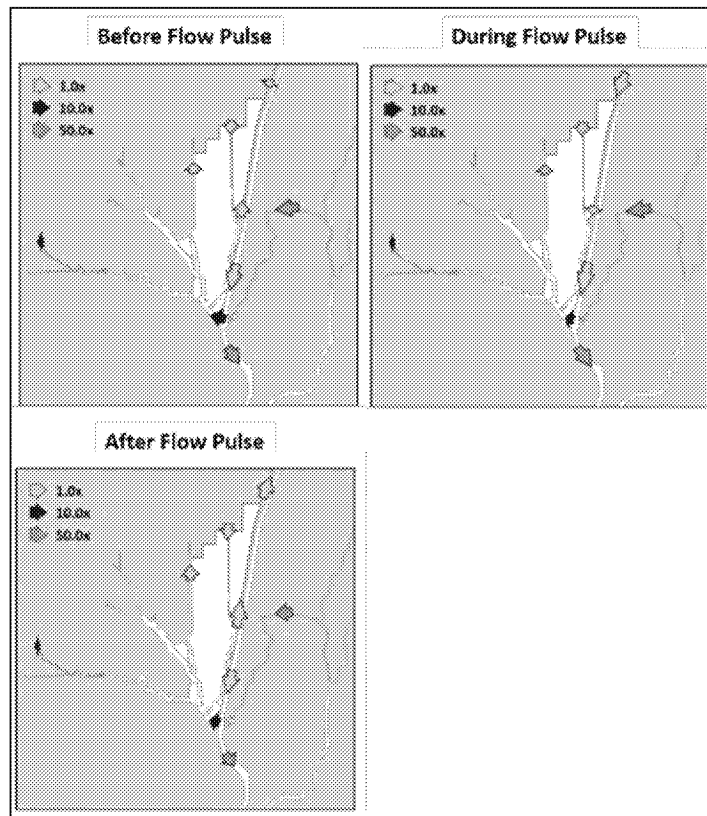
Task 4 Figure 20. Map of UnTRIM San Francisco Bay-Delta modeled percent Little Holland Tract, Liberty Island, and Cache Slough Complex channel water at the end of the ebb tide near the end of the managed flow pulse in 2016.



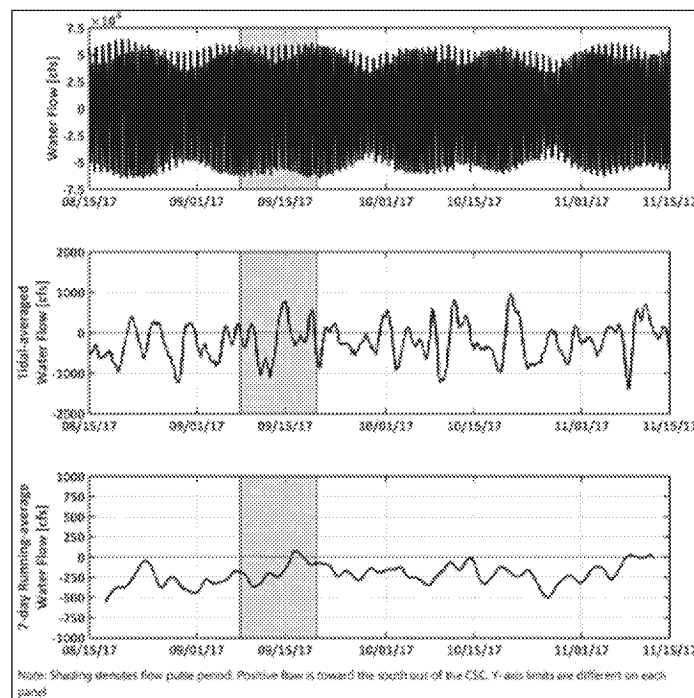
Task 4 Figure 21. Map of UnTRIM San Francisco Bay-Delta modeled percent Little Holland Tract, Liberty Island, and Cache Slough Complex channel water at the end of flood tide near the end of the flow pulse in 2016

2017

The flow pulse during 2017 was much smaller than the other years (Task 4 Table 2) and serves as an example of hydrodynamics during a very small flow pulse (Task 4 Question 1 and 2). Net water flow past Lisbon Weir was near zero before the 2017 flow pulse but switched to southward during the flow pulse (Task 4 Figure 2). The flow past Lisbon Weir returned to be net northward following the flow pulse. This results in the flow at the Toe Drain at Screw Trap, just north of Little Holland Tract, being toward the north before the flow pulse, switching to toward the south during the flow pulse and returning to northward after the flow pulse (Task 4 Table 5; Figure 22). The net flow between the CSC and Cache Slough near Ryer Island was northward into the CSC (Task 4 Question 1 and 2) when averaged over the periods before, during, and after the flow pulse (Task 4 Table 6). The predicted net flow into the CSC during the flow pulse results from the magnitude of the flow pulse not being large enough to overcome intakes and diversions to produce a net flow out of the CSC, when averaged over the entire duration of the flow pulse (Task 4 Question 1 and 2). However, there are periods of tidal-averaged flow out of the CSC, and a very short period of predicted 7-day running-average net flow out of the CSC during the flow pulse (Task 4 Figure 23). The net flow in Cache Slough by Ryer Island, to the south of the CSC, is consistently directed toward the south and is much larger magnitude than flows in the CSC (Task 4 Table 6; Figure 22). This relatively large net flow through Cache Slough results from the flow of Sacramento River water down Miner Slough and down Cache Slough to the confluence of Cache Slough and the Sacramento River (Table 7 and 8).



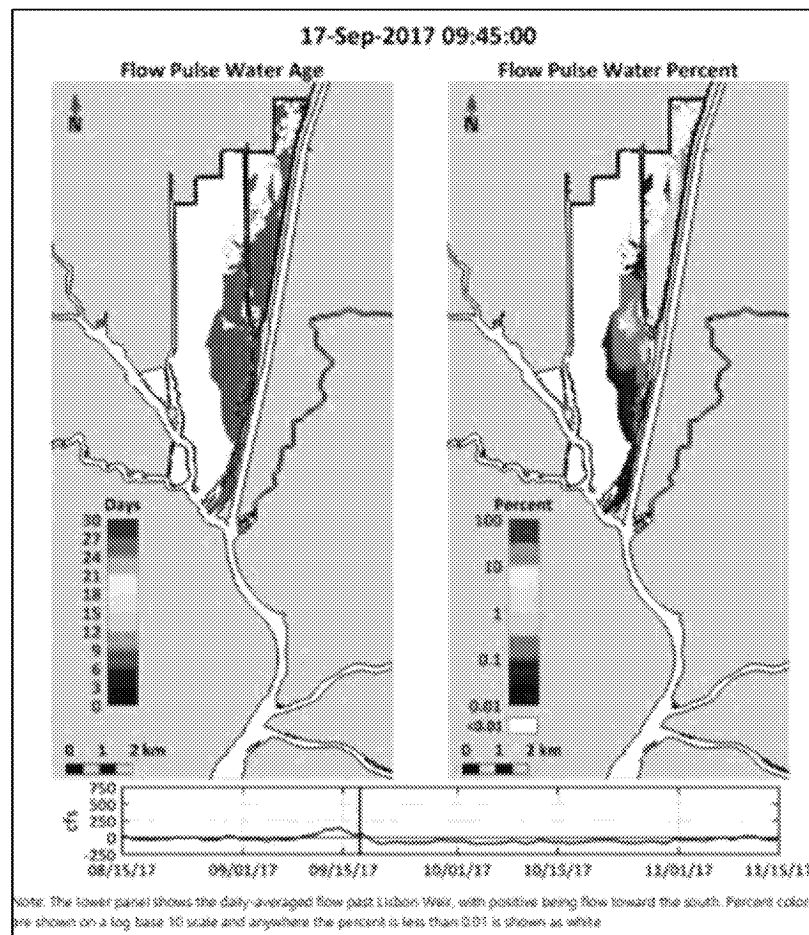
Task 4 Figure 22. UnTRIM San Francisco Bay-Delta modeled net water flow before, during, and after the 2017 flow pulse



Task 4 Figure 23. UnTRIM San Francisco Bay-Delta modeled water flow southward out of Cache Slough Complex in 2017

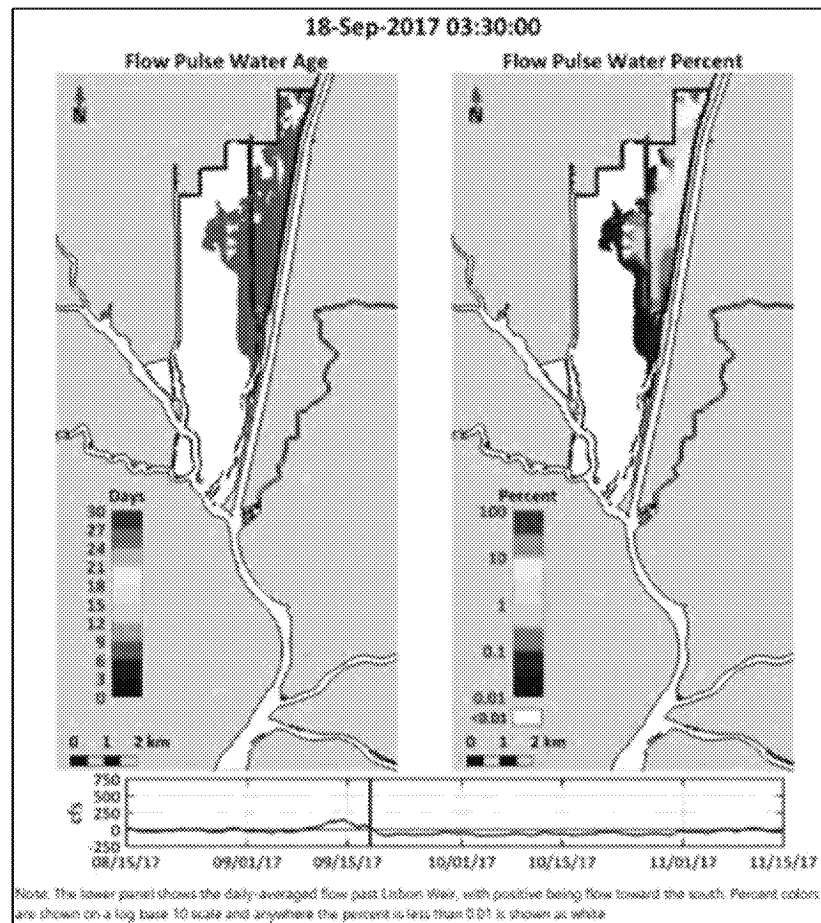
Flow pulse water was predicted to reach the bottom of the Toe Drain about 5 days after the start of the flow pulse in 2017 (Task 4 Question 1 and 2). The percent of the flow pulse water at the bottom of the Toe Drain is lower than in the other years and never reaches 100% of the water at the bottom of the Toe Drain due to the small size of the flow pulse. During the flow pulse, there is a large amount of tidal variation in the percent of flow pulse water at the bottom of the Toe Drain. Flow pulse water is transported south on ebb tide and the percent of flow pulse water increases, while the percent of the flow pulse water decreases on flood tide. The average age of the flow pulse water, the average amount of time since the water passed Lisbon Weir, increases linearly throughout the simulation because of the small magnitude of the flow pulse (Task 4 Question 3).

Flow pulse water was predicted to reach Lower Liberty Island about 10 days after the start of the flow pulse in 2017 (Task 4 Question 1 and 2). The flow pulse water percent then increases but remains relatively low, with less than about 0.2% of the water being composed of the flow pulse water. Flow pulse water was predicted to reach Cache Slough about 13 days after the start of the flow pulse in 2017. The flow pulse water percent then increases but remains relatively low, with less than about 0.1% of the water being composed of the flow pulse water. Flow pulse water was predicted to reach Rio Vista about 23 days after the start of the flow pulse in 2017 (Task 4 Question 3). The flow pulse water percent then increases but remains relatively low, with less than about 0.03% of the water being composed of the flow pulse water.



Task 4 Figure 24. Map of UnTRIM San Francisco Bay-Delta modeled flow pulse water age and percent at the end of ebb tide near the end of the flow pulse in 2017

On every tidal cycle, the flow pulse water is transported southward on ebb tide and then back northward on flood tide, represented by the tidal-timescale variation in the time series figures. The spatial distribution of flow pulse water age and flow pulse water percent at the end of ebb and flood tides are shown on Task 4 Figures 24 and 25. Task 4 Figure 24 shows the distributions at the end of ebb tide near the end of the flow pulse, while Task 4 Figure 25 shows the distributions at the end of flood tide. These figures highlight that little of the flow pulse water was predicted to exit the CSC. Near the end of the flow pulse, the flow pulse water was mostly on the eastern side of Liberty Island and in Little Holland Tract (Task 4 Question 3).

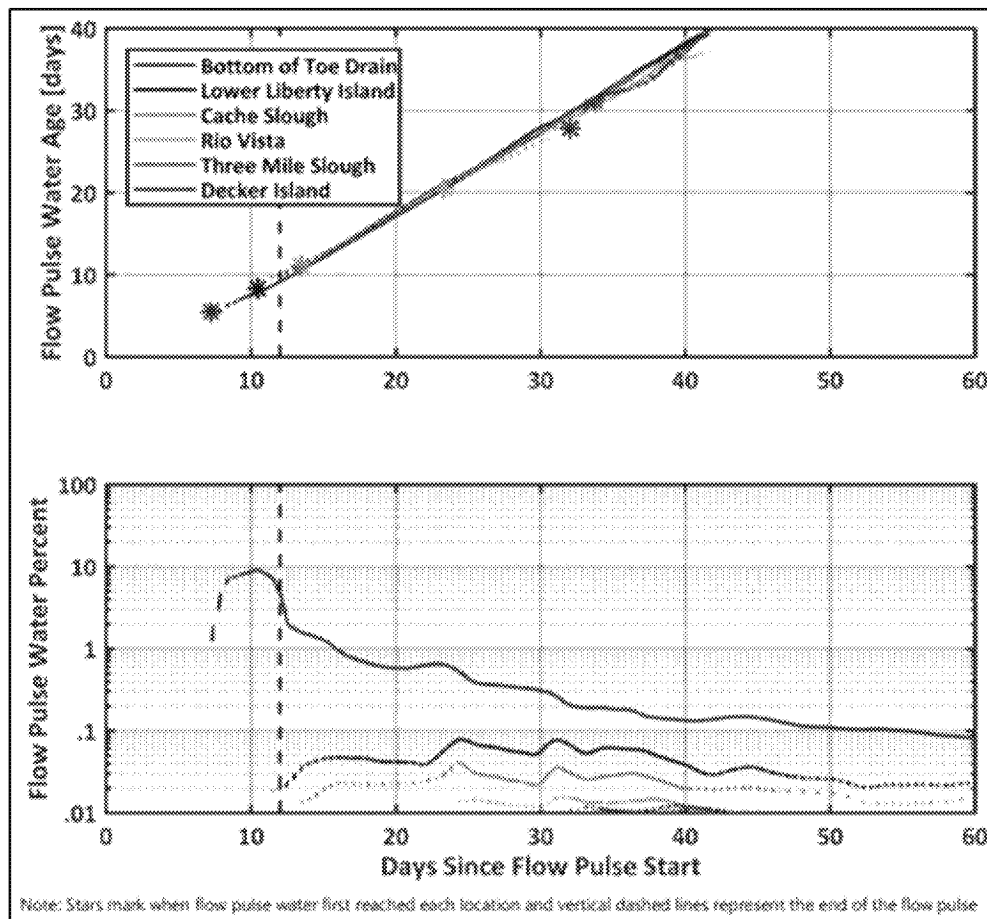


Task 4 Figure 25. Map of UnTRIM San Francisco Bay-Delta modeled flow pulse water age and percent at the end of flood tide near the end of the flow pulse in 2017

Tidal-averaging the time series of water age and water percent at the discrete locations makes them more easily comparable between locations (Task 4 Figure 26). The water age at each of the locations was predicted to age linearly at each of the locations. This indicates that the small flow pulse is supplying a small amount of water that then ages approximately linearly as the flow pulse water is transported throughout the system (Task 4 Question 3). There is a large variation in the amount of time it takes flow pulse water to reach the different locations at proportions above 0.01% in 2017.

On the first day of the flow pulse, water in Little Holland Tract, Liberty Island, and the CSC channels is tagged with a tracer to investigate the transport of those water masses through the study area (Task 4 Figure 14). Water moving down Miner Slough is continuously tagged from the start of the flow pulse to

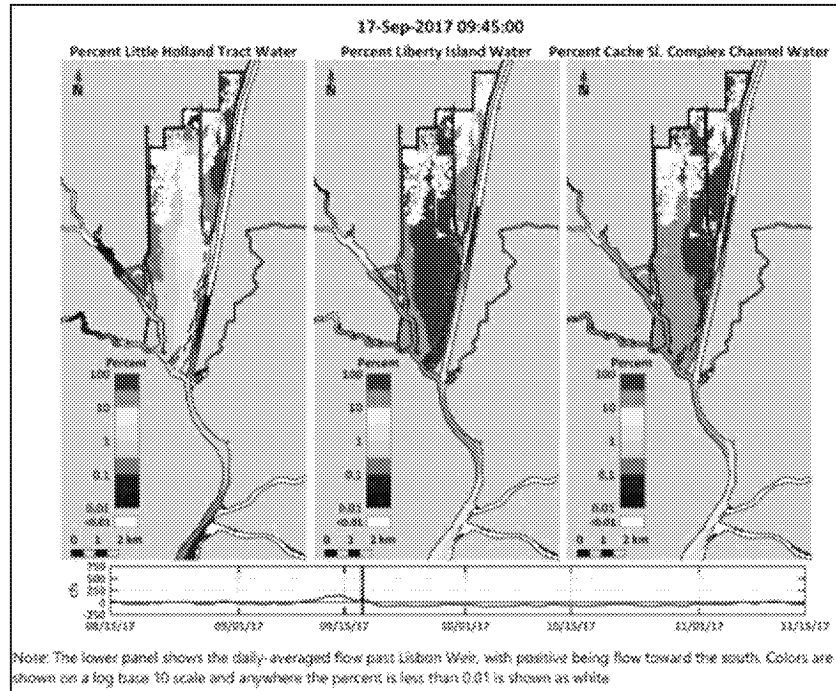
the end of the simulation. The percent of the water composed of Little Holland Tract, Liberty Island, and CSC channel water is highest at the bottom of the Toe Drain and decreases toward Decker Island and Three Mile Slough (Task 4 Figure 26). Throughout the flow pulse, the proportion of the water composed of Miner Slough water is the highest at Lower Liberty Island and decreases toward Decker Island and Three Mile Slough. The proportion decreases toward the south because distributaries of the Sacramento River converge and dilute the water coming down Miner Slough. During the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is relatively low, because the southward net flow of water through the Toe Drain restricts the mixing of Miner Slough water northward into the Toe Drain. Following the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is similar to the percentage at Lower Liberty Island.



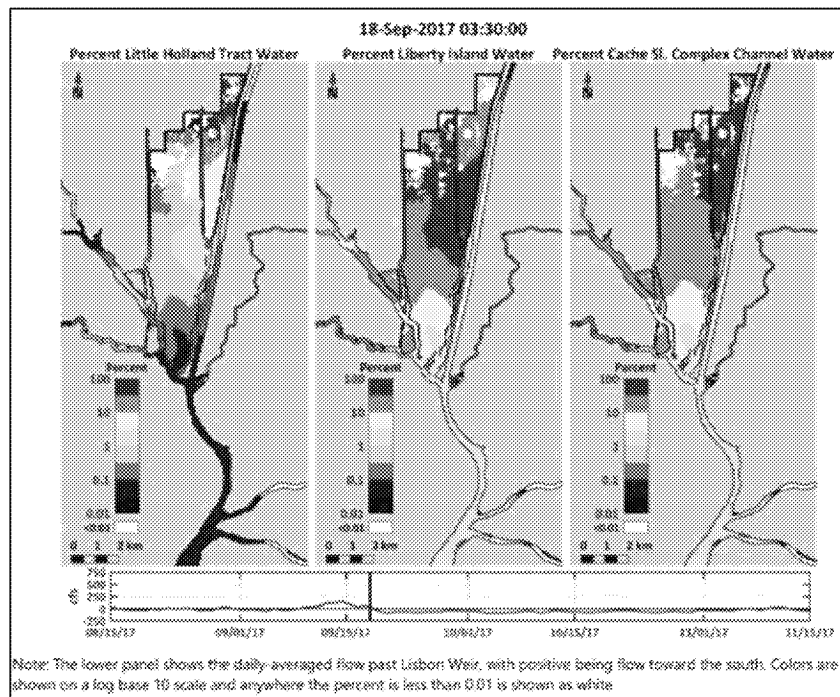
Task 4 Figure 26. UnTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at each location in 2017

The spatial distributions of water initially in the CSC on the first day of the flow pulse are shown at the end of ebb tide (Task 4 Figure 27) and flood tide (Task 4 Figure 28). These maps show the distributions near the end of the flow pulse. These figures highlight the decrease in the proportion of water from the CSC toward the south and that water initially in Little Holland Tract makes up a smaller proportion outside of Little Holland Tract than the water initially in Liberty Island or the CSC channels (Task 4 Question 3). The southward transport of water on ebb tide results in relatively high proportions of water from the CSC downstream at Cache Slough and Rio Vista (Task 4 Figure 25). However, on flood tide,

water from Cache Slough, which is composed of a large percentage of water from Miner Slough (Task 4 Figure 26) is transported into the CSC (Task 4 Figure 28).

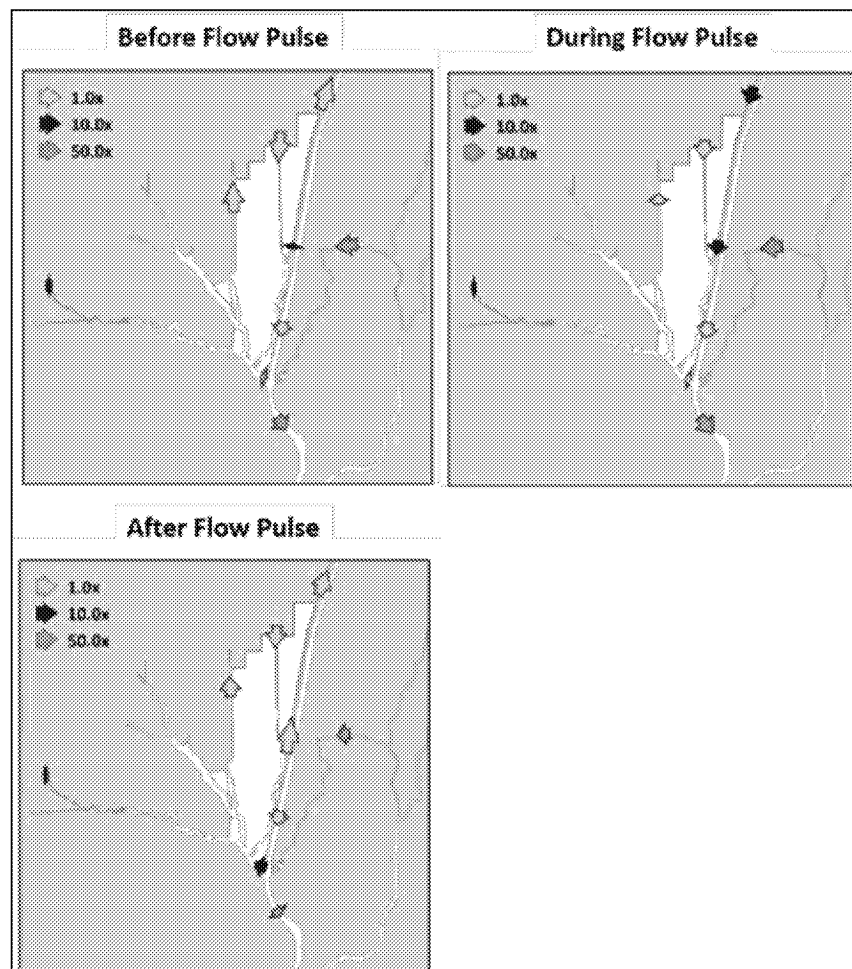


Task 4 Figure 27. Map of UnTRIM San Francisco Bay-Delta modeled percent Little Holland Tract, Liberty Island and Cache Slough Complex channel water at the end of ebb tide near the end of the flow pulse in 2017

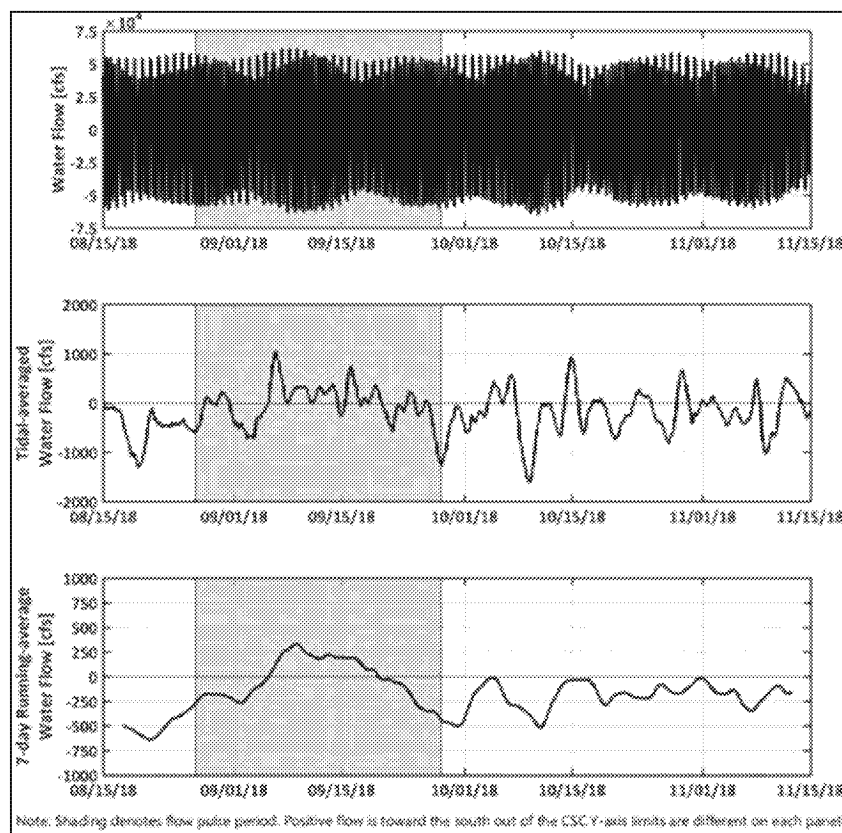


Task 4 Figure 28. Map of UnTRIM San Francisco Bay-Delta modeled percent Little Holland Tract, Liberty Island, and Cache Slough Complex channel water at the end of the flood tide near the end of the flow pulse in 2017

Net water flow past Lisbon Weir was northward before the 2018 flow pulse but switched to southward (Task 4 Question 1 and 2) during the flow pulse (Task 4 Figure 2). As the flow pulse trailed down, the daily-averaged flow past Lisbon Weir switched to be consistently toward the north following the flow pulse. This results in the flow at the Toe Drain at Screw Trap, just north of Little Holland Tract, being toward the north before the flow pulse, switching to toward the south during the flow pulse and returning to toward the north after the flow pulse (Task 4 Table 5; Figure 29). The net flow between the CSC and Cache Slough near Ryer Island was northward (Task 4 Question 1 and 2) into the CSC when averaged over each of the periods before, during, and after the flow pulse (Task 4 Table 6). Even though the predicted net flow during the flow pulse was into the CSC, there are periods of predicted tidal-averaged flow out of the CSC and a period of time that the 7-day running-averaged net flow was out of the CSC during the flow pulse. Notably, the 7-day running-averaged net flow was out of the CSC when the flow pulse was relatively high (Task 4 Figure 30). The net flow in Cache Slough by Ryer Island, to the south of the CSC, is consistently directed toward the south and is much larger magnitude than flows in the CSC (Task 4 Table 7; Figure 29). This relatively large net flow through Cache Slough results from the flow of Sacramento River water down Miner Slough and down Cache Slough to the confluence of Cache Slough and the Sacramento River (Task 4 Table 8).



Task 4 Figure 29. UnTRIM San Francisco Bay-Delta modeled net water flow before, during, and after the 2018 flow pulse



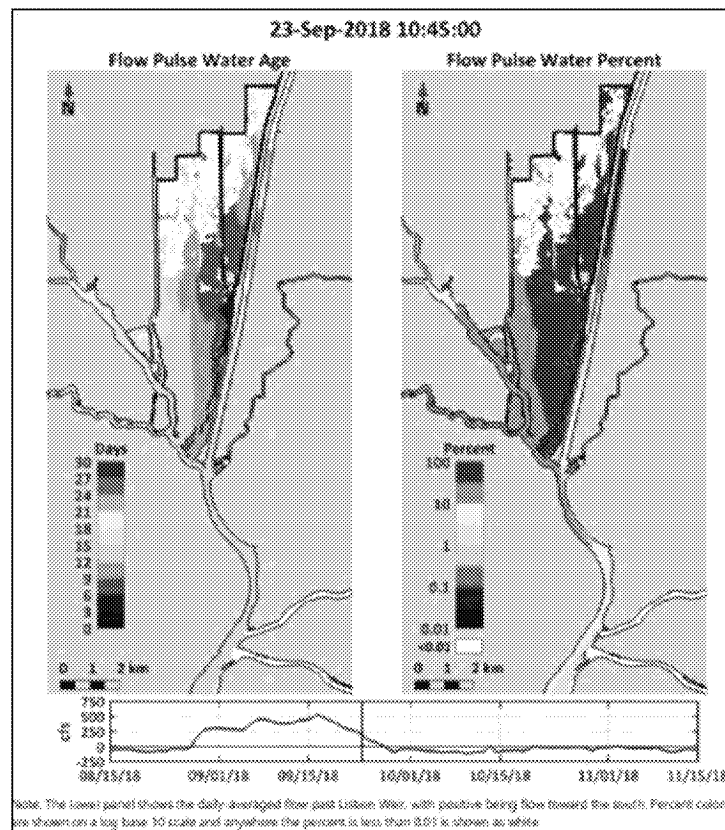
Task 4 Figure 30. UnTRIM San Francisco Bay-Delta modeled water flow southward out of the Cache Slough Complex in 2018

Flow pulse water was predicted to reach the bottom of the Toe Drain about 3 days after the start of the flow pulse in 2018 (Task 4 Question 1 and 2). The percent of the flow pulse water at the bottom of the Toe Drain then increases to about 30% to 100% of the water at the bottom of the Toe Drain, depending on the tides (Task 4 Question 3). Flow pulse water is transported south on ebb tide and the percent of flow pulse water increases, while the percent of the flow pulse water decreases on flood tide. The average age of the flow pulse water, the average amount of time since the water passed Lisbon Weir, remains less than about 7 days until about 22 days after the start of the flow pulse, when the water age begins to gradually increase. This start of the gradual increase in the age corresponds to the start of the trailing down of the magnitude of the flow pulse (Task 4 Figure 2).

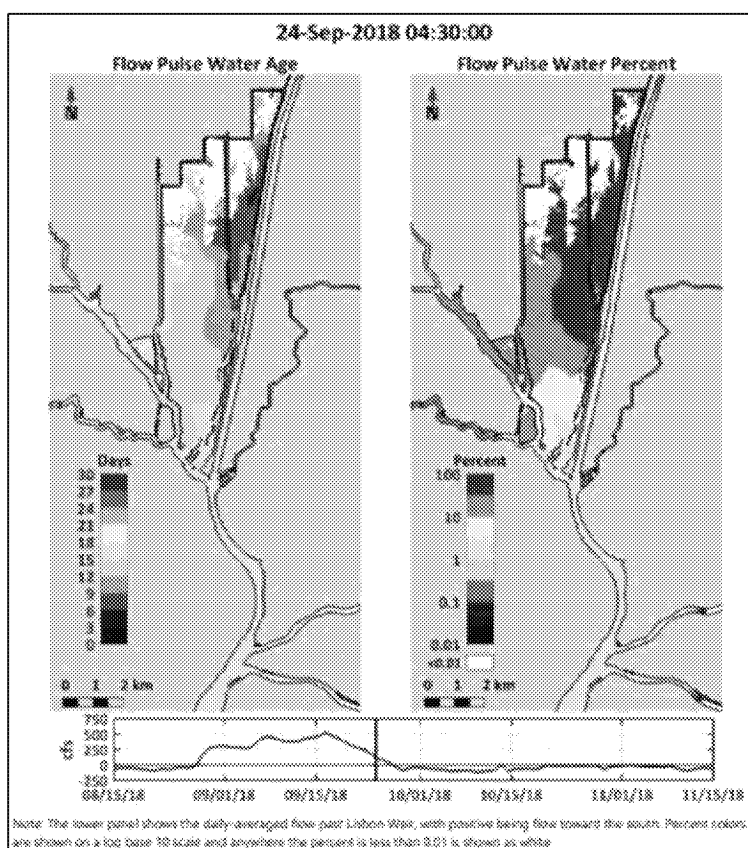
Flow pulse water was predicted to reach Lower Liberty Island about 6 days after the start of the flow pulse in 2018 (Task 4 Question 1 and 2). The flow pulse water percent then increases but has a large tidal variation. On ebb tide, the percent flow pulse water increases, and on flood tide, the relatively low percent water from Cache Slough is transported into the CSC and the percentage of flow pulse water at Lower Liberty Island decreases. The water age at Lower Liberty island does not vary as much with the tides as at the bottom of the Toe Drain (Task 4 Question 3). The average age at Lower Liberty Island is also larger than at the bottom of the Toe Drain, indicating that the flow pulse water spends a significant amount of time transiting through Liberty Island. Flow pulse water was predicted to reach Cache Slough about 7 days after the start of the flow pulse in 2018 (Task 4 Question 1 and 2). This is a similar amount of time predicted for the flow pulse water to reach Lower Liberty Island, because the Cache Slough location is within a tidal excursion of Lower Liberty Island. Even though the percentage of flow pulse water is less than at Lower Liberty Island, the water age is similar to that at Lower Liberty Island. Flow pulse water

was predicted to reach Rio Vista about 8 days after the start of the flow pulse in 2018 (Task 4 Question 1 and 2). This is a similar amount of time predicted for the flow pulse water to reach Lower Liberty Island and Cache Slough, because there is a large net flow through Cache Slough transporting water southward toward Rio Vista on every tidal cycle (Task 4 Question 3). Even though the percentage of flow pulse water is less than at Cache Slough, the water age is similar to that at Lower Liberty Island and Cache Slough.

On every tidal cycle, the flow pulse water is transported southward on ebb tide and then back northward on flood tide, represented by the tidal-timescale variation in the time series figures. The spatial distribution of flow pulse water age and flow pulse water percent at the end of ebb and flood tides are shown on Task 4 Figures 31 and 32. Task 4 Figure 31 shows the distributions at the end of ebb tide near the end of the flow pulse, while Task 4 Figure 32 shows the distributions at the end of flood tide. These figures highlight both the increasing water age from the bottom of the Toe Drain to Lower Liberty Island and into Cache Slough and the decrease in the proportion of flow pulse water toward the south. The southward transport of flow pulse water on ebb tide results in relatively low age flow pulse water on the eastern side of Liberty Island relative to at the end of flood tide, that is, the flow pulse water on the eastern side of Liberty Island at the end of ebb tide relatively recently passed Lisbon Weir, compared to the flow pulse water on the eastern side of Liberty Island at the end of flood tide. On ebb tide, the flow pulse water in the CSC is transported into Cache Slough near Ryer Island, resulting in an increase in the proportion of flow pulse water downstream at Cache Slough and Rio Vista (Task 4 Question 3). On flood tide, the water from Cache Slough is transported into the CSC and water in southern Liberty Island is composed of a relatively low proportion of flow pulse water.



Task 4 Figure 31. Map of UnTRIM San Francisco Bay-Delta modeled flow pulse water age and percent at the end of ebb tide near the end of the flow pulse in 2018

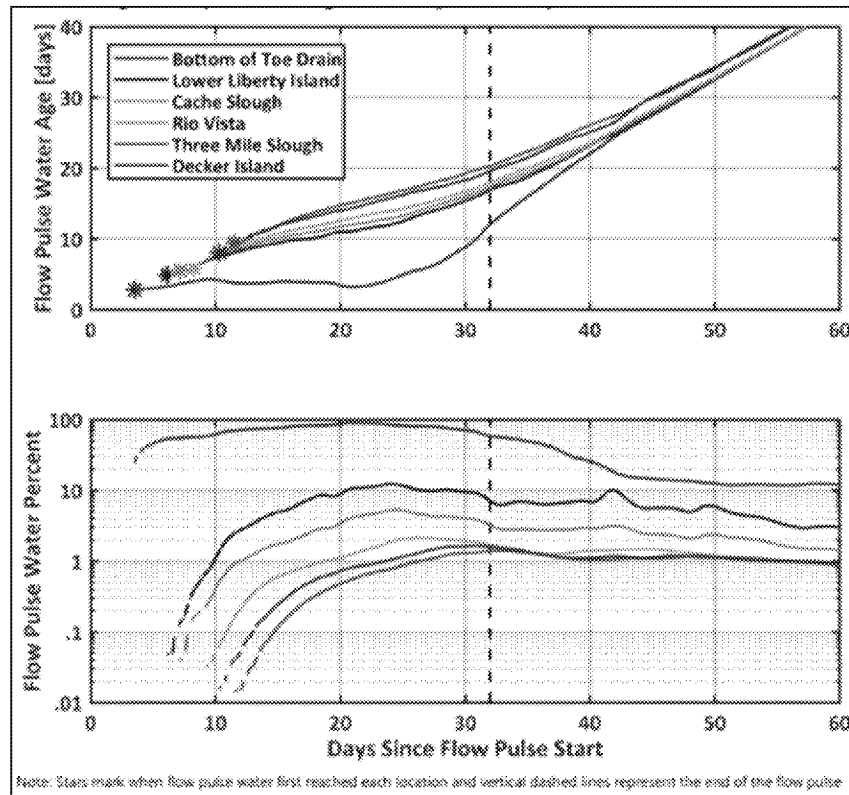


Task 4 Figure 32. Map of UnTRIM San Francisco Bay-Delta modeled flow pulse water age and percent at the end of flood tide near the end of the flow pulse in 2018

Tidal-averaging the time series of water age and water percent at the discrete locations makes them more easily comparable between locations (Task 4 Figure 31). Flow pulse water was predicted to reach the bottom of the Toe Drain relatively quickly in 2018, represented by low water age (Task 4 Question 1 and 2). Water age from Lower Liberty Island to the Sacramento River at Decker Island increases linearly until about 10 days after the start of the flow pulse (Task 4 Question 3) and is representative of the water age trending toward equilibrium with the top of the flow pulse (Task 4 Figure 2). By 20 days after the start of the flow pulse, when the magnitude of the pulse begins to decrease, there is a relatively large spread in the water age between Lower Liberty Island and Rio Vista and Decker Island downstream. This large spread indicates that it is taking a noticeable amount of time for the flow pulse water to travel downstream from Lower Liberty Island to Rio Vista. At about 25 days after the start of the flow pulse, the age of water at Lower Liberty Island increases faster than at the downstream locations and the spread in the ages becomes smaller, that is, the water age at Lower Liberty Island becomes more similar to the water age at the downstream locations.

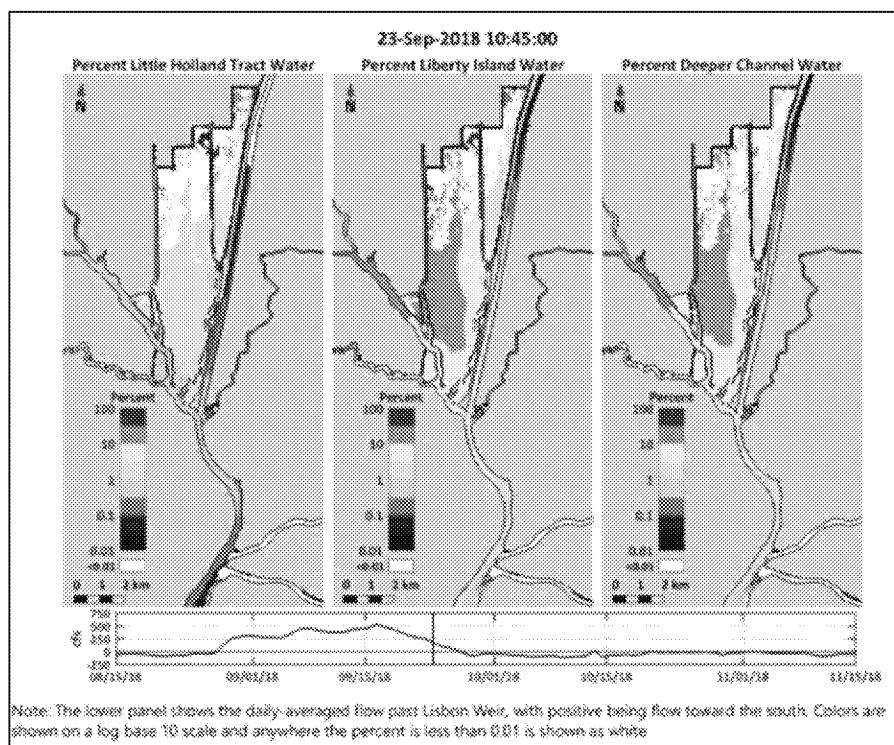
On the first day of the flow pulse, water in Little Holland Tract, Liberty Island, and the CSC channels is tagged with a tracer to investigate the transport of those water masses through the study area (Task 4 Figure 14). Water moving down Miner Slough is continuously tagged from the start of the flow pulse to the end of the simulation. The percent of the water composed of Little Holland Tract, Liberty Island, and CSC channel water is often the highest at the bottom of the Toe Drain and decreases toward Decker Island and Three Mile Slough (Task 4 Figure 33). However, when the magnitude of the flow pulse is large, between about 10 and 23 days after the start of the flow pulse (Task 4 Figure 2), the flow pulse

water makes up a large percentage of the water at the bottom of the Toe Drain and the percentage composed of the other water masses decreases (Task 4 Question 3). Near the start of the flow pulse, the proportion of the water composed of Miner Slough water is the highest at Lower Liberty Island and decreases toward Decker Island and Three Mile Slough. The proportion decreases toward the south because distributaries of the Sacramento River converge and dilute the water coming down Miner Slough. During the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is relatively low, because the southward net flow of water through the Toe Drain restricts the mixing of Miner Slough water northward into the Toe Drain. Following the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is similar to the percentage at Lower Liberty Island.

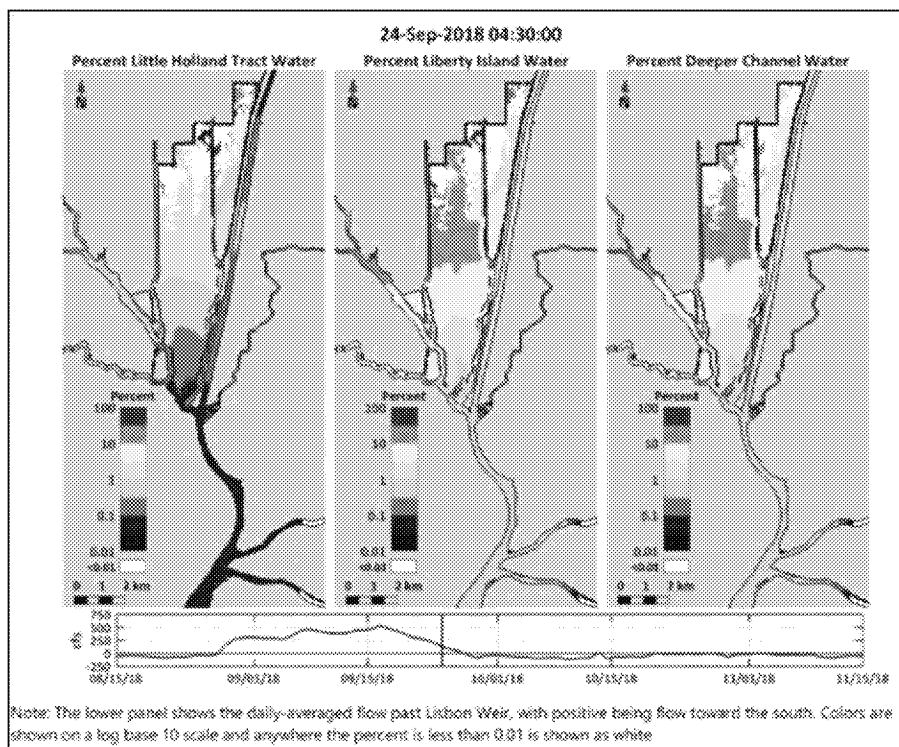


Task 4 Figure 33. UnTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at each location in 2018

The spatial distributions of water initially in the CSC on the first day of the flow pulse are shown at the end of ebb tide (Task 4 Figure 34) and flood tide (Task 4 Figure 35). These maps show the distributions near the end of the flow pulse. These figures highlight the decrease in the proportion of water from the CSC toward the south and that water initially in Little Holland Tract makes up a smaller proportion outside of Little Holland Tract than the water initially in Liberty Island or the CSC channels (Task 4 Question 3). The southward transport of water on ebb tide results in relatively high proportions of water from the CSC downstream at Cache Slough and Rio Vista (Task 4 Figure 34). However, on flood tide, water from Cache Slough, which is composed of a large percentage of water from Miner Slough (Task 4 Figure 33) is transported into the CSC (Task 4 Figure 35).



Task 4 Figure 34. Map of UnTRIM San Francisco Bay-Delta modeled percent Little Holland Tract, Liberty Island, and Cache Slough Complex channel water at the end of ebb tide near the end of flow pulse in 2018



Task 4 Figure 35. Map of UnTRIM San Francisco Bay-Delta modeled percent Little Holland Tract, Liberty Island, and Cache Slough Complex channel water at the end of flood tide near the end of the flow pulse in 2018

Comparison of 2011, 2012, and 2016-18 hydrodynamics during flow pulse periods

This section summarizes the similarities and differences in the water flow and tracer transport during the flow pulse for each of the years simulated. In this section, figures show predictions for each year on the same figure to aid in the comparison between different years. All the time series figures are shown based on the number of days after the start of the flow pulse to facilitate the comparison between years.

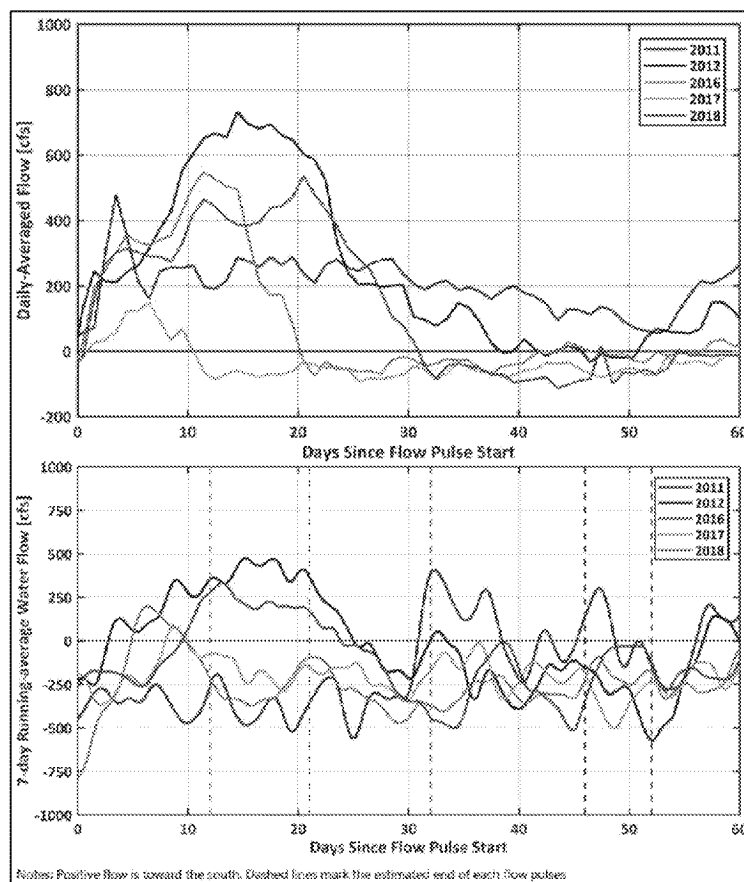
The flow pulse magnitude and duration were different in each of the years simulated (Task 4 Figure 36, top) Each of the years simulated were predicted to have different net flow between the CSC and Cache Slough (Task 4 Figure 36, bottom). In each of the years, the 7-day running-average flow was out of the CSC (Task 4 Question 3) for at least part of the period during the flow pulse (Task 4 Table 9). In 2012 and 2018, the flow was into the CSC at the start of the flow pulse and then transitioned to southward out of the CSC as the flow pulse ramped up. As the flow pulses decreased, the time-averaged flow transitioned to again, be into the CSC. The time-averaged flow in 2016 showed a similar pattern to 2012 and 2018, with the flow northward into the CSC at the start of the flow pulse, transitioning to southward out of the complex, and then transitioning to again be northward into the complex Task 4 Question 1 and 2). However, the southward flow out of the complex was shorter duration and lower magnitude than in 2012 and 2018. The flow pulse in 2011 was longer duration with lower peak flow rates than 2012, 2016, and 2018 (Task 4 Figure 36). The predicted time-averaged flow was northward into the CSC until about 30 days after the start of the flow pulse. The predicted time-averaged flows then switched to southward out of the CSC but trended toward more northward flow until the end of the flow pulse. The flow pulse in 2017 was much smaller than the other years and the predicted time-averaged flow was only toward the south out of the CSC for a very short duration.

Year	Days
2011	16
2012	26
2016	5
2017	2
2018	14

Task 4 Table 9. Number of days the 7-day running-averaged net flow out of Cache Slough was southward during the flow pulse

These similarities and differences in the predicted time-averaged flows result from a combination of differences in the magnitudes of the flow pulses and other factors, such as meteorological, tidal spring-neap, and larger Delta-wide forcing on the net flows between the CSC and Cache Slough. The relatively large flow pulse flow rate at Lisbon Weir (Task 4 Figure 36, top) in 2012 and 2018 helped generate the relatively large time-averaged flows out of the CSC during the flow pulses (Task 4 Question 1 and 2). The relatively short duration of the flow pulse in 2016 relative to 2012 and 2018 likely limits the southward transport out of the CSC relative to 2012 and 2018 (Task 4 Question 3). In 2011, the relatively low-magnitude inflow rate of the flow pulse limited the effectiveness of the flow pulse to generate a net flow southward out of the CSC during the first 30 days of the flow pulse, relative to 2012, 2016, and 2018. However, around 30 days after the start of the flow pulse, conditions other than the magnitude of

the flow pulse changed the predicted net flow southward out of the CSC in 2011. Possible factors affecting the net flow between the CSC and Cache Slough near Ryer Island are a decrease in the North Bay Aqueduct intake rate and rain near the beginning of October (Task 4 Table 3).



Task 4 Figure 36. UnTRIM San Francisco Bay-Delta modeled daily-averaged water flow past Lisbon Weir (top) and 7-day running-average water flow southward out of the Cache Slough Complex (bottom) in each year simulated

The flow pulse water initially reached the analysis locations (Task 4 Figure 11) at a percentage of 0.01% or higher after a similar amount of time in each of the simulated years, except for 2017 (Task 4 Figure Tables 10). Task 4 Figures 37 to 40 also show these similarities and differences in arrival times by the stars indicating the 0.01% threshold clustering close together for 2011, 2012, 2016, and 2018, and the star for 2017 instead being farther after the start of the flow pulse. The flow pulse water was predicted to take 8 to 10 days to reach the most southward Decker Island location (Task 4 Question 3), except 2017, in which the flow pulse water was predicted to arrive 32 days after the start of the flow pulse. This indicates that each of the flow pulses in 2011, 2012, 2016, and 2018 was large enough in magnitude to result in the transport of flow pulse water out of the CSC and farther downstream relatively quickly, while the small magnitude flow pulse in 2017 supplied a very small amount of flow pulse water that was predicted to transit through the study area at percentages above 0.01% much more slowly. The maximum percentage of flow pulse water downstream at Rio Vista was highest in 2012, then 2018, 2011, 2016, and 2017 (Task 4 Table 12; Figure 40). Very little flow pulse water reached Rio Vista in 2017. In 2012 and 2018, the maximum percentage of flow pulse water at Rio Vista occurred during the flow pulse and about 27 days after the start of the flow pulse (Task 4 Question 3). In 2011, 2016, and 2017, the maximum percentage of flow pulse water at Rio Vista occurred after the flow pulse.

Year	Days Since Start of Flow Pulse					
	Bottom of Toe Drain	Lower Liberty Island	Cache Slough	Rio Vista	Decker Island	Three Mile Slough
2011	3	5	5	7	9	11
2012	3	5	6	7	10	11
2016	3	5	5	7	8	10
2017	5	7	10	23	32	33
2018	3	6	7	8	10	11

Task 4 Table 10. UnTRIM San Francisco Bay-Delta modeled day after the start of the flow pulse that flow pulse water reached a given location.

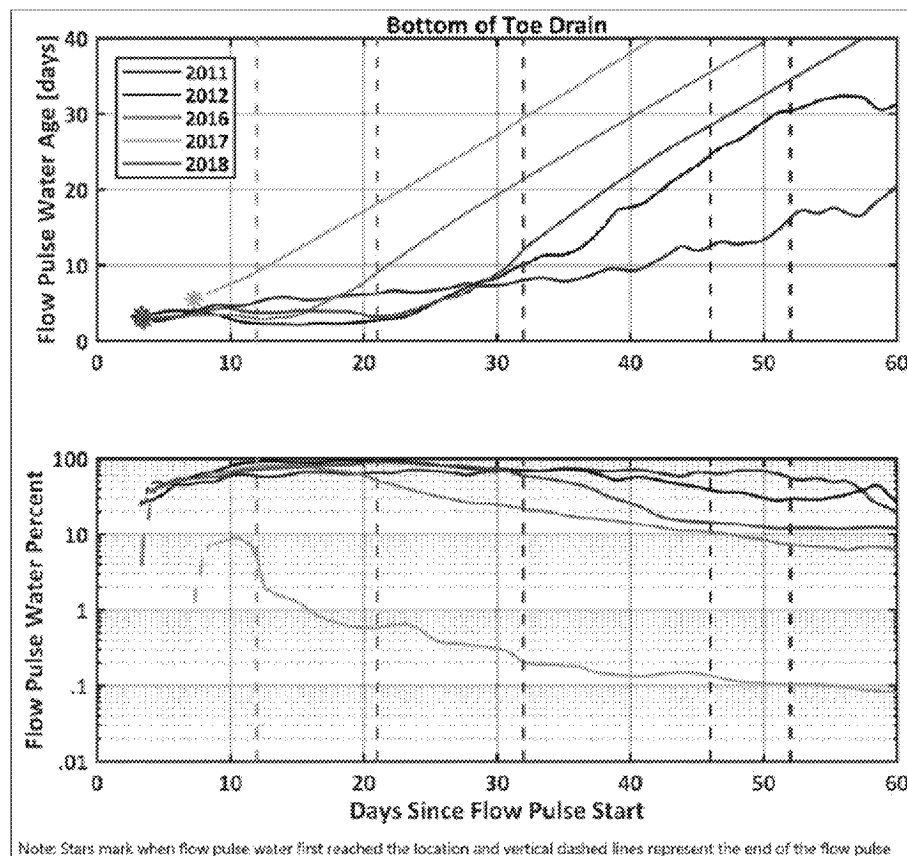
Year	Flow Pulse Water	
	Maximum Percent	Days
2011	2.0	64
2012	4.0	27
2016	1.0	23
2017	0.02	32
2018	2.1	27

Task 4 Table 11. UnTRIM San Francisco Bay-Delta modeled maximum percentage of flow pulse water at Rio Vista and the number of days after the start of the flow pulse the maximum was reached

The age of the flow pulse water at the bottom of the Toe Drain is related to the magnitude of the flow pulse. Around 12 days after the start of the flow pulse, the age of the water is the lowest in 2012, then 2016, 2018, 2011, and the oldest in 2017 (Task 4 Figure 37). This corresponds to the relative order of the rate of inflow of the flow pulses (Task 4 Figure 36). As the flow pulses trail off, the average age of the water then increases, such that 2011 has the youngest water at the bottom of the Toe Drain because the duration of the flow pulse is the longest. The percentage of the flow pulse water at the bottom of the Toe Drain follows a similar but inverse pattern between the years as the water ages. The proportion of flow pulse water was highest in the year with the highest magnitude flow pulse inflow rate (Task 4 Figure 37).

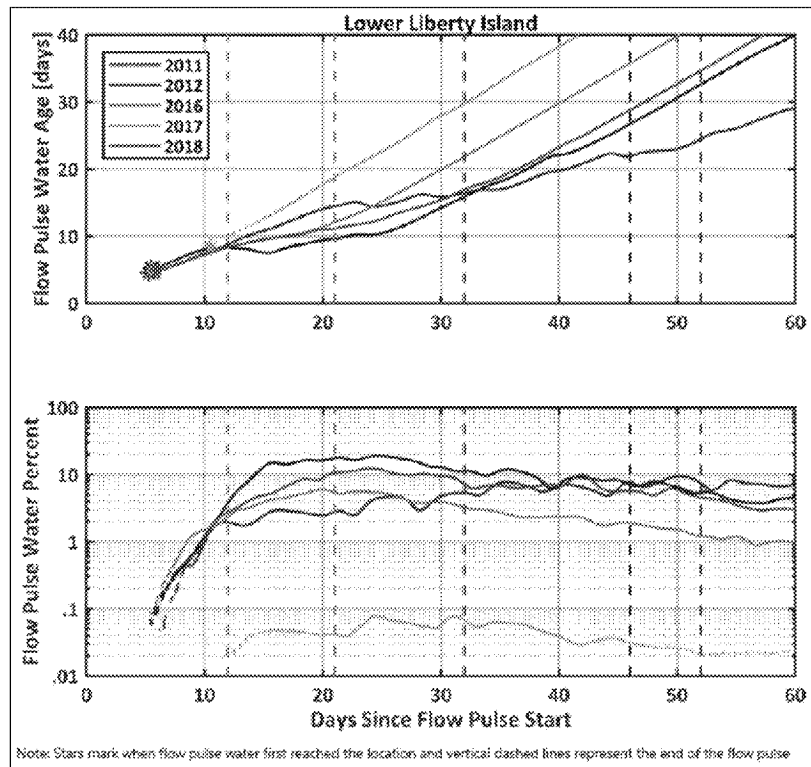
In each of the years simulated, there is a relatively large difference in age between the water at the bottom of the Toe Drain and the water at Lower Liberty Island (Task 4 Figures 37 and 38). This indicates there is a relatively long residence time from the bottom of the Toe Drain to Lower Liberty Island (Task 4 Question 2 and 3). However, the relative order of the age of the water at Lower Liberty Island (Task 4 Figure 38), Cache Slough (Task 4 Figure 39), and Rio Vista (Task 4 Figure 40) between the years follows the same pattern as at the bottom of the Toe Drain (Task 4 Figure 37). The years with the higher flow pulse magnitudes have lower water age and higher flow pulse water percent than the years with lower flow pulse inflow magnitude. The lower water age indicates that the flow pulse water was predicted to reach Lower Liberty Island on average faster than higher water ages. The similarity of the relative order of the years in terms of youngest and oldest water, and percent flow pulse water, results from the relatively large net flows through Cache Slough and the Sacramento River. Once the flow pulse water reaches Lower Liberty Island it is well within a tidal excursion of Cache Slough where the large net

flows can transport the water southward toward Rio Vista (Task 4 Question 3).

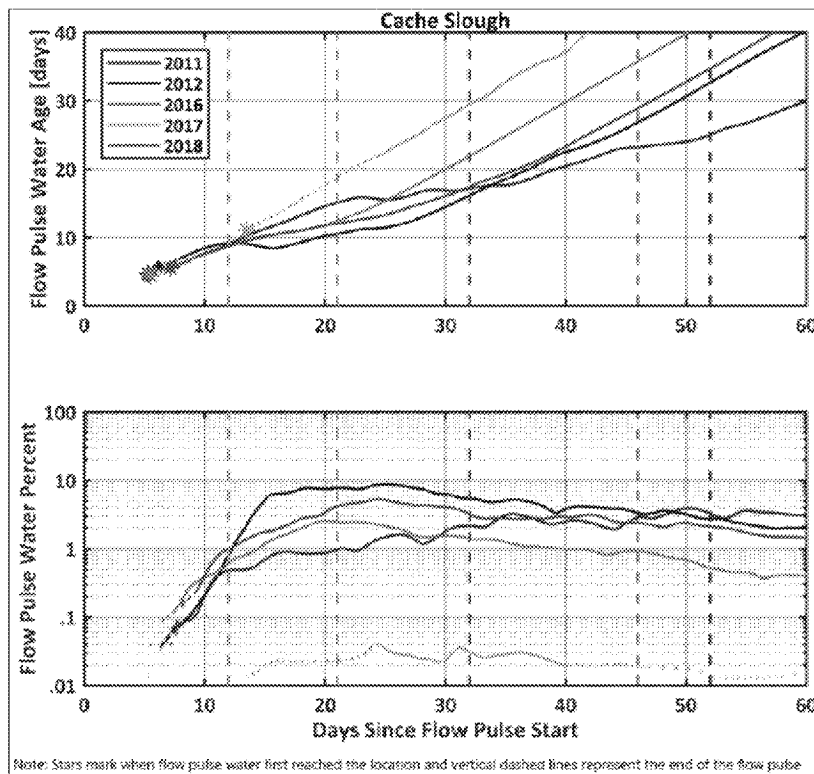


Task 4 Figure 37. UnTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at the bottom of the Toe Drain in all years

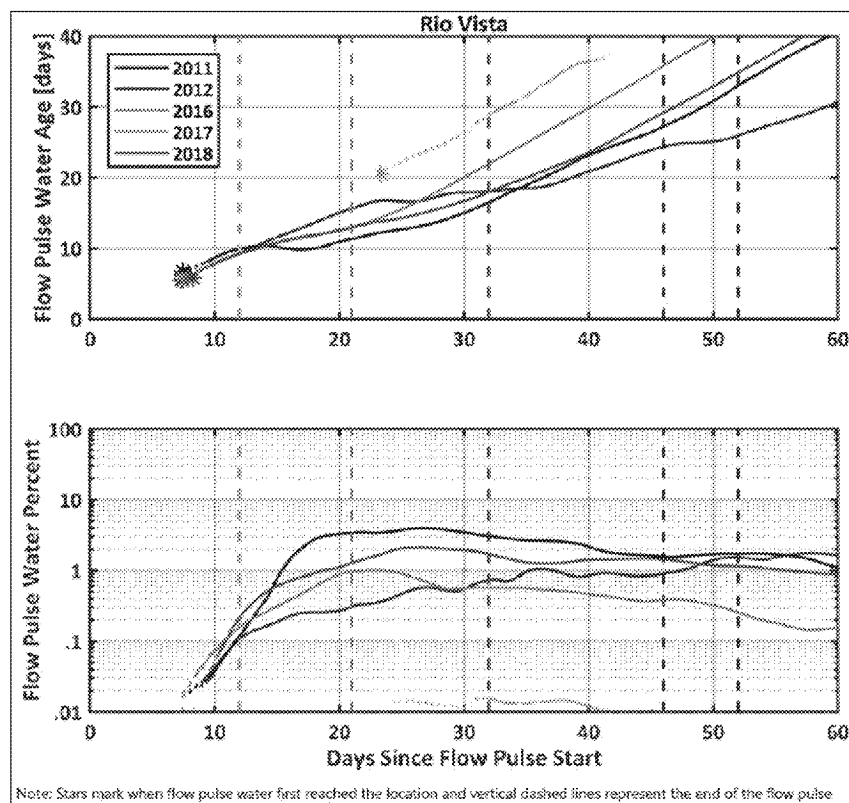
On the first day of each flow pulse, water in Little Holland Tract, Liberty Island, and the CSC channels is tagged with a tracer to investigate the transport of those water masses through the study area (Task 4 Figure 14). Water moving down Miner Slough is continuously tagged from the start of the flow pulse to the end of the simulation. The percent of the water composed of Little Holland Tract, Liberty Island, and CSC channel water is often the highest at the bottom of the Toe Drain and decreases toward Rio Vista. However, in each of the years when the magnitude of the flow pulse is relatively large, the flow pulse water makes up a large percentage of the water at the bottom of the Toe Drain and the percentage composed of the other water masses decreases (Task 4 Figures 37-40). The relatively small percentage of the CSC at the bottom of the Toe Drain during the flow pulse is highlighted when all three of the CSC water masses are added together (Task 4 Figure 37-40). During the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is relatively low, because the southward net flow of water through the Toe Drain restricts the mixing of Miner Slough water northward into the Toe Drain. Following the flow pulse, the percent of the water at the bottom of the Toe Drain that is composed of Miner Slough water is like the percentage at Lower Liberty Island.



Task 4 Figure 38. UnTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at Lower Liberty Island in all years



Task 4 Figure 39. UnTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at Cache Slough in all years



Task 4 Figure 40. UNTRIM San Francisco Bay-Delta modeled tidal-averaged flow pulse water age and flow pulse water percent at Rio Vista in all years

From Lower Liberty Island downstream, the relative proportion between the simulated years of Little Holland Tract, Liberty Island, and CSC channel water at each of the discrete locations is similar to that described for the flow pulse water. The proportion of these water masses at each location is generally highest in 2012, then 2018, 2016, 2017, and lowest in 2011 (Task 4 Figures 37-39). This relative ranking results from the larger magnitude flow pulses resulting in increased transport of these three water masses out of the CSC (Task 4 Question 3), relative to lower-magnitude flow pulses. This increased transport of the CSC water downstream with higher flow pulse magnitudes is highlighted when all three water masses are added together to get the total proportion of the water at a given location composed of water initially in the CSC (Task 4 Figure 37-39). The maximum percentage of CSC water at Rio Vista was highest in 2012, then 2016, 2018, 2011, and 2017 (Task 4 Question 3) and occurred from 4 to 7 days after the start of the flow pulse (Task 4 Table 14).

Adding the flow pulse water to the water initially in the CSC at the start of the flow pulse periods further highlighted similarities and differences between the years (Task 4 Figure 38-39). At the bottom of the Toe Drain, the proportion of water composed of the flow pulse plus CSC water is near 100% for each of the years, except 2017, until about 20 days after the start of the flow pulses. Then, the proportion of water begins to decrease in 2016 because the flow pulse ends. The proportions in 2011, 2012, and 2018 are then similar until their respective flow pulses ramp down and end. From Lower Liberty Island downstream, the highest proportion of water was generally in 2012, then 2018, 2016, and 2011, until about 35 days after the start of the flow pulses. However, the maximum percentage of CSC water plus flow pulse water at Rio Vista was highest in 2012, then 2016, 2018, 2011, and 2017 (Task 4 Table 14). During this period, the proportion of water at each location in 2017 was closest to the proportion in 2011. Following about 35 days after the start of the flow pulses, the proportion of

water from the flow pulse and CSC in 2011 increased relative to the other years because the flow pulse remained relatively high. After about 35 days following the start of the flow pulses, the proportion of water from the flow pulse and CSC at these locations in 2016 and 2017 were similar and continued to decrease. By the end of the flow pulse in 2011, the proportion of water from the flow pulse and CSC at Lower Liberty Island and downstream was similar to 2012 and 2018.

Year	Maximum Percent	Days
2011	5.6	5
2012	8.5	5
2016	7.0	7
2017	4.8	4
2018	6.2	4

Task 4 Table 12. UnTRIM San Francisco Bay-Delta modeled maximum percentage of Cache Slough Complex channel water and Cache Slough Complex channel plus flow pulse water at Rio Vista and the number of days after the start of the flow pulse the maximum was reached

The predicted water age and water percent maps highlight some predicted transport pathways that are similar between all the simulated years. On ebb tide, the flow pulse water being supplied to the CSC through the Toe Drain was transported down the eastern side of the CSC, with limited mixing across Liberty Island to the west (Task 4 Figures 17, 24, and 31). A similar transport pathway on ebb tide of water from Little Holland Tract along the eastern side of Liberty Island is also highlighted in 2017 (Task4 Figure 27). This transport pathway is much more evident in the 2017 map than in the maps for the other years because the 2017 flow pulse is such a short duration that the Little Holland Tract water has not been as mixed throughout the CSC at the end of the flow pulse period as in the other years. The maps highlight that at the confluence of Cache Slough and the Sacramento River, the water traveling down Cache Slough is somewhat confined to the western side of the Sacramento River at least until Rio Vista (Task 4 Question 3). This is shown by the higher percentages of the water masses on the western side of the Sacramento River than on the eastern side. This matches with the general understanding of the mixing of water masses downstream of channel junctions in the Delta (Bever and MacWilliams 2016).

Typically, the net flow between the CSC and Cache Slough near Ryer Island during the low-flow time of year is northward into the CSC. Because of the general northward directed flow into the CSC during the low-flow time of year, the flow pulses need to be large enough to overcome the northward flow to generate net flow out of the CSC. The flow pulses in 2012 and 2018 were predicted to be large enough to create a relatively long duration of net flows out of the CSC (Task 4 Question 1). The flow pulse in 2016 was predicted to be just large enough to generate a net flow out of the CSC (Task 4 Figure 36, bottom). The magnitude of the flow pulse in 2011 was predicted to be large enough to generate a net flow out of the CSC only after a change in conditions unrelated to the flow pulse, possibly a combination of a decrease in the North Bay Aqueduct intake rate and rain near the beginning of October (Task 4 Table 3 and Figure 36). The small flow pulse in 2017 corresponded to only a very small net flow out of the CSC. This analysis of flows out of the CSC suggests that flow pulse magnitude, the rate of water flow past Lisbon Weir, should be in the range of those in 2016 and 2018 to ensure a sustained net flow out of the CSC at some point during the flow pulse.

The analyses of the transport of flow pulse water and CSC water demonstrate that the magnitude

and duration of the flow pulses affect the hydrodynamics of the CSC and the transport of flow pulse water and CSC water out of the CSC and downstream. Larger-magnitude flow pulses (larger downstream flow rates past Lisbon Weir) resulted in higher percentages of both flow pulse water and CSC water out of the CSC downstream to at least Rio Vista. However, the flow pulse in 2011 resulted in a similar percentage of flow pulse and CSC water downstream at the end of the flow pulse as was in 2012 and 2018. This similarity in 2011, 2012, and 2018 at the end of the 2011 flow pulse is because the flow pulse in 2011 was much longer in duration than the other years and eventually “caught up” to 2012 and 2018 in terms of the percentages of flow pulse and Cache Slough Water.

The analyses of water flow and water transport through the study area demonstrate that the flow pulse and hydrodynamics in 2018 were the most similar to the flow pulse in 2012. The shape of the flow pulse hydrograph and inflow rates were most similar between 2012 and 2018. The effects of the 2018 flow pulse on net water flow out of the CSC and the transport of both flow pulse water and CSC water downstream to Cache Slough, Rio Vista, and Decker Island was also the most similar to 2012. One difference between 2012 and 2018 is that the flow pulse ramped down more slowly in 2012 than in 2018, which may have effects on the average age of the water at Lower Liberty Island and residence time in Liberty Island during the trailing end of the flow pulse.

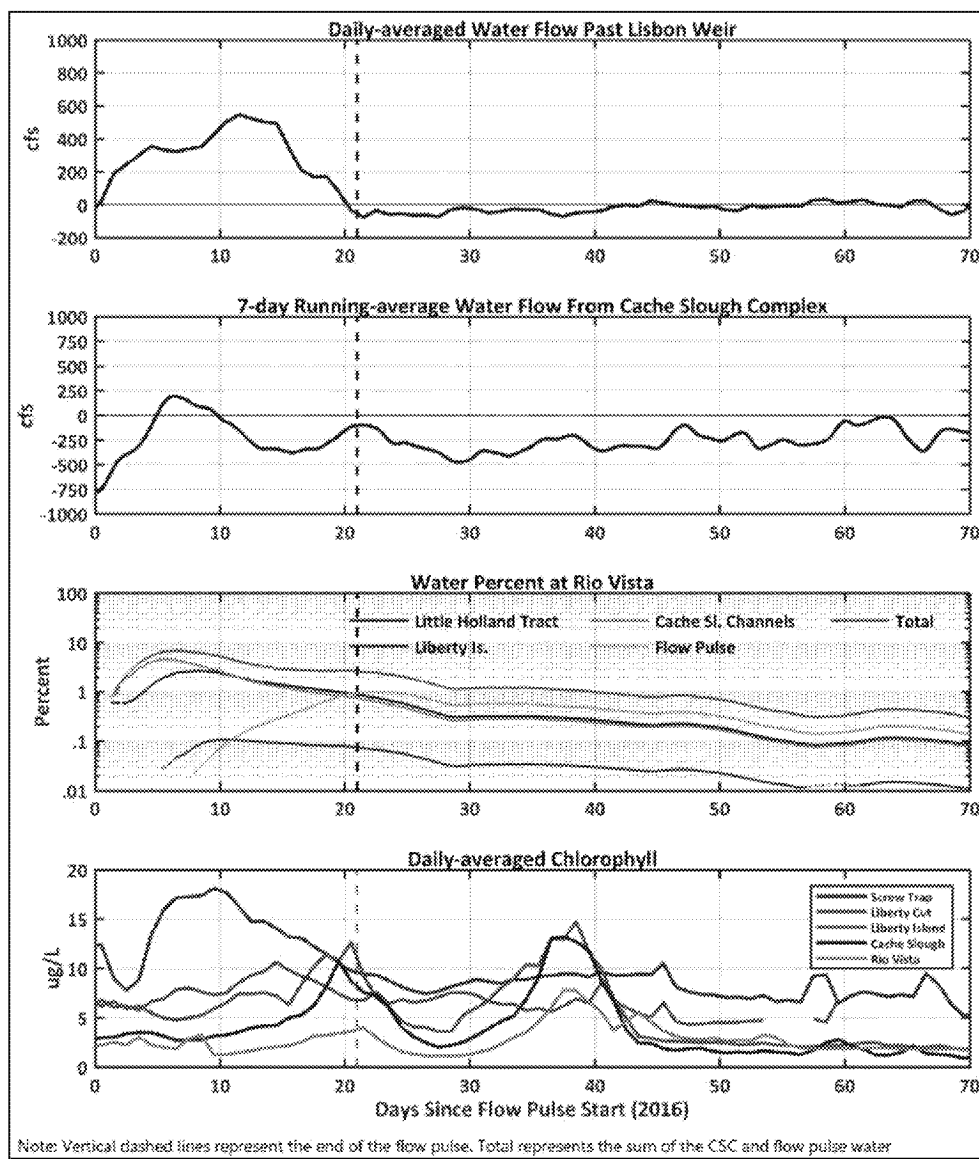
Comparison of chlorophyll concentration to modeled tracer transport

Flow pulses through the Toe Drain in 2011, 2012, and 2016 are believed to have resulted in phytoplankton blooms and increased food production for fishes downstream of the CSC (Frantzi et al. 2018). This section of the report presents a general comparison of hydrodynamics, the percent of water at Rio Vista composed of CSC and flow pulse water and observed chlorophyll *a* concentration for these 3 years when phytoplankton blooms occurred, and for 2017 and 2018 when blooms did not occur.

Chlorophyll data was available at more locations in 2016 than in 2011 and 2012. The chlorophyll *a* concentration in the Toe Drain at Screw Trap increased in the middle of the flow pulse and then slowly decreased (Task 4 Figure 41). Chlorophyll *a* concentration at Liberty Cut toward the northern end of Liberty Island increased during the flow pulse and then slowly decreased (Task 4 Question 3 and 4). Two peaks in chlorophyll *a* concentration was observed at Liberty Island, Cache Slough, and Rio Vista. The first peak closely followed the trailing down of the flow pulse and the second occurred about 15 days after the flow pulse ended.

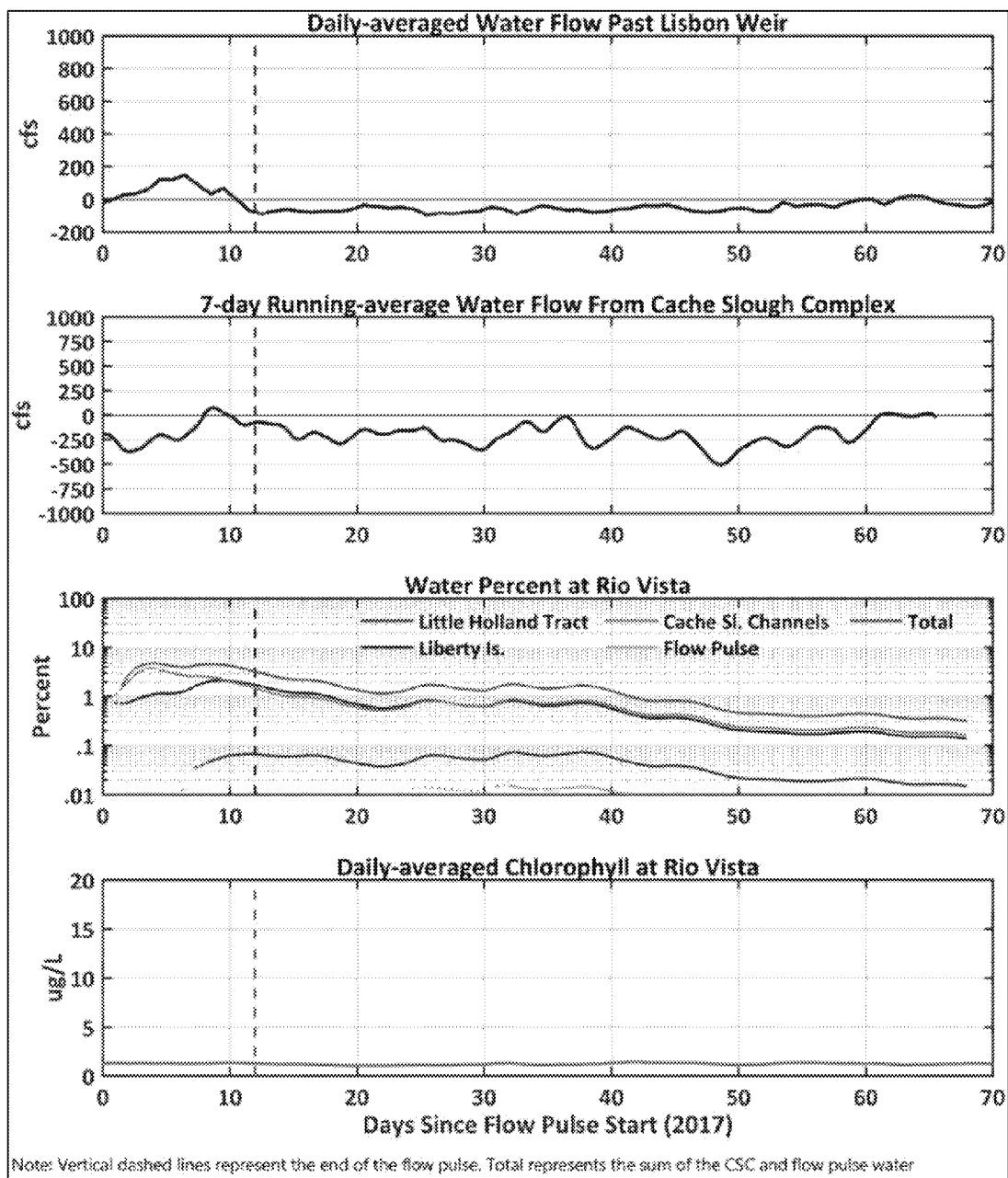
The 7-day running average flow was predicted to be directed out of the CSC for only a short period between 5 and 10 days after the start of the flow pulse in 2016. For the remainder of the analysis period, the 7-day running average flow was into the CSC. Increases in the chlorophyll *a* in Liberty Island peaked about 21 and 38 days after the start of the flow pulse and correspond to peaks in observed chlorophyll *a* downstream in Cache Slough and at Rio Vista (Task 4 Question 3 and 4).

Time-averaged water flow was predicted to be directed out of the CSC for only a short period between 8 and 9 days after the start of the flow pulse in 2017. For the remainder of the analysis period, the 7-day running average flow was into the CSC. The small flow pulse in 2017 resulted in a much lower percentage of water from the flow pulse and from CSC that was transported downstream to Rio Vista (Task 4 Figure 42). In 2017, an increase in chlorophyll *a* at Rio Vista was not observed during or following the flow pulse (Task 4 Question 3 and 4).

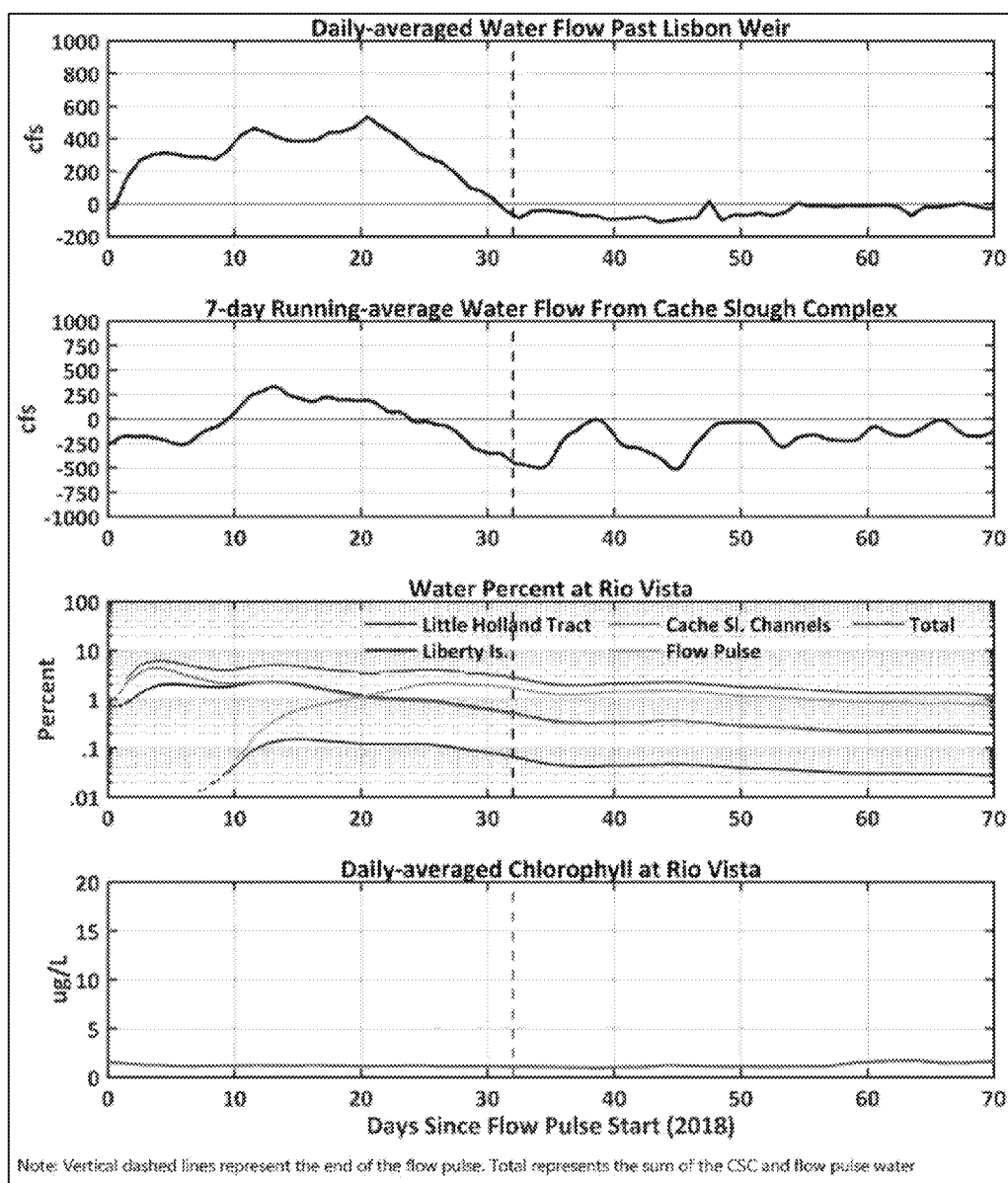


Task 4 Figure 41. 2016 UnTRIM San Francisco Bay-Delta modeled hydrodynamics and total chlorophyll ($\mu\text{g/L}^{-1}$) fluorescence

Time-averaged water flow was predicted to be directed out of the CSC for the period between 10 and 25 days after the start of the flow pulse in 2018. The proportion of flow pulse water at Rio Vista peaked shortly after the predicted reversal of the 7-day running-averaged flow from out of the CSC to into the CSC about 25 days after the start of the flow pulse (Task 4 Figure 43). In 2018, an increase in chlorophyll *a* at Rio Vista was not observed during or following the flow pulse (Task 4 Question 3 and 4).



Task 4 Figure 42. 2017 UnTRIM San Francisco Bay-Delta modeled hydrodynamics and total chlorophyll ($\mu\text{g/L}^{-1}$) fluorescence



Task 4 Figure 43. 2018 UnTRIM San Francisco Bay-Delta modeled hydrodynamics and total chlorophyll ($\mu\text{g/L}^{-1}$) fluorescence

Task 4. Conclusion:

The WY types varied between study years from drought (2016) to record wet (2017) conditions in the Sacramento Valley. These preceding conditions were influential in the amount of tributary inflow and the water management strategies in both the Sacramento River and the Yolo Bypass. Our study covered three very different water management outflow strategies from a summer managed flow pulse using primarily Sacramento River water sources in 2016, to unmanaged outflow year in 2017, and a fall positive flow pulse year using agricultural tailwater in 2018. These varied strategies resulted in very different positive outflow timing, velocities, and total discharge volumes.

In 2016, the flow pulse occurred over a short period of two weeks from July 14-August 1 and flows reached moderate max outflows rates of just over 500 CFS. This short duration restricted net discharge volume to 12,700 AF as measured at LIS gauge. In 2017, as a result of in channel construction in Ridge Cut Slough to build the new Wallace Weir facility, there was no managed flow pulse through the Yolo Bypass. Although there was no managed action there was a short positive outflow period in September as a result of local Yolo Bypass rice-field drainage during the harvest period. This flow pulse lasted 10-days from September 9-18 and reached a daily net positive outflow of 125 CFS at the LIS and a total discharge volume of only 1,022 AF. In 2018, with the completion of the new Wallace Weir structure, we chose to target a fall managed flow pulse utilizing exclusively agricultural tailwater during the rice harvest period in the northern Sacramento Valley. The fall flow pulse reached a max daily net positive outflow of 548 CFS lasted approximately 4-weeks from August 28-September 26. The total flow discharge volume was 19,821 AF.

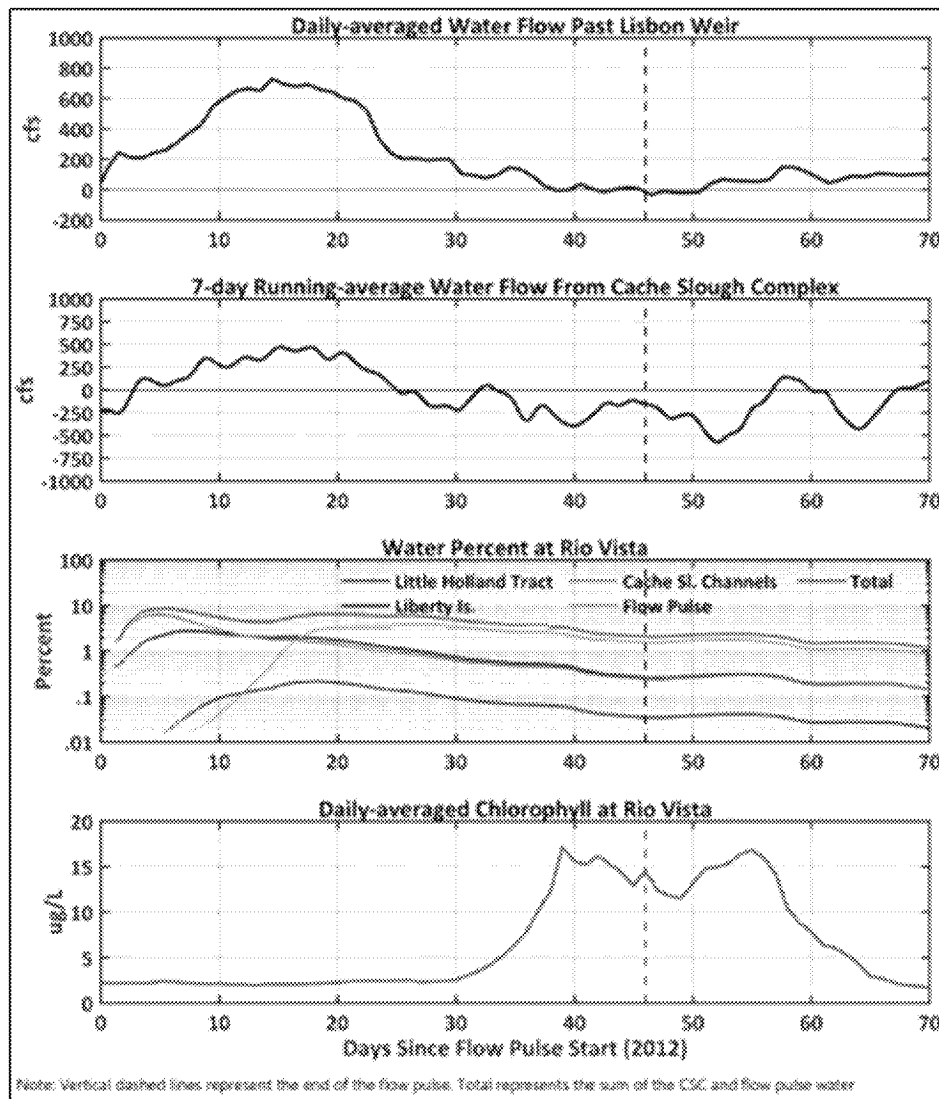
In the managed flow pulse years of 2016 and 2018, there was evidence of changes in nutrients and Chl a concentration in downstream regions as water sources were exported from north to south. The Lower Yolo Bypass, especially site LIS, showed drastic changes in water chemistry during the flow pulse events, as high nutrient and Chl a water sources in the northern Bypass moved downstream. The flow pulse in 2016 showed the largest footprint as high ambient Chl a throughout the Lower Yolo Bypass and CSC were moved down into the Lower Sacramento River region at site RVB. The flow pulses also resulted in changes in other physical water quality parameters, as water temperatures and water clarity changed by flow pulse timing and water source used. Water temperatures remained higher in the summer months utilizing Sacramento River water sources, while fall agricultural return water was lower in water temperature. Unexpected, the flow pulses resulted in increased water clarity as Secchi depth was lower during the flow pulses.

UnTRIM San Francisco Bay-Delta Model

While flows vary on both tidal and spring-neap cycles, during summer and fall, net flows are often northward into the CSC. This results primarily because observed flows are net northward over the Lisbon Weir, corresponding to a net diversion of water northward of the weir, there is a net export out of the CSC from the North Bay Aqueduct, and there is a net loss of water from the CSC resulting from the combination of evaporation and other local diversions within the CSC (represented in the model through DICU). For a flow pulse down Tule Canal into the Toe Drain to create a net flow of water out of the CSC, the flow pulse must be large enough to exceed the net upstream flow resulting from these three components.

During each flow pulse, there are periods when the tidally-averaged net flows are into the CSC, and periods when the tidally-averaged net flows are out of the CSC (e.g., Task 4 Figure 16, middle panel). Over longer-timescales, the 7-day running average flow provides a measure of the duration of the periods when net outflows from the CSC were dominant. The number of days that the 7-day running-average net flow was predicted to be out of the CSC ranged from 2 days in 2017 to 26 days in 2012 (Task 4 Table 9). The flow pulses in 2011 and 2018 were predicted to have a 7-day running average net flow out of the CSC for 16 and 14 days, respectively. The flow pulse in 2016 was predicted to be just large enough to generate a 7-day running average net flow out of the CSC for 5 days. The magnitude of the flow pulse in 2011 was relatively low compared to other years, but extended over a longer period. The flow pulse in 2011 generated a net 7-day running-average flow out the CSC only during the beginning of October when the exports from the North Bay Aqueduct were low and precipitation occurred. The small flow pulse in 2017 corresponded to only a very small and short duration net flow out of the CSC. This analysis suggests that the magnitude of the flow pulse past Lisbon Weir needs to be maintained at approximately 400 to 500 CFS in order to result in a

sustained period when the predicted 7-day running-average flow is out of the CSC, based on the net upstream flow resulting from the North Bay Aqueduct exports, DICU in the Cache Slough Complex, and typically, northward net flows at Lisbon Weir prior to the start of the flow pulses evaluated.



Task 4 Figure 44. 2012 UnTRIM San Francisco Bay-Delta modeled hydrodynamics and total chlorophyll ($\mu\text{g/L}$) fluorescence.

The analyses of the transport of flow pulse water and CSC water demonstrate that the magnitude and duration of the flow pulses affect the hydrodynamics of the CSC and the transport of flow pulse water and CSC water out of the CSC and downstream. Larger magnitude flow pulses with longer periods when the net flow was southward out of the CSC resulted in more transport of both flow pulse water and CSC water out of the CSC downstream past Rio Vista. The export of the water initially in the CSC occurred relatively quickly following the beginning of the flow pulse, such that the largest percentage of water originating in the CSC reached Rio Vista between 4 and 7 days following the beginning of the flow pulse (Task 4 Table 12). The highest percentages of water originating in the CSC were predicted to occur at Rio Vista in 2012 (8.5%) and in 2016 (7%), while the maximum percentage ranged from 4.8% to 6.2% in the other 3 years (Task 4 Table 12).

During the flow pulse, the age of the incoming water from the flow pulse increased with distance downstream from the Toe Drain. Following the transition of the flow from out of the CSC to into the CSC at the end of the flow pulse, the water age at Lower Liberty Island increased to be more similar to the age at Rio Vista, and there was less variation in age of the flow pulse water moving downstream. This increase in water age at Lower Liberty Island indicates an increase in residence time in Liberty Island once the flow pulse ended and the net flows were again dominantly into the CSC. The increase in residence time following the peak of the flow pulse may provide the necessary conditions for a phytoplankton bloom in southern Liberty Island and then the transport of phytoplankton biomass to Cache Slough on each tidal cycle.

The analyses of water flow and water transport through the study area demonstrate that the flow pulse and hydrodynamics in 2018 were similar to the flow pulse in 2012. The shape of the flow pulse hydrograph and the flows at Lisbon Weir were most similar between 2012 and 2018. The effects of the 2018 flow pulse on net water flow out of the CSC and the transport of both flow pulse water and CSC water downstream to Cache Slough, Rio Vista, and Decker Island was also similar between 2012 and 2018. One difference between 2012 and 2018 is that the flow pulse generated a longer period when the 7-day running-average flow was out of the CSC in 2012 (26 days) than in 2018 (14 days). In addition, the flow pulse ramped down more slowly in 2012 than in 2018, which may have affected the increase in residence time in Liberty Island on the trailing end of the flow pulse. Despite these similarities in hydrodynamics between 2012 and 2018, the 2018 flow pulse did not result in a phytoplankton bloom downstream (Task 4 Figure 43), while the 2012 flow pulse did (Task 4 Figure 44). The lack of an increase in chlorophyll *a* at Rio Vista in 2018 suggests that, although the hydrodynamic conditions were similar between 2012 and 2018, either the phytoplankton dynamics, nutrient inputs, or other factors differed between 2012 and 2018 such that the necessary biological conditions for a bloom to form were present in 2012 but did not occur in 2018.

VI. Task 5 (Zooplankton): Measure zooplankton densities, grazing impacts, and production within each sampling region

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Task 5. Background:

There is substantial evidence that the pelagic community within the Delta is highly driven by phytoplankton production (Kimmerer et al. 2005; Muller-Solger et al. 2002; Sobczak et al. 2005; Sobczak et al. 2002). Studies within the CSC by Benigno et al. (in review) have identified considerably higher levels of Chl a than other IEP Environmental Monitoring Program (EMP) stations and subsequently higher levels of calanoid copepods (Sommer and Mejia 2013). Initial results from both 2011 and 2012 from fall zooplankton tows in the Yolo Bypass have shown significantly higher densities of both cladocera and calanoid copepods because of fall phytoplankton blooms (Frantzich et al. 2018).

The Yolo Bypass has shown evidence of increased phytoplankton biomass during floodplain inundation (Schemel et al. 2004), with draining events contributing to the accumulation of large diameter diatoms and green algal cells (Lehman et al. 2008). Recent evidence from Chl a data collected by the DWR Yolo Bypass Fish Monitoring Program in 2011-2013, has also shown increased fall phytoplankton biomass and subsequent high densities of zooplankton within the Yolo Bypass (Frantzich et al. 2018). More importantly copepods and cladocerans comprised most of the species that were observed in the samples post fall flow pulses. This is significant as they comprise a significant portion of the diet of larval and post-larval pelagic fishes, including Delta smelt (Moyle 2002; Nobriga 2002; Sommer and Mejia 2013). It is essential to obtain a better spatial representation of the zooplankton communities in these regions to not only determine their effects on phytoplankton biomass, but also their availability to pelagic fishes downstream of the Yolo Bypass.

Task 5. Research Questions:

1. What are the densities of zooplankton within each region described in the conceptual model during the summer/fall?
2. What is the predominant species composition and size classes of the zooplankton communities within each region during the summer/fall?
3. Does the fall flow pulse in the Yolo Bypass facilitate an increase in the densities and production (i.e. growth and reproductive rate) of zooplankton downstream into the Cache Slough Complex and lower Sacramento River?

Task 5. Methods:

Zooplankton Composition and Enumeration

To determine the species composition and densities of zooplankton within each region of the conceptual model, half meter 150-micron mesh plankton nets affixed with General Oceanic's Flow meters was used to collect a representative sample. The zooplankton net was submerged just below the surface at a fixed position or towed by boat for a minimum of 5 minutes. Samples were collected every other week by DWR staff from July – October before, during and after during the flow action period targeting the ebb

tide in the tidally influenced regions. The samples were collected and analyzed at six sites: 1.) Lisbon Weir (LIS); 2.) Toe Drain at Screw Trap (STTD); 3.) Prospect Slough (BL5); 4.) Cache Slough at Liberty Island (LIB); 5.) Cache Slough at Ryer Island (RYI); and 6) Sacramento River at Rio Vista (RVB) (Figure 1). Samples were preserved and later sorted and counted by BSA Environmental, Inc. under an ongoing contract with the DWR Yolo Bypass Fish Monitoring Program. Sample collection and sorting will follow the same protocol as the current methods used by DWR Yolo Bypass Fish Monitoring Program for their year-round sampling in the Yolo Bypass and Sacramento River.

Zooplankton Growth, Reproductive, and Grazing Rate

The Kimmerer laboratory investigated the growth rate of zooplankton using the artificial cohort method (Kimmerer and McKinnon 1987), previously applied to measure growth of *P. forbesi* and *Eurytemora affinis* in the low-salinity zone (Kimmerer et al. 2014). The artificial cohort experiments (6 replicates and 6 initials, at one size class) occurred at 4 stations (sites: LIS, STTD, BL5 and RYI) each month over the sampling period. This required the collection of a 150 micron-mesh surface tow zooplankton sample at each site that was size fractionated for the preferred size range, and those samples will be incubated for 24hrs and 48hrs by size fractions to obtain growth rate. The feeding rate will then be estimated from the growth rate by artificial cohort, and through the analysis of previous feeding experiments along with paired samples of phytoplankton abundance and taxonomic composition.

In addition, the Kimmerer lab will determine reproductive rate by the egg ratio method (Edmondson 1962) using estimates of temperature-dependent egg development time (Sullivan and Kimmerer 2013). This will require taking separate zooplankton samples at each station and counting enough females and their eggs to constrain the egg ratio (eggs: female; see Gould and Kimmerer 2010, Kimmerer et al. 2014). Additional measurements of particulate matter, notably lipid analyses and flow cytometry, will also occur to try and determine the conditions that can lead to high and/or low growth rates.

Task 5. Results and Discussion:

Over the three years 2016-18, a total of 117 zooplankton samples were collected every other week from July-October and enumerated from six sites that covered the three downstream regions (Figure 1): 1) Lower Yolo Bypass Region (Site: LIS and STTD); 2) Cache Slough Region (Site: BL5, LIB, RYI); 3) Lower Sacramento River Region (Site: RVB). We selected these sites for this analysis due to their overlap with known year-round residency of Delta smelt (Sommer and Mejia 2013). Data was also grouped into summer (July and August) and fall (September and October) seasons for comparison. Data was further grouped into the primary mesozooplankton groups: Cladocerans, Cyclopoids copepods, and Calanoid copepods, due to their prevalence in Delta smelt diets (Nobriga 2002). All zooplankton results are reported as the number per cubic meter for each mesozooplankton taxon group using the following equation:

$$N = ((C/S)/V)$$

N = the number of a taxon per cubic meter of water sampled

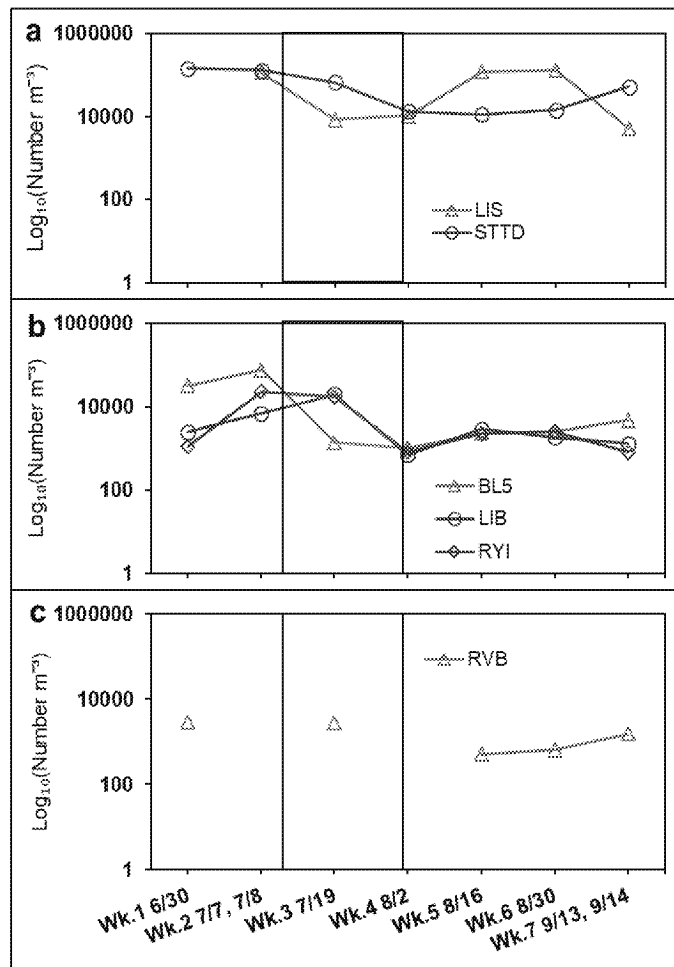
C = the total number of a taxon counted for the sample

S = the total subsample volume

V = the volume of water sampled through the net (m³)

Historical zooplankton enumeration data (total of 92 samples) from July-October 2013-2015 was also included in this analysis to determine differences in the spatial and temporal taxa grouping response to unmanaged (2013-2015 and 2017) and managed (2016 and 2018) flow pulses.

Zooplankton taxon group data was log-transformed and data for all years for summer and fall seasons was analyzed using analysis of similarities (ANOSIM) to determine the significant difference in zooplankton catch totals between the past six-years of study.

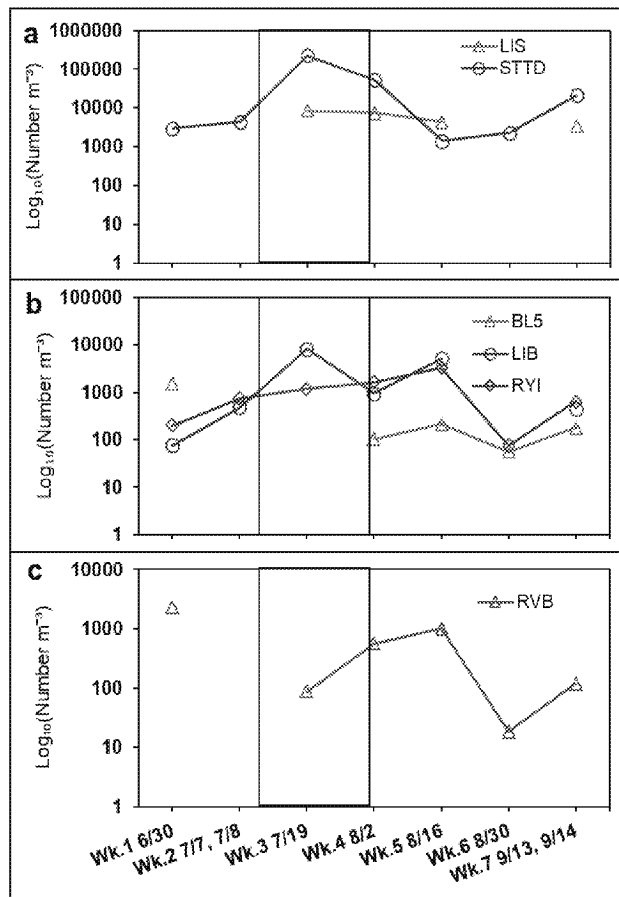


Task 5 Figure 1. 2016 total (Log base 10) number of cladoceran zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the managed net positive flow pulse time period.

2016

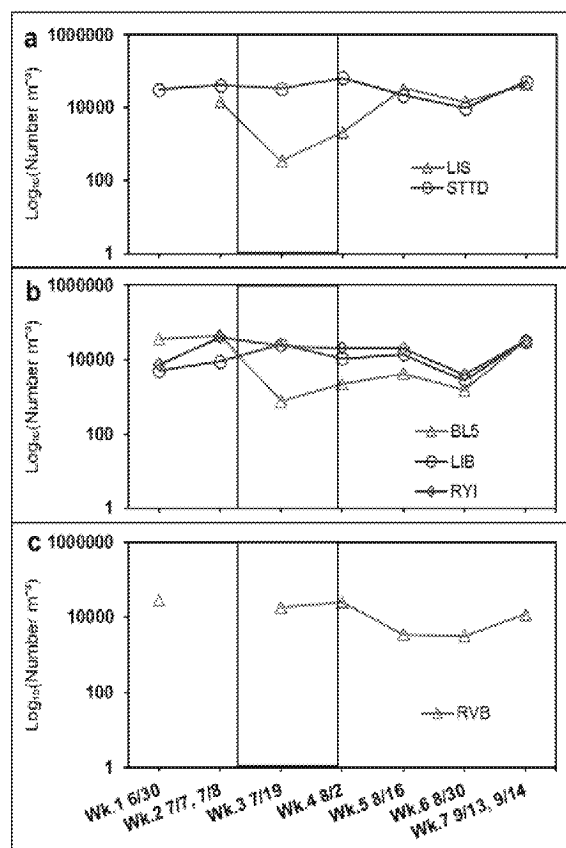
In 2016, DWR collected 30 zooplankton samples in the summer (July-August) and only 10 samples in fall (September-October). Monitoring efforts were focused on sampling before, during, and after the first managed DSRS North Delta Flow Action that occurred from July 14-August 1 (Task 4 Figure 3).

Samples were collected twice before (Wk.1 6/30 and Wk. 2 7/7-8) and twice during (Wk. 3 7/19 and Wk. 4. 8/2), and three times after (Wk. 5 8/16, Wk. 6 8/30, Wk. 7. 9/13-14) the flow pulse.



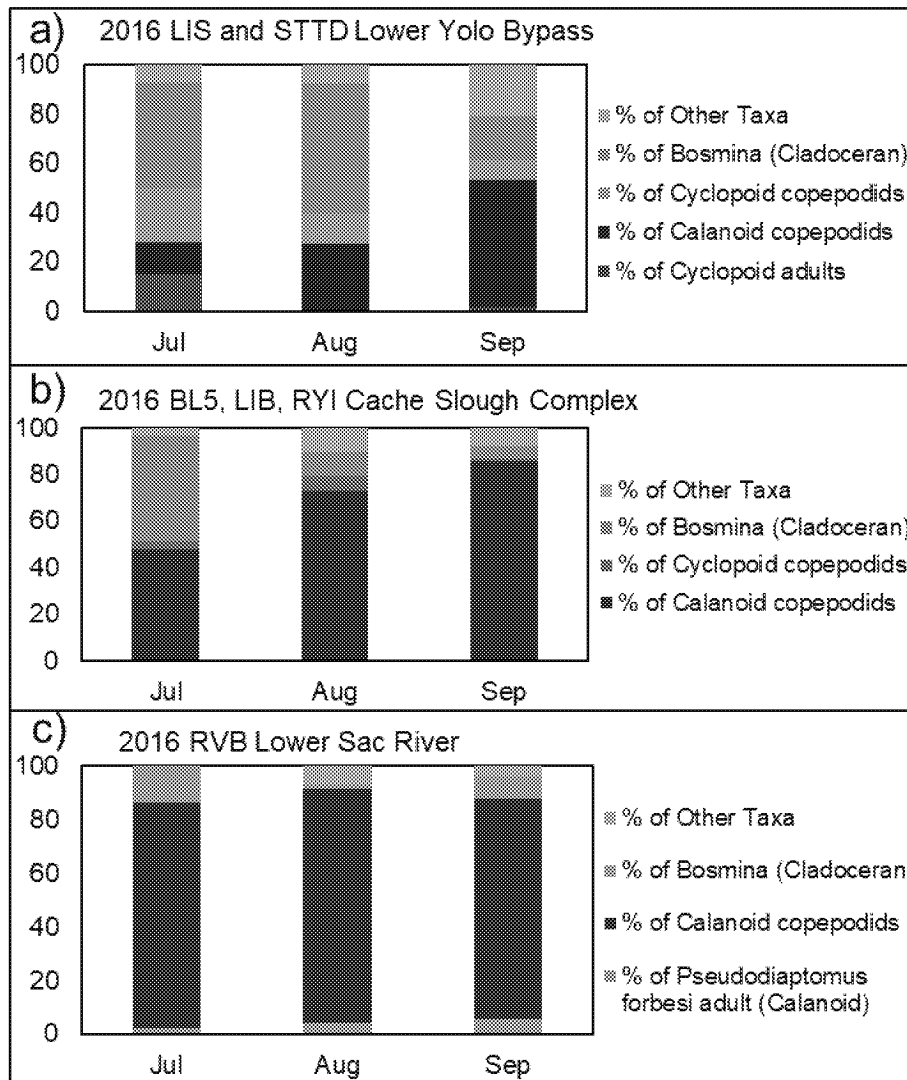
Task 5 Figure 2. 2016 total (Log base 10) number of cyclopoid zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the managed net positive flow pulse time period.

Prior to the managed flow pulse cladocera and calanoid copepod densities were high in all regions (Task 5 Figure 1a, 1b, 1c and 3a, 3b, 3c). During the managed flow pulse densities of cladocerans and calanoids decreased in the Lower Yolo Bypass (Task 5 Question 1), this is likely as result of reduced water residence time and transport of these zooplankton into downstream habitats. Zooplankton and phytoplankton are known to be at higher densities in the lower velocity and warmer back water habitats of the estuary (Lopez et al. 2006). Calanoid copepods are known to be negatively correlated with high flows in the Yolo Bypass and other regions of the Delta (Sommer et al. 2004). There was however some evidence of increased calanoid copepod densities in the Cache Slough Complex Region (site LIB) during the managed flow pulse (Task 4 Figure 3b) and sustained high densities in the Lower Sacramento River Region (Task 5 Question 1 and 3), suggesting some downstream transport from upper island and channel habitats. Cyclopoid copepod densities were very low in the Lower Yolo Bypass Region and Cache Slough Complex before the flow pulse, but densities increased in both regions during the managed flow pulse (Task 5 Question 3), as high as 50-fold at site STTD (Task 4 Figure 2a, 2b). Similar to cladocerans and calanoids the managed flow action seems to aid in the transport of higher densities of cyclopoid copepods in the upper high residence tidal and non-tidal slough channels into the Bypass and Cache Slough Complex into the larger downstream channel habitats.



Task 5 Figure 3. 2016 total (Log base 10) number of calanoid zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the managed net positive flow pulse time period.

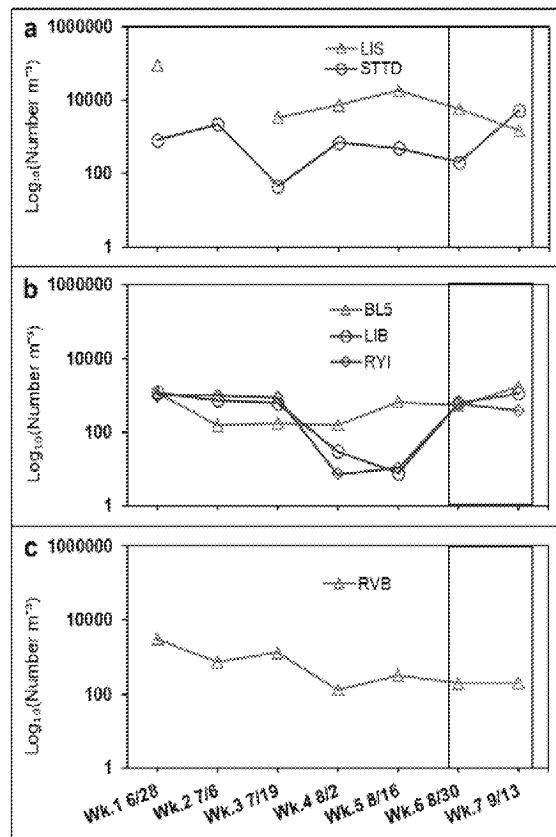
After the flow pulse ended, the densities of both cladocerans and calanoids increased at the upper most site LIS in the Lower Yolo Bypass Region (Task 4 Figures 1a and 3a). Calanoid copepod densities maintained similar levels in the Lower Yolo Bypass at site STTD and at all sites in Cache Slough Complex region post flow pulse (Task 4 Figures 3a and 3b). Cyclopoid densities in the Lower Yolo Bypass Region remained low after the flow pulse, but the Cache Slough Complex and Lower Sacramento River Regions observed 2-5-fold increases (Task 4 Figures 2a, 2b and 2c).



Task 3 Figure 4. 2016 region monthly zooplankton taxa total CPUE by group and % of taxa making up $\geq 3\%$ of total CPUE. Regions: a) Lower Yolo Bypass (site LIS and STTD), b) Cache Slough Complex (site BL5, LIB, RYI), and c) Lower Sacramento River (site RVB).

In 2016, the Lower Yolo Bypass region during the flow pulse months of July and August was composed primarily by the cladoceran *Bosmina* (Task 5 Question 2), making up $\geq 43\%$ of the total CPUE (Task 5 Figure 4a). There was also a higher contribution of cyclopoids (primarily cyclopoid copepodites) in these summer months and this was likely as a result of net transport of these smaller more freshwater taxa from the upper Yolo Bypass channels into the lower tidal reach of the Yolo Bypass Toe Drain (Task 5 Question 2). In September, well after the flow pulse the composition was much more dominated by the larger and more common estuary zooplankton taxa calanoid copepodites, making up $> 50\%$ of the total CPUE (Task 5 Figure 4a). The Cache Slough Complex region had a similar trend to the Lower Yolo Bypass region, with a higher contribution of the cladoceran *Bosmina* and cyclopoid copepodites during the flow pulse (Task 5 Figure 4b). Although, calanoid copepodites were still the primary taxa in all study months in the Cache Slough Complex (Task 5 Question 2), making up as high as 85% of the total CPUE in September (Task 5 Figure 4b). The Lower Sacramento River region total CPUE was composed almost entirely by

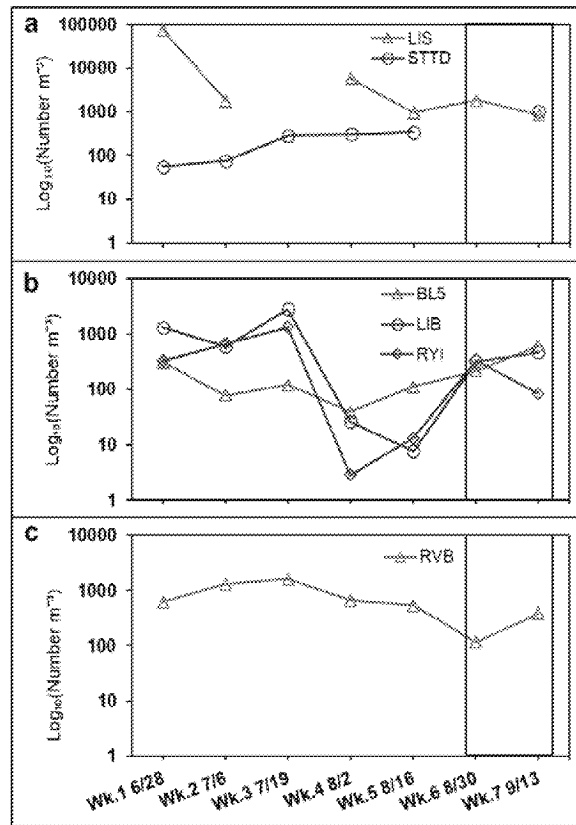
calanoid copepodites at over 80% in all study months. The calanoid copepod *Pseudodiaptomus forbesi* adult life-stage were also a higher contributor to the total CPUE than the other regions (Task 5 Figure 4c).



Task 5 Figure 5. 2017 total (Log base 10) number of cladoceran zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the fall net positive flow pulse time period

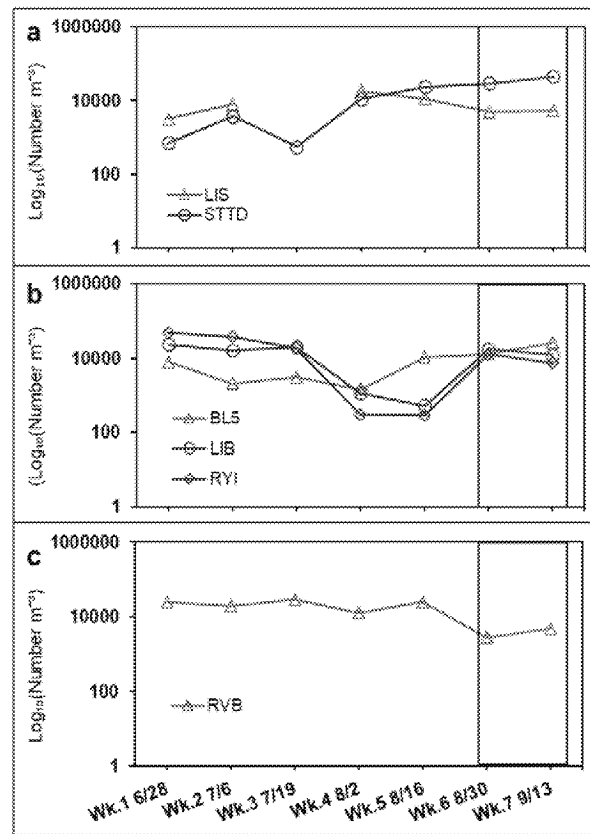
2017

In 2017, DWR collected 29 zooplankton samples in the summer (July-August) and 13 samples in fall (September-October). Although, there was no managed flow action in 2017, monitoring efforts were focused on overlapping sampling timing with 2016 DSRs North Delta Flow Action for data comparison. Samples were collected twice before (Wk.1 6/28 and Wk. 2 7/6) and twice during (Wk. 3 7/19 and Wk. 4. 8/2), and three times after (Wk. 5 8/16, Wk. 6 8/30, Wk. 7. 9/13) the timing of the 2016 flow pulse. Note, there was still a short but positive net flow pulse that occurred in the fall September 9-18, from local agricultural (primarily rice-field) discharge (Task 4 Figure 2).



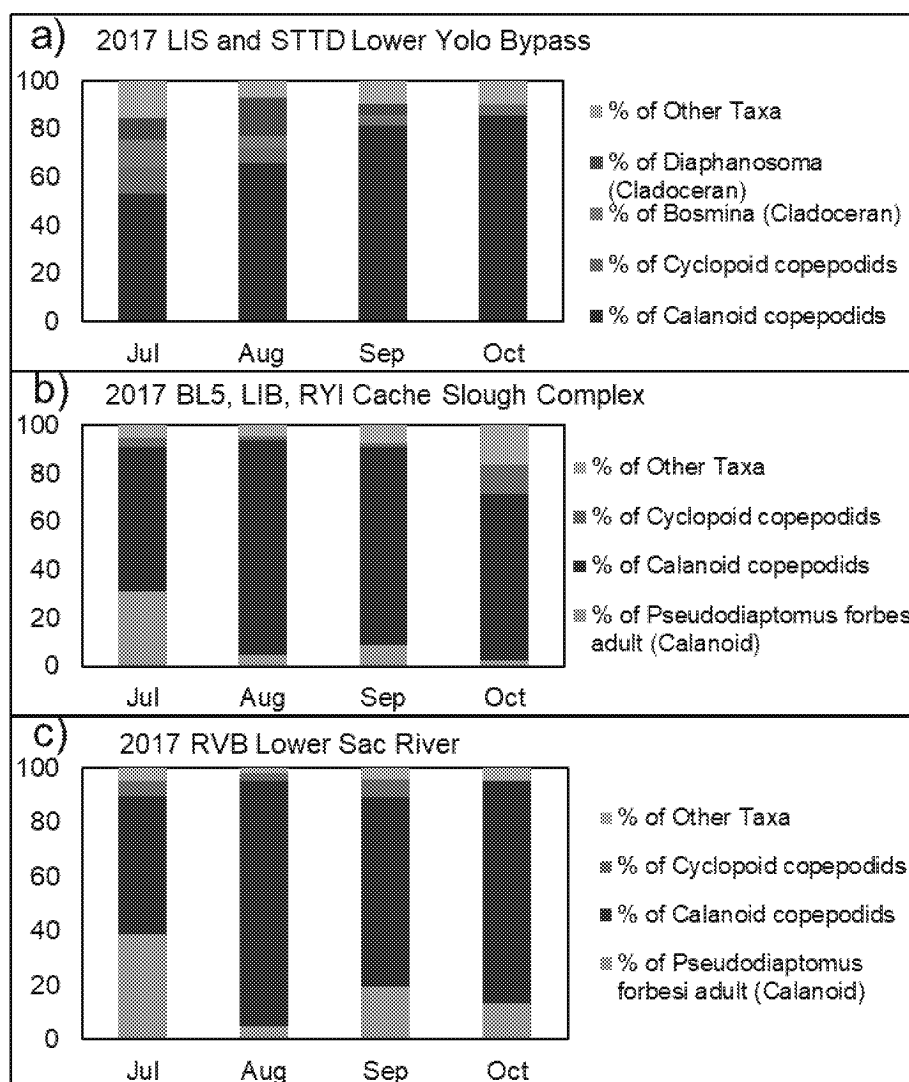
Task 5 Figure 6. 2017 total (Log base 10) number of cyclopoid zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the fall net positive flow pulse time period.

The densities of cladocerans, cyclopoids, and calanoid copepods maintained relatively high levels (Task 5 Question 1) through the early part of the summer months of June-July in all regions (Task 5 Figures \5, 6,7). There was however an evident decline in all three zooplankton groups in Cache Slough Complex in the month of August, especially at the more downstream sites LIB and RYI (Task 5 Figure 5b, 6b, 7b). The upper tidal channel habitats within the Lower Yolo Bypass maintained relatively high densities throughout the summer and fall months (Task 5 Figure 5a, 6a, 7a). The record rain-fall, prolonged floodplain inundation and higher flows in the Yolo Bypass Toe Drain into early June, was likely an important factor in maintaining connectivity with the important nutrient and phytoplankton rich sources from upper tributaries (Frantzich et al. 2018; Schemel et al. 2004), benefiting zooplankton growth and survival.



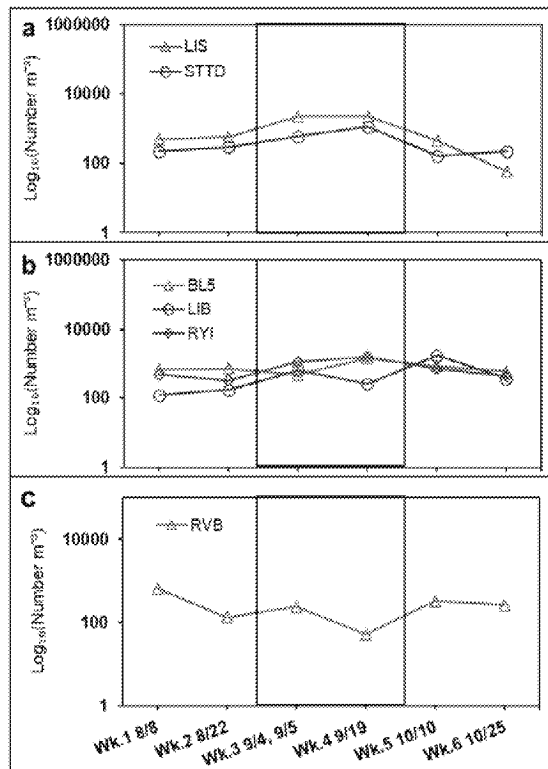
Task 5 Figure 7. 2017 total (Log base 10) number of calanoid zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the fall net positive flow pulse time period.

The small unmanaged positive flow pulse in early September, provided evidence of both increased densities of cyclopoid and calanoid copepods (Task 5 Figure 6b, 7b), likely as a result of export from upstream tidal slough and island habitats into the larger downstream channels. In addition, the Lower Yolo Bypass site STTD observed a 25-fold increase in cladoceran densities in September (Task 5 Question 1 and 2), a prevalent freshwater taxa in the upper tidal and non-tidal tributary habitats in the Yolo Bypass (Frantzich et al. 2018; Schemel et al. 2004).



Task 3 Figure 8. 2017 region monthly zooplankton taxa total CPUE by group and % of taxa making up $\geq 3\%$ of total CPUE. Regions: a) Lower Yolo Bypass (sites LIS and STTD), b) Cache Slough Complex (sites BL5, LIB, RYI), and c) Lower Sacramento River (site RVB).

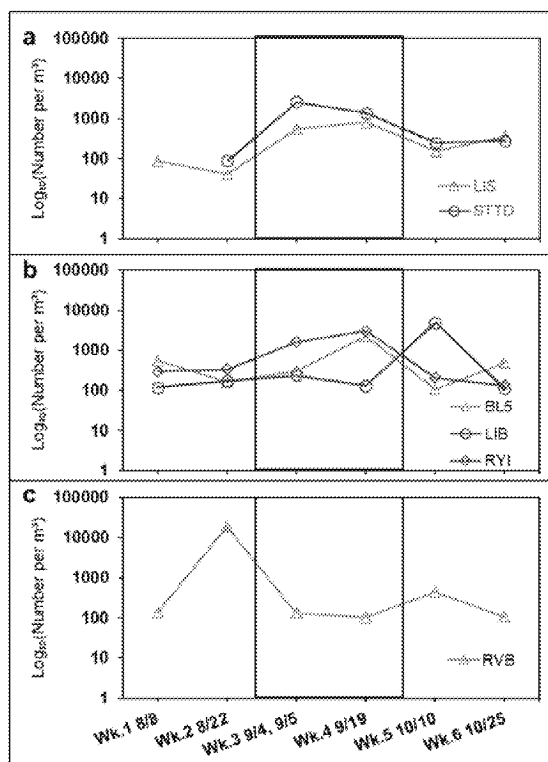
In 2017, the Lower Yolo Bypass region zooplankton taxa composition was dominated by calanoid copepodids (Task 5 Question 2), making up $>50\%$ of the total CPUE in all sampling months (Task 5 Figure 8a). The contribution of cladoceran and cyclopoid taxa was highest in July and decreased into the fall months. The absence of a flow pulse in 2017 reduced the exchange of upstream watersources and likely contributed to the lower abundance of the more freshwater cladoceran and cyclopoid taxa to the total CPUE in the Lower Yolo Bypass region (Task 5 Question 2). The Cache Slough Complex and Lower Sacramento River regions were both dominated by calanoid copepodids, with *Pseudodiaptomus forbesi* adults making up a larger portion of the total CPUE than 2016 (Task 5 Figure 5b, 5c, 8b, 8c).



Task 5 Figure 9. 2018 total (Log base 10) number of cladoceran zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the managed net positive flow pulse time period

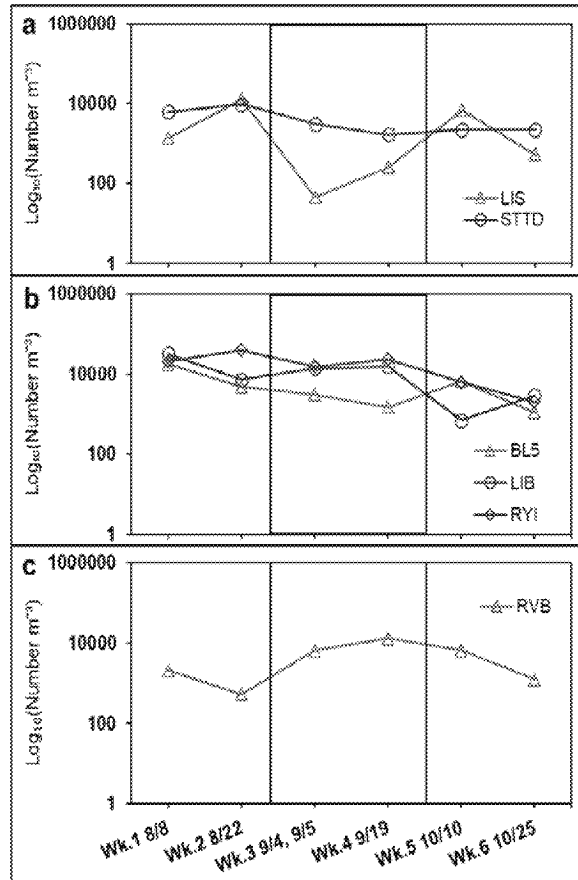
2018

In 2018, DWR collected 12 zooplankton samples in the summer (July-August) and 24 samples in fall (September-October). Monitoring efforts were focused on sampling before, during, and after the second managed DSRS North Delta Flow Action that occurred in the late summer and fall from August 28-September 26 (Task 4 Figure 2). Samples were collected twice before (Wk.1 8/8 and Wk. 2 8/22) and twice during (Wk. 3 9/4-5 and Wk. 4. 9/19), and three times after (Wk. 5 10/10, Wk. 6 10/25) the timing of the 2018 flow pulse.



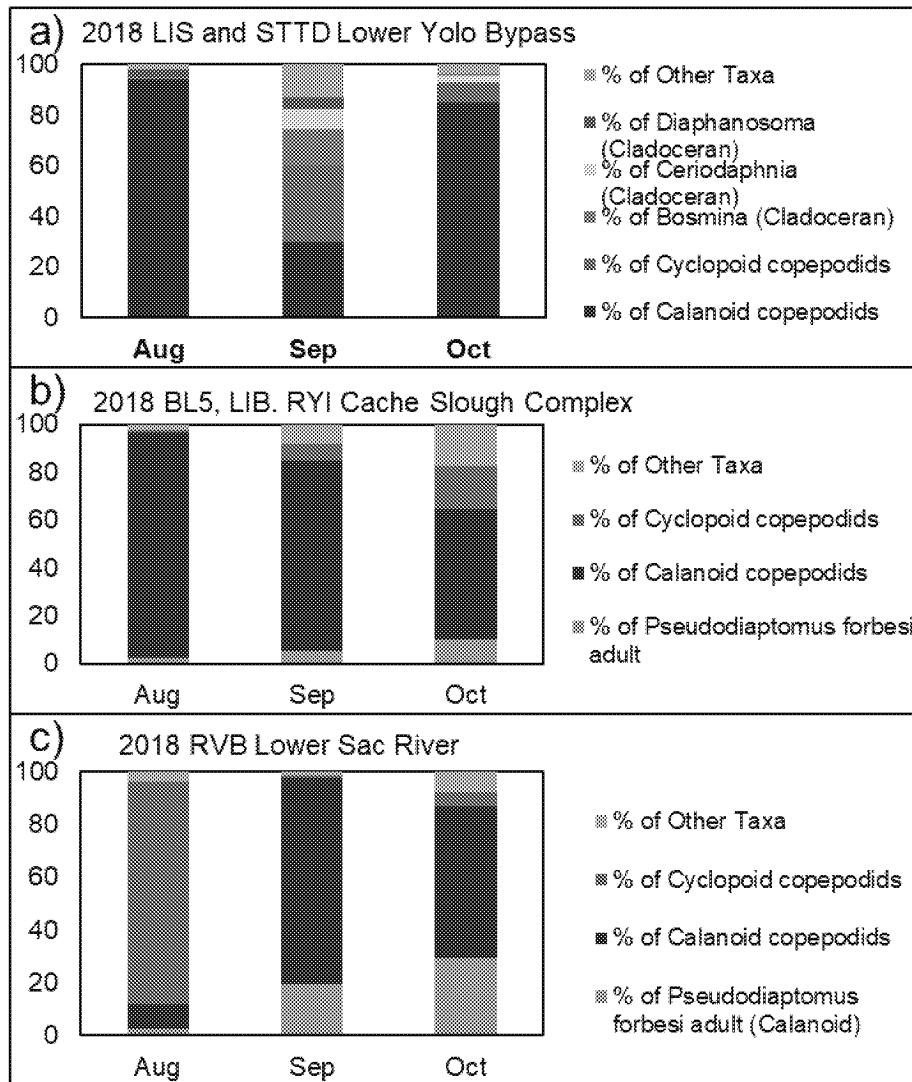
Task 5 Figure 10. 2018 total (Log base 10) number of cyclopoid zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the managed net positive flow pulse time period.

The cladoceran and calanoid copepod densities in all regions were low (Task 5 Question 1) in 2018 compared to the previous two years (Task 5 Figure 9a, b, c and 10a, b, c). In contrast, the smaller cyclopoid copepods were higher in density than prior years and were the dominant taxa in many of the samples (Task 5 Figure 10a, b, c). During the flow pulse densities of cladocerans and cyclopoids increased (Task 5 Questions 1 and 3) in both the Lower Yolo Bypass and Cache Slough Regions (Task 5 Figure 9a, 9b, 10a, 10b), following a similar trend of downstream transport from the prior 2016 managed flow pulse (Task 5 Figure 1a, 1b, 2a, 2b). In addition, there was a substantial 2-fold increase in the densities of calanoid copepods in the Lower Sacramento River (Task 5 Question 1 and 3) during the 2018 flow action (Task 5 Figure 11c).



Task 5 Figure 11. 2018 total (Log base 10) number of calanoid zooplankton caught per meter³ in the conceptual model regions: a) Lower Yolo Bypass Region (sites: LIS and STTD), b) Cache Slough Complex Region (sites: BL5, LIB, RYI), and c) Lower Sacramento River (site: RVB). Shaded box denotes the managed net positive flow pulse time period.

In 2018, the Lower Yolo Bypass region was composed primarily by calanoid copepodids (Task 5 Question 2) prior to the flow pulse, making up >90% of the total CPUE (Task 5 Figure 12a). The zooplankton composition changed drastically during the flow pulse, with cyclopoid copepodids and cladoceran taxa: *Bosmina*, *Ceriodaphnia*, and *Diahanosoma* comprising >50% of the total CPUE (Task 5 Figure 12a). This is similar to trends observed during the 2016 flow pulse, when increased flows transport smaller freshwater cladoceran and cyclopoid taxa from upper regions into the lower tidal reaches of the Yolo Bypass Toe Drain (Task 5 Question 2). The downstream zooplankton composition in the Cache Slough Complex and Lower Sacramento River regions were similar to prior years, except those samples collected in August in the Lower Sacramento River were almost entirely composed of cyclopoid copepodids at over 80% of the total CPUE (Task 5 Figure 12b and 12c). Both the Cache Slough Complex and Lower Sacramento River region did see an increasing contribution of the calanoid copepod *Pseudodiaptomus forbesi* after the flow pulse (Task 5 Figure 12b and 12c).



Task 3 Figure 12. 2018 region monthly zooplankton taxa total CPUE by group and % of taxa making up $\geq 3\%$ of total CPUE. Regions: a) Lower Yolo Bypass (sites LIS and STTD), b) Cache Slough Complex (sites BL5, LIB, RYI), and c) Lower Sacramento River (site RVB)

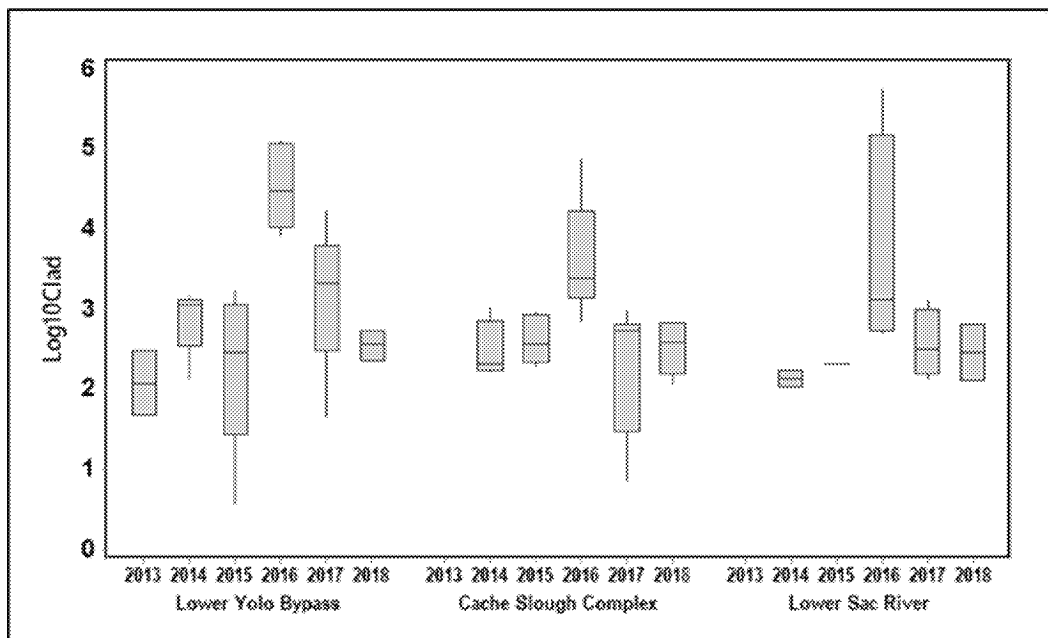
2013-2018 Summer and Fall Data Comparison

Summer

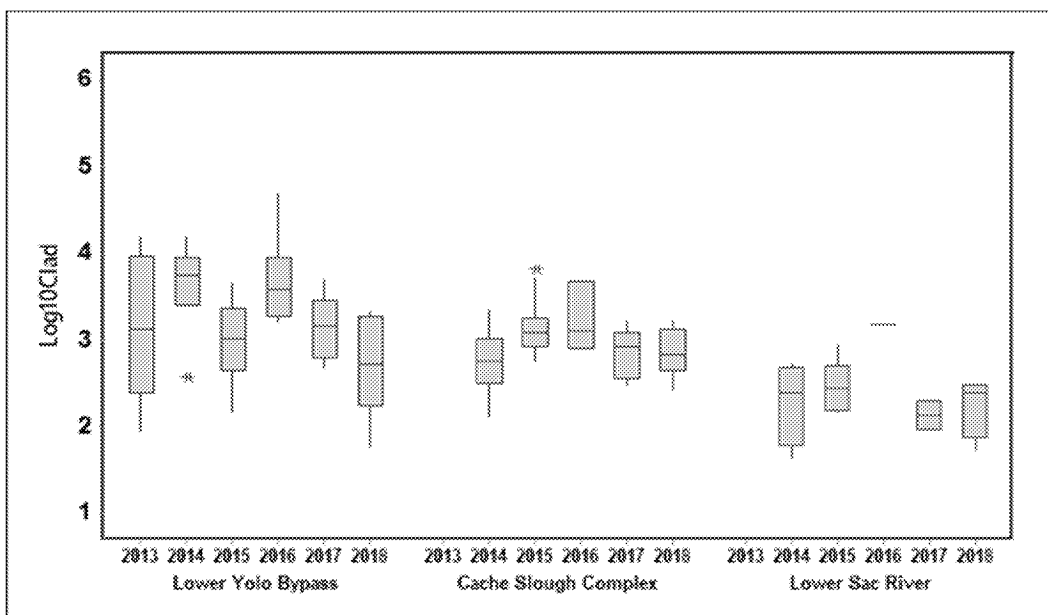
In comparing all years (2013-2018), during the summer (July-August) and fall (September-October) months, it was evident that 2016 was a special year. The median summer densities in 2016 for cladocerans, cyclopoids and calanoid copepods were higher (Task 5 Question 1) for the Lower Yolo Bypass and Cache Slough Complex Regions compared to all other years (Task 5 Figures 13, 15, 17). In 2016, the Lower Yolo Bypass zooplankton densities were significantly higher from all other years (ANOSIM $p < 0.05$, $R > 0.4$).

The Cache Slough Complex Region in 2016 was also found to be significantly different from both 2017 and 2014 (ANOSIM $p < 0.05$, $R=0.2$ and $R=0.4$ respectively). This was explained primarily by higher densities of cladocerans and cyclopoids (Task 5 Figures 13 and 15). In addition, the Lower Sacramento

River Region was significantly different in zooplankton densities in the higher outflow 2017, compared to the drought years of 2013 and 2014 (ANOSIM $p < 0.05$, $R = 0.2$). This difference was explained primarily by higher densities of cladocerans and cyclopoids (Task 5 Figures 13 and 15).



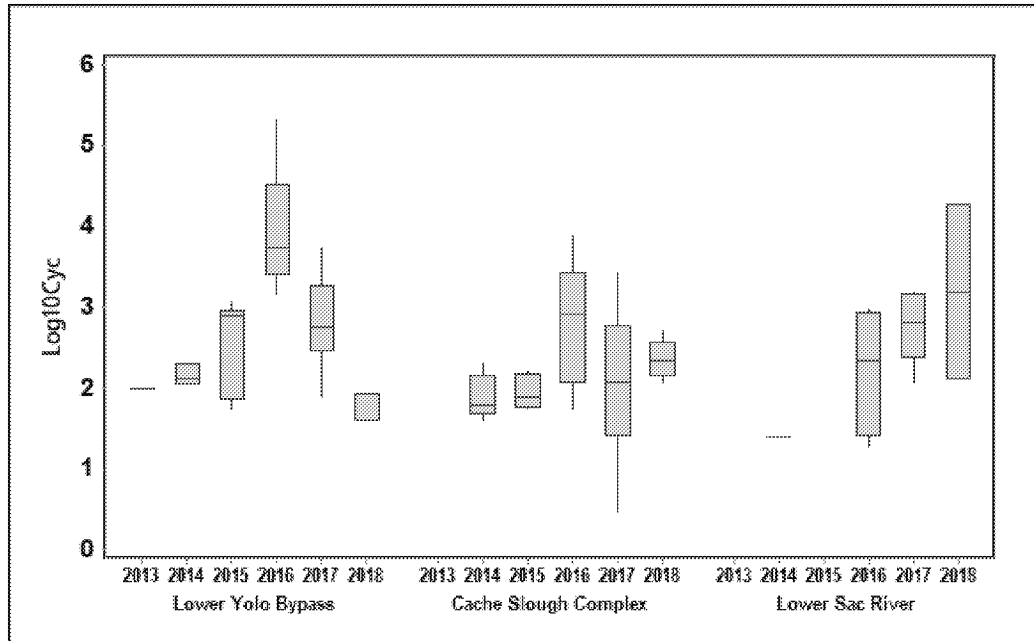
Task 5 Figure 13. 2013-2018 box plots of summer (July-August) total (Log base 10) number of cladoceran zooplankton caught per meter³ in the conceptual model regions: Lower Yolo Bypass Region (sites: LIS and STTD), Cache Slough Complex Region (sites: BL5, LIB, RYI), and Lower Sacramento River (site: RVB).



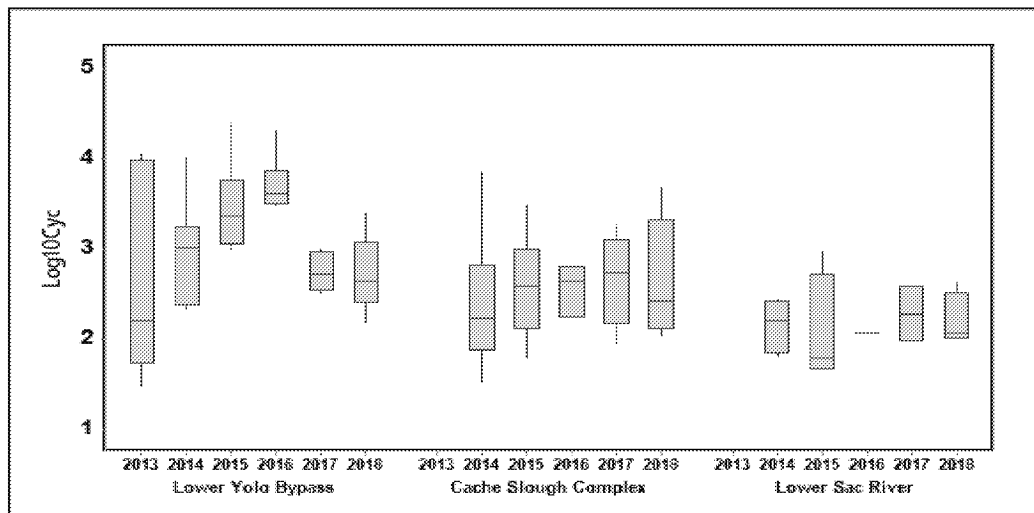
Task 5 Figure 14. 2013-2018 box plots of fall (September-October) total (Log base 10) number of cladoceran zooplankton caught per meter³ in the conceptual model regions: Lower Yolo Bypass Region (sites: LIS and STTD), Cache Slough Complex Region (sites: BL5, LIB, RYI), and Lower Sacramento River (site: RVB)

Fall

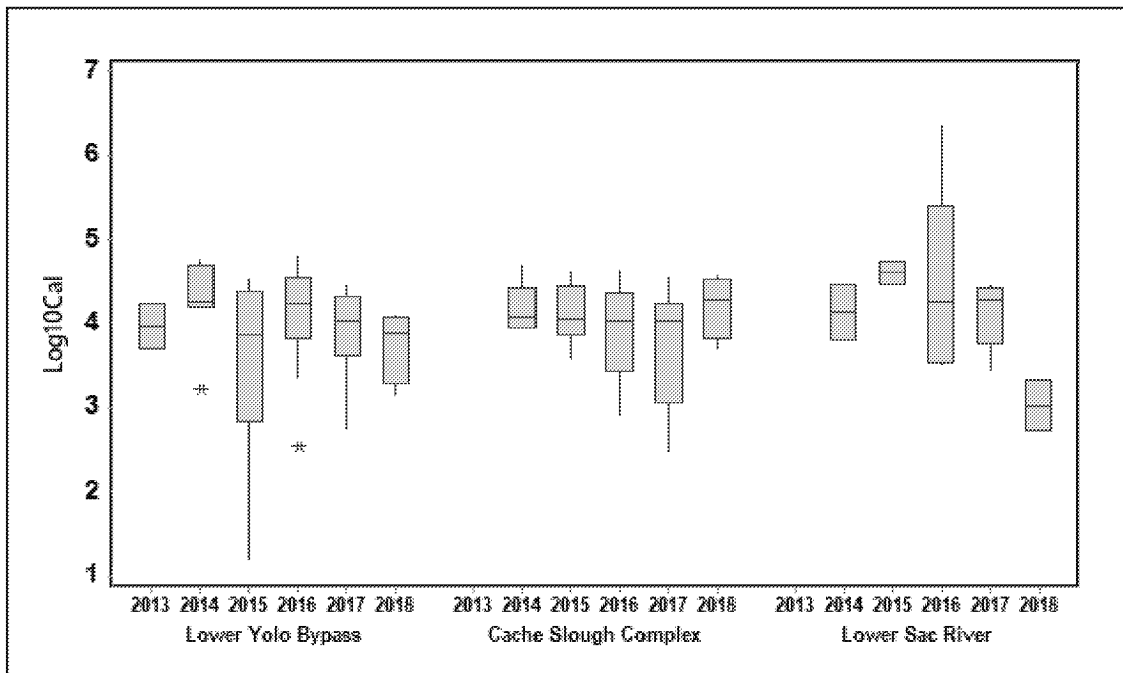
In the fall months there was no significant difference found in zooplankton densities (ANOSIM $p > 0.05$) in the Cache Slough Complex and Lower Sacramento River Regions (Task 5 Figures 14, 16, 18). In fall 2018, the zooplankton densities were low compared to other years (Task 5 Question 1), especially for calanoid copepods (Task 5 Figure 17 and 18). The Lower Yolo Bypass Region was significantly higher in 2016 than years 2013, 2017, and 2018 (ANOSIM $p < 0.05$, $R > 0.3$).



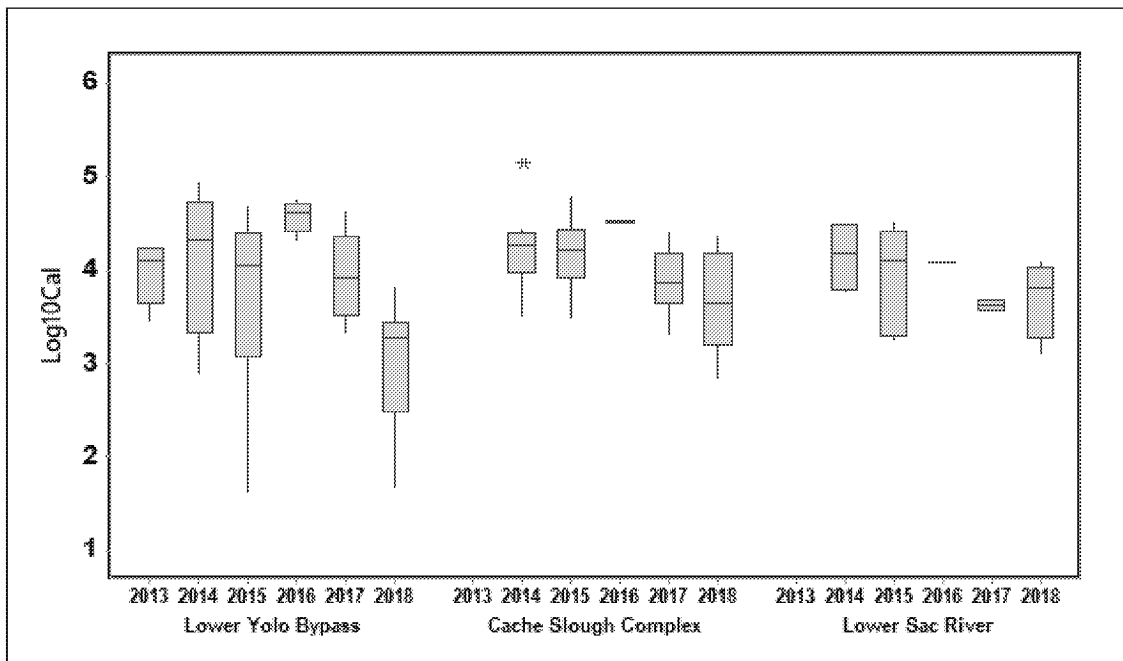
Task 5 Figure 15. 2013-2018 box plots of summer (July-August) total (Log base 10) number of cyclopoid zooplankton caught per meter³ in the conceptual model regions: Lower Yolo Bypass Region (sites: LIS and STTD), Cache Slough Complex Region (sites: BL5, LIB, RYI), and Lower Sacramento River (site: RVB).



Task 5 Figure 16. 2013-2018 box plots of fall (September-October) total (Log base 10) number of cyclopoid zooplankton caught per meter³ in the conceptual model regions: Lower Yolo Bypass Region (sites: LIS and STTD), Cache Slough Complex Region (sites: BL5, LIB, RYI), and Lower Sacramento River (site: RVB).



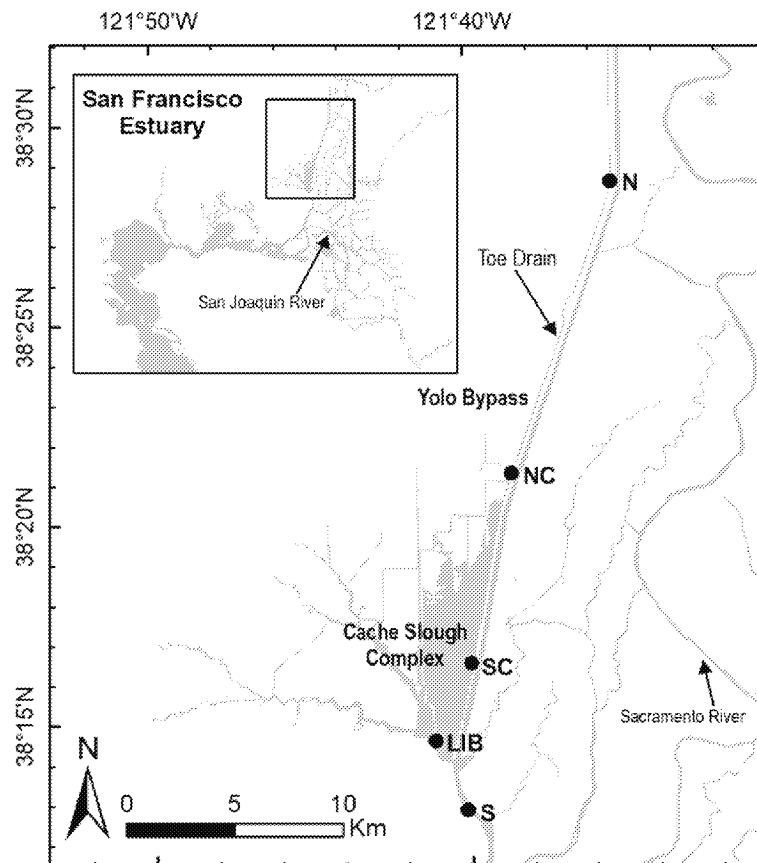
Task 5 Figure 17. 2013-2018 box plots of summer (July-August) total (Log base 10) number of calanoid zooplankton caught per meter³ in the conceptual model regions: Lower Yolo Bypass Region (sites: LIS and STTD), Cache Slough Complex Region (sites: BL5, LIB, RYI), and Lower Sacramento River (site: RVB).



Task 5 Figure 18. 2013-2018 box plots of fall (September-October) total (Log base 10) number of calanoid zooplankton caught per meter³ in the conceptual model regions: Lower Yolo Bypass Region (sites: LIS and STTD), Cache Slough Complex Region (sites: BL5, LIB, RYI), and Lower Sacramento River (site: RVB).

Zooplankton Reproductive Rate

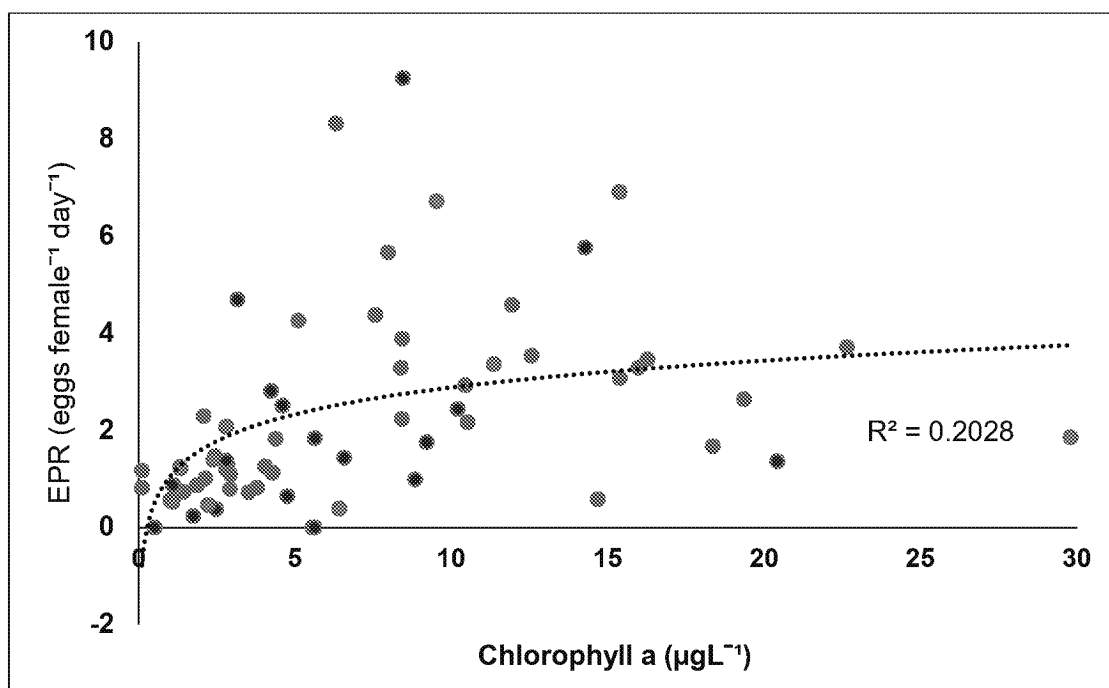
To determine the spatial and temporal differences in zooplankton reproductive rate as it relates to ambient chlorophyll a (Chl a) concentration, egg counts were performed on gravid female calanoid copepods (*Pseudodiaptomus forbesi*) collected in surface tow samples from 2015-2018. Samples were collected at sites: Lisbon Weir below Toe Drain (N or LIS), Screw Trap at Toe Drain (NC or STTD), and Prospect Slough (SC or BL5) in all years, the Cache Slough at Ryer Island (S or RYI) was sampled only in 2017 and 2018 (Task 5 Figure 19). The sampling months and total number of samples varied between years and sites, focusing on sampling before, during and after the managed flow pulse events (Task 5 Table 12). Tow samples were targeted for 30 or more gravid females, but samples often did not contain this target number (number of gravid females ranged from 0-58 and averaged 26 per sample) and are noted by color in Task 5 Figure 20. The relationship between calanoid copepod egg production rate and Chl a was positive for the samples in the Yolo Bypass and Cache Slough Complex, but the relationship was nonlinear (Task 5 Figure 20). The highest egg production rates between years were often measured near ambient Chl a of $10 \mu\text{gL}^{-1}$. The threshold of Chl a concentration at $10 \mu\text{gL}^{-1}$ has also been identified as a critical level for the growth of zooplankton in the Delta (Muller-Solger et al. 2002) and was found to be where calanoid copepod growth rate peaked for our paired grow-out experiments (Task 5 Figure 25).



Task 5 Figure 19. Map of sample sites in the Yolo Bypass within the San Francisco Estuary. Copepod growth rate sites included Toe Drain below Lisbon Weir (N or LIS), Screw Trap at Toe Drain (NC or STTD), Prospect Slough (SC or BL5), and Ryer Island (S or RYI). Copepod growth rate incubations took place at Liberty Island (LIB) during summers 2015 and 2016 and at NC or STTD during summer 2017. Map also shows the Sacramento River and the San Joaquin River that drain into the Delta.

Year	Station	Station Code	Jun. Samples	Jul. Samples	Aug. Samples	Sep. Samples	Oct. Samples	Total Number of Samples	Ave. EPR (eggs/fem /day)	Ave. Number of Gravid Females in Egg Ratio
2015	Lisbon Weir	LIS or N	NS	NS	1	1	1	3	2.1	23
	Screwtrap	STTD or NC	NS	NS	1	1	1	3	3.3	41
	Prospect Slough	BL5 or SC	NS	NS	1	1	1	3	1.1	46
2016	Lisbon Weir	LIS or N	0	1	3	1	NS	5	4.2	20
	Screwtrap	STTD or NC	1	2	3	1	NS	7	3.1	36
	Prospect Slough	BL5 or SC	1	2	3	1	NS	7	3.5	40
2017	Lisbon Weir	LIS or N	1	1	3	NS	NS	5	3.3	22
	Screwtrap	STTD or NC	1	1	3	NS	NS	5	1.3	9
	Prospect Slough	BL5 or SC	1	1	3	NS	NS	5	0.8	23
	Ryer Island	RYI or S	1	1	3	NS	NS	5	1.3	37
2018	Lisbon Weir	LIS or N	NS	NS	2	2	1	5	3.7	10
	Screwtrap	STTD or NC	NS	NS	2	2	1	5	1.4	8
	Prospect Slough	BL5 or SC	NS	NS	2	2	1	5	1.5	26
	Ryer Island	RYI or S	NS	NS	2	2	1	5	0.6	27

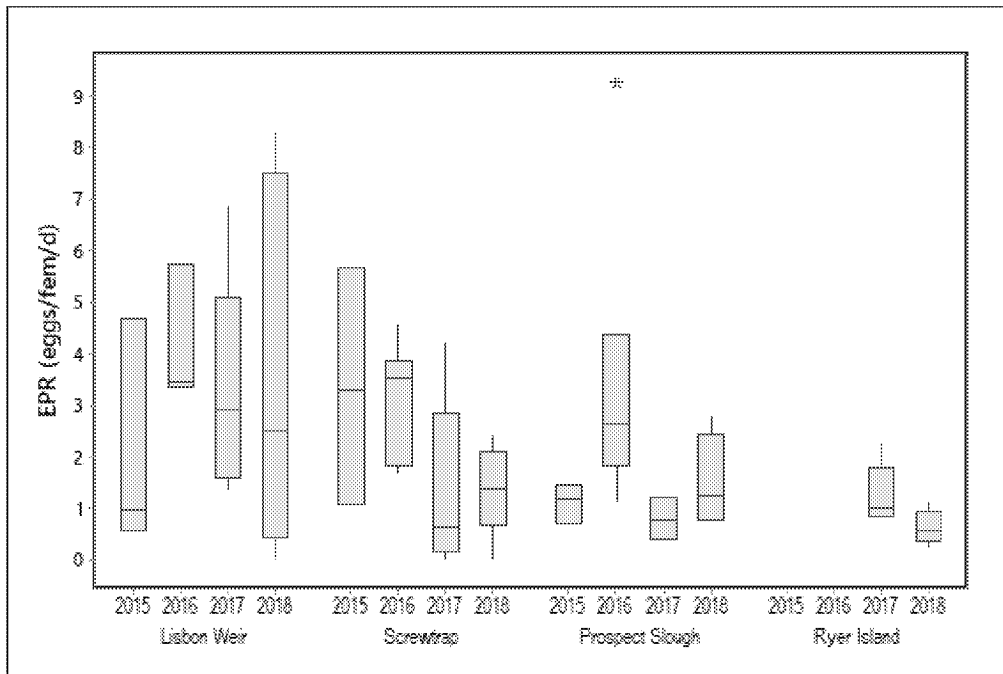
Task 5 Table 1. 2015-2018 total number of subsurface zooplankton tow samples collected and analyzed for egg production rate (EPR) by station. Average EPR and number of gravid females in the egg ratio was calculated by station for all samples. NS denotes months with no samples collected.



Task 5 Figure 20. 2015-2018 calanoid copepod (*Pseudodiaptomus forbesi*) egg production rate as eggs per female per day from surface zooplankton tow samples in relation to chlorophyll *a* from sites: LIS, STTD, BL5, and RYI. Red dots denote gravid females with less than 10 eggs, green dots denote less than 30 eggs, and blue dots greater than 30 eggs.

The calanoid copepod egg production rate was highest at the upper most sampling site in the Yolo Bypass below Lisbon Weir (N or LIS), with rates decreasing as sites moved southward (Task 5 Table 12 and Figures 21). The summer managed flow pulse year of 2016 had the highest egg production rates for all sampling sites (Task 5 Figure 21), with an average across all sites of 3.4 eggs/female/day (Task 5

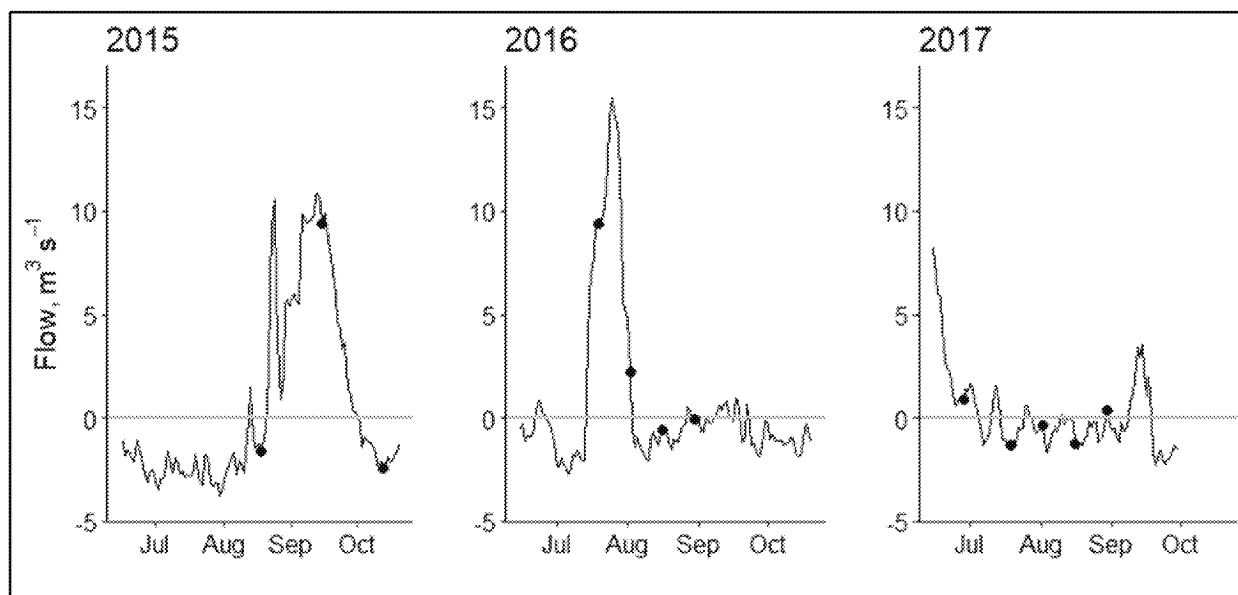
Question 3). The Screw Trap at Toe Drain (STTD or NC) site had the lowest egg production rates during unmanaged flow pulse year 2017 and fall flow pulse year 2018 (Task 5 Table 12 and Figure 21). Although 2018 egg production rates were considerably lower than 2016, the rates were higher at the Screw Trap and Prospect Slough (BL5 or SC) sampling sites compared to unmanaged flow pulse year 2017 (Task 5 Question 3). This suggests that years with higher summer and fall positive outflows in the Yolo Bypass and Cache Slough Complex may improve zooplankton habitat conditions, aiding in reproduction and subsequent recruitment.



Task 5 Figure 21. 2015-2018 calanoid copepod boxplot of copepod egg production rate by year.

Zooplankton Growth Rate

We determined *P. forbesi* growth rates at four sites within the study area during summer and autumn of 2015 to 2017 during differing outflow conditions (Task 5 Figure 22). These study sites were distributed along the long axis of the Yolo Bypass and the CSC to its south: the northernmost site (N; Toe Drain at Lisbon Weir), the north-central site (NC; Toe Drain at Screw Trap), the south-central site (SC; Prospect Slough), and the southernmost site (S; Cache Slough at Ryer Island in 2017 only) (Task 5 Figure 19). Zooplankton samples were taken concurrently with samples for determination of specific growth rate, and concentrations of Chl a, lipids, pigments, and main phytoplankton groups. The biochemical composition of phytoplankton was analyzed on water samples taken at each site to investigate the effects of food quantity and quality on copepod growth rates.



Task 5 Figure 22. Daily-averaged net flow at site N or LIS during July to October 2015–2017. Positive flows (above horizontal line at a flow of $0 \text{ m}^3 \text{ s}^{-1}$) reflect water moving in to the San Francisco Estuary from north to south in the Toe Drain. The large flow peak in 2016 is the result of the managed flow pulse conducted by the California Department of Water Resources (DWR). Points represent sample dates. Data from <https://cdec.water.ca.gov>.

We conducted 38 growth rate experiments (8 in 2015, 12 in 2016, and 18 in 2017) using a modified version of the artificial cohort method (Kimmerer and McKinnon, 1987; Kimmerer et al., 2018). Copepods were collected from each sample site with a 0.5-m diameter, 150- μm mesh plankton net towed at the surface for 2–3 min. Copepods were immediately placed in a dark, insulated 20-L bucket containing 35- μm filtered site water. Copepods were size fractionated using nylon sieves and gentle upward filtration to establish an artificial cohort of 200–224 μm in size. This size fraction usually contained early copepodites of *P. forbesi*. The size fraction was then diluted in 35- μm filtered site water and thoroughly mixed, and a subsample was counted to determine density of copepods. Subsamples containing approximately 150 copepods were alternately concentrated and transferred to 20-mL vials (6 replicates) or poured into 4-L polyethylene plastic cubitainers® (10 replicates) containing 35- μm filtered water from the sample site. The six initial samples in the 20-mL vials were fixed with 2% glutaraldehyde (final conc., vol/vol), which minimizes the change in mass or volume during preservation (Kimmerer and McKinnon, 1986). The cubitainers were placed in random order in a moored floating chamber for 1–3 d of incubation. Incubations took place at the Liberty Island (LIB) site in 2015 and 2016 and the NC site in 2017 (Task 5 Figure 19). After 1–2 d (2016 and 2017) or 2–3 d (2015) of incubation, five replicate cubitainers per site were removed each day from the floating chamber and fixed for initial samples.

Image analysis and copepod growth rate measurement

After a minimum of one month of fixation in glutaraldehyde, growth rate samples were processed using an image analysis technique to estimate carbon mass per copepod (Alcaraz et al., 2003; Kimmerer et al., 2018). Each sample was transferred to a petri dish, thoroughly mixed, and examined with a Leica M125 dissecting microscope. All *P. forbesi* within the frame were selected to avoid bias. This process was repeated until a minimum of 30 copepods were obtained. Copepods were arranged (so none were touching and no debris) and imaged with a Spot Idea S8APO digital camera. Images were processed with ImageJ scientific imaging freeware to create a silhouette and fitted ellipse for each individual, using the

major and minor axes of each copepod. We then calculated the volume (mm^3) of each copepod as that of an ellipsoid of rotation about the minor axis (Alcaraz et al., 2003; Kimmerer et al., 2018) and calculated carbon mass using a relationship between volume and carbon mass previously measured for *P. forbesi* (Kimmerer et al., 2018). Copepod growth rate was calculated as the slope of log carbon mass versus time using two alternative models: one a linear model over all days, and the other a linear model with a second parameter for a change in slope after the first incubation interval. These models were compared by analysis of covariance. Of the 38 growth rate experiments, four had changes in slope; for these only the first incubation interval was used to calculate growth rate.

Growth rate and development have different thermal responses (Forster et al., 2011), but we ignored this difference because the temperature range in our study was relatively narrow (mean of 22 °C) so the differences were minimal. To facilitate comparison with growth rate studies from other regions (CSC and central Delta; Kimmerer et al., 2014; 2017; 2018) we adjusted all growth rates to a temperature of 22 °C using the exponential fit of egg development time to temperature for *P. forbesi* (Sullivan and Kimmerer, 2013). We compared *P. forbesi* growth rates in the Yolo Bypass to those previously determined in other regions of the San Francisco Estuary; the low-salinity zone (LSZ) (Kimmerer et al., 2014), Sacramento River (SR) and San Joaquin River (SJR) (Kimmerer et al., 2017), and the Cache Slough Complex (CSC) (Kimmerer et al., 2018).

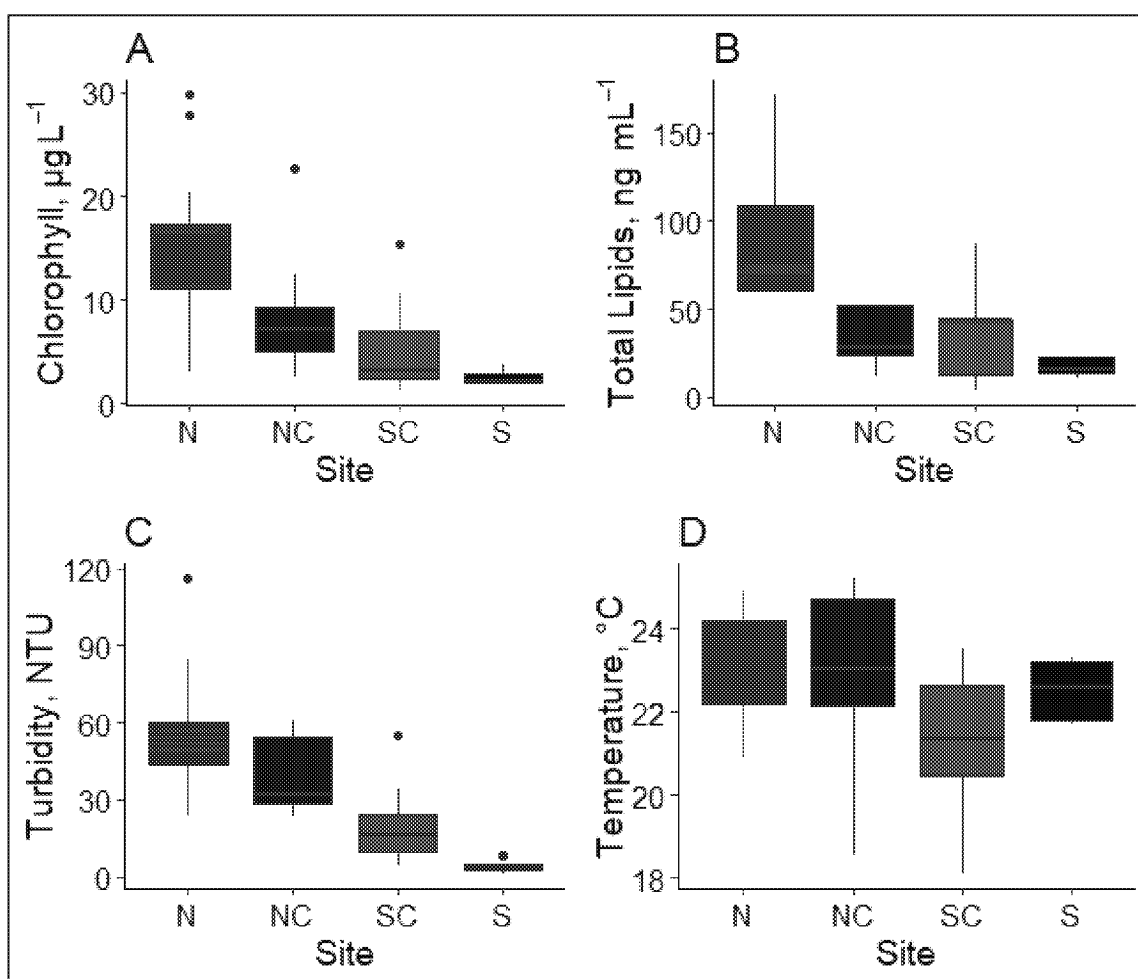
Food quality and quantity measurements

Samples for Chl a were filtered onto 47-mm glass-fiber filters (0.7- μm nominal pore size; PALL Life Sciences) and stored at -20 °C until analyzed. Pigments were extracted from the filters in 90% (v/v) acetone following tissue grinding and centrifugation and analyzed spectrophotometrically (APHA, 1998) at the Department of Water Resources' Bryte Chemical Laboratory.

During sampling events in 2017 we also collected samples for the analysis of lipids and photosynthetic pigments. For lipids, whole water was collected at each site and stored on ice in a dark cooler for a maximum of 7 h until it was filtered using a glass and stainless-steel filtration rig. Triplicate samples of 600 mL were filtered onto previously combusted (450 °C for 4 h), 47-mm glass fiber filters (Whatman). The filters were stored individually in pre-combusted foil packets at -80 °C until analysis. Total lipid and lipid classes were analyzed by the Memorial University of Newfoundland Aquatic Research Cluster using a Chromarod thin-layer chromatography (TLC) with Iatroscan flame ionization detection (FID) (Parrish, 2013). Individual lipid compounds were identified and quantified using Capillary gas chromatography (GC) with FID (Parrish, 2013). The percent of polyunsaturated fatty acids (PUFA) in total fatty acids was calculated as the sum of PUFA, fatty acids containing two or more ethylenic bonds with the ethylenic bonds generally interrupted by a single methylene (CH_2) group, divided by total fatty acids. The percent of long-chain essential fatty acids (LCEFA) in total fatty acids was calculated as the sum of eicosapentaenoic acid (EPA; 20: 5 ω 3), arachidonic acid (ARA; 20: 4 ω 6), and docosahexaenoic acid (DHA; 22: 6 ω 3) divided by total fatty acids (Galloway and Winder, 2015).

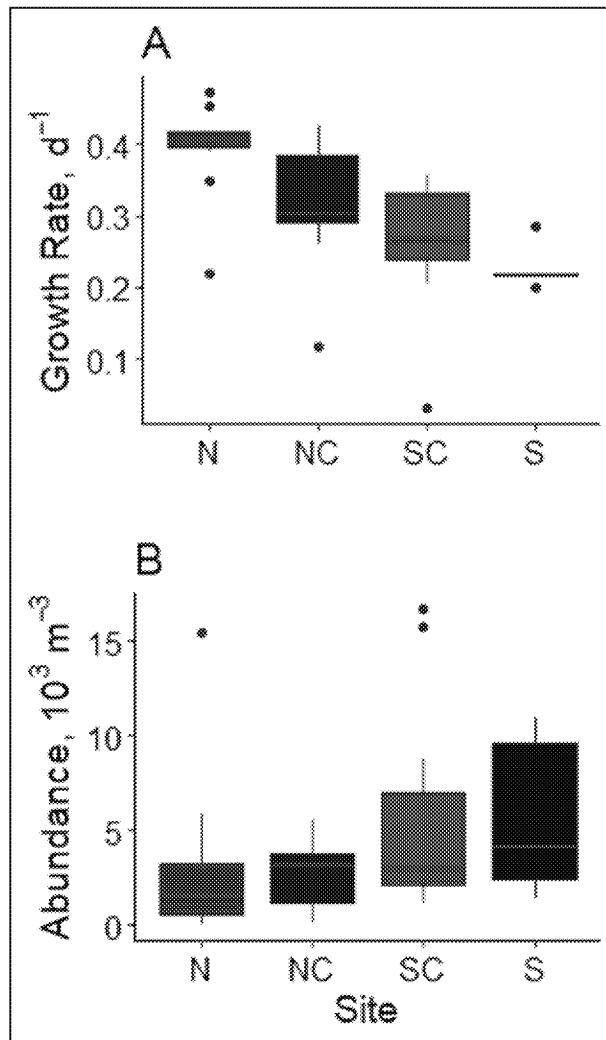
For pigment analyses, whole water was filtered onto 25-mm glass-fiber filters (Poretics) and filters were frozen at -80 °C. Pigment analyses were conducted at the University of Maryland Center for Environmental Science using an Agilent 1100 model high-performance liquid chromatography (HPLC) system. The pigment data proved to be uninformative and therefore was not used in this study.

Surface water temperatures in our study site ranged from 18.1 to 25.2°C during growth-rate experiments; mean temperatures were highest at the N or LIS site (23°C) and lowest at the SC or BL5 site (21.4°C). Chl a, total lipids, and turbidity decreased from north (N) to south (S) (Task 5 Figure 23).



Task 5 Figure 23. Environmental data by sample site during growth rate experiments during summers 2015–2017 in the Yolo Bypass. Sample sites are arranged from north (left) to south (right) on each panel for Chl a(A), total lipids (B), turbidity (C), and temperature (D). For each box plot: line is the median, upper and lower edges of each box are the quartiles, and data points are outliers.

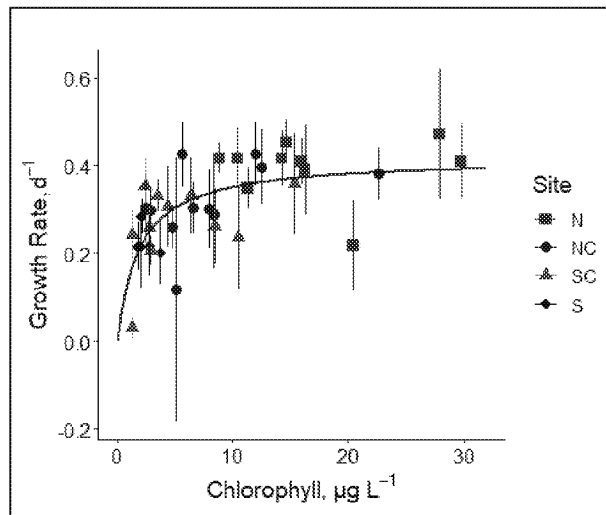
Among study years, 2016 had the highest mean growth rate (0.36 d^{-1}) compared to 2015 (0.34 d^{-1}) and 2017 (0.28 d^{-1}). Copepod growth rates varied spatially and generally decreased from north (median 0.41 d^{-1} at site N) to south (median 0.22 d^{-1} at site S) (Task 5 Figure 24A). A linear model of growth rate as a function of distance from site N fit better than a linear mixed effects model, as determined by AIC. Growth rate was negatively related to distance from site N (slope = $(-5.55 \pm 3.13) \times 10^{-3} \text{ (95\% CI) d}^{-1}/\text{m}$).



Task 5 Figure 24. *Pseudodiaptomus forbesi* growth rate (A) and copepodite abundance (B) by sample site, from north (left) to south (right). For each box plot: line is the median, upper and lower edges of each box are the quartiles, and data points are outliers.

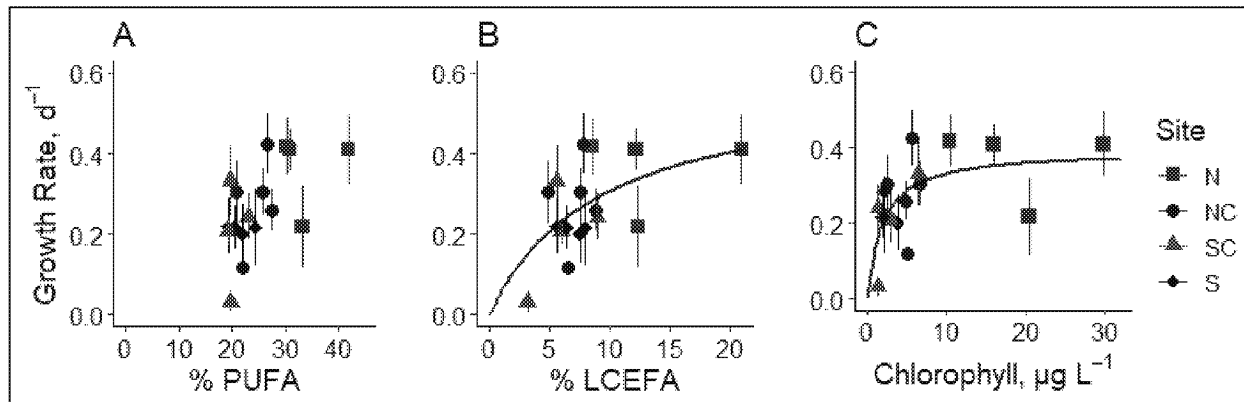
Copepod growth rates in relation to food quantity and quality

Chl a concentration ranged from 1.3 to 29.8 $\mu\text{g L}^{-1}$ during growth rate experiments and generally decreased from station N to S (Task 5 Figure 23A). Growth rates were non-linearly related to Chl a concentration (Task 5 Figure 25). The Type II functional response had a g_{max} of $0.42 \pm 0.07 \text{ d}^{-1}$ and a K_m of $1.85 \pm 1.23 \mu\text{g L}^{-1}$ ($\pm 95\%$ CI), and a residual standard error of 0.074 d^{-1} . This model was a better predictor of growth rate than the null model and linear model, as determined by AIC. Growth rate increased most steeply between Chl a concentration of ~ 1 and $5 \mu\text{g L}^{-1}$ (Task 5 Figure 25). The separation among sites (Task 5 Figure 23A) was largely due to differences in Chl a and no other site attributes, which was confirmed by plotting the residuals by site and finding no difference.



Task 5 Figure 25. *Pseudodiaptomus forbesi* growth rate, with 95% confidence intervals, in relation to total Chl a concentration (N=38). The curved line is a rectangular hyperbola fitted to the data (function *nls* in R) using equation (1) and determined a maximum growth rate (g_{max}) of $0.42 \pm 0.07 \text{ d}^{-1}$ (95% CI) and a K_m of $1.85 \pm 1.23 \text{ µg L}^{-1}$ (95% CI).

Total lipid concentration decreased southward from site N or LIS to S or RYI (Task 5 Figure 23B) and was positively related to Chl a concentration (slope = 4.72 ± 1.27 (95% CI) $\text{ng mL}^{-1} / \text{µg L}^{-1}$) and phytoplankton total biovolume (slope = $(2.51 \pm 1.31) \times 10^{-6}$ (95% CI) $\text{ng mL}^{-1} / \text{µm}^3 \text{ mL}^{-1}$). Growth rates were positively related to total PUFAs and LCEFAs and the percent of PUFAs and LCEFAs in total fatty acids (Task 5 Figure 26A and 26B).

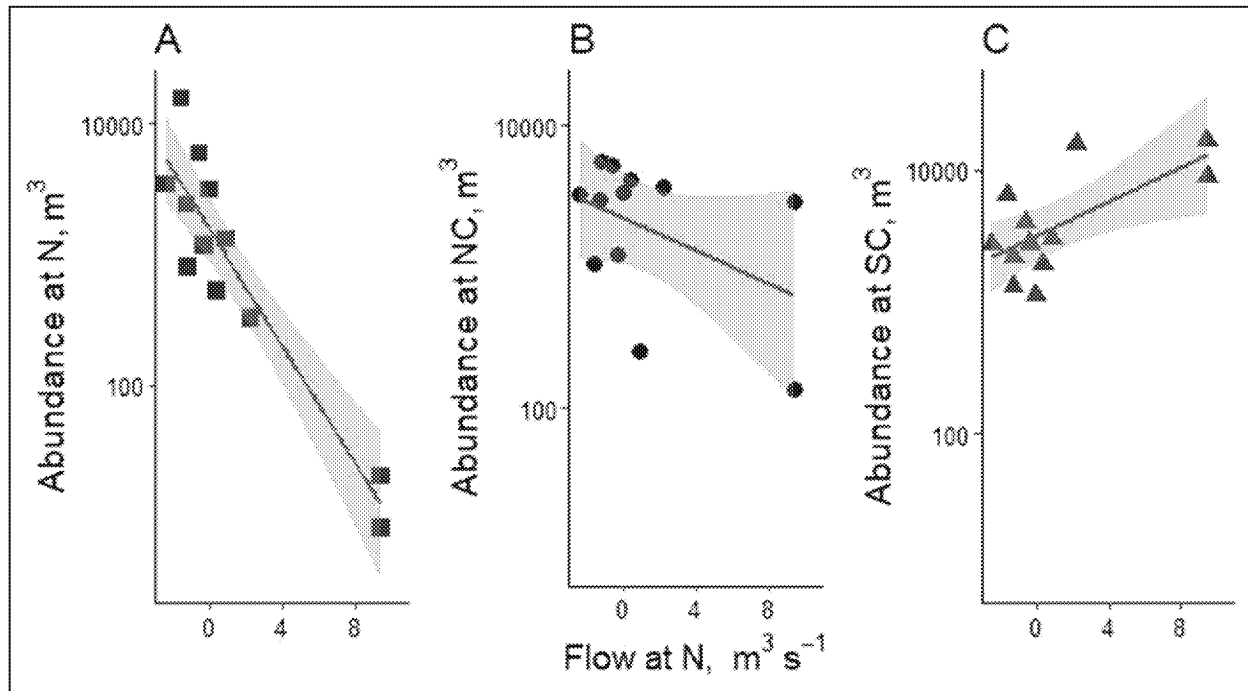


Task 5 Figure 26. *Pseudodiaptomus forbesi* growth rate, with 95% confidence intervals, in relation to the proportion of polyunsaturated fatty acids (PUFA) (A) and long-chain essential fatty acids (LCEFA) (B) in total fatty acids and total chlorophyll (C) in samples collected in only 2017. The curved line is a rectangular hyperbola fitted to the data (function *nls* in R) using equation (1).

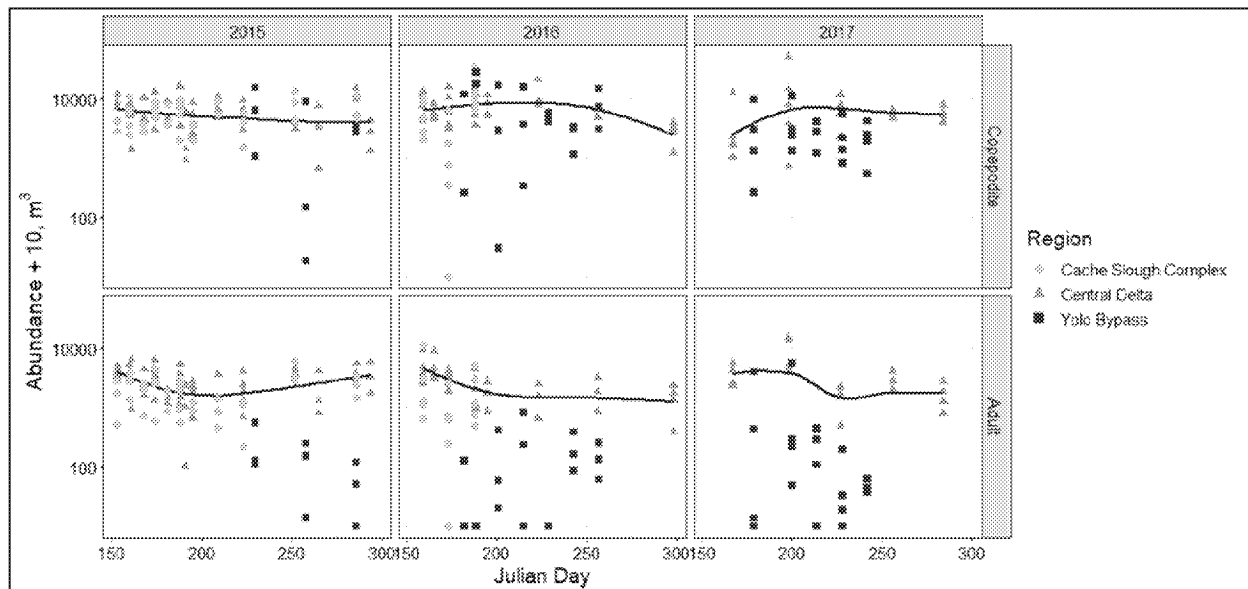
Copepod growth rate and abundance

P. forbesi growth rate and abundance had opposite spatial patterns (Task 5 Figure 24). Copepodite abundance was negatively related at site N, unrelated at site NC, and positively related at site SC to daily-averaged net freshwater flow ($\text{m}^3 \text{ s}^{-1}$) at site N (Task 5 Figure 27). Abundance of *P. forbesi* copepodites

was slightly lower and abundance of adults substantially lower in the Yolo Bypass than in the Central Delta and Cache Slough Complex during 2015 to 2017 (Task 5 Figure 28).



Task 5 Figure 27. *Pseudodiaptomus forbesi* copepodite abundance on a log scale at site N (A), site NC (B), and site SC (C) in relation to water flow at site N. Site S was not included because it was only sampled in 2017.



Task 5 Figure 28. *Pseudodiaptomus forbesi* copepodite (top panels) and adult (bottom panels) abundance in the Cache Slough Complex (cyan), Central Delta (grey) and Yolo Bypass (red) by year. Data from the CDFW 20 mm Survey, TNMW Survey, and IEP Environmental Monitoring Program.

Discussion

What controls copepod growth?

We investigated the relationship between lipids, particularly polyunsaturated fatty acids (PUFAs) and long-chain essential fatty acids (LCEFAs), and growth rates in 2017 only. We used the proportion of PUFAs and LCEFAs in total fatty acids as an indicator of the food quality available to *P. forbesi* (Winder et al., 2017). There appeared to be a positive relationship between the proportion of PUFAs in total fatty acids and *P. forbesi* growth rate, but we were unable to fit a model to it (Task 5 Figure 26A). We found a positive and non-linear relationship between the proportion of LCEFAs (Task 5 Question 3) in total fatty acids and *P. forbesi* growth rate (Task 5 Figure 26B). This relationship is similar to other documented relationships between the proportion of LCEFAs in total fatty acids and crustacean growth rate (Winder et al., 2017). We plotted growth rates in relation to Chl a for 2017 only (Task 5 Figure 26C) to compare the relationship of growth rates to food quality and quantity. Growth rates increased more gradually and had higher maximum rates in relation to the proportion of LCEFAs in total fatty acids (g_{max} of 0.58 d⁻¹) than Chl a (g_{max} of 0.39 d⁻¹). Total Chl a was a better predictor of growth rate than the proportion of LCEFAs in total fatty acids, as determined by AIC (Task 5 Question 3).

Chl a is the most commonly applied measure of food available to copepods and the relationship between Chl a and copepod growth rate is variable across a range of species and environments (Hirst and Bunker, 2004). Hirst and Bunker (2004) related 139 copepodite growth rates of egg-carrying species to Chl a concentration that ranged from 0.027 to 8.49 µg L⁻¹. When their growth rates were adjusted to 15 °C, copepodites had a maximum growth (g_{max} in equation 1) of 0.15 d⁻¹ and a half-saturation constant (K_m) of 0.02 µg L⁻¹ Chl a (Hirst and Bunker, 2004; Table 5). We adjusted our *P. forbesi* growth rates to 15 °C (Sullivan and Kimmerer, 2013) and fitted them to equation (1) to get a g_{max} of 0.18 d⁻¹ and a K_m of 2.37 µg L⁻¹ Chl a. Our K_m was much higher than that of Hirst and Bunker (2004), indicating that *P. forbesi* requires much more Chl a to support maximum growth rates. However, Hirst and Bunker (2004) data set included mostly growth rates from *Oithona* spp., which may explain the low K_m value. *Oithona* spp. are smaller than *P. forbesi* and the K_m values for different genera were found to rank positively with body weight (Hirst and Bunker, 2004). However, the difference in K_m values of a species at different body-weights is minimal (Vidal, 1980). The difference in K_m values between *Oithona* spp. and *P. forbesi* is therefore more likely related to different metabolic requirements. *Oithona* spp. feeding and metabolic rates are comparatively lower than those of calanoid copepods like *P. forbesi* (Castellani et al., 2005; Saiz and Calbet, 2007) because *Oithona* spp. are ambush predators while *P. forbesi* continuously swims (Svensen and Kiørboe 2000; Paffenhöfer and Mazzocchi, 2002).

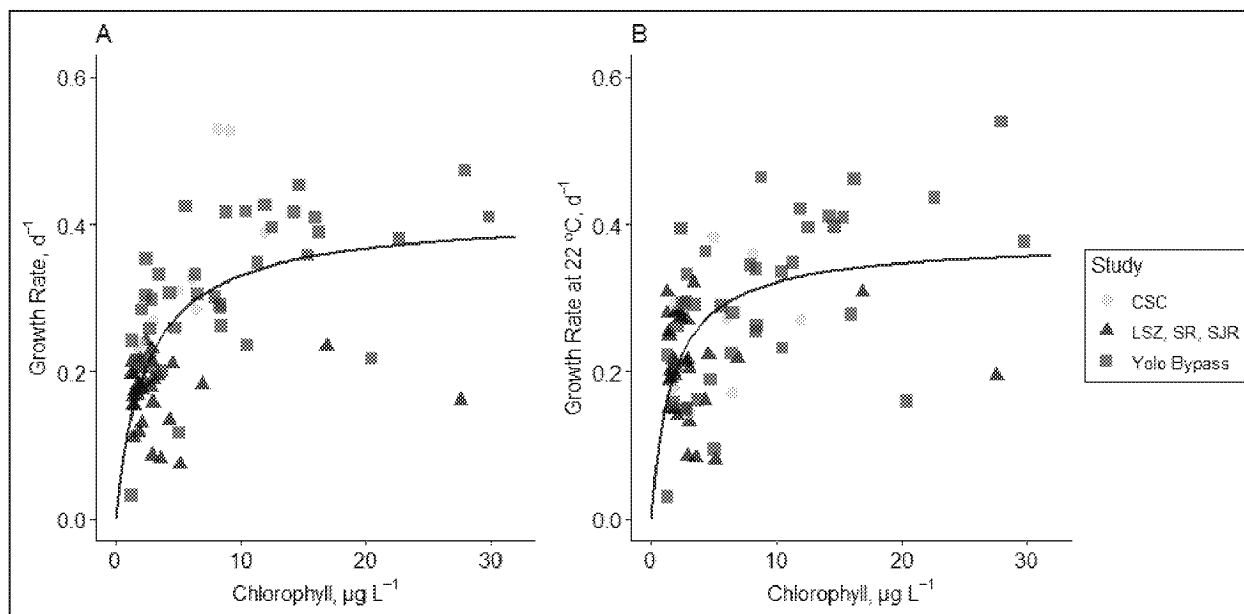
Other studies have determined a relationship between Chl a or food concentration and copepod growth rates on closely-related species and the rates we found are comparable to these prior studies. In the Inland Sea of Japan, copepodites of *Pseudodiaptomus marinus* had a g_{max} of 0.45 d⁻¹ (mean of copepodites C1-C3) at 20 °C and food saturation (Uye et al., 1983). The environment in which *P. marinus* growth rates were determined was food saturated because the phytoplankton density was always high and food deficiency could not occur (Uye et al., 1983). In laboratory experiments, *P. forbesi* (copepodites C1-C5) fed at saturation had a g_{max} of 0.40 d⁻¹ (adjusted to 20 °C). The g_{max} probably would have been higher if later stages of copepodites were not included because they grow slower than earlier stages (Kimmerer et al., 2017). In our study, *P. forbesi* growth rates adjusted to 20 °C and fitted with equation (1) had a g_{max} of 0.32 d⁻¹, which suggests *P. forbesi* was often food-limited in our study because our g_{max} was lower than that of *P. marinus* and *P. forbesi* at food saturation (Uye et al., 1983; Kimmerer et al., 2017). Our results showed a similar pattern for *P. forbesi* in relation to Chl a compared with other copepod studies in similar habitats, in which growth rate increased hyperbolically with food concentration (Vidal, 1980, Kimmerer

and McKinnon, 1985, Kimmerer and McKinnon, 1987), but with different rates. These comparisons highlight that copepods have similar responses to food concentration, but the rates of these responses vary among species, life stage, and temperature.

Copepod growth in the San Francisco Estuary

The Yolo Bypass is a small part of the northern San Francisco Estuary, an unproductive freshwater to brackish system (Cloern and Jassby 2012; Kimmerer and Thompson 2014). High turbidity limits primary productivity through light limitation (Cole and Cloern, 1984) and high ammonium concentrations may inhibit phytoplankton access to nitrate and limit the maximum growth rates of at least some phytoplankton in the SFE (Wilkerson et al., 2006). Chl a concentration in the upper estuary declined sharply in 1987 and since has rarely exceeded $\sim 10 \mu\text{g L}^{-1}$ except during occasional brief blooms (Kimmerer et al., 2012). The decline in Chl a coincided with the spread of the introduced clam, *Potamocorbula amurensis* (Nichols et al. 1990), which grazes at high rates on phytoplankton, limiting the buildup of biomass (Thompson, 2005; Kimmerer, 2006; Kimmerer and Thompson 2014).

Earlier studies on *P. forbesi* growth rates in the SFE could not determine a relationship between growth rate and Chl a because nearly all Chl a was low (Kimmerer et al., 2014; Kimmerer et al., 2017). The wide range of Chl a in our study allowed for a model that included both high and low values of growth rate (Task 5 Figure 25) and as a result we were able to confirm that *P. forbesi* growth is food-limited in most of the SFE (Task 5 Figure 29). In our study, growth rates saturated at $\sim 10 \mu\text{g L}^{-1}$ (Task 5 Figure 25), suggesting copepods may be food-limited at Chl a $< \sim 10 \mu\text{g L}^{-1}$ (Task 5 Question 3). The low growth of primary consumers likely impacts the productivity of higher trophic organism's dependent on them.



Task 5 Figure 29. *Pseudodiaptomus forbesi* growth rate in relation to Chl a concentration from various regions in the SFE, including; the Complex (CSC) (Kimmerer et al., 2018) (cyan), low salinity zone (LSZ) (Kimmerer et al., 2014; Kimmerer et al., 2017), and Sacramento River (SR) and San Joaquin River (SJR) (Kimmerer et al., 2014) (grey), and Yolo Bypass (red). Plots show growth rates at incubation temperature (A) and growth rates adjusted to 22°C (B) in relation to total chlorophyll.

Measured growth rates in our study area were, on average, 1.5 times greater (Task 5 Question 3) and 1.3 times greater when adjusted to 22 °C (Sullivan and Kimmerer, 2013) than rates determined in previous studies in the SFE (Task 5 Figure 29). These regions generally have lower Chl a concentrations and temperatures than the Yolo Bypass, while the CSC is hydrologically connected to the Yolo Bypass and has similar Chl a and temperatures. Temperature-adjusted (22 °C) growth rates from all studies had a g_{max} of $0.37 \pm 0.07 \text{ d}^{-1}$ and a K_m of $1.72 \pm 1.13 \mu\text{g L}^{-1}$ (95% CI). The laboratory growth rate of *P. forbesi* was $0.51 \pm 0.05 \text{ d}^{-1}$ (95% CI) at 22 °C under food saturation (Kimmerer et al., 2017), suggesting food limitation in the field. However, field growth rates could saturate at lower values than laboratory values due to an artifact of laboratory rearing, initial conditions of the females used to start the laboratory cohorts, and differences in nutritive value in the cells of the chlorophyll.

Copepod growth rates and Chl a were higher in the Yolo Bypass than other parts of the SFE and had a strong spatial gradient that decreased from north to south into the broader estuary (Task 5 Question 3). Copepodite growth rate and abundance were inversely related (Task 5 Figure 24) and abundance was negatively related to flow at site N and positively at site SC (Task 5 Figure 27), implying that copepods from a productive area were being transported downstream (Task 5 Question 3). The southern site is strongly linked to the CSC by tidal mixing, so that site is probably more representative of CSC waters. Populations at the northern site may also be diluted by high flows. This dilution probably explains the lower copepodite abundance in the Yolo Bypass than in the downstream CSC and Central Delta (Task 5 Figure 29, top panel). Adult abundance was lower in the Yolo Bypass than in the CSC and Central Delta (Task 5 Figure 29, bottom panel), probably because late copepodites and adults were on the bottom during the daytime (Kimmerer and Slaughter, 2016).

Task 5 Conclusion:

Zooplankton Densities and Composition

The summer and fall zooplankton densities fluctuated between study years and those densities changed regionally in response to seasonal managed flow pulses. The Lower Yolo Bypass region had higher densities of the smaller freshwater cladoceran and cyclopoid copepod taxa in all years. These cladoceran taxa were primarily made up of the genus *Bosmina* and *Ceriodaphnia*. This region observed increases in cladocerans and cyclopoid taxa from upstream sources, as they were exported downstream during the managed flow pulse events in 2016 and 2018. The Cache Slough Complex and Lower Sacramento River regions were composed primarily by larger and predominately tidal calanoid copepods taxa, with *P. forbesi* being the primary species. These regions, especially the Cache Slough Complex, observed increases in the densities of cladoceran and cyclopoid copepod taxa during the managed flow pulses in 2016 and 2018, as positive flow pulses advected these zooplankton downstream into the channel, slough and island habitats. The zooplankton densities in all regions were highest in the summer managed flow pulse year of 2016 and this corresponded to high Chl a before, during and after the flow pulse period. In both 2016 and 2018, there was also an observed increase in calanoid copepod densities in the Lower Sacramento River region and this is likely attributed to downstream export from the Cache Slough Complex tidal habitats. Throughout all study years adult calanoid copepod numbers were low, especially in the Yolo Bypass, as the juvenile copepodite life stage was the primary contributor to total calanoid CPUE. This low abundance of adult life stage calanoid copepods is likely a result of daytime sampling, as calanoids are known to vertically migrate and reside near the bottom during the daytime (Kimmerer and Slaughter, 2016). Overall, our results provide evidence that the Yolo Bypass and Cache Slough Complex often have 2-3-times higher densities of zooplankton than the lower Sacramento River and can export cladocerans and copepods (i.e. cyclopoids and calanoids) downstream, during periods of net outflow, acting as donor habitat.

Calanoid Copepod Reproductive and Growth Rate

The calanoid copepod (i.e. *Pseudodiaptomus forbesi*) reproduction as estimated through egg production rate was positively associated with higher Chl a concentrations, especially at levels of 5-10 $\mu\text{g L}^{-1}$. The reproductive rates were highest in the Yolo Bypass and had a decreasing trend as sites moved southward into the lower Cache Slough Complex. Reproductive rates were highest in 2016 and much like zooplankton densities this corresponded to higher ambient Chl a. This suggests that increased Chl a in response to net positive outflows, such as the summer action in 2016, can improve calanoid copepod reproductive rates.

Our results indicate that calanoid copepods of the genus *Pseudodiaptomus* have similar maximum growth rates and *P. forbesi* growth rates in the SFE are food-limited most of the time. With *P. forbesi* being a preferred prey item for Delta smelt (Interagency Ecological Program 2015; Nobriga 2002; Slater and Baxter 2014), these results suggest that bottom-up food limitation may be a primary factor negatively effecting the growth and recruitment of this endemic species and other pelagic fishes. To alleviate food limitation and reach growth rates that are 90% of the maximum growth rate would require Chl a concentration of $\sim 16 \mu\text{g L}^{-1}$ ($9 \times K_m$ of $1.85 \mu\text{g L}^{-1}$) in the Yolo Bypass. In this study Chl a proved to be a better predictor of copepod growth rate than lipids. Those growth rates became saturated at $\sim 10 \mu\text{g L}^{-1}$ and this suggests that calanoid copepod may be food-limited at $\text{Chl a} < \sim 10 \mu\text{g L}^{-1}$. Overall calanoid copepod growth rate and Chl a were higher in the Yolo Bypass compared to other parts of the SFE. The calanoid copepod growth rates had a strong north to south spatial gradient, with highest growth rates at the northern most sites. The growth rates measured during the study were 1.3 times greater when adjusted to 22°C than rates measured in other regions of the SFE. Also, in this study we got the range of Chl a needed to resolve the entire response of growth to Chl a concentration and thereby provide some context and understanding to earlier studies. This suggests that increased Chl a in response to net positive outflows, such as the summer action in 2016, can improve calanoid copepod reproductive and growth rates.

VII. Task 6: (Primary Productivity) Phytoplankton growth, nutrient uptake, and health in the Yolo Bypass

Contributing authors:

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Frances Wilkerson, SFSU Dugdale/Wilkerson Lab**

Task 6. Background:

The San Francisco Estuary as compared to other estuaries throughout the world has a poor pelagic biomass and primary productivity (Cloern and Jassby 2008). The decline in phytoplankton biomass and primary productivity has been a long-term trend since the mid-1970s (Jassby 2008). The Yolo Bypass has been identified as a significant source of phytoplankton biomass to the Delta during the winter and spring times during floodplain inundation (Lehman et al. 2008; Sommer et al. 2004), but little has been known about its contribution to the food web during the dryer summer and fall months. Since the observed bloom events in 2011 and 2012, we have realized the potential of the Yolo Bypass as a source of valuable phytoplankton to the Cache Slough Complex and as far south as Antioch. This has direct positive implications for the zooplankton and pelagic fish community, which has also been on the decline. Initial study results from 2012 and 2013 have shown that the phytoplankton species composition during the fall flow pulse is dominated by the higher nutritional quality diatoms. The Yolo Bypass has shown evidence of increased phytoplankton biomass during floodplain inundation (Sommer et al. 2004), with draining events contributing to the accumulation of large diameter diatoms and green algal cells (Lehman et al. 2008).

Loss of plankton is a major factor responsible for the decline of many SF Estuary/Delta fishes including the endangered Delta Smelt (Baxter et al. 2010). Since the late 1980's phytoplankton blooms have rarely been reported. However, following a very wet spring in 2011, during the 2011 Fall Low Salinity Habitat (FLaSH) studies a phytoplankton bloom (reaching $30 \mu\text{g L}^{-1}$), dominated by the chain-forming diatom *Aulacoseira* was observed in the lower Sacramento River in late October/early November shortly after a seasonal agricultural flow pulse passed through the Yolo Bypass. This was one of the first fall blooms to be reported for the estuary, based upon various monitoring programs in the Delta and was likely observed because there was increase temporal sampling during the FLaSH study.

During these surveys in 2011 and 2012, the lower Sacramento River, below Rio Vista, appears to be a "hot spot" for pelagic phytoplankton during the fall. It is unclear why phytoplankton abundance and rates (primary productivity and nutrient uptake activity) are higher at these locations; however, it is likely that seed populations of phytoplankton are being advected into the lower Sacramento River from the productive CSC.

Additional sampling efforts in 2012, 2013, and 2014 provided evidence of significant fall phytoplankton blooms and subsequent increased zooplankton abundance occurring in the Toe Drain of the Yolo Bypass, while conversely there was no increase in phytoplankton abundance within the main-stem Sacramento River (J. Frantzich, DWR, 2014 IEP Workshop). In 2013 and 2014, a collaborative study that included DWR (Jared Frantzich), Central Valley Water Resources Control Board (CVWRCB) (Chris Foe), University of California at Davis (UCD) (Randy Dahlgren), and U.S. Bureau of Reclamation (USBR) (Erwin Van Nienwenhuyse), investigated nutrient concentrations, water quality, flow and phytoplankton dynamics within the Yolo Bypass and south through the CSC. Preliminary results suggest that such

blooms are likely determined by several interacting factors including: flow, phytoplankton dynamics, nutrient inputs, and grazing (from zooplankton and clam community).

Task 6. Research Questions:

1. How does primary productivity change spatially within each region described in the conceptual model during the summer/fall?
2. Do the managed flow actions in the Yolo Bypass and/or Sacramento River facilitate an increase in primary productivity accompanied by increased chlorophyll?
3. Do rates of primary productivity vary with ambient water temperature, nutrient conditions, flow regime or light?

Task 6. Methods:

Primary productivity rates (surface and depth-integrated) were measured and assimilation numbers were calculated (chlorophyll-specific rates of primary productivity), along with nitrate and ammonium uptake by phytoplankton from water samples collected on six occasions between June and September 2017 and 2018 (Note: There was not an approved contract in place to complete 2016 primary productivity or nutrient uptake rate experiments) - two before, two during and two after experimental flow pulses are generated. .

Productivity and uptake incubations were carried out with water collected by DWR staff from surface and at depth from 9 site locations (north to south): 1) Ridge Cut Slough at Hwy 113 (RCS), 2) Rd. 22 at Toe Drain (RD22), 3) I80 Bridge at Toe Drain (I80), 4) Toe Drain below Lisbon Weir, 5) Screw Trap at Toe Drain (STTD), 6) Prospect Slough at BL5 (BL5), 7) Base of Liberty Island (LIB), 8) Cache Slough at Ryer Island (RYI), 9) Sacramento River at Rio Vista (RVB) and 10) Decker Island (SDI) (Figure 1). All sites were sampled in one day with two separate crews: Land crew and Boat crew. The land crew started at RCS and progress south to LIS, collecting at a total of 7 sites. The boat crew launched at Rio Vista public ramp and started at SDI boating northward up to STTD, collecting at a total of 7 sites.

SFSU Romberg Tiburon Center (RTC) researchers met DWR staff and receive station sample water for a series of outdoor primary production (and nutrient uptake) incubations (using ^{13}C -bicarbonate and ^{15}N -ammonium or -nitrate), at RTC, under natural incoming solar irradiance and ambient Delta water temperatures. A submersible heater was used to get the appropriate temperatures.

For each station (i.e. water sample), 24-hour duplicate isotope tracer primary production incubations were carried out with additions of ^{13}C -bicarbonate to obtain rates of primary production ($\text{mg C m}^{-3} \text{ d}^{-1}$) by the phytoplankton community (according to Wilkerson et al. 2015). Using estimates of biomass (e.g. Chl a) provided by DWR staff, an provide assimilation number ($\text{mg C (mg Chl a)}^{-1} \text{ d}^{-1}$) was provided. Using the rates measured at two depths a calculated ratio of surface: deep rates and estimate depth-integrated rates ($\text{mg C m}^{-2} \text{ d}^{-1}$) was attained, assuming homogenous distribution of phytoplankton between the two depths.

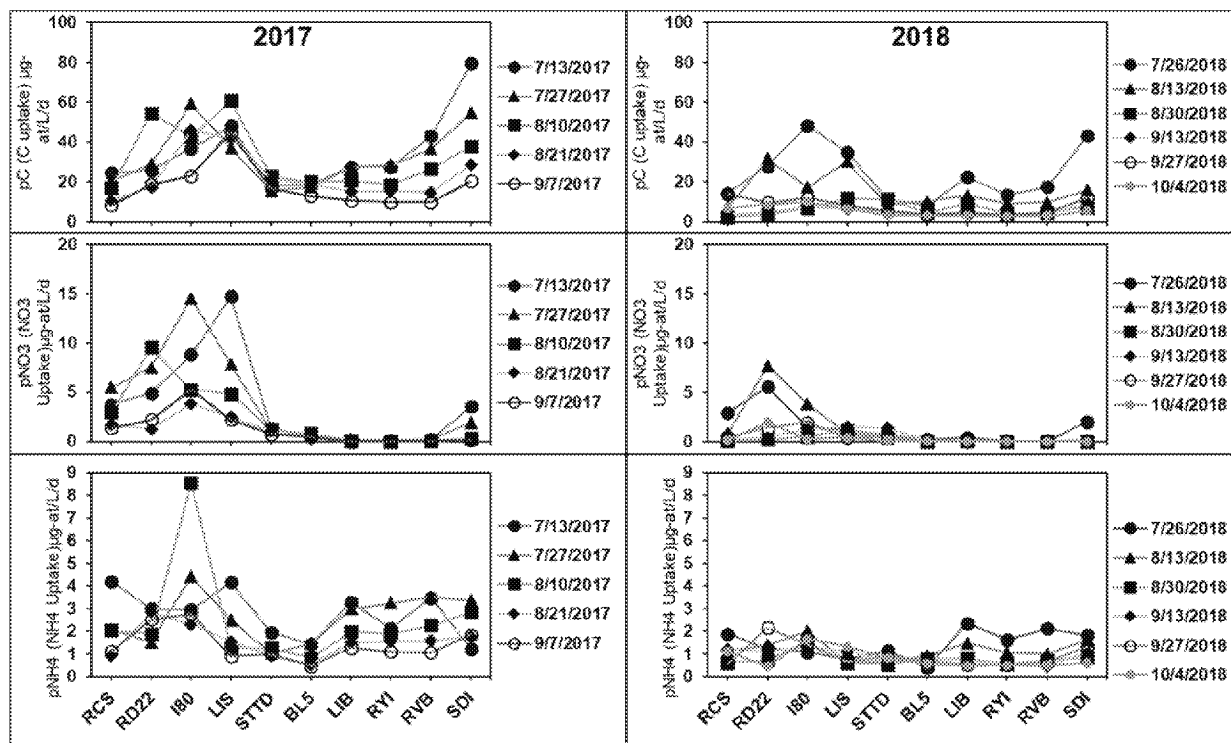
$^{15}\text{NO}_3$ and $^{15}\text{NH}_4$ was added to the incubated bottles to obtain nutrient uptake rates. The near-surface water sample was incubated at 50% of surface solar irradiance, and the near-bottom samples at 10% of surface irradiance – by screening the bottles in bags made of window screening. After 24 hours, samples were filtered onto precombusted GF/F filters, frozen until analyzed with a PDZ Europa TracerMass mass spectrometer, and rates calculated according to Dugdale and Wilkerson (1986) and Legendre and Gosselin (1996). Dissolved inorganic carbon (DIC) concentrations were determined on the water sampled

for productivity measurements as DIC is needed for calculating primary production rates. DIC will be measured in 20-ml samples using a Monterey Bay Research Institute-clone DIC analyser with acid-sparging and non-dispersive infrared analysis (Friederich et al. 2002; Parker et al. 2006) following preservation with 200 μ L of 5% w/v HgCl_2 .

Task 6. Results and Discussion:

2017

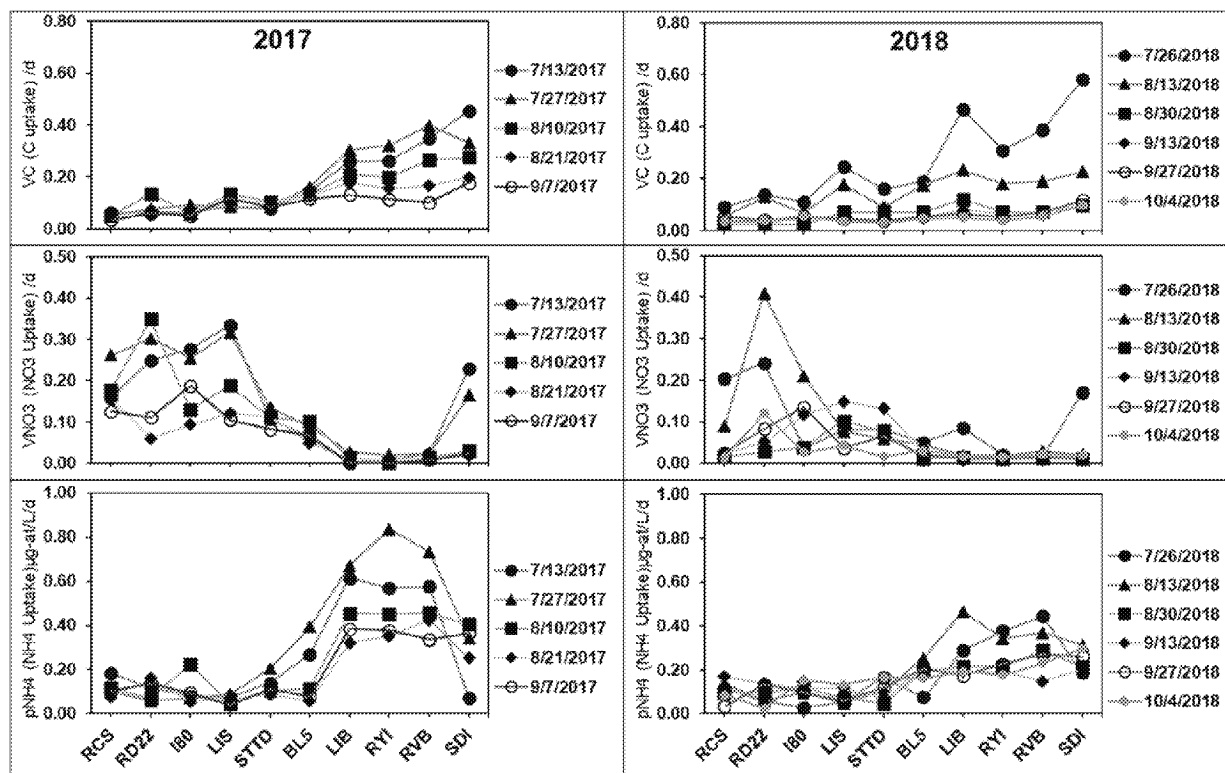
In 2017, the summer primary productivity rate as carbon uptake $\text{pC } \mu\text{g-at/L/d}$ in the Colusa Basin-Ridge Cut Slough region ranged from 10.64 – 24.51 $\mu\text{g-at/L/d}$ (Task 6 Figure 1). The carbon uptake rates decreased overtime from early summer to early fall (Task 6 Question 1), with the fall sampling event yielding the lowest rate in this region of 8.46 $\mu\text{g-at/L/d}$ (Task 6 Figure 1). As carbon uptake rates decreased so did the nutrient uptake rates for nitrate (NO_3) and ammonium (NH_4), with concentrations ranging from 1.75-5.45 $\text{pNO}_3 \mu\text{g-at/L/d}$ and 0.93-4.21 $\text{pNH}_4 \mu\text{g-at/L/d}$ (Task 6 Question 1 and 2). The carbon and ammonium uptake rates from assimilation by phytoplankton biomass were low in this region and decreased over time (Task 6 Figure 2). The nitrate uptake rates by phytoplankton biomass were high in this region at 0.16-0.26 VNO_3/d . The water temperature in this region remained high at $\geq 25^\circ\text{C}$ and the region was light-limited with Secchi depth ranging from 0.21-0.25m (Task 6 Question 3). The primary productivity rates tracked closely with ambient Chl a and nitrogen concentration (Task 6 Figure 3).



Task 6 Figure 1. 2017 and 2018 carbon (C), nitrate (NO_3), and ammonium (NH_4) uptake rates

The upper Yolo Bypass region had high primary productivity rates as carbon uptake $\text{pC } \mu\text{g-at/L/d}$ compared to other regions (Task 6 Question 1), especially at site I80 with measured rates ranging from 23.15-59.21 $\mu\text{g-at/L/d}$ (Task 6 Figure 1). This region also maintained high nitrogen (NO_3 and NH_4) uptake rates throughout the summer and fall (Task 6 Figure 1). The trend of high nitrate and low carbon

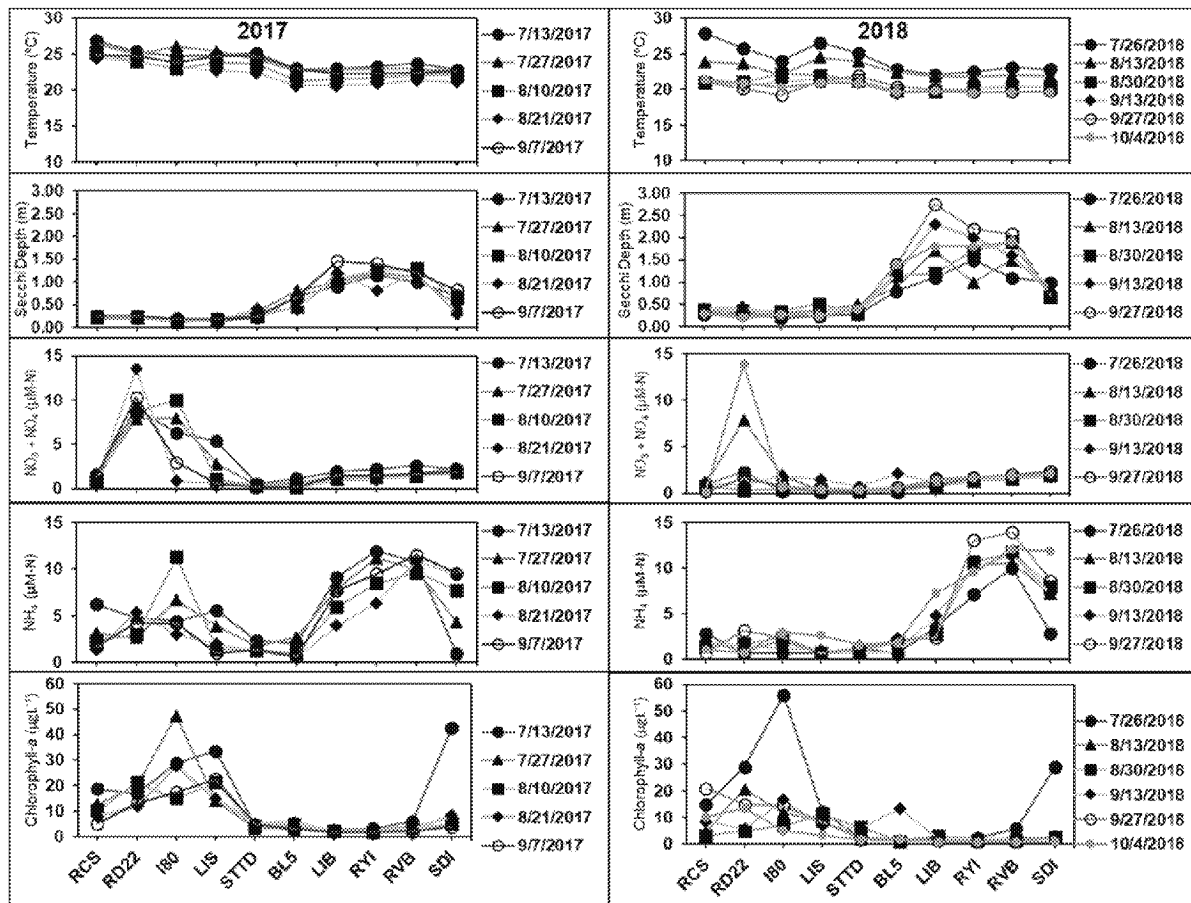
and ammonium uptake rates by phytoplankton assimilation were similar to Colusa Basin-Ridge Cut Slough region (Task 6 Figure 2). Primary productivity and nutrient uptake rates followed ambient Chl a and nutrient concentrations (Task 6 Figure 3), as this region had the highest measured phytoplankton biomass and nitrogen concentrations throughout the study period (Task 6 Questions 2 and 3). The water temperature in this region during the study period was $\geq 24^{\circ}\text{C}$ and conditions were light-limited with Secchi depth ranging from 0.12-0.25m (Task 6 Question 3).



Task 6 Figure 2. 2017 and 2018 carbon (C), nitrate (NO3), and ammonium (NH4) uptake rates by phytoplankton biomass specific rates V.

The lower Yolo Bypass region sites had drastically different primary productivity rates between upstream and downstream sites (Task 6 Question 1), with average carbon uptake of $46.63 \text{ pC } \mu\text{g-at/L/d}$ at site LIS and $18.92 \text{ pC } \mu\text{g-at/L/d}$ at the downstream site STTD (Task 6 Figure 1). These two sites had very different ambient nitrogen concentrations and the proximity of the LIS site to upstream water sources were a contributing factor. The higher outflow conditions in 2017 provided periodic connectivity and exchange of higher nutrient water sources (Task 6 Question 3) to the LIS site below the Lisbon Weir (Task 6 Figure 3). This resulted in higher nitrate uptake rates at site LIS especially in July while flows were still higher in the Yolo Bypass Toe Drain (Task 3 Figure 2). The ammonium uptake rates were low at both sites in this region averaging $1.65 \text{ pNH}_4 \text{ } \mu\text{g-at/L/d}$ (Task 3 Figure 1). The ambient Chl a remained high at site LIS ranging from $14.03\text{-}33.72 \text{ } \mu\text{g/L}^{-1}$ and this contributed to the higher nitrate assimilation rates (Task 6 Question 2) by phytoplankton biomass (Task 3 Figure 2). Notable, was the higher average ammonium uptake assimilation rate of $0.13 \text{ VNH}_4/\text{d}$ by phytoplankton biomass at the further downstream site STTD and this is likely contributed to lower availability of nitrogen as NO_3 (Task 6 Question 3). The STTD site is known to have limited levels of nitrogen, especially during periods of low outflow and the landward flow causes higher ammonium concentrations from the Sacramento River to move upstream into the bottom end of the lower Yolo Bypass region (Frantzich et al. 2018). The ambient water

temperature in the lower Yolo Bypass region was similar to upper Yolo Bypass averaging 24°C (Task 6 Question 3) and Secchi depth was marginally higher ranging from 0.22-0.4m (Task 6 Figure 3).



Task 6 Figure 3. 2017 and 2018 water temperature (°C), Secchi depth (m), nitrate + nitrite (µM-N), and chlorophyll a (µg/L) field measurements collected during primary productivity and nutrient uptake rate sample collects

The Cache Slough Complex and lower Sacramento River region primary productivity rate as carbon uptake $\text{pC } \mu\text{g-at/L/d}$ increased (Task 6 Question 1) as sampling progressed southward in these regions (Task 6 Figure 1). The nitrate uptake rate was low with an average of $0.38 \text{ pNO}_3 \mu\text{g-at/L/d}$, but ammonium uptake rates were higher in these regions averaging $0.40 \text{ pNH}_4 \mu\text{g-at/L/d}$ (Task 6 Figure 1). The NO_3 and NH_4 uptake assimilation rates by phytoplankton biomass followed the same trend of high NH_4 uptake and low NO_3 uptake (Task 6 Figure 2). The higher uptake rate of NH_4 was not surprising in the lower Cache Slough and lower Sacramento River sites, as ambient concentrations of nitrogen as NH_4 were elevated here and much higher than the available NO_3 concentrations (Task 6 Question 3). Although, NH_4 is assimilated first as part of the available nitrogen pool, phytoplankton growth is lower with only NH_4 as the primary nitrogen source. The high concentrations of ammonium in the lower Sacramento River have shown to inhibit phytoplankton growth (Wilkerson et al. 2006). The high ammonium concentrations may be one reason the Chl a in this region remained low (Task 6 Question 2) in 2017 (Task 6 Figure 3). The ambient water temperature in the Cache Slough Complex and lower Sacramento River regions was cooler averaging 21 °C, but still ideal for phytoplankton growth (Task 6

Question 3). These regions also had much higher water column light availability with Secchi depth averaging 1.5m (Task 6 Figure 3).

2018

In 2018, the primary productivity rate as carbon uptake in the Colusa Basin-Ridge Cut Slough region peaked at 14.36 pC $\mu\text{g-at/L/d}$ in July (Task 6 Figure 1). The carbon uptake rate was reduced during the managed flow action, with a mean of 3.07 pC $\mu\text{g-at/L/d}$ (Task 6 Question 1 and 2). Carbon uptake rate did increase soon after the managed flow action ended in this region (Task 6 Question 2), with rates increasing to 14.03 pC $\mu\text{g-at/L/d}$ on September 27th (Task 6 Figure 1). The higher NO_3 uptake rate corresponded with peak carbon uptake rates, with highest rates measured on July 26th at 2.98 p NO_3 $\mu\text{g-at/L/d}$. The NH_4 uptake rates ranged between 0.59-1.88 p NH_4 $\mu\text{g-at/L/d}$ and did not show a strong relationship with carbon uptake rate (Task 6 Figure 1). Phytoplankton biomass specific uptake rates followed similar trends, with highest rates on July 26th and lower rates during the remaining sampling weeks (Task 6 Figure 2). The ambient nitrogen concentrations remained low compared to 2017, with concentrations reducing after the managed flow pulse (Task 6 Question 3). Chl a corresponded to carbon and NO_3 uptake rates (Task 6 Question 2), with concentrations decreasing during the managed flow action (Task 6 Figure 3). Water temperature decreased 3 °C from the first sampling event on July 26th at 27 °C to next sampling event on August 13 at 23 °C. The Secchi depth ranged from 0.27-0.4 meters and increased during the managed flow pulse (Task 6 Question 3).

The upper Yolo Bypass region had the highest primary productivity rates as carbon uptake (Task 6 Question 1), with the highest measured rates in July and early August before the managed flow pulse (Task 6 Figure 1). The carbon uptake rates were lower than 2017 and remained low at an average of 7.93 pC $\mu\text{g-at/L/d}$ during and after the managed flow pulse (Task 6 Question 1 and 2). The NO_3 uptake rate was highest during peaks in carbon uptake, while NH_4 uptake did not show the same relationship (Task 6 Figure 1). Phytoplankton biomass specific uptake rates for carbon and NO_3 followed the same trend, with highest rates prior to the managed flow pulse (Task 6 Figure 2). The specific uptake rates by phytoplankton biomass of NO_3 were almost 2-fold lower compared to 2017. The Chl a concentration was highest in this region, but concentrations reduced during the flow pulse and this coincided with low primary productivity rates (Task 6 Question 2). The ambient water temperature ranged from 19-26 °C throughout the sampling period, with water temperatures cooling 3-4 °C during the flow pulse (Task 6 Figure 3). The Secchi depth ranged from 0.2-0.43 meters and water clarity was higher throughout the sampling period compared to 2017 (Task 6 Figure 3). The average NO_3 concentration were 3-fold lower and the average NH_4 concentration 2-fold lower than measured concentrations in 2017 (Task 6 Question 3).

The lower Yolo Bypass had elevated primary productivity rates as carbon uptake before the managed flow pulse in July and early August (Task 6 Question 1), peaking at 35.12 pC $\mu\text{g-at/L/d}$ on July 26th (Task 6 Figure 1). Similar to the Colusa Basin Drain-Ridge Cut Slough and upper Yolo Bypass regions the carbon uptake rates decreased during the managed flow pulse (Task 6 Figure 1). In 2018, the NO_3 and NH_4 uptake rates were 2-3-fold lower in this region compared to the prior year (Task 6 Figure 1). This was likely due to the lower ambient nitrogen concentrations (Task 6 Question 3) throughout the study period (Task 6 Figure 3). Specific uptake rates of NO_3 and NH_4 by phytoplankton biomass did increase in this region during the managed flow pulse (Task 6 Question 2) and this was during periods of peak Chl a concentration (Task 6 Figure 2 and 3), but carbon uptake rates did not have the same relationship (Task 6 Figure 2). The ambient water temperature in this region similar to the Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass regions ranging from 21-26 °C and decreasing over the study period

(Task 6 Question 3). The Secchi depth in this region ranged from 0.24-0.51 meters and increased during the managed flow action (Task 6 Figure 3).

The Cache Slough Complex and Lower Sacramento River primary productivity rates as carbon uptake were highest on July 26th prior to the managed flow action (Task 6 Figure 1). Overall, the carbon, NO₃ and NH₄ uptake rates show a downward trend throughout the study period (Task 6 Question 1) and duration of the managed flow action (Task 6 Figure 1). The specific uptake rates by phytoplankton biomass followed the same decreasing trend, with no observed response to the managed flow action. The Chl a increased only at the BL5 site in the upper Cache Slough Complex, with all other sites showing low concentrations and no response during the flow pulse (Task 6 Question 2). The ambient NO₃ and NH₄ concentrations were similar to 2017 for both regions (Task 6 Figure 3). The ambient water temperature in these regions ranged from 20-23 °C (Task 6 Question 3) and Secchi depth was on average 0.5 meters higher in 2018 as compared to 2017 (Task 6 Figure 3).

Task 6. Conclusion

The primary productivity measured as carbon uptake was highest in the northern most regions of the study area that included the Colusa Basin Drain-Ridge Slough and Upper Yolo Bypass. These regions had higher ambient NO₃+NO₂ and during peak primary productivity the NO₃ uptake rates were highest. The primary productivity rates were often lowest at the STTD and BL5 sites, where ambient nitrogen was often at limiting concentrations for phytoplankton growth. The Cache Slough Complex and Lower Sacramento River regions had lower primary productivity in both study years, but there were some higher rates at the lowest site in the Sacramento River at Decker Island (SDI). This section of the Sacramento River widens, outflows are reduced, and tidal mixing increases, improving physical conditions for phytoplankton growth. These southern most regions also had high ambient NH₄ concentrations and uptake rates. These high NH₄ concentrations from the Sacramento Regional Wastewater Treatment Plant in these regions, have been linked to inhibiting phytoplankton growth (Dugdale et al. 2012; Wilkerson et al. 2006) and could be one contributing factor to the absence of a bloom during the 2018 managed flow pulse.

Our results from the primary productivity rates measured throughout the managed flow pulse year of 2018, did not show strong evidence for increased rates corresponding to increased Chl a. The ambient Chl a remained low throughout most of the lower study regions despite the positive outflow, which was not expected based on prior summer and fall flow pulse events. The water temperature and Secchi depth conditions between the two study years (i.e. 2017 and 2018) were very similar. The nutrient concentrations followed the same pattern of high NO₃ concentrations in the Upper Yolo Bypass and low concentrations in the lower Toe Drain leading up to the flow pulse. However, the NH₄ concentrations were lower in the Upper Yolo Bypass and higher in the Cache Slough Complex and Lower Sacramento River. This change in predominant forms of nitrogen within each region between years can have substantial effects on Chl a concentration and are a key controlling factor in primary productivity rates. Our results suggest that these Yolo Bypass flow pulses may be more of a phytoplankton transport process rather than facilitating increased growth rates. Another year of study seems necessary to provide more substantial evidence to support this hypothesis.

VIII. Task 7: (Contaminants) Analyze the concentrations, distributions, and sources of various contaminants

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Task 7. Background:

In addition to dramatic changes in various estuarine habitat characteristics over the past several decades, contaminants are also an important component in changing Delta Smelt habitat suitability and the overall ecosystem function and productivity. There has been some recent progress in analyzing trends in contaminant concentrations and loadings in the Delta (Kuivila and Hladik 2008, Johnson 2010), but the exact effects of specific contaminants on local fishes and other aquatic organisms is still not well understood. The effects of pesticides, including herbicides and insecticides, are known to cause acute toxicity and/or chronic (sublethal) effects to both fish and aquatic invertebrates. There is some evidence of both lethal and sublethal effects on both fish and invertebrates from agricultural drainage from various isolated studies in the Delta and associated watersheds (e.g. Bailey et al. 1994, Kuivila and Foe 1995, Giddings 2000, Werner et al. 2000, Weston et al 2004). Due to this study's use of agricultural drainage flows to improve the food web downstream, we are particularly interested in the timing, concentrations and spatial distributions of those contaminants over the study period. From water management perspective, knowing more about the timing of higher concentrations of pesticides can help in future management strategies in the timing of the flow pulse and effects of discharge volume on contaminant concentration dilution and transport.

Pesticides, including herbicides, insecticides, and fungicides associated with agricultural and urban runoff have been detected in the Yolo Bypass and CSC throughout the year and the types and concentrations of these pesticides vary based largely on flow and their use in the surrounding watersheds (Smalling and others, 2005, Smalling and others, 2007, Weston and others, 2014; Orlando and Drexler, 2017). Previous studies have shown that environmental levels of herbicides can inhibit phytoplankton growth (Peterson and others, 1994; Ricart and others, 2009). The herbicide diuron, when combined with other herbicides, has been shown to have additive toxic effects (Magnusson and others, 2010), and in mixtures with its degradants, diuron has been shown to act synergistically to inhibit phytoplankton growth (Gatidou and Thomaidis, 2007). Additionally, the rice herbicide propanil has been shown to negatively affect phytoplankton and zooplankton in mesocosm studies of the effect of spray drift (Perschbacher and Edziyie, 2017).

Agricultural and urban runoff enters the Yolo Bypass and CSC at various points as well as from agricultural operations within the Bypass itself. These waters can contain mixtures of current-use pesticides and degradants in concentrations that vary depending in large part on spatial and temporal patterns of pesticide application and hydrologic conditions.

Since 1990, the California Department of Pesticide Regulation (CDPR) has required both agricultural and professional urban pesticide applicators to provide detailed information on pesticide use. The CDPR system is the most comprehensive pesticide reporting system in the nation, and these data are extremely valuable in assessing the potential for environmental contamination. The CDPR reporting system, however, does not contain information on pesticide applications made by homeowners using products purchased at retail stores, which could contribute substantially to total pesticide use in urban areas.

Applications of synthetic pesticides (excluding natural pesticides like sulfur, kaolin, mineral oil etc.) in the summer/fall of 2016 (the latest year for which data is available) totaled 862,846 kilograms in the Yolo Bypass low-flow watershed and 1,578,801 kilograms in the Sacramento River watershed (California Department of Pesticide Regulation, 2018). Task 7 Tables 1 and 2 list the total pesticide applications of over 1,000 kilograms by crop and by pesticide for each watershed.

Pesticide applications to rice made up 54 and 42 percent of the total amount of pesticides applied in the Yolo Bypass low-flow and Sacramento River watersheds, respectively. Other application sites with significant pesticide use (2 percent or greater of the total applications) in the two watersheds included several agricultural uses (walnuts, almonds, prunes, peaches, processing tomatoes, alfalfa, soil fumigation, uncultivated agriculture, outdoor transplants), urban uses (rights of way, landscape maintenance, public health), as well as timberland.

Pesticides whose major use is on rice and which were analyzed for in this study include propanil and its degradant 3,4-dichloroaniline, thiobencarb, azoxystrobin, cyhalofop-butyl, and carbaryl, (Task 7 Tables 1 and 2 see Appendix). The rice herbicide propanil was by far the most heavily applied pesticide in both watersheds. Pesticides whose major use is in urban settings and which were analyzed for in this study include carbendazim (a degradant of thiophanate-methyl and which is used in paints and coatings on building materials), dichlorovos (a degradant of naled), piperonyl butoxide, diuron and its degradants DCPMU and DCPU, and fipronil and its degradants desulfinylfipronil, desulfinylfipronil amide, fipronil sulfide, and fipronil sulfone.

To better understand water-quality in the Yolo Bypass and CSC in relation to summer/fall augmented flows the U.S. Geological Survey, Pesticide Fate Research Group collaborated with the California Department of Water Resources and State and Federal Contractors Water Agency on a study to assess the occurrence of current-use pesticides in the Bypass and CSC before, during and after summer/fall pulse flows in 2016, 2017, and 2018.

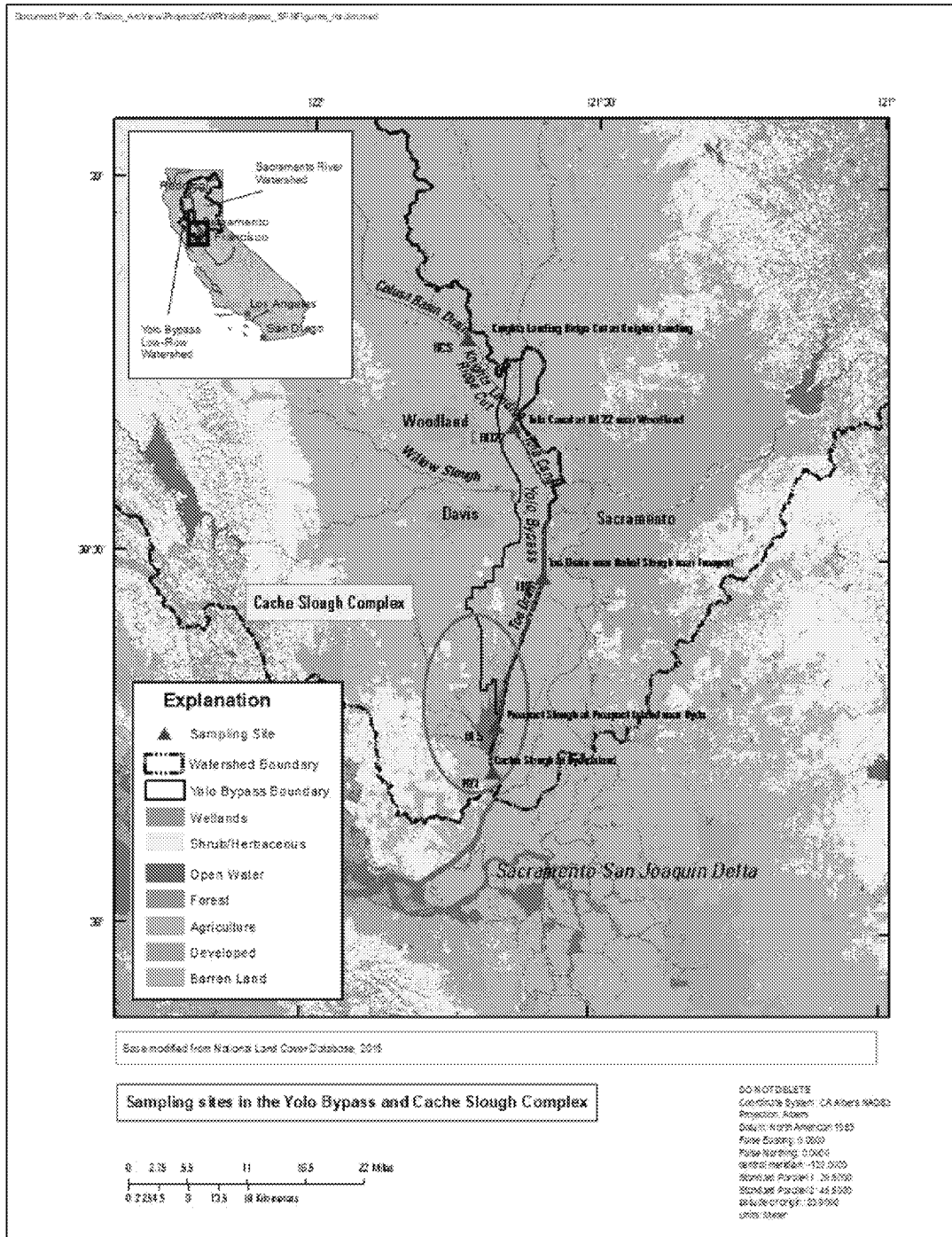
Task 7. Research Questions:

1. Is rice field drainage water a significant source of contaminants to the Yolo Bypass and downstream Cache Slough Complex?
2. What are the ambient concentrations of contaminants before, during and after summer/fall flow pulses?
3. What are the spatial differences in contaminant concentrations and are there regions that are sources (e.g. Woodland and Dais wastewater treatment discharge) and/or sinks during elevated summer/fall flows?

Task 7. Methods:

Samples were collected at five sites, from Knights Landing Ridge Cut in the north (RCS) and extending south within the Yolo Bypass on the Tule Canal (RD22) and Toe Drain (LIS), to the Cache Slough Complex (BL5 and RYI) (Task 7 Figure 1). During low flow periods, as occurred during this study, water drains north to south along the eastern edge of the Bypass through the Tule Canal and Toe Drain (Task 7 Figure 1). Agricultural irrigation water which eventually drains through the Bypass has a variety of sources including the Sacramento River, Putah Creek, and pumped groundwater. This water then enters the Bypass as tailwater, primarily through the Colusa Basin Drain and Knights Landing Ridge Cut, with additional tailwater coming directly from agriculture within the Bypass. Urban wastewater from the city of Woodland enters the Bypass just upstream of study site RD22, while wastewater from the city of Davis enters the Bypass through the Willow Sough Bypass approximately 10 kilometers upstream from study

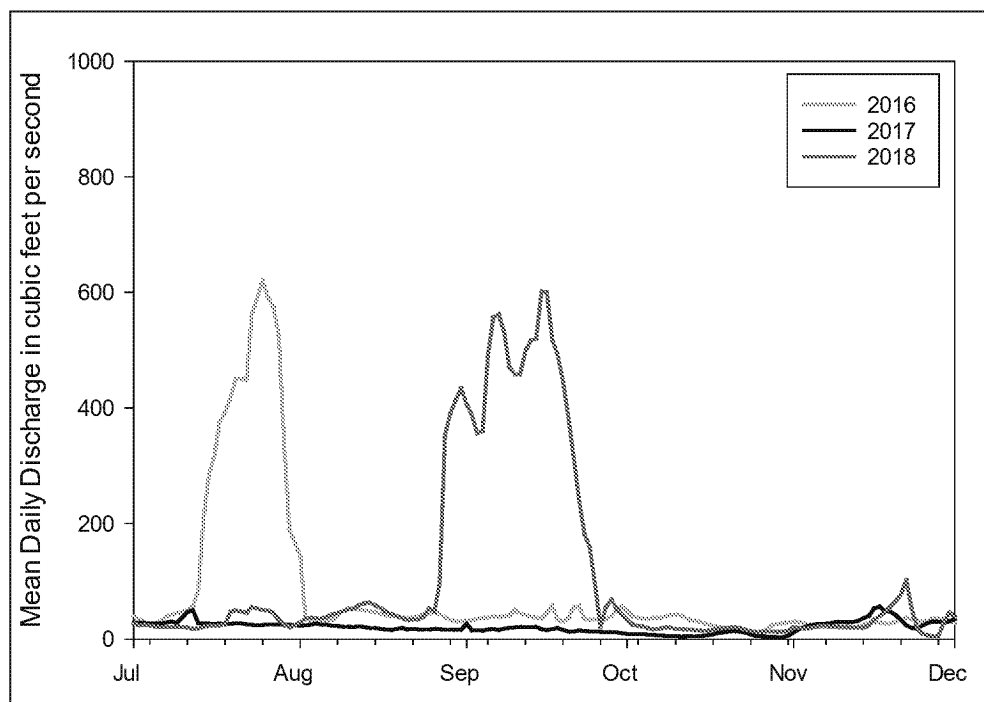
site LIS. At the southern end of the Yolo Bypass the Toe Drain terminates in Prospect Slough and site BL5 is located approximately 2 kilometers below this junction. The farthest downstream site (RYI) was on Cache Slough at the lower end of the CSC. During low flow periods, tidal pumping results in net upstream flow in the CSC and lower reaches of the Toe Drain with source water mainly from the Sacramento River (Morgan-King and Schoellhamer, 2013).



Task 7 Figure 1. USGS map showing locations of surface water sampling in the Yolo Bypass and Cache Slough Complex

For the purposes of this analysis, watersheds which drain directly into the Yolo Bypass and CSC can collectively be described as the low-flow watershed (Task 7 Figure 1). As previously described, water is tidally pumped into the CSC under low-flow conditions and this water can be a mixture of Sacramento River water and waters influenced by local within-Delta sources. Previous research by Frantzieh and others suggests that during the low-flow periods these waters likely influence the two southern-most sites (RYI and BL5) sampled during this study. As such land and pesticide use practices in the entire Sacramento River watershed (Task 7 Figure 1) can potentially influence pesticide occurrence in waters of the CSC and lower Yolo Bypass.

Land-use within the Yolo Bypass low-flow watershed is predominantly agricultural in the lowlands within and adjacent to the Bypass and CSC, and a mixture of shrub and herbaceous grasslands and forest in upper reaches of the watershed (U.S. Geological Survey, 2019). Similarly, in the Sacramento River watershed agricultural and urban land dominates in the lowlands while uplands are primarily forested (Task 7 Figure 1). The primary crops grown in the Yolo Bypass low-flow and Sacramento River watersheds are rice, nuts (almonds, walnuts, pistachios), stone fruits (prunes, peaches, cherries), alfalfa/hay, sunflowers, grapes, olives and tomatoes. (U.S. Department of Agriculture, 2019)



Task 7 Figure 2. Mean daily discharge at USGS site 11453000 Yolo Bypass near Woodland for the summer/fall of 2016, 2017, and 2018.

Surface-water samples were collected by DWR or USGS personnel at four sites in the Yolo Bypass and CSC during summer/fall of 2016 and at five sites in 2017 and 2018 (Task 7 Table 3). Samples were collected over the summer and fall months of June-October (sampling months varied by year). Sample timing targeted the collection of samples before, during, and after summer and fall managed flow actions (Task 7 Figure 2). At sites RCS, RD22 and LIS samples were collected from the stream bank by hand dipping or using a pole sampler to submerge 1L amber glass bottles 0.5 m below the surface. At sites BL5 and RYI samples were collected by boat from the center of the channel by hand dipping 1L amber glass

bottles 0.5 m below the surface. Samples were collected following guidance contained in a quality assurance project plan (QAPP) developed for the project. After collection, samples were placed on ice and transported to the USGS OCRL for extraction and analysis.

[Abbreviations: CA, California; DWR, California Department of Water Resources; USGS, U.S. Geological Survey]

DWR Site Code	USGS station number	USGS station name	Latitude ¹	Longitude ¹	Years sampled
ROS	384737121433201	Knights Landing Ridge Cut at Knights Landing CA	38.79353	-121.72544	2016, 2017, 2018
RD22	384035121383801	Tule Canal at Road 22 near Woodland CA	38.67636	-121.64397	2016, 2017, 2018
LIS	382829121351801	Toe Drain near Babel Slough near Freeport CA	38.47478	-121.58823	2016, 2017, 2018
BL5	381627121395101	Prospect Slough at Prospect Island near Ryde CA	38.27425	-121.66417	2016, 2017, 2018
RYI	11455350	Cache Slough at Ryer Island	38.21278	-121.66917	2017, 2018

¹All locations reference North American Datum 1983

Task 7 Table 3. Surface-water sampling sites located in the Yolo Bypass and Cache Slough Complex

Water samples were transported to the USGS Organic Chemistry Research Laboratory (OCRL) in Sacramento, California, and analyzed for a suite of 175 current-use pesticides using two methods: (1) gas chromatography with mass spectrometry (GC/MS) and (2) liquid chromatography with tandem mass spectrometry (LC/MS/MS) (Task 7 Table 4 see Appendix). Suspended sediments filtered from the water samples were analyzed for 143 pesticides by GC/MS (Task 7 Table 4 see Appendix). Extensive quality-control (QC) sampling was also performed for each method, including field blanks, field replicates, and laboratory matrix-spike and matrix-spike-replicate sample.

Task 7 Results and Discussion:

Over the three years of this study a total of 50 dissolved pesticides and pesticide degradants (15 fungicides, 16 herbicides, 18 insecticides, and 1 synergist) were detected in 113 water samples (Task 7 Table 5 see Appendix). Over this same period 6 pesticides (2 fungicides, 2 herbicides, and 2 insecticides) were detected in suspended sediments filtered from the water samples. The pyrethroid insecticides bifenthrin and fenpropathrin, and fungicide fluoxastrobin were only detected in suspended sediment (Task 7 Table 6 see Appendix). Concentrations of pesticides in suspended sediments are provided in nanograms per liter (ng/L) to facilitate the approximation of a whole-water pesticide concentration by summing the dissolved and suspended-sediment concentrations of pesticides.

Pesticide or Pesticide Degradate	Pesticide Type	2016 Detection Frequency (percent)	2016 Maximum Concentration (ng/L)	2017 Detection Frequency (percent)	2017 Maximum Concentration (ng/L)	2018 Detection Frequency (percent)	2018 Maximum Concentration (ng/L)	Overall Detection Frequency (percent)
Azoxystrobin	Fungicide	ND	ND	2	11.4	30	22.5	13
Bifenthrin	Insecticide	22	4.2	15	3.2	ND	ND	10
Clomazone	Herbicide	22	12.7	6	6.8	ND	ND	6
Fenpropathrin	Insecticide	ND	ND	ND	ND	4	21.7	2
Fluoxastrobin	Fungicide	ND	ND	ND	ND	7	142	3
Thiobencarb	Herbicide	ND	ND	4	5.8	ND	ND	2

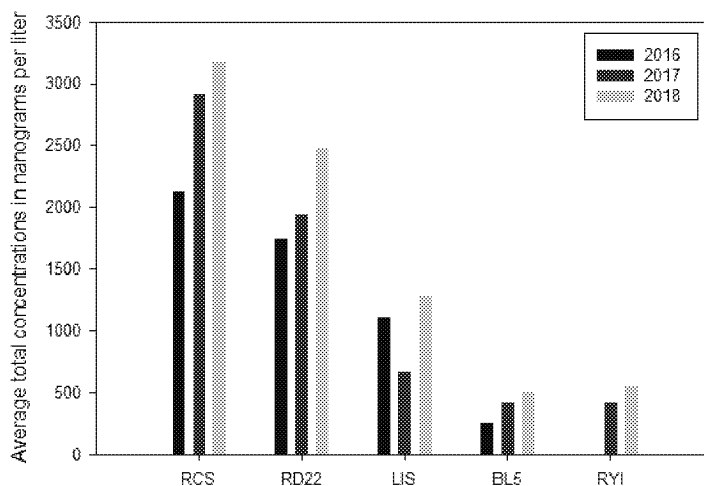
[Abbreviations ng/L, nanograms per liter; ND, not detected]

Task 7 Table 8. Detection frequencies and maximum concentrations of pesticides detected in suspended sediment collected from the Yolo Bypass and Cache Slough Complex in 2016, 2017, and 2018.

All samples contained mixtures of from 7 to 27 pesticides, and along with the fungicide azoxystrobin and herbicide degradant 3,4-dichloroaniline which were detected in every sample, the most frequently detected pesticides were the fungicide boscalid (detected in 94 percent of samples), the herbicides hexazinone (99 percent), and metolachlor (89 percent), and the insecticides methoxyfenozide (97 percent), and chlorantraniliprole (87 percent) (Task 7 Table 7 see Appendix). Six pesticides were detected in suspended sediments and the fungicide azoxystrobin (13 percent) and the pyrethroid insecticide bifenthrin (10 percent) were the most frequently detected (Task 7 Table 8). Site RD22 had the highest average number of pesticides detected per sample (20), followed by sites RCS (16), LIS (15) and BLC and RYI (11) (Task Question 2).

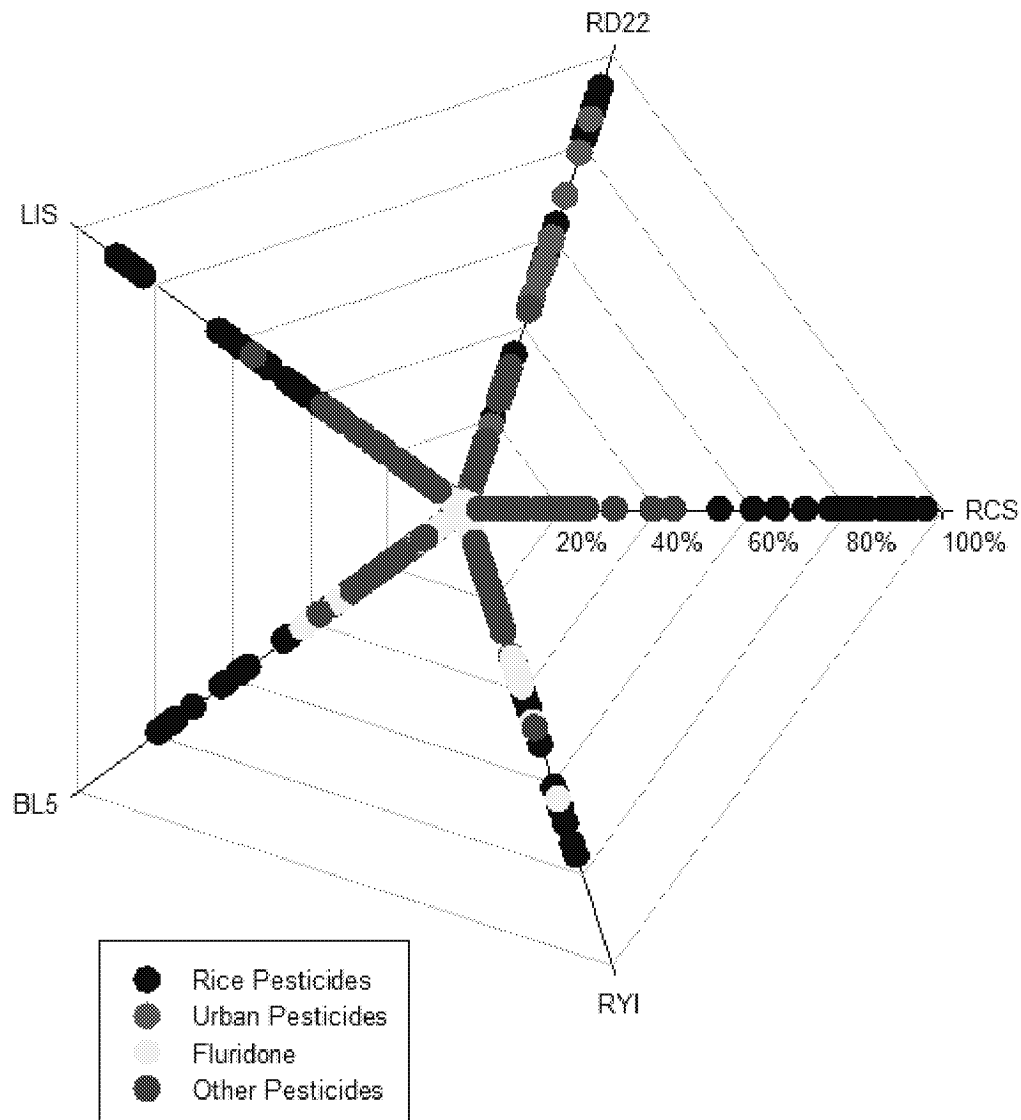
Twenty-three percent (26 of 113) of all samples contained at least one pesticide with a concentration above an aquatic life benchmark as established by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 2019). Sixty-one percent of the samples collected at site RD22, which is immediately downstream of where treated wastewater from the city of Woodland enters the Bypass contained at least one pesticide with a concentration above an aquatic life benchmark (Task Question 3), while 36% of the samples collected at site RCS (primarily agricultural tailwater) contained pesticides at concentrations above benchmarks (Task Question 1). Less than 10% of the samples from sites LIS, BL5 and RYI had pesticide concentrations above benchmarks.

Comparing average total pesticide concentrations at each site over the three years of the study, two general patterns are apparent. In each of the three years, concentrations were highest at the most upstream site (RCS) and declined steadily downstream to site BL5 (Task Question 2). Average total pesticide concentrations at site RYI (the furthest downstream) however did not follow this pattern and were similar or higher than those at site BL5 (Task 7 Figure 3). This was likely due to pesticides in water from the Sacramento River being tidally transported into the lower CSC. Task 7 Figure 3 also shows that average total pesticide concentrations were generally lowest in 2016 (Sacramento River pulse water) and highest in 2018 when agricultural tail water from the Colusa Basin Drain was used to supply the flow pulse (Task Question 1). Overall, the highest total pesticide concentrations at each site were detected either immediately prior to (RCS, and RYI) or during the flow pulse in 2018.



Task 7 Figure 3. Average total pesticides concentrations in nanograms per liter by sampling site for 2016, 2017, and 2018.

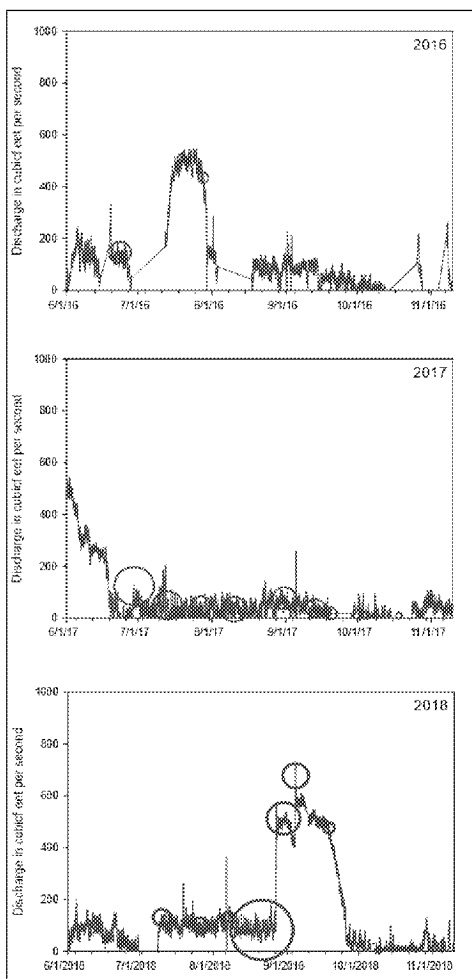
The radar plot in Task 7 Figure 4 shows the percent contribution of previously described pesticide use groups to the total amount of pesticides measured in each sample (Task Question 1, 2 and 3). Concentrations of rice pesticides accounted for more than 50% of the total in nearly all samples collected at sites RCS, LIS, BL5, and RYI (Task Question 1), while urban pesticides account for most of the total pesticide concentration in samples from RD22 (Task Question 3). In addition, the aquatic herbicide fluoridone was an important contributor at sites BL5 and RYI. Together, rice pesticides, urban pesticides and fluoridone account for more than 75 % of the total pesticide burden in 90 of the 113 samples collected.



Task 7 Figure 4. Radar plot showing the percent contribution of four groupings of pesticides to the total concentration of all pesticides in a given sample per site for 2016, 2017 and 2018.

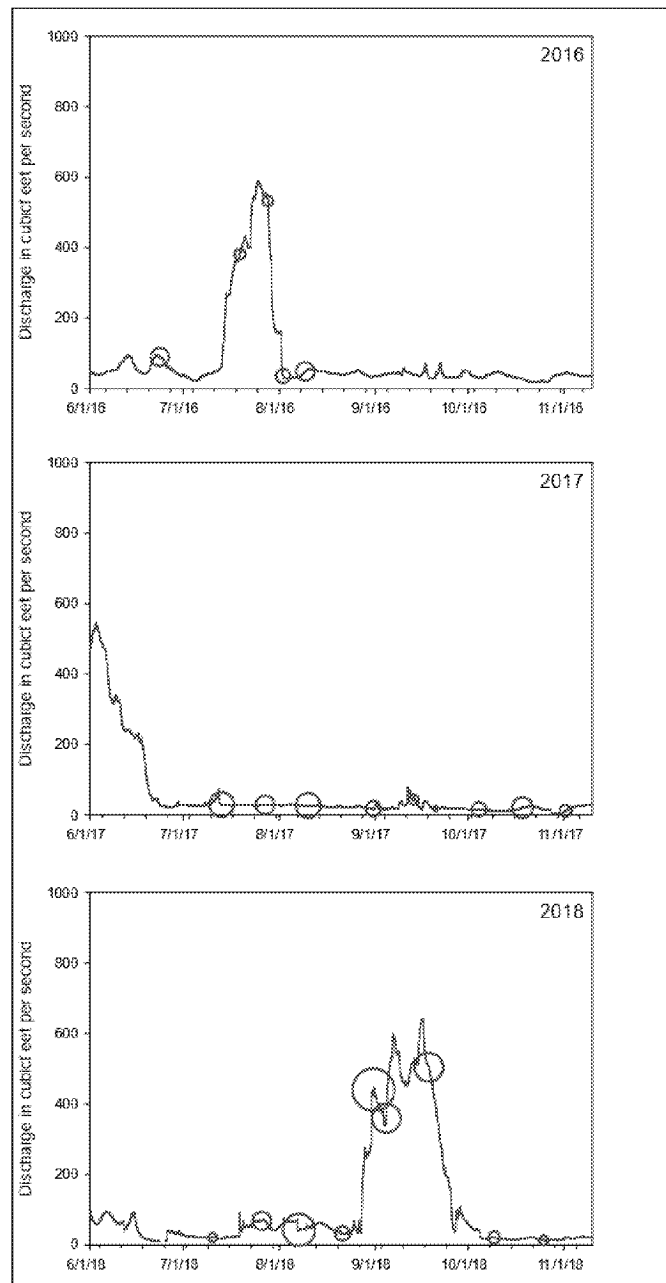
2016

A total of 34 dissolved pesticides and pesticide degradants (9 fungicides, 13 herbicides, 11 insecticides, and 1 synergist) were detected in 18 water samples collected from four sites (Task 7 Table 5 see Appendix). The insecticide bifenthrin and the herbicide clomazone were detected in the suspended sediments at all four sites sampled during the first sampling event but were not detected in any subsequent suspended sediment samples (Task 7 Table 6 see Appendix). Mixtures of from 9 to 25 pesticides were detected in every sample and the fungicide azoxystrobin, the herbicides clomazone and hexazinone, and the herbicide degradant 3,4-dichloroaniline were detected in every sample. Other frequently detected pesticides included the fungicides boscalid and fluxapyroxad (94 percent), the herbicides metolachlor and penoxsulam (94 percent), and the insecticides methoxyfenozide (94 percent), and chlorantraniliprole (83 percent) (Task 7 Table 7 see Appendix). Pesticide concentrations ranged from below the method detection limits to 1,280 nanograms per liter (3,4-dichloroaniline) (Task 7 Tables 5 and 6 see Appendix). In four samples the pyrethroid insecticide bifenthrin was detected at concentrations above U.S. Environmental Protection Agency's aquatic life benchmark of 1.3 ng/L for chronic invertebrate toxicity, and one of these samples also contained the insecticide fipronil at a concentration above the chronic invertebrate toxicity benchmark of 11.0 ng/L.



Task 7 Figure 5. Discharge and total pesticide concentrations at site RCS in 2016, 2017, and 2018. The size of the open circle represents the sum-total concentration of all pesticides detected in a sample and are depicted at a common scale for all three graphs.

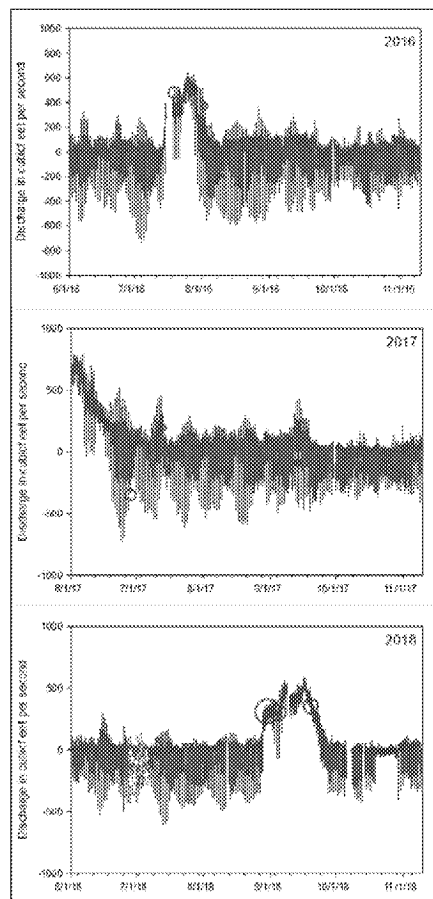
In 2016, Sacramento River water was used to generate a pulse flow in the Yolo Bypass during the last two weeks of July (Task 7 Figure 2). Total pesticide concentrations per sample at the two most upstream sites (RCS and RD22) were lower during the flow pulse compared to before and after (Task 7 Figures 5 and 6). At the tidally affected LIS site, total pesticide concentrations were higher in the first sample collected during the flow pulse (Task Question 1 and 2) compared to other samples due to high rice pesticide concentrations (Figure 7 and Tables 5 and 6 see Appendix). Flow data is not available for site BL5, however total pesticide concentrations were highest prior to the flow pulse and lowest following the pulse (Task 7 Tables 5 and 6 see Appendix).



Task 7 Figure 6. Discharge and total pesticide concentrations at site RD22 in 2016, 2017, and 2018. The size of the open circle represents the sum-total concentration of all pesticides detected in a sample and are depicted at a common scale for all three graphs.

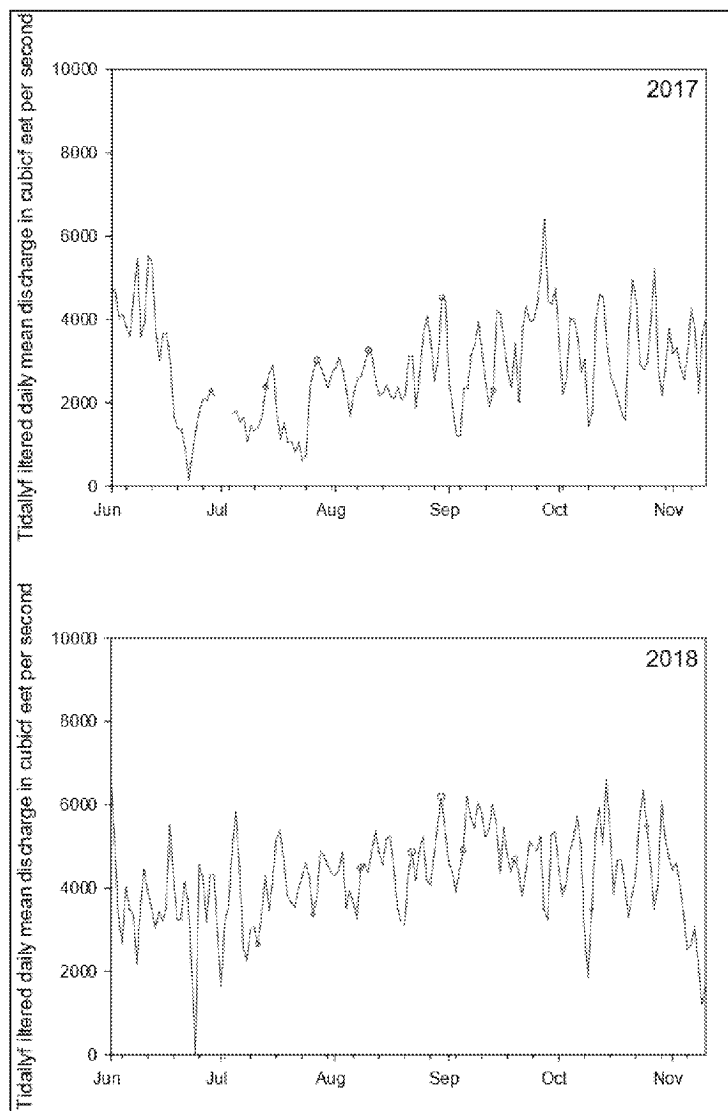
2017

In 2017, a total of 39 pesticides and pesticide degradants were detected in water samples (11 fungicides, 14 herbicides, 13 insecticides, and 1 synergist) (Task 7 Table 5 see Appendix). The fungicide azoxystrobin, the herbicides clomazone and thiobencarb and the insecticide bifenthrin were detected in the suspended sediments filtered from the water samples (Task 7 Tables 6 see Appendix and 8). Mixtures of 7 to 27 pesticides were detected in every water sample and the fungicide azoxystrobin, the herbicide hexazinone, and the herbicide degradant 3,4-dichloroaniline were detected in every sample. Other frequently detected pesticides included the fungicide boscalid (90 percent), the herbicide metolachlor (98 percent), and the insecticides methoxyfenozide (96 percent), and chlorantraniliprole (82 percent) (Task 7 Table 7 see Appendix). Pesticide concentrations ranged from below the method detection limits to 3,610 nanograms per liter (3,4-dichloroaniline) (Task 7 Tables 5 and 6 see Appendix). Fourteen of the 49 samples collected in 2017 contained at least one pesticide with a concentration above U.S. Environmental Protection Agency's aquatic life benchmarks. Pesticides detected above chronic invertebrate toxicity benchmarks included the insecticides bifenthrin (7 samples), dichlorvos (2 samples), fipronil (2 samples) and imidacloprid (5 samples). One sample from site RD22 also contained dichlorvos at a concentration above the acute invertebrate toxicity benchmark of 35 ng/L (Task Question 3). Lastly, in four samples also collected from site RD22, concentrations of the fungicide carbendazim were above the chronic fish toxicity benchmark of 990 ng/L (Task Question 3).



Task 7 Figure 7. Discharge and total pesticide concentrations at site LIS in 2016, 2017, and 2018. The size of the open circle represents the sum-total concentration of all pesticides detected in a sample and are depicted at a common scale for all three graphs.

A managed flow pulse was not conducted in the Yolo Bypass and CSC in 2017. At all sites total pesticide concentrations per sample were similar (Task Question 2) or generally decreasing through the study period (Task 7 Figures 5-8 and Tables 5 and 6 see Appendix).



Task 7 Figure 8. Tidally filtered daily mean discharge and total pesticide concentrations at site RYI in 2017 and 2018. The size of the open circle represents the sum-total concentration of all pesticides detected in a sample and are depicted at a common scale for all graphs.

2018

In 2018, a total of 37 pesticides and pesticide degradants were detected in water samples (11 fungicides, 13 herbicides, 12 insecticides, and 1 synergist) (Task 7 Table 5 see Appendix). The fungicides azoxystrobin and fluoxastrobin and the insecticide fenpropathrin were detected in the suspended sediments filtered from the water samples (Task 7 Tables 6 see Appendix and 8). Mixtures of 8 to 27 pesticides were detected in every water sample and the fungicide azoxystrobin, the herbicide degradant

3,4-dichloroaniline and the insecticide methoxyfenozide were detected in every sample. Other frequently detected pesticides included the fungicides boscalid (98 percent) and fluxapyroxad (83 percent), the herbicide hexazinone (98 percent), and the insecticide chlorantraniliprole (93 percent) (Task 7 Table 7 see Appendix). Pesticide concentrations ranged from below the method detection limits to 8,870 nanograms per liter azoxystrobin) (Task 7 Tables 5 and 6 see Appendix). Eight of the 46 samples collected in 2018 contained at least one pesticide with a concentration above U.S. Environmental Protection Agency's chronic invertebrate toxicity benchmarks. Pesticides detected above benchmarks included the insecticides dichlorvos (1 sample), fipronil (6 samples), and imidacloprid (2 samples).

In 2018, a managed flow pulse was conducted from the end of August through the end of September using agricultural tailwater (Task Question 1) from the Colusa Basin Drain. Total pesticide concentrations per sample at the most upstream site (RCS) were highest immediately prior to the flow pulse (as water was being pooled to supply the pulse) and remained elevated during the pulse, though the concentrations decreased as the pulse went on (Task 7 Figure 5 see Appendix). At sites RD22 and LIS, total pesticide concentrations per sample were elevated during the flow pulse (Task Question 2) compared to nearly all other samples collected at those sites during 2018 (Task 7 Figure 6 and 7 see Appendix). Concentrations at site BL5 increased during the flow pulse and then dropped by roughly 2/3 immediately after the pulse (Task 7 Table 5 see Appendix). Finally, at site RYI total pesticide concentrations per sample were similar prior to and during the flow pulse and lower after the pulse (Task 7 Figure 8).

Task 7. Conclusion:

Water source and timing of pulse flows are likely critical factors influencing biomass production and downstream distribution. Contaminants such as current-use pesticides may affect both the quantity and quality of biomass contributed by pulse flows and water source influences the total amounts of pesticides present during pulse flows. Pesticides used in growing rice are the dominant pesticides present in most areas of the Bypass and CSC during the summer/fall period, however the area receives inputs of pesticides from other crops as well as urban use pesticides, and herbicides used for invasive aquatic weed control. As a result, waters of the Yolo Bypass and CSC consistently contain mixtures of multiple current-use pesticides and pesticide degradants. Waters from the northern portions of the Yolo Bypass often contain pesticides at concentrations above chronic invertebrate toxicity aquatic life benchmarks. Many of those pesticides detected at benchmark exceedance levels were at site RD22 which is below the Woodland wastewater discharge and were primarily from urban use. RCS had many of the highest concentrations of agriculturally based pesticides. Little data exists however concerning the toxicity of mixtures of pesticides (as were detected during this study) to either aquatic invertebrates, phytoplankton or zooplankton. There was evidence that flow pulses do increase the pesticide concentrations as far south as below Lisbon Weir and upper CSC, but concentrations seem to degrade or dilute as they reach the lower Yolo Bypass and CSC. The total pesticide concentrations were higher in 2018 using the agricultural return water to generate the flow pulse, while the summer 2016 flow pulse using Sacramento River had lower overall pesticide concentrations. Data gathered in this study will aid DWR and other regulatory agencies in evaluating and determining if there is an overall ecosystem benefit in conducting summer and/or fall pulse flows in the Yolo Bypass.

The research program of managed flow pulses in the Yolo Bypass and CSC is expected to continue for several years and the role of contaminants will continue to be a topic of study. Additional USGS/DWR research focused on understanding the occurrence of pesticides in zooplankton and how the presence of these contaminants may affect fish health is currently underway.

IX. Task 8: (Salmon Telemetry) Adult fall-run Chinook Salmon acoustic telemetry to investigate residence time and movement in the Yolo Bypass

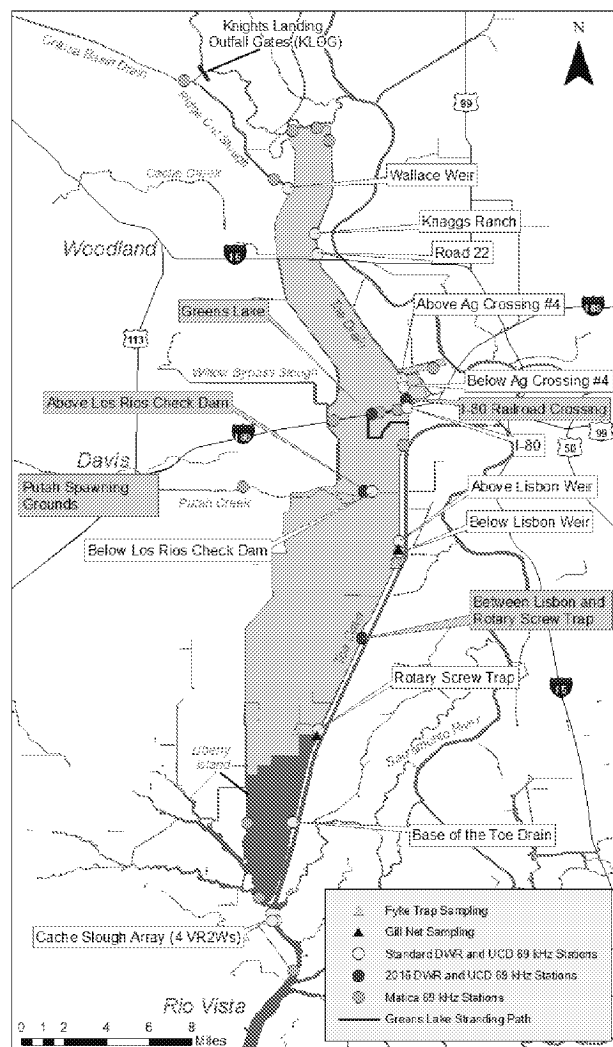
Contributing authors:

Gabe Singer, UCD Biotelemetry Lab

Jared Frantzich, DWR Division of Environmental Services

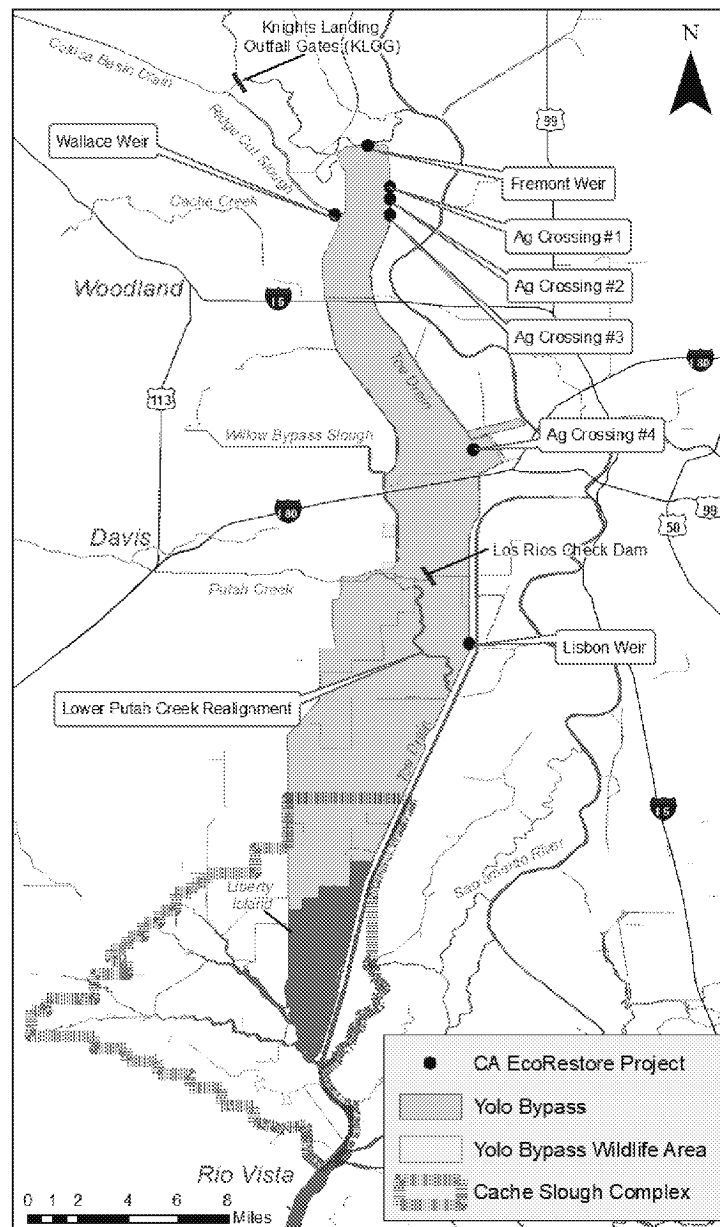
Task 8. Background:

The Fremont Weir is located at the northern most tip of the Bypass (Task 8 Figure 1 and 2) and only connects to the Sacramento River during brief windows of high flows in the winter and spring. Therefore, the Yolo Bypass presents a major passage issue for migratory fishes in the Central Valley (NMFS, 2009), especially during the lower flow time-periods of summer and fall. However, beyond a basic description of the timing and occurrence of migrating Chinook salmon (Harrell et al., 2003; BDCP, 2013; Frantzich et al., 2013; Sommer et al. 2014), little is known what happens to these fishes once they enter the Yolo Bypass.



Task 8 Figure 1. Map of Yolo Bypass telemetry array and fish capture sites

The presence of adult Chinook salmon in the Yolo Bypass during the fall has been historically observed based on fyke trap data collected by the DWR Yolo Bypass Fish Monitoring Program (Harrell et al., 2003; Frantzieh et al., 2013; Sommer et al. 2014). Even modest flows (e.g. >1,000 CFS) appear to be enough to draw a suite of native fish into the Yolo Bypass during winter. However, Sommer et al. (2014) found that Chinook Salmon entry to Yolo Bypass was tied more to seasonality than flows. This may be because the base of Yolo Bypass at Cache Slough Complex is strongly tidal, so tidal dynamics may have a greater influence on fish movements during fall, when stream flows are relatively low. Nonetheless, fall flows may have an important effect on how far upstream into Yolo Bypass Chinook Salmon migrate. Therefore, it is essential to investigate how an increased flow within the Yolo Bypass during the migration of fall-run Chinook Salmon affects their residence time, mortality and movement patterns



Task 8 Figure 2. Current locations of potential Yolo Bypass fish barriers and planned fish passage improvement projects under California Eco Restore

Task 8. Research Questions:

1. What is the residence time of adult fall-run Chinook Salmon in the Yolo Bypass?
2. Where does adult fall-run Chinook Salmon move within the reaches of the Toe Drain of the Yolo Bypass during the increased fall flows?
3. Are there specific areas of the Toe Drain where there is evidence of increased mortality, stress or holding behavior?

Task 8. Methods:

Telemetry was used to determine the residence time and movement behavior of adult fall-run Chinook salmon in the Yolo Bypass in respect to fall-flow pulses. This required the installation of eighteen monitors (VR-2W, 69 kHz, Vemco Ltd.) throughout the extent of the Yolo Bypass (Task 8 Figure 1). Coded ultrasonic beacon tags were then surgically implanted in 25-50 adult Chinook salmon

From 2015 to 2017 (Note: Tagging studies did occur in 2018, but data was not downloaded and analyzed in time for this report), Chinook salmon were captured in the DWR fyke trap below Lisbon Weir in the Toe Drain, and with gill nets operated by DWR and the UCD (see Task 8 Figures 1 and 2). Fish sampling for tagging started in September when water temperatures are no higher than 21°C, and end in November. Temperatures above this threshold are likely to inhibit fish passage (e.g., [Strange 2010](#)).

Once captured, DWR and UCD staff surgically affix coded ultrasonic beacon tags (V9, 69 kHz, Vemco Ltd.) below the dorsal fin of the salmon (Note, only if the fork length is greater than 550 mm and if the fish is in good condition). For this project, both adipose fin clipped, and non-adipose fin clipped salmon were tagged.

The salmon were not anesthetized before surgery but restrained by staff in a fish cradle and water was forced over the salmon's gills to maintain oxygen supply. All salmon recovered in an additional O₂ bath before release. During the tagging process, staff performed a RAMP assessment (reflex action mortality predictor), as described in Raby et al. (2012), to assess the vitality of the salmon.

Prior to release, an external Floy tag was placed into the muscle tissue behind the dorsal fin of the salmon on the opposite side of the acoustic tag to help with mark and recapture data from hatcheries, fish monitoring programs, and anglers. In addition, a tissue sample was taken from the caudal fin of the salmon for genetic analysis by the UCD Genomic Variation Laboratory.

Task 8. Discussion and Results:

2016

During the 2016 field season we captured and affixed 69kHz acoustic transmitters to 51 adult fall run Chinook Salmon. All the tagging occurred in less than two months, spanning from September 21, 2016 to November 10, 2017. Twenty-two of the 51 fish were captured in a 9-day span beginning on the October 18th and ending on October 26th, approximately ten days earlier than our peak capture period in 2015. These captures occurred shortly after a 3°C decrease in the water temperature in the Toe Drain. Flows during this time period fluctuated with the tides, but otherwise were relatively stable.

Forty-two of the tagged fish were captured in gillnets (29 at Lisbon and 13 at BRST), and 9 of the salmon were captured in the Fyke trap (Task 8 Table 1). The tagged fish had a mean fork length (FL) of 700mm (552-919mm). A sex determination was made for 28 of the 51 fish, with a distribution of 14 females and

14 males (Task 8 Table 2). The mean surgery time across the seven researchers that tagged fish was 2 minutes, with surgeries ranging from 1-4 minutes (Task 8 Table 3).

Tagging Location	N	Mean Handling Time	Mean Recovery Time	Mean Ramp Score
BRSTR	13	19.00	3.69	0.11
FYKE	9	72.29	1.67	0.00
LIS	29	19.10	1.43	0.06

Task 8 Table 1. 2016 adult Chinook salmon tagging results by site

Sex	N
Females	14
Males	14
Unknown	23

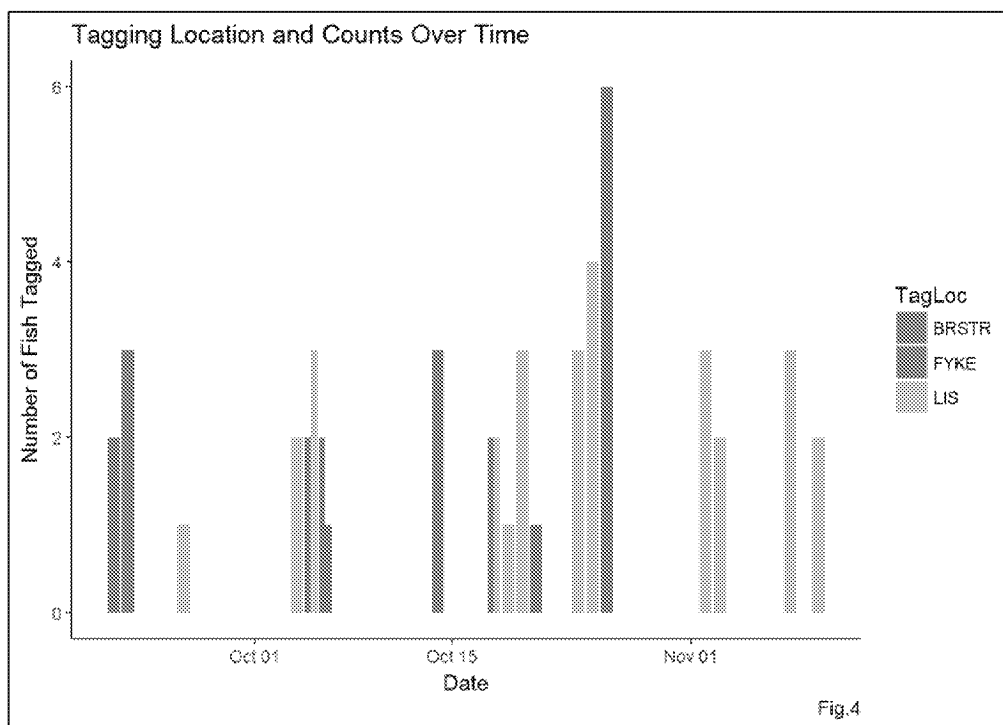
Task 8 Table 2. 2016 total number of tagged adult Chinook salmon males, females and unknown sex

Most of the salmon (n = 29) were captured at the Lisbon (LIS) site (Task 8 Figure 1). The site below the rotary screw trap (BRSTR) accounted for the second most captures (n = 13). These fish were captured on four separate sampling days. The Fyke trap accounted for the fewest number of captures (n = 9) (Task 8 Figure 3). Sampling efforts were planned for tidal transition periods, and the distribution of fish captured during different tidal phases can be found in Task 8 Figure 4. Like the 2015 study year, most of the fish were capture during flood tides, however there was not equal effort across each phase of the tidal cycle. Captures in the Fyke were more unpredictable and tagging at this location occurred opportunistically. Because of the Fyke trap's geographic proximity to LIS for certain analyses these locations are pooled and referred to as upstream tagging locations.

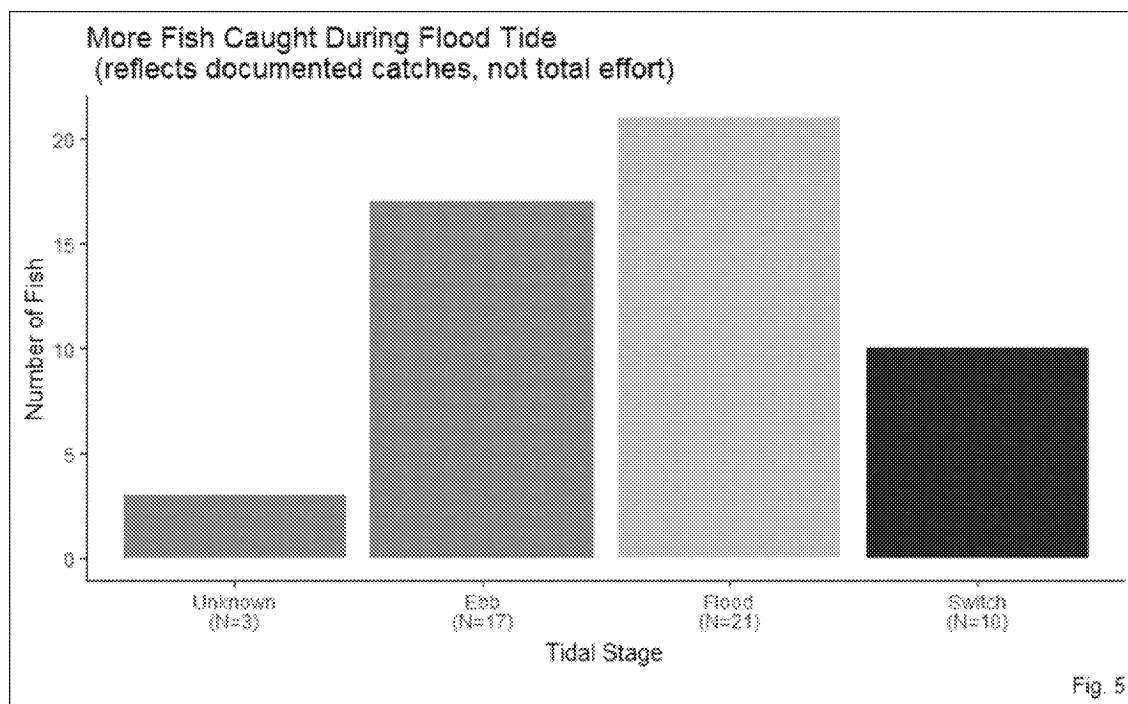
Surgeon	N	Mean Surgery Time
SH	12	2.08
PG	10	1.60
JF	8	1.88
NI	7	1.71
RA	7	3.00
MJ	4	2.00
MEJ	3	1.67

Task 8 Table 3. 2016 surgeons and total surgery time

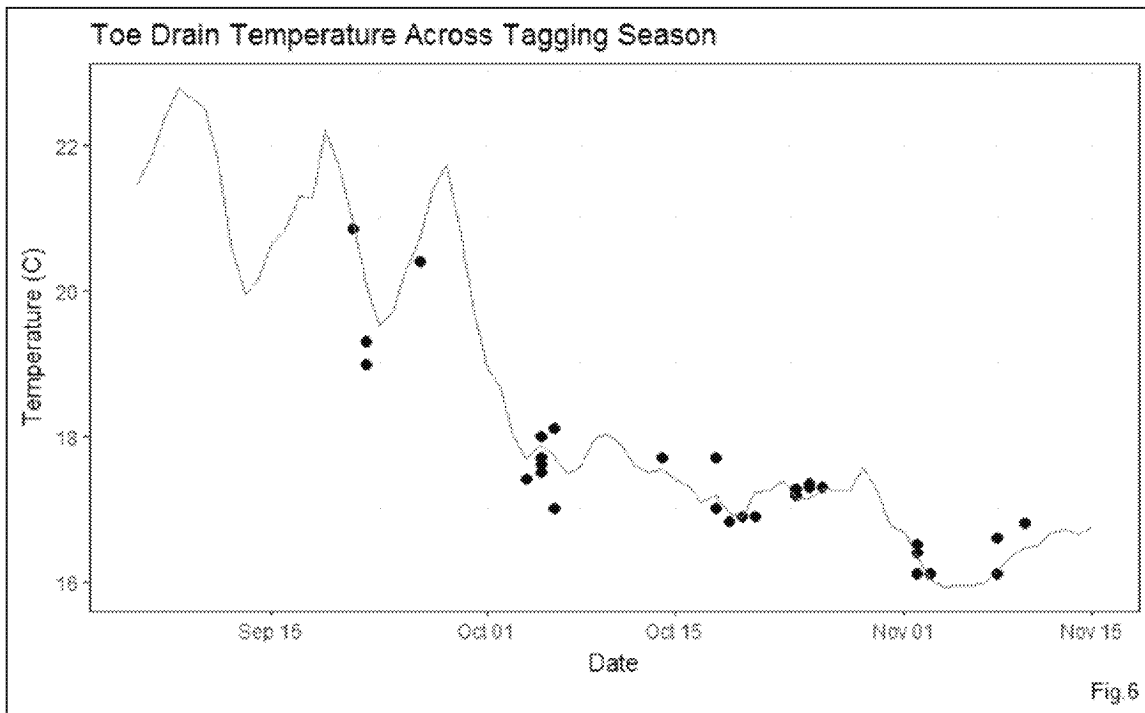
Water temperature in the Toe Drain ranged from 15.9-22.8°C throughout the tagging season, declining as the season progressed (Task 8 Figure 5). There was an approximately 3°C decline in temperature during the final week of September, with 45 of 51 fish captured after the decline in temperature. Dissolved oxygen remained relatively steady throughout the study season; it oscillated between 3.7-7.7mg/L and declined slightly from mid-October through the end of the year (Task 8 Figure 6). As, previously mentioned, flows in the Toe Drain during the study period were uniformly low and fluctuated with the tidal cycle.



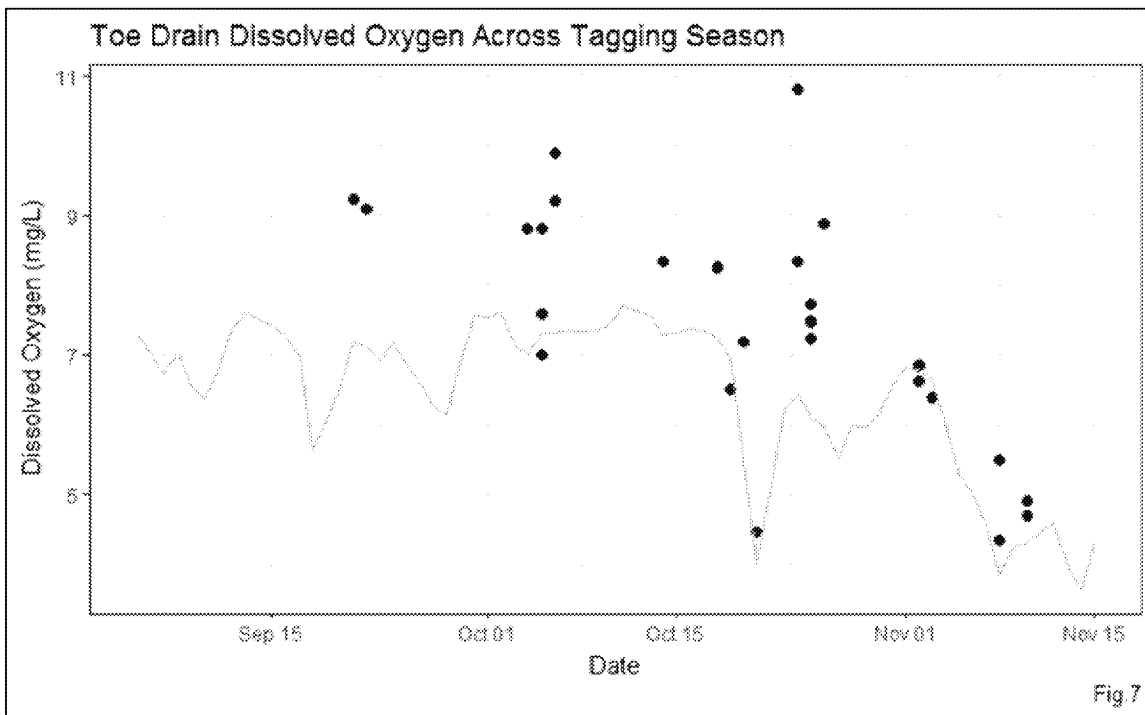
Task 8 Figure 3. 2016 total number of tagged adult Chinook salmon by site and tagging date



Task 8 Figure 4. 2016 adult Chinook salmon total catch by tidal phase



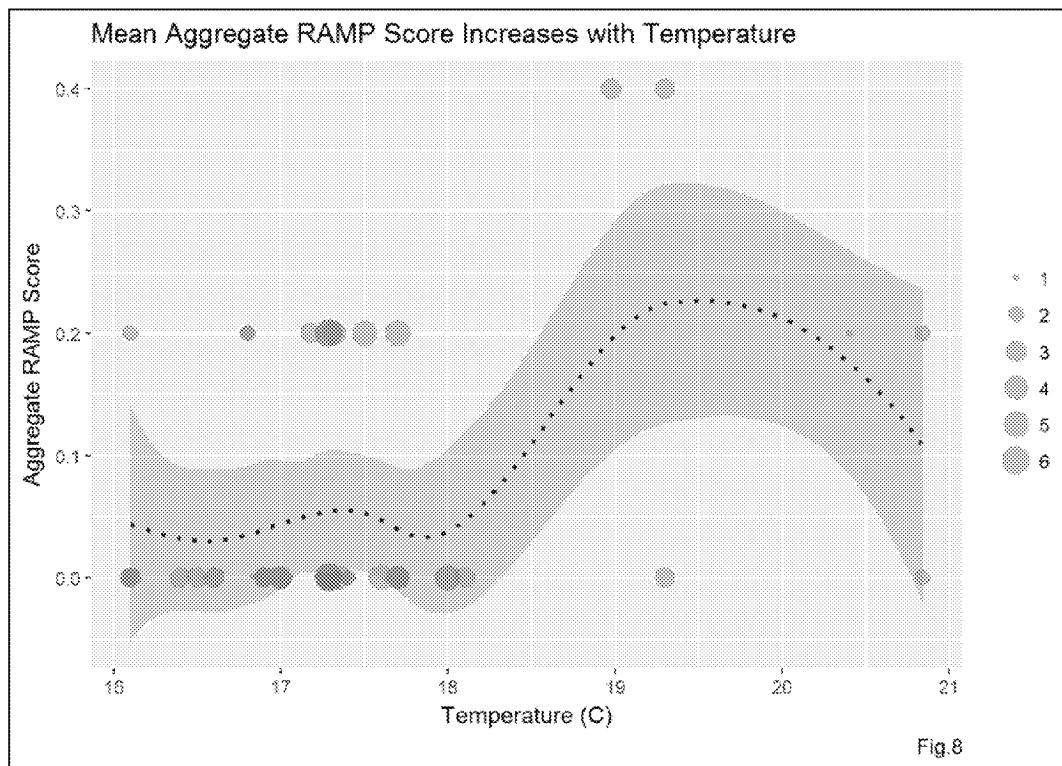
Task 8 Figure 5. 2016 Toe Drain water temperature during the tagging season



Task 8 Figure 6. 2016 Toe Drain dissolved oxygen during the tagging season

We recorded a measure of impairment of each tagged fish post-tagging immediately prior to releasing each fish back into the Toe Drain. Reflex impairment assessments have been used as an indicator of physiological stress and a predictor of delayed mortality in fishes (Davis 2005 & 2007, Raby et al. 2012). We utilized a battery of simple, rapid, minimally invasive applied tests with binary outcomes (e.g.

0 or 1), referred to as reflex action mortality predictors (RAMP), to score each fish that we tagged. There was a total of five predictors compiled to produce the RAMP score for each fish. The five predictors were used were tail grab, body flex, head complex, vestibular-ocular response (VOR), and orientation. For each test a score of zero reflected no impairment, whereas a score of one signified a stress induced impairment response (for a more thorough description of each test, please refer to the 2015 report). The final RAMP score for each fish is the average value across all five tests, resulting in a final score between 0 and one. Final scores closer to one indicate more impaired reflexes, and potentially more risk of delayed mortality. Data points for RAMP scores of fish captured at higher temperatures are sparse resulting from the inverse relationship with catch and temperature, as well as a maximum sampling/tagging temperature of 21°C. However, the trend line suggests that temperatures higher than 18.5°C at time of capture correlate to higher levels of impairment (Task 8 Figure 7).



Task 8 Figure 7. 2016 aggregate RAMP score in relation to Toe Drain water temperature

Movement Patterns

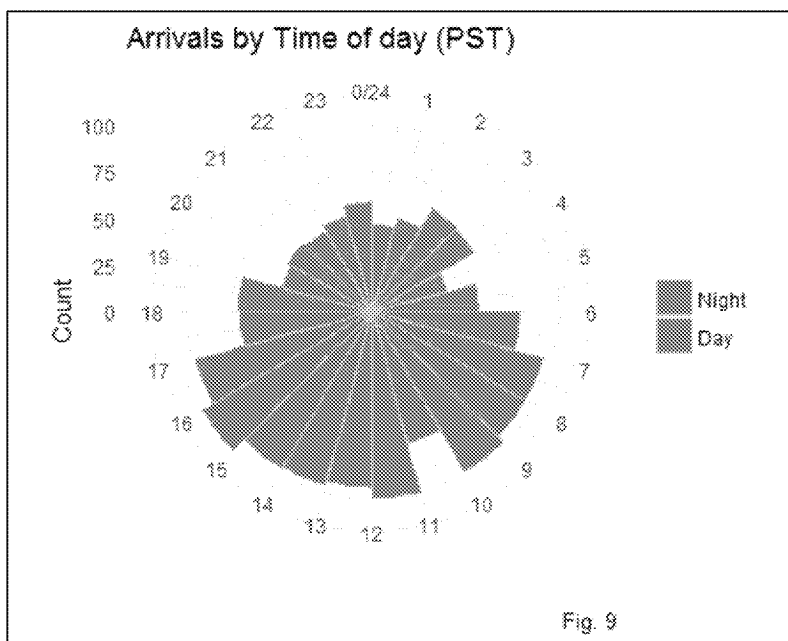
Within the Bypass the furthest upstream detection (Task Question 2) of a Chinook Salmon was above Agricultural Road Crossing 4 (rkm = 148.4; n=2). However, White Sturgeon tagged in previous years for this study were detected on the Knaggs Ranch and Cache Creek receiver stations, both of which are upstream of Ag. Crossing 4. Twenty-seven salmon were tagged on or prior to October 20th, and 11 of 27 of these fish were detected on the receiver array above Lisbon Weir (BRSTR n=2/7, Lisbon n=4/12, Fyke n=5/8). Twenty-four fish were tagged after October 20th (total N=51, one fish was capture by an angler in the American River and the tag was returned and redeployed). Twenty of the 24 fish tagged later in the season, were detected on the receiver array above Lisbon Weir ((BRSTR n=4/6, Lisbon n=15/17, Fyke n=1/1).

A higher proportion of fish from each tagging location moved above Lisbon Weir in 2016 compared to prior tagging season in 2015 (BRSTR = 0.46, FYKE = 0.67, LIS = 0.66). Thirty-one of 51 tagged fish

passed above Lisbon Weir (Task Question 2), and two of those fish continued up the Toe Drain and were detected above Ag. Crossing 4 (Task 8 Figure 2). These fish were the furthest upstream migrants within the Toe Drain proper. Both salmon were tagged in mid-October, one on October 14th and one on the 24th. Detection data from these two fish suggests that these fish either died in the Toe Drain (natural or harvest mortalities) or shed their acoustic tag, as there were no subsequent detections, in the upstream or downstream directions, after the final detections on the above Ag. Crossing 4 receiver (Task Question 1 and 2). A benign acoustic environment under low flow conditions, and high detection probabilities make it unlikely that these fish would exit the Toe Drain without being detected on any of the downstream receivers.

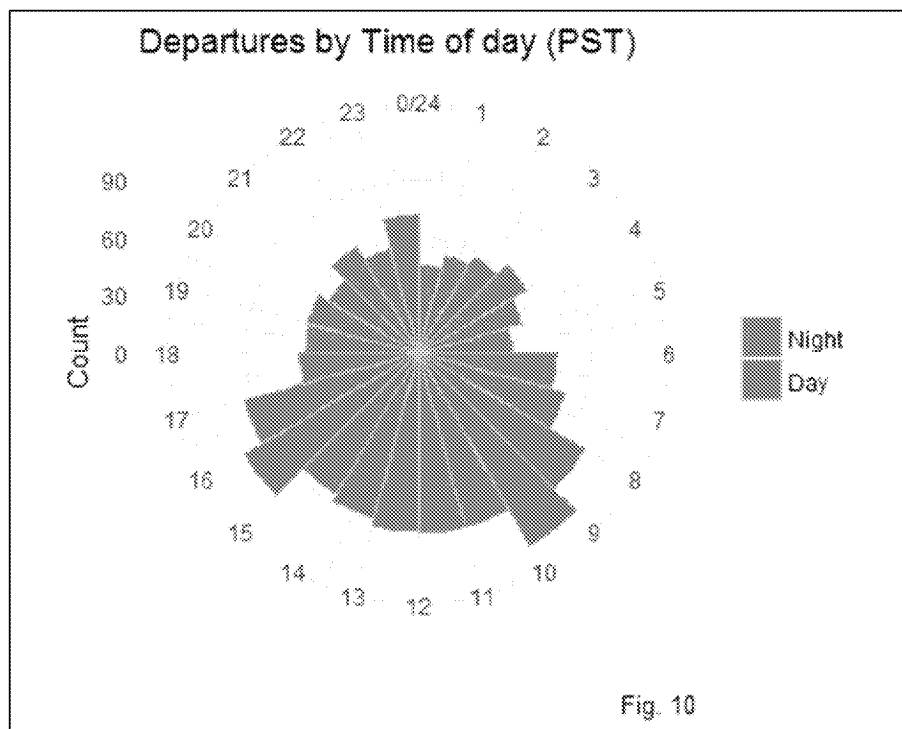
Eleven of the 31 fish that moved above Lisbon fish were detected in Putah Creek, ten of which were recorded on the acoustic receiver located near the putative spawning grounds. Every fish that was recorded on the receiver below the Los Rios Dam was subsequently detected above the dam. However, this is not enough information to determine whether or not Los Rios was a hindrance to upstream migration into Putah Creek (Task Question 3). The stretch of Putah Creek immediately below the dam may have not had enough water to allow fish to reach the receiver location below the dam prior to opening the flashboards. This notion is supported by the acoustic data. The very first detection of a fish at the below Los Rios station wasn't until November 15th, when the flashboards were opened, presumably providing enough water in the final reach of Putah Creek to facilitate movement to the below Los Rios station.

Ten of the 31 fish that moved above Lisbon were subsequently detected leaving the Toe Drain and moving into the rivers of Central Valley (Task Question 2). These fish were detected in the Sacramento River (as far upstream as Red Bluff), the Mokelumne River, the San Joaquin River, the American River, and the Feather River. Eight of 31 fish that moved above Lisbon reversed course and headed downstream but were last detected in the Toe Drain. River kilometer plots of individual fish can be found in Appendix B.



Task 8 Figure 8. 2016 tagged adult Chinook salmon receiver location arrivals by time of day

The cyclical daily movement patterns of the tagged fish were examined within the Toe Drain (Task Question 2). As with the 2015 study year fish, the first 24 hours of movements post tagging were censored to allow the fish time to recover from handling stress, resume normal behavior, and to avoid bias based on the capture location and TOC. Arrival and departure times between receiver locations were used as indicators of active movement of the tagged fish. The size of each of the wedges in the rose diagrams below is scaled by the total number of movements observed by an hour of the day across all locations (Task 8 Figures 8 and 9). The hours of 07:00 to 17:00 (inclusive) were designated as day-time and 18:00 to 06:00 (inclusive) night-time. The distribution for both arrival and departure times of fish at receiver stations were significantly non-uniform in distribution (Rayleigh's Test, p-values < 0.001 for arrivals and departures). More movement activity was documented during the day-time hours. Density plots of the arrival time broken down by individual receiver station don't reveal any deviations from this pattern at any site (Task 8 Figure 10). As in the 2015 study year, the receiver stations adjacent to our tagging locations recorded the highest density of detections, even after censoring the first 24 hours of detections post- tagging.



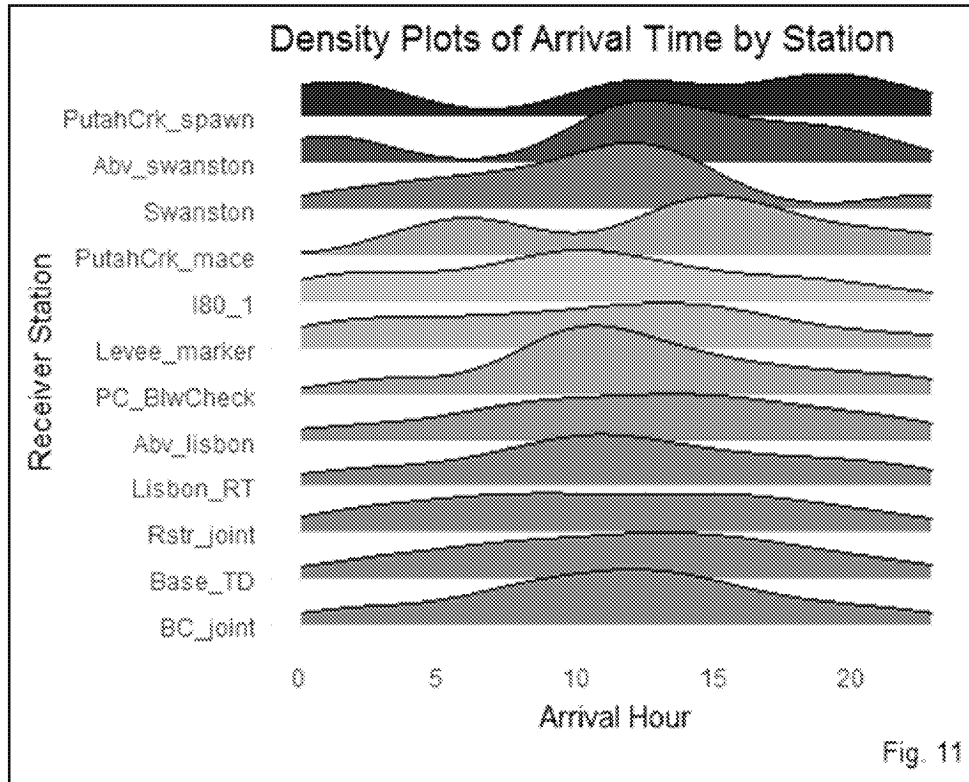
Task 8 Figure 9. 2016 tagged adult Chinook salmon departures from receiver locations by time of day

Residence Time

Records of detection for the 2016 fish were examined to remove detections, and thus truncate residence time, of shed transmitters. We examined residency time at each receiver station searching for 7 consecutive days of uninterrupted detections at a single station. While tags shed in the vicinity of a receiver may affect residency estimates, they should not affect other analyses conducted with the acoustic data.

Median residence time of adult fall-run Chinook Salmon in the Toe Drain was 16.85 days and ranged from 0 to 52 days (Task 8 Question 1). Median residence time for adult Chinook in the Toe Drain in 2016 was approximately two days shorter than the 2015 fish, and the mean residence time (18.43 days) for the

2016 fish was approximately 4 days shorter than the 2015 fish. To examine whether fish tagged lower in the Toe Drain exhibited the tendency to exit the system more rapidly than fish that were tagged near Lisbon Weir, residence times were examined by tagging location (Task 8 Table 4). Differences in residence time by tagging location (Task 8 Figure 11) were not significant (Kruskal-Wallis rank sum test, $p=0.2541$). This result is consistent with previous years of tagged fish detection data.



Task 8 Figure 10. 2016 density plots showing arrival time by receiver location

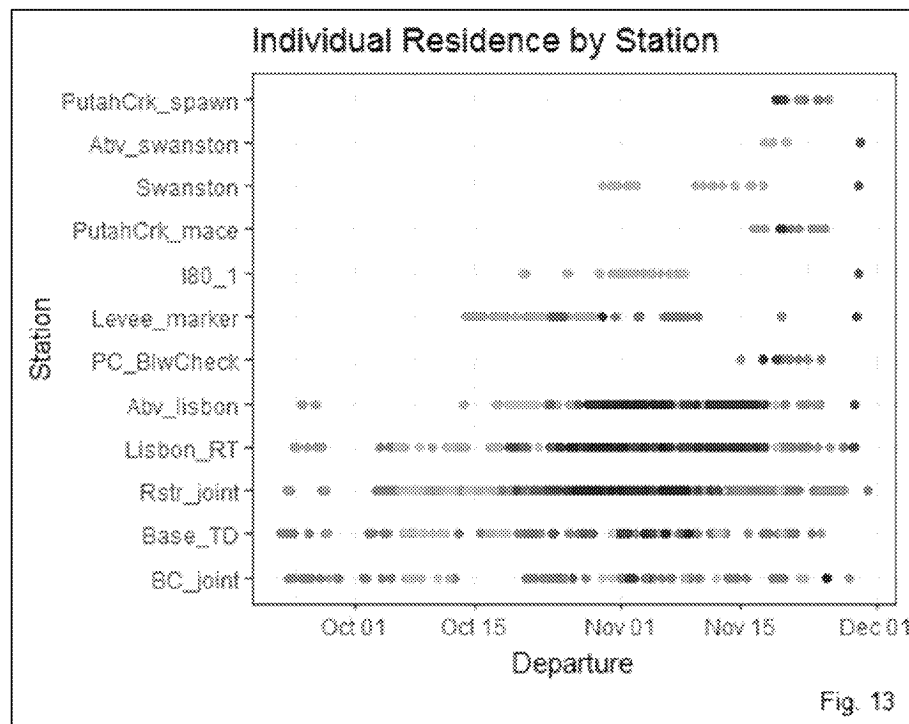
Tagging Location	Minimum Residency Start Date	Maximum Residency End Date	Mean Residence Time	Standard Deviation (days)	Number of Fish
BRSTR	2016-09-22	2016-11-29	19.19265 days	14.76733 days	13
FYKE	2016-10-06	2016-11-20	24.17997 days	11.74737 days	9
LIS	2016-09-26	2016-11-29	16.29827 days	12.70398 days	29

Task 8 Table 4. 2016 adult Chinook salmon residency time by tagging location

In Task 8 Figure 12, each dot represents a "departure" (a detection that was not succeeded by another detection within the same hour) from a receiver station. Each of the 51 fish is represented by a distinct color. It is interesting to note that in 2016 when the flashboards on the Los Rios Check Dam were opened fish are immediately detected at the below Los Rios Check Dam station. We then see tagged fish detected at our Mace Road receiver location, and shortly after that at the spawning grounds station. We know that juvenile salmon were produced in Putah Creek (Eric Chapman, UCD, pers. comm.), and we observed a roughly 20% of our tagged fish at the putative spawning grounds. We are unsure of the origin of the adult fish returning to Putah Creek, some are likely strays, however some of these fish may be returning to their natal stream.



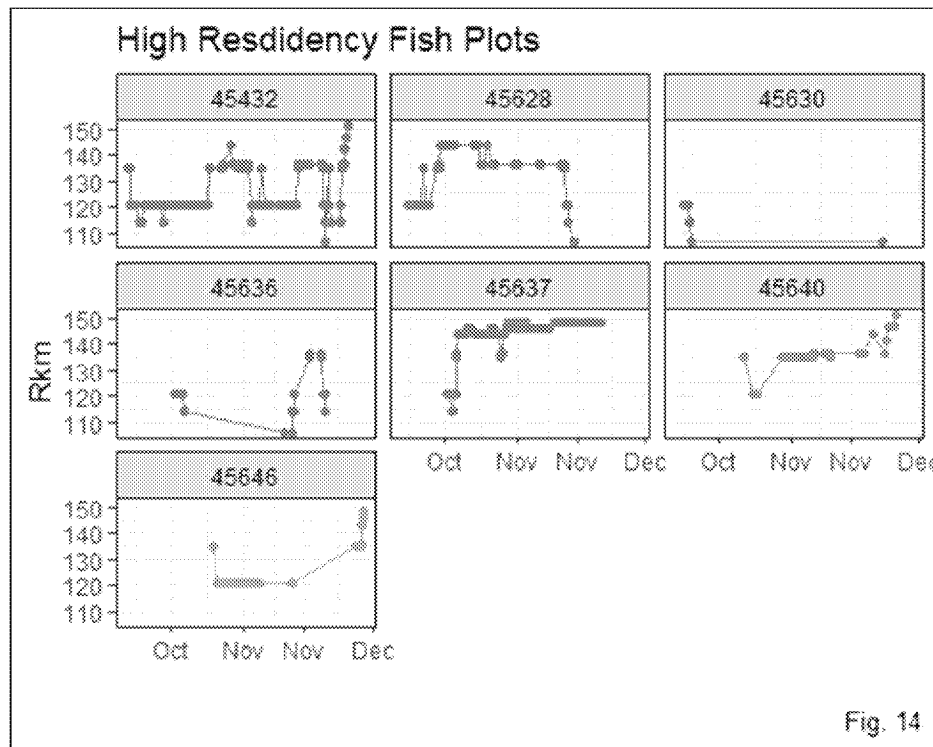
Task 8 Figure 11. 2016 box plot of adult Chinook salmon residence time in days by tagging location



Task 8 Figure 12. 2016 individual tagged adult Chinook salmon residence time as departure date by receiver location. Each salmon represents a different unique color shade.

While the median residency time was slightly longer than 16 days (Task 8 Question 1), there were some fish that were detected in the system for more than twice that amount of time (>35 days). Below (Task 8

Figure 13) is the River km. plot for these high residency fish in the Bypass. Two of the seven fish were Putah Creek spawners (Tag IDs 45632 and 45640), and 2 were fish that went above Ag Crossing 4 (Tag IDs 45637 and 45646) and were not detected subsequently. Fish 45630 was detected at the BC receivers and nowhere else outside of the Bypass for longer than one month before returning to the BC receivers. It is possible that it ventured outside of the Bypass and evaded other receiver stations, but more likely it remained in the Bypass or Cache Slough Complex outside of the detections range of other receivers. These high residency fish were observed making active movements, so tag shedding as an explanation for the long residency is not a consideration.



Task 8 Figure 13. 2016 tagged adult Chinook salmon with high residency within the Yolo Bypass receiver array

Aggregating and Holding

In 2015, we observed four fish residing in the Bypass for more than 60 days. This contrasts with the 2016 fish, in that the longest period that a fish was observed residing in the bypass was 51 days. Of note in the plots of these high residency fish without long gaps in detections (Tag IDs: 45432, 45628, 45637, and 45640) are prolonged periods of holding around Weirs (Task 8 Question 3) within the Toe Drain (Task 8 Figure 13). Three fish spent long periods at Lisbon Weir, and the fourth (45637) was observed for more than one month around Ag. Crossing 4 (Task 8 Figure 13). This fish was last detected in the vicinity of the Ag Crossing 4 suggesting that the barrier may have had some role in its inability to successfully migrate upriver towards Wallace Weir or downstream to exit the Toe Drain potentially continuing up one of the rivers of the Central Valley.

2017

During the 2017 field season we captured and affixed VEMCO 69kHz acoustic transmitters (V9) to 50 adult fall-run Chinook salmon. All the tagging occurred in less than two months, spanning from

September 22, 2017 to November 15, 2017. Thirty-one of the 50 fish were captured in a 12-day span beginning on October 20th and ending on November 1st, immediately following a 5°C decrease in the water temperature in the Toe Drain from 21°C (middle of September) to 16°C (mid-October). Flows during this time period fluctuated with the tides, but otherwise were relatively low and stable, only briefly exceeding a mean daily flow $> 4 \text{ m}^3\text{sec}^{-1}$ (LIS CDEC Station) in mid-September.

Capture Location	N	Mean Handling Time (min)	Mean Recovery Time (min)	
BRSTR	13	21.77	3.00	
Fyke	21	48.38	0.86	
LIS	16	15.12	1.28	

Task 8 Table 5. 2017 adult Chinook salmon tagging results by site

Sex Determination	Number Caught
Female	18
Male	31
Unknown	1

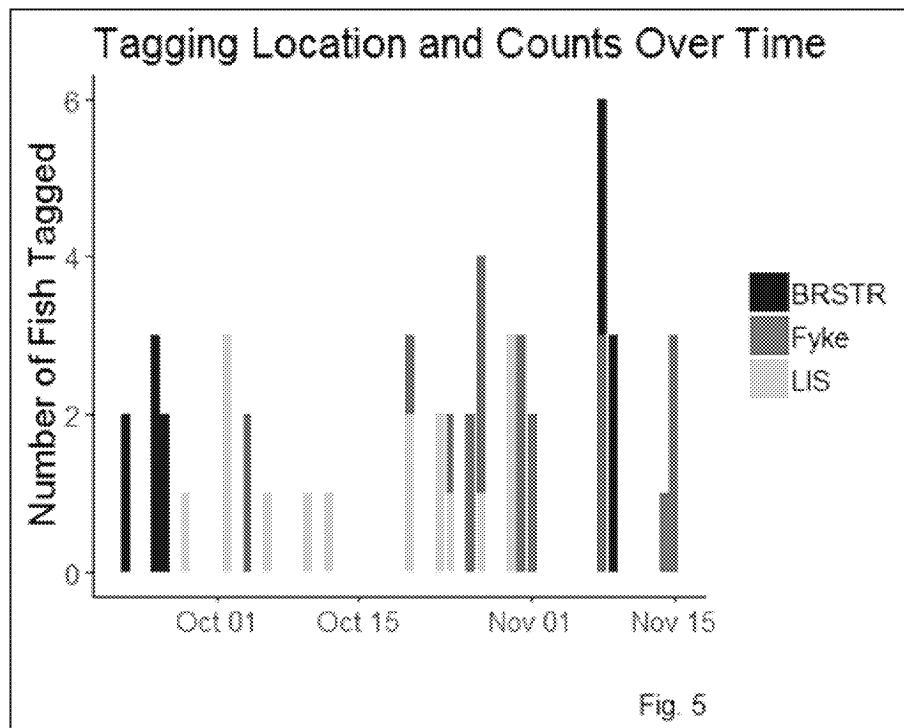
Task 8 Table 6. 2017 total number of males and female adult Chinook salmon tagged

Out of the 50-tagged salmon, 29 were captured in a gill-net (16 at Lisbon and 13 at BRSTR), and 21 were captured in the Fyke trap (Task 8 Table 5). The proportion of fish caught in the Fyke trap during the 2017 field season was greater than in previous years. The tagged fish had a mean fork length (FL) of 695mm (range: 555-925mm). A sex determination was made for 49 of the 50 fish, with a distribution of 18 females and 31 males (Task 8 Table 6). The mean surgery time across the seven researchers that tagged fish was 1.94 minutes with surgeries ranging from 1-4 min (Task 8 Table 7).

Surgeon	N	Mean Surgery Time (min)
RE	13	2.15
NI	11	2.09
PG	10	1.40
SH	7	1.43
LP	6	2.33
JF	3	2.67

Task 8 Table 7. 2017 surgeons and total surgery time

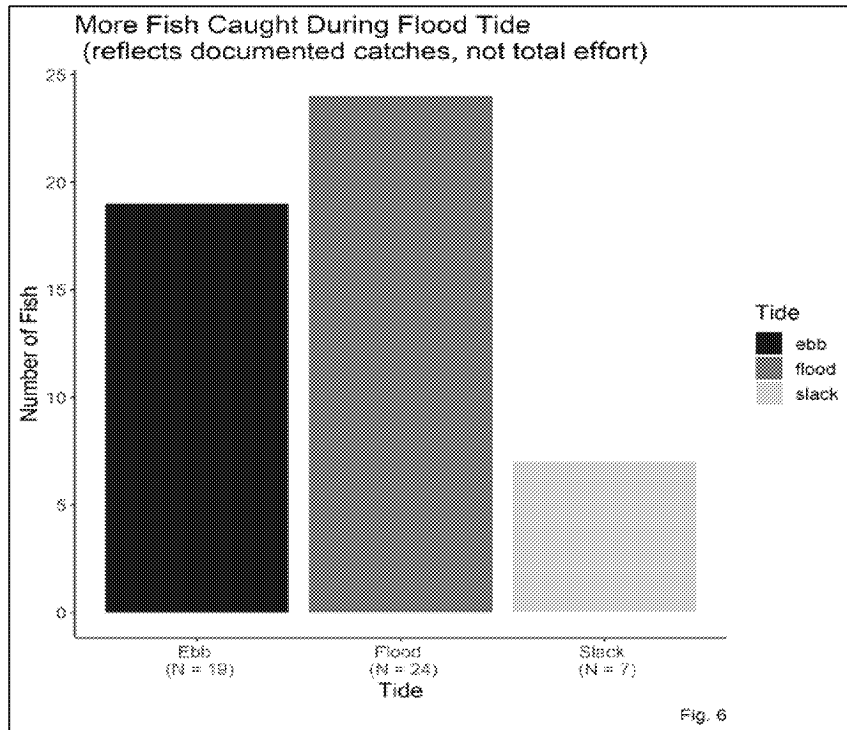
Unlike previous years, the Fyke trap yielded the highest number of tagged fish ($n = 21$; Task 8 Table 5). Lisbon (LIS) accounted for the second highest number of captures ($n = 16$), and the fewest number of fish ($n = 13$) were captured at the sampling location below the rotary screw trap (BRSTR; Task 8 Figure 14). The sampling effort was conducted in a manner that limited the total number of salmon captured at BRSTR and created some temporal variation throughout the tagging season. In previous years, gill-net sampling across a wider range of tidal conditions has indicated that capture rates are higher during the tidal transition; as a result, gill-net sampling efforts were focused around times of tidal transition in 2017. It should be noted that equal effort across each phase of the tidal cycle did not occur. Similar to 2015 and 2016 most of the captures occurred during the early stages of flood tides, shortly after the tide transitioned from ebb to flood (Task 8 Figure 15). This suggests selective transport and movement of the tagged salmon, consistent with limiting energetic expenditure (Levy and Candenhed 1995).



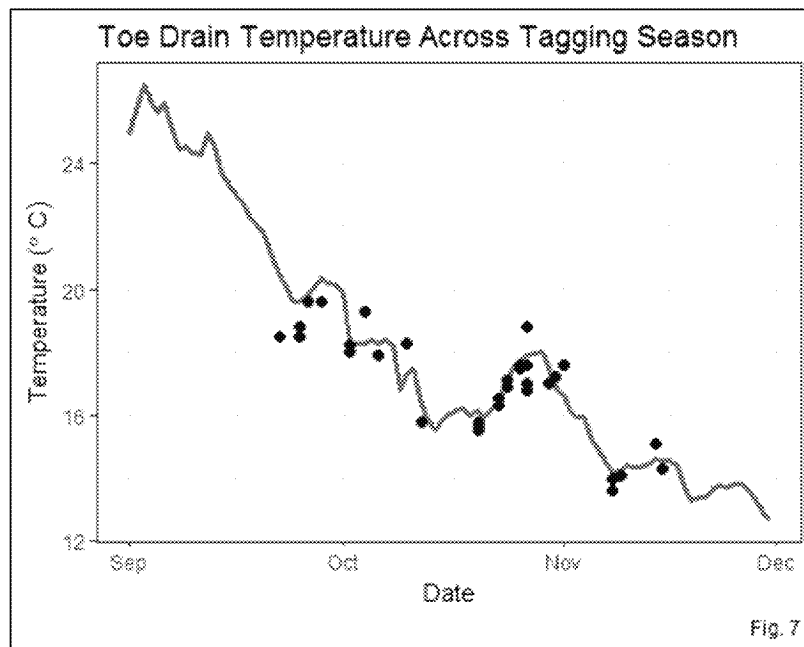
Task 8 Figure. 14. 2017 total number of tagged adult Chinook salmon by site and tagging date. Number of adult Chinook salmon tagged (y-axis) by date (x-axis) and location (bar color).

From the beginning of September to the end of November, mean daily water temperatures in the Toe Drain ranged from 12.7-26.5°C, declining steadily as the tagging season progressed (Task 8 Figure 16). This was a broader range of temperatures than was experienced during both the 2015 and 2016 season, with more extreme high and low values. It is likely that fish were in the Toe Drain prior to water temperatures dropping below 21°C (late September), however, study protocols require that we only tag salmon below this temperature threshold for the wellbeing of the study individuals. Fish were captured almost immediately upon initiating sampling efforts. Most of the salmon were tagged during times of day when water temperatures were below the daily average (Task 8 Figure 16). Temperatures dropped relatively steadily in mid-late September, which was matched with a reciprocal increase in dissolved oxygen (DO) levels of approximately 3 mgL⁻¹ (from ~4-7 mgL⁻¹). From the beginning of October through the end November daily mean DO levels plateaued, oscillating between ~6-8 mgL⁻¹ (Task 8 Figure 17). Salmon tagging exclusively occurred when DO levels were at or above the daily average. Flows (collected from the LIS CDEC gaging station), during this time period, fluctuated with the tides, but

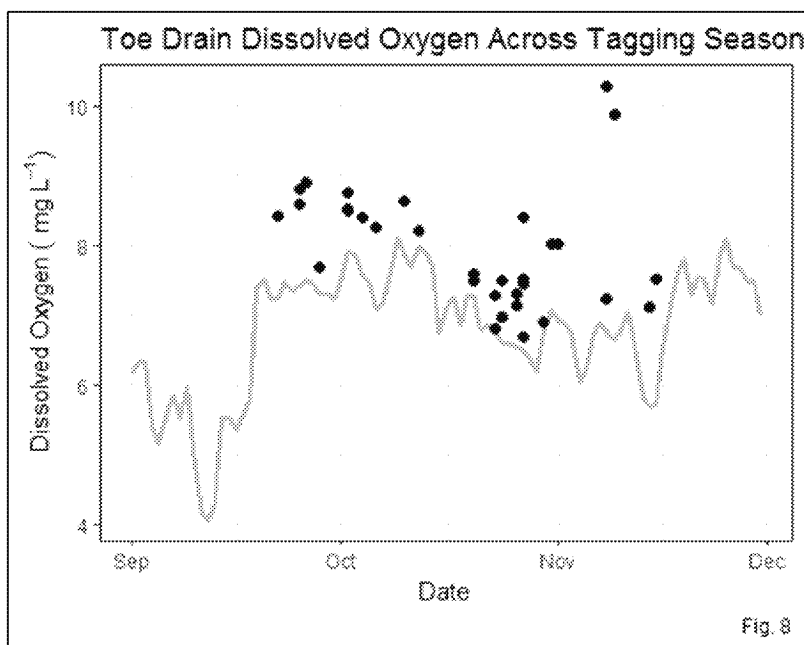
otherwise were relatively low and stable, ($<4 \text{ m}^3\text{sec}^{-1}$ for most of the study season). All days that fish were captured, except for one, had negative mean daily flows (Task 8 Figure 18).



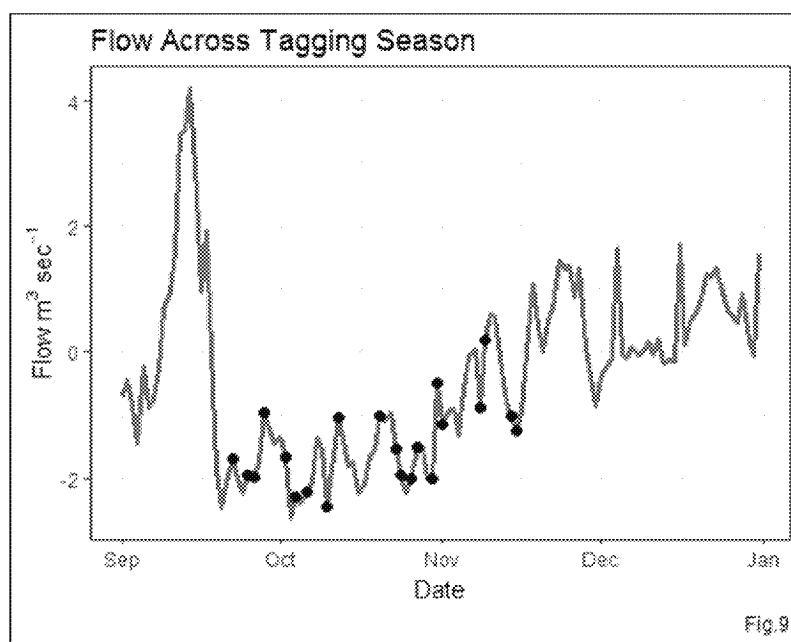
Task 8 Figure 15. 2017 Number of adult Chinook salmon captured during each phases of the tidal cycle.



Task 8 Figure 16. 2017 Toe Drain below Lisbon Weir water temperature during the tagging season. The solid line represents the mean daily temperature ($^{\circ}\text{C}$) through the tagging season, as recorded at the LIS CDEC gaging station. The black dots represent the value of temperature ($^{\circ}\text{C}$) measured at the tagging location, with the YSI, at the time of tagging.



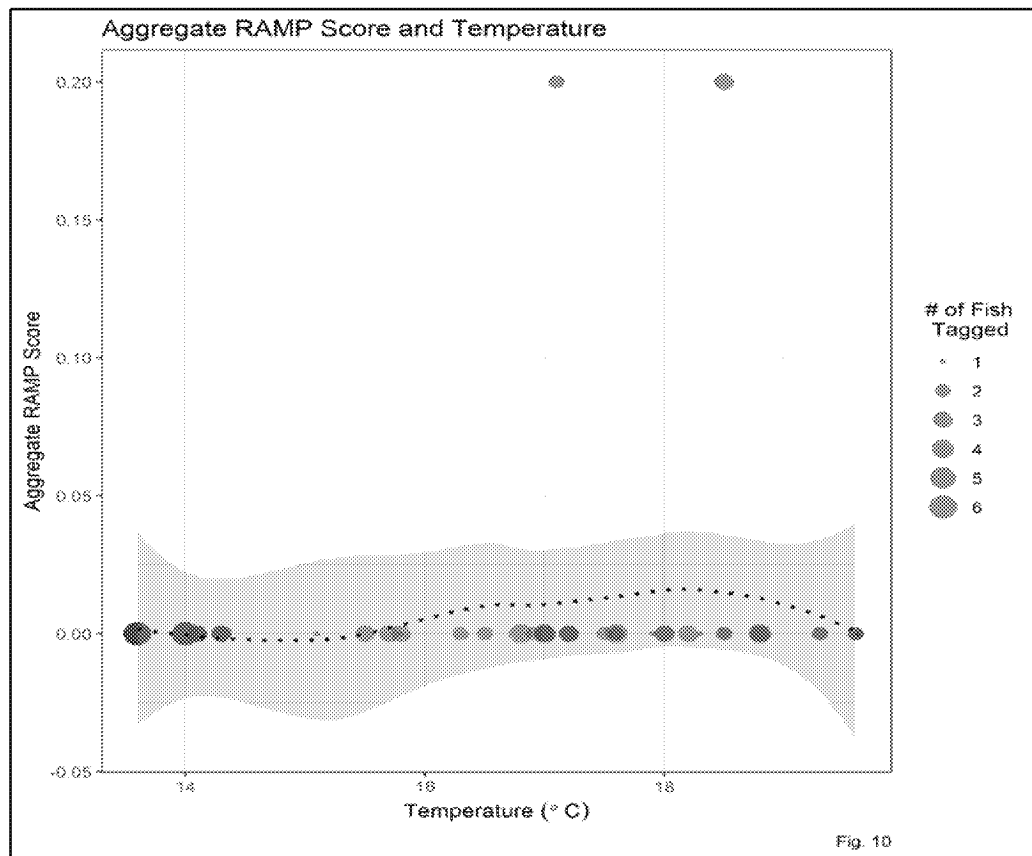
Task 8 Figure 17. 2016 Toe Drain below Lisbon Weir dissolved oxygen during the tagging season. The solid line represents the mean daily dissolved oxygen levels (mgL^{-1}) through the tagging season, as recorded at the LIS CDEC gaging station. The black dots represent the value of dissolved oxygen (mgL^{-1}) measured at the tagging location, with the YSI, at the time of tagging.



Task 8 Figure 18. 2017 Toe Drain below Lisbon Weir flow data during the tagging season. The solid line represents the mean daily flow ($\text{m}^3\text{sec}^{-1}$) through the tagging season, as recorded at the LIS CDEC gaging station. The black dots represent days when fish were tagged. Here, the black dots fall on the line, because flow was not a parameter that was measured independently of the LIS CDEC gaging station.

In accordance with the previous two years of study, we conducted a post-tagging assessment of fish impairment immediately prior to release back into the Toe Drain. Reflex impairment assessments can be

used as both an indicator of physiological stress and a predictor of delayed mortality in fishes (Davis 2005, 2007; Raby et al. 2012). Here we are studying the movements of pre-spawn adults, and so using the assessment as an indicator of physiological stress appears to be more appropriate, as all the fish handled will experience mortality (natural or unnatural) within a few months.



Task 8 Figure 19. 2017 reflex action mortality predictors (RAMP) score for all tagged adult Chinook salmon. Temperature is presented on the x-axis, and aggregate RAMP score is on the y-axis. Each point value is scaled by the total number of adult Chinook salmon tagged on the day when the RAMP score was recorded. The smoothed line represents the relationship between aggregate RAMP score and temperature (Loess method) and the shaded area represents the confidence intervals around the value of the line.

We employed a battery of simple, rapid, and minimally invasive applied tests with binary outcomes (e.g. 0 or 1), referred to as reflex action mortality predictors (RAMP), to score each fish (Raby et al. 2012). The five tests used were 1) tail grab, 2) body flex, 3) head complex, 4) vestibular-ocular response (VOR), and 5) orientation. In each testing scenario a score of '0' was indicative of no impairment, whereas a score of '1' reflected a stress induced impairment response (For detailed explanations of each of the test, please refer to the 2015 report). The final RAMP score for each fish is the average value across all five tests, resulting in a final score between 0 and 1. Consistent with previous years, when one of our tagged fish exhibited signs of physiological stress, it coincided with higher temperatures ($>17^{\circ}\text{C}$; Task 8 Figure 19). Overall, indicators of stress were rare, even with mean daily water temperatures hovering near 18°C through the end of October. Dissolved Oxygen levels in the Toe Drain were relatively high (7.49 mgL^{-1} and 8.58 mgL^{-1}) at the time of tagging, for the two fish that showed signs of impairment. Post-release movements of the fish with elevated RAMP scores warrant future study. One tagged salmon (Tag ID 2591; Capture Location: BRSTR; Handling Time: 24 min) appeared to recover well and was detected

at Ag. Crossing 4 (also referred to as, “Swanston Weir”), traveling more than 25km upstream after tagging. However, the other tagged salmon (Tag ID 2619; Capture Location: FYKE; Handling Time: 34 min) with an elevated RAMP score, was only detected at Lisbon, indicative of either post-release mortality or tag shedding. It should be noted that both fish with elevated RAMP scores had comments regarding physical injury at the time of tagging. Larger samples sizes of impaired fish would allow us to make stronger connections between environmental effects related to impairment, as well as post-release consequences of impairment at the time of tagging.

Receiver Stations	RKMs
Wallace Weir	165.6
Knaggs	161
Putah Ck. Spawn	160.45
Abv Ag. 4 Crossing (or Abv. Swanston)	148.4
Ag. 4 Crossing (or Swanston)	148
Green Lake	147.5
I80	146.4
Levee Marker	143.5
Putah Creek	141.9
Abv Lisbon	136.1
Lisbon	135.4
RSTR	121.01
Base ID	113.9
BCE/W	106.4
BCE/W 2	105.9

Task 8 Table 8. 2017 receiver stations and associated river kilometers from Golden Gate Bridge

Movement Patterns

The configuration of the 2017 receiver array was similar to the 2016 receiver array (Task 8 Figure 1). The upper extent of the study reach, was heavily impacted by construction projects (continuing through November) related to the flow control structure and fish salvage facility at the Wallace Weir site (<http://resources.ca.gov/ccorestore/>). Built across the lower portion of the Knights Landing Ridge Cut Slough, near its confluence with the Toe Drain, the facility aims to capture and return stranded salmon to the Sacramento River to renew the potential for a successful spawning run. Flows in Ridge Cut Slough were drastically reduced because of the construction projects, contributing to the low observed flows in the Toe Drain, and likely restricting movements of adult fish in the upper reaches of the study area. A

receiver maintained by CDFW at the Wallace Weir location (RKM 165.6) represented our furthest upstream site, however, no detections were retrieved from this receiver during the 2017 study season. The site above Ag. 4 Crossing (RKM 148.4) was the furthest upstream location that recorded detections, capturing a single individual. Ag. 4 Crossing is used for impounding agricultural water and is a seasonal fish passage impediment (Task 8 Table 8). That individual was tagged in early November at the BRSTR location, spent the end of November and nearly all of December between Lisbon and Ag. Crossing 4 and was last detected at the above Ag. Crossing 4 site on December 26th. In 2017, the Yolo Bypass receiver array detected a total of 21 white sturgeon that were tagged in 2012 (n = 11) and 2014 (n = 10) as part of the ERP funded project entitled, “Fisheries Evaluation of Floodplain Rearing and Migration in the Yolo Bypass Floodplain” conducted by DWR and UCD. The sturgeon was only detected as high as the I80 receiver location.

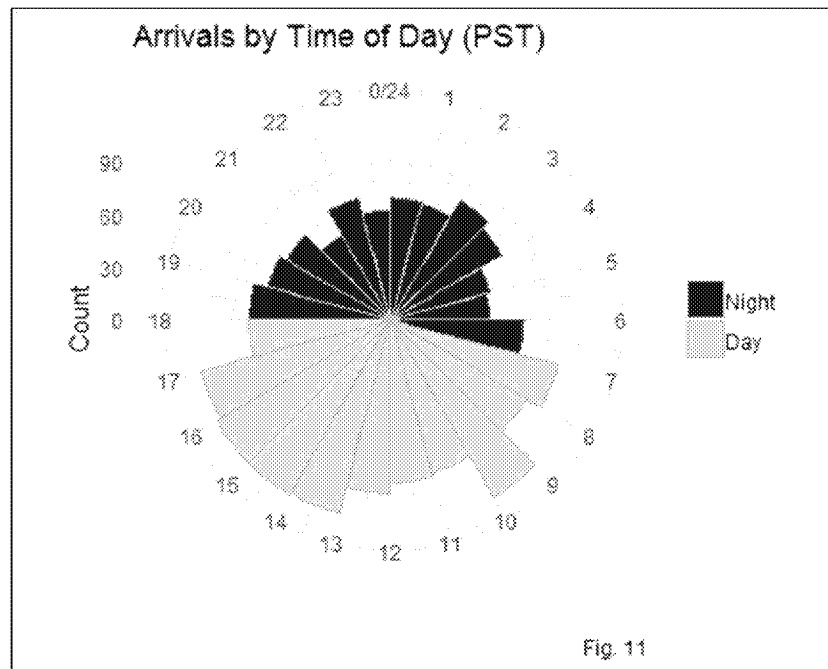
In 2017, we maintained our effort to spatially and temporally distribute the tagging events to ensure that we 1) captured as much of the temporal diversity in the fall-run migration as possible and 2) increased our opportunity to record detections of salmon that move above Lisbon Weir. Previous years of tagging indicated that salmon tagged after October 20th were more likely to move above the barrier at Lisbon than fish tagged earlier in the season (Johnston 2016). The 2017 study fish were consistent with this pattern (Task 8 Question 2). Nineteen salmon were tagged prior to or on October 20th, and 8 of the 19 fish were detected on the receiver array above Lisbon Weir (BRSTR n = 1/7, Fyke n = 2/3, LIS n = 5/9). Thirty-one fish were tagged after October 20th. Twenty-two of the 31 fish tagged later in the season were detected on the receiver array above Lisbon Weir (BRSTR n = 4/6, Fyke n = 15/18, LIS n = 4/7). Overall, 42% of the fish tagged on or before October 20th moved above Lisbon, compared to 71% of the salmon tagged after October 20th.

A lower proportion of fish tagged at the BRSTR and the LIS locations moved above Lisbon Weir (Task 8 Question 2) in 2017 (BRSTR = 0.38, LIS = 0.56) relative to 2016 (BRSTR = 0.46, LIS = 0.66), however a higher proportion of fish from the Fyke location moved above Lisbon Weir in 2017 (0.76) relative to 2016 (0.67). Overall, 30 of 50 fish tagged passed above Lisbon Weir, a similar ratio as observed in 2016 (31/51). One of these fish continued upstream beyond Ag. 4 Crossing (Task 8 Figure 2), this fish (Tag ID: 2625) represented our furthest upstream migrant (Task 8 Question 2). The last detection of this fish on the acoustic array was at the above Ag. 4 Crossing station, suggesting that the transmitter may have been shed in the Toe Drain above the barrier. Receiver stations and their associated river kilometers can be found in Task 8 Table 5.

Five of the 30 fish that moved above Lisbon Weir were detected on the receiver array in Putah Creek. One additional fish (mentioned above) was known to have entered Putah Creek, for a total of six tagged salmon entering Putah Creek (Task 8 Question 2). In total, three salmon continued upstream in Putah Creek to reaches with suitable habitat for spawning. The flashboards at the Los Rios check-dam were opened earlier in 2017 (10/30/2017) than they were in 2016 (11/15/2017) or 2015 (11/13/2015), however, the first detection on the Putah Creek receivers wasn’t until 11/22/2017, roughly three weeks later. Every fish that was detected in Putah Creek swam upstream beyond its confluence with the Toe Drain, often by several kilometers, before entering the creek. This may be representative of the searching behavior of a stray salmon unsuccessfully attempting to home. This is supported by CWT data from salmon carcasses recovered in Putah Creek, the as well as CWT data from one of our 2017 tagged fish. The carcass of the salmon with acoustic tag 2625 was recovered (identified by its Floy tag), and its CWT was read by the CA Department of Fish and Wildlife (CDFW).

Eleven of the 30 salmon that moved upstream of Lisbon Weir were subsequently detected leaving (Task 8 Question 2) the Toe Drain (as marked by the BCE/W and BCE/W 2 stations). Although there is not an

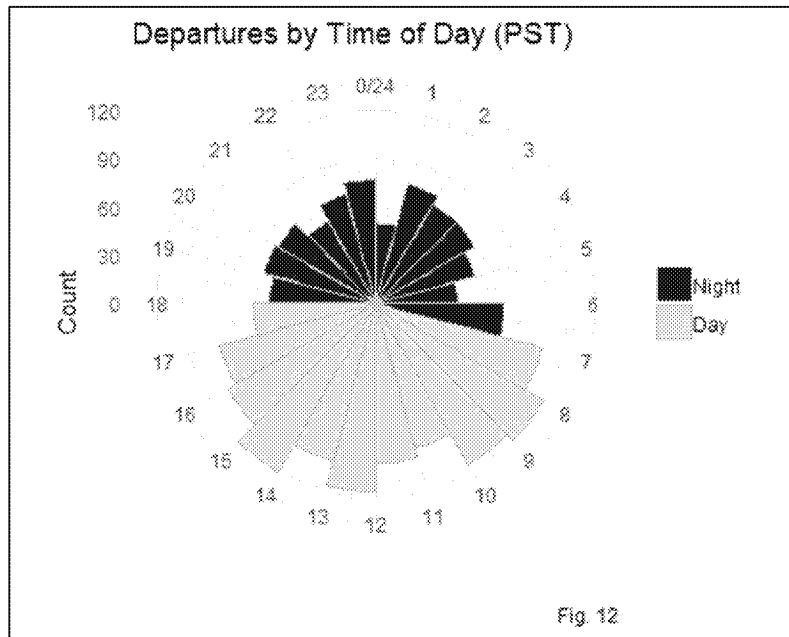
optimally placed receiver line downstream of the BCE 2 and BCW 2 receiver stations, it is likely that detection probabilities at these locations are very high, as every salmon that that was detected on receivers outside of our array (maintained by other agencies) was detected exiting the Toe Drain. While the total number of receivers available throughout the Central Valley were reduced in 2017, in total 12 fish tagged in the Toe Drain were detected elsewhere in the Central Valley, predominately in the mainstem Sacramento River. Six of the fish tagged in the Toe Drain (4 acoustic and Floy, 2 Floy only) were recaptured at the Mokelumne River Hatchery, further supporting the assertion that a large proportion of the fish captured in the Toe Drain are of Mokelumne River origin and have strayed into the Toe Drain.



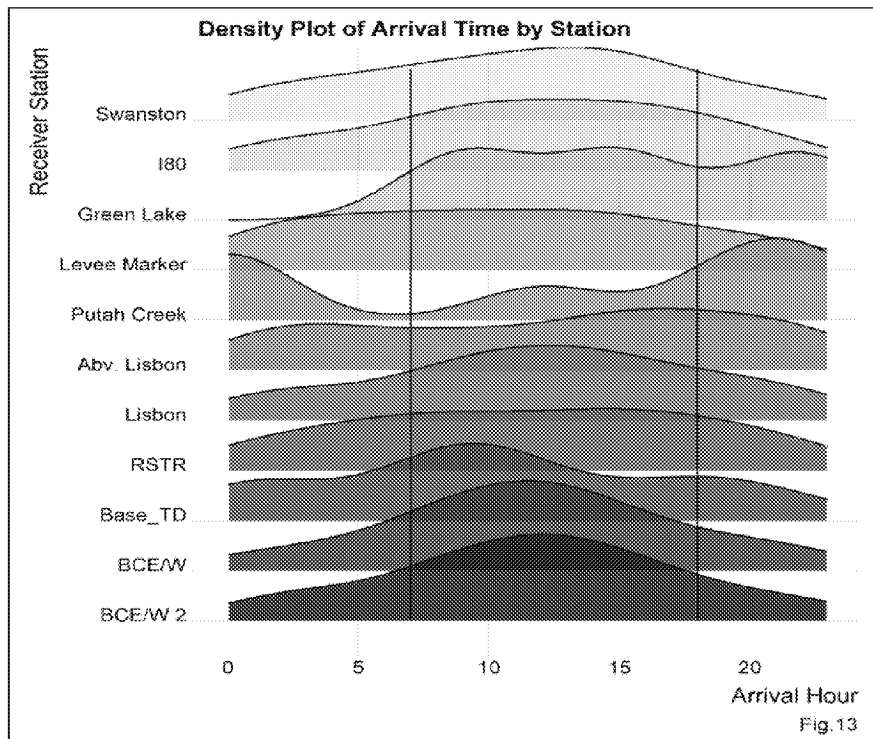
Task 8 Figure 20. 2017 Rose diagram representing the count of arrival times for unique individual-by-receiver combinations throughout the array. Here, arrival times were used as an indicator of active movement.

The cyclical daily movement patterns of the tagged fish were examined within the Toe Drain. As with the previous two years of study, the first 24 hours of detections post-tagging were censored to allow the fish time to recover from handling stress, resume normal behavior, and to avoid bias based on the capture location and time of capture. Arrival and departure times between receiver locations were used as indicators of active movement of the tagged fish. The size of each of the wedges in the rose diagrams below is scaled by the total number of movements observed for each hour of the day across all locations (Task 8 Figures 20 and 21). The hours of 07:00 to 17:00 (inclusive) were designated as day-time and 18:00 to 06:00 (inclusive) night-time. The distribution for both arrival and departure times of fish at receiver stations were significantly non-uniform in distribution (Rayleigh's Test, p -values < 0.001 for arrivals and departures). While slightly more movement activity was documented during the day time hours than during night time hours (Task 8 Question 2), movement within the Toe Drain occurred at all hours of the day. Density plots of the arrival time broken down by individual receiver station don't reveal any deviations from this pattern at any site, except for Putah Creek (Task 8 Figure 22). However, there were relatively few fish detected at this station, and the predominately night-time detection record observed here may be due to chance. Consistent with the two previous years of study, even after

censoring the detections recorded within the first 24 hours' post-release, the receiver stations closest to our capture locations recorded the highest density of tagged fish.



Task 8 Figure 21. 2017 Rose diagram representing the count of departure times for unique individual-by-receiver combinations throughout the array. Here, departure times were used as an indicator of active movement.



Task 8 Figure. 22. 2017 stacked density plots of arrival times at each receiver station. Stations with very low numbers of detections were not included in the figure. Black vertical lines delineate daylight hours

Residence Time

Records of detection for the 2017 fish were examined to remove detections of transmitters that were presumed to be shed, truncating residency times, when appropriate. We examined residency time at each receiver station searching for 7 consecutive days of uninterrupted detections at a single station. While tags shed in the vicinity of a receiver may affect residency estimates at that station, they should not affect other analyses conducted with the acoustic data.

Tagging Location	Minimum Residency Start Date	Maximum Residency End Date	Mean Residence Time	Standard Deviation (Days)	Number of Fish
BRSTR	2017-09-22	2018-01-02	16.67 days	20.95	13
Fyke	2017-10-04	2017-12-06	18.52 days	15.16	21
LIS	2017-09-28	2017-11-28	15.78 days	11.27	16

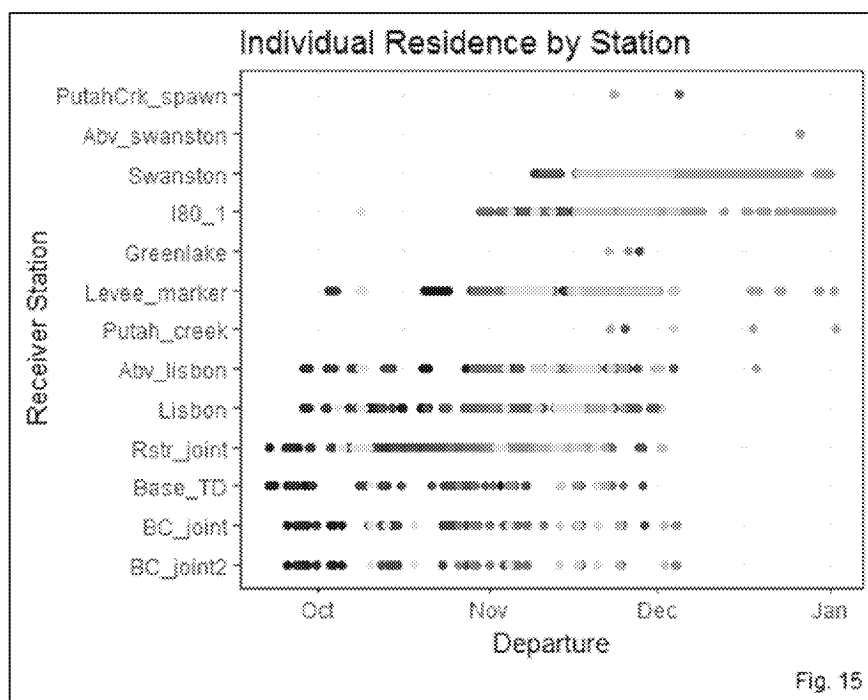
Task 8 Table 9. 2017 adult Chinook salmon residence time by tagging location

Median residence time of adult fall-run Chinook Salmon in the Toe Drain was 14.15 days and ranged from <1 to 55 days (Task 8 Question 1). Median residence time was approximately 2.5 days shorter than the previous study year continuing the trend of decreasing residence time over the last three years (median residence time 2015: 18.04; 2016: 16.85). Mean residence time was approximately one day shorter in 2017 (17.16 days) than it was in 2016 (18.43 days). To examine whether fish tagged lower in the Toe Drain (BRSTR location) exited the system more rapidly than fish that were tagged further upstream (LIS and Fyke locations), residence times were grouped by tagging locations (Task 8 Table 9) and then median values were compared using the non-parametric Kruskal-Wallis rank sum test. Median residence time values (Task 8 Figure 23) were not significantly different (Kruskal-Wallis chi-squared = 1.0231, df = 2, p-value = 0.5996). This indicates that differences in tagging location do not affect the amount of time that adult salmon spend in the Yolo Bypass, this is consistent with results from the previous two years (2015 and 2016) of study.

Visually inspecting all tagged salmon movement (Task 8 Figure 24) provides insight regarding fish movement in the Bypass. In contrast to 2016, fish did not immediately move into Putah Creek as soon as the flashboards were opened. This may be related to the lower discharge experienced in 2017 (Task 8 Question 2). The initial reach of Putah Creek (from its confluence with the Toe Drain to the Los Rios Check Dam) is difficult to pass in low flows due to impaction from the growth and spread of creeping water-primrose (*Ludwigia peploides*). Despite the lower number of our tagged fish entering Putah Creek, 2017 was another good year for reproducing salmon in Putah Creek, with more than 30,000 juvenile fish captured in the UCD rotary screw trap in Putah Creek (pers. comm. Emily Jacinto). For fish that didn't attempt to ascend Putah Creek, early December appears to be the cut-off time for when fish exited the Toe Drain. While we still recorded activity in the upper reaches after early December, none of these fish successfully exited the Toe Drain to continue a spawning run migration in one of the rivers of the Central Valley.



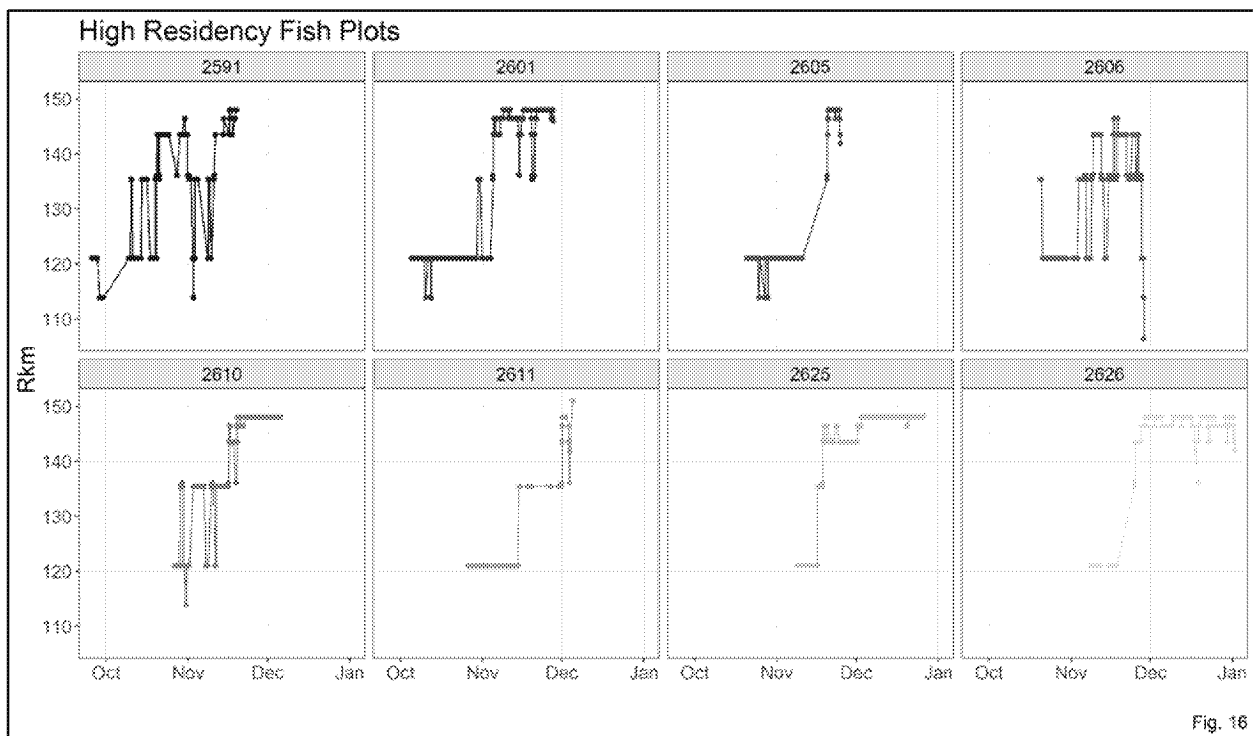
Task 8 Figure 23. 2017 Box and whisker plots of the residence time grouped by tagging location. Horizontal lines are the median values, boxes represent the inter-quartile range (IQR), the upper whisker extends to the largest value no more that $1.5 \times \text{IQR}$ from the upper hinge, and the lower whisker extends to the smallest value no more than $1.5 \times \text{IQR}$ away from the lower hinge. The dots overlain on the boxes represent the raw individual residence time values, jittered for ease of viewing



Task 8 Figure 24. 2017 Visualization of tagged population movement patterns through the array during the 2017 study season. Receiver stations are in order of descending rkm. Each fish is represented by a different color.

Aggregating and Holding

While median residence time in the Yolo Bypass in 2017 was 14.15 days, there were eight fish that were detected in Yolo Bypass for longer than 35 days. Below, (Task 8 Figure 25) are the river km plots for these high residency fish (Task 8 Question 3). Two of the eight high residency fish were known to have made it to the Putah Creek spawning grounds station (Tag IDs 2611, detection on array and 2625, carcass recovery). Two were last detected in Putah Creek but didn't make it all the way to our spawning grounds receiver station (Tag IDs 2626 and 2605), which doesn't necessarily preclude them from spawning successfully in the Putah Creek. Our receiver marks a point in the creek where the majority of suitable spawning habitat exists upstream. Two fish were last detected below Swanston Weir (Tag IDs 2591 and 2610), likely representing fish that either shed their tags or died without exiting the Toe Drain or finding suitable spawning habitat (Task 8 Question 3). One of the eight high residency fish was detected leaving the Toe Drain and subsequently moving up the Sacramento River. The final high residency fish was last detected on the Green Lake receiver station in the Yolo Bypass Wildlife Area. All eight of these fish were detected actively moving within the Yolo Bypass, so tag shedding was not considered as an explanation for the unusually high residence times.



Task 8 Figure 25. 2017 river kilometer plots of the high residency salmon. River kilometer is on the y-axis and date is on the x-axis.

During the 2015 study year, we observed four fish that resided in the Yolo Bypass for more than 60 days. While we did not observe any fish in 2016 or 2017 that resided in the Yolo Bypass for more than 60 days (Task 8 Question 3), we did have three fish in 2017 that were consistently detected for more than 50 days (Tag IDs 2591, 2601, 2626). There are two general movement behaviors that these high residency fish display 1) an oscillating movement history between upstream and downstream receiver stations, which may be indicative of a searching behavior (Tag ID 2591); and 2) prolonged periods of time spent in the vicinity of a barrier to migration (Tag ID 2626; Swanston Weir or Ag. 4 Crossing).

To investigate factors contributing to the ability of a tagged salmon (study year 2017) to exit the Toe Drain, I modeled success rates using a logistic regression framework and then used both forward and backward selection to choose the most parsimonious model. I included independent variables related to tagging: Toe Drain temperature ($^{\circ}\text{C}$) at time of tagging, Toe Drain DO (mgL^{-1}) at time of tagging, tagging location, date tagged, length of recovery from tagging (min), surgeon, and FL(mm); and variables related to movement: residence time (days) and maximum river kilometer reached. The final model (residual deviance 46.52, AIC 52.52) included length of recovery and max river kilometer reached. Both coefficients associated with these variables were negative, indicating an inverse relationship with successfully exiting the Toe Drain (i.e. the longer it took to recover or the further upstream the fish traveled, the less likely they were to exit the Toe Drain). Maximum river kilometer reached held the stronger relationship ($p < 0.001$). Further, traveling upstream of the I80 receiver location (rkm 146.4) appeared to represent “a point of no return.” Of the 27-tagged salmon that were able to successfully exit the Toe Drain, only a single fish traveled upstream of I80 (Task 8 Question 2).

Reach travel times were calculated as the distance between successive receiver stations divided by the elapsed time that it took for the tagged salmon to move from station ‘A’ to station ‘B’, regardless of the direction (upstream or downstream) of travel. The reaches containing weirs did not consistently show delays in migration for the 2017 fish (Task 8 Question 3). Movement from the Lisbon to the Above Lisbon receiver station in both the upstream (mean travel time = $5.87 \text{ km} \cdot \text{h}^{-1}$) and downstream (mean travel time = $7.79 \text{ km} \cdot \text{h}^{-1}$) directions were the two reaches with the fastest mean travel times. This could reflect the structure of both the array and the weir. It is possible that over this short reach we are largely capturing the burst swimming rates required to pass the weir. However, travel time in the reach from the Swanston to Above Swanston receiver station was the slowest recorded, although only one fish was recorded transiting that reach (mean travel time = $0.04 \text{ km} \cdot \text{h}^{-1}$).

The regression analysis indicated that the further upstream the salmon traveled the more likely they were to get stranded in the Yolo Bypass. Beyond that, three of our tagged salmon were last detected in Green Lake. These fish likely perished there, as they weren’t detected elsewhere in the array. Nine fish were last detected on either the I80 receiver station (rkm = 146.4) or the Swanston receiver station (rkm = 148), qualifying this short reach as a mortality hotspot

Seven of the acoustic tagged fish were recaptured and identified by their Floy tags. Four of the seven fish were recaptured at the Mokelumne River Hatchery, one at the Feather River Hatchery, and one at the Nimbus Hatchery (Task 8 Question 2). The remaining recaptured fish was identified when its carcass was recovered by UCD researchers surveying Putah Creek (Task 8 Question 2). The carcass was discovered just downstream of the Putah Diversion Dam, and near the stretch of creek where most of the spawning occurs. The carcass was sampled for genetic analysis, to determine if it spawned and produced viable offspring. This fish had its adipose fin clipped. The CWT was read, and it was identified as a Mokelumne River Hatchery fish. Data confirms this fish was trucked from the Mokelumne River Hatchery to a net pen near Sherman Island as a juvenile, bypassing a significant portion of the migratory pathway, preventing the proper imprinting needed to aid in successful homing as an adult. In fact, every single one of the CWTs that were recovered in Putah Creek (23/23 in 2016; 49/49 in 2017) were from fish that were part of an offsite release group (i.e. trucked downstream instead of released at the hatchery). Further, in 2016 (17/23) and in 2017 (33/49), most CWT fish were from the Mokelumne River Hatchery and were trucked to net pens near Sherman Island.

Task 8 Conclusion:

The Yolo Bypass can present a detriment to a proportion of migratory Central Valley Adult Chinook Salmon, especially during the lower outflow periods in the fall. The reasons reside in the various fish barriers that can cause aggregating and holding (i.e. Lisbon Weir and Ag. 4 Crossing), including the added stress from higher water temperatures and lower dissolved oxygen levels, and the overall lack of connectivity to their natal spawning tributaries. The results from this monitoring effort provide evidence that fall-run adult Chinook Salmon are present in the Yolo Bypass Toe Drain in all years during the fall months of September-November. The increase in Fyke trap catch by the DWR Yolo Bypass Fish Monitoring Program in recent years, suggest that adult Chinook Salmon straying in the Delta may have increased in recent years and could have been expounded by drought conditions and forced changes in hatchery release practices. This monitoring effort discovered a strong movement response of the Chinook Salmon during tidal switches, with highest catches occurring on the flood tide, as these salmon seem to use these tidal switches as a cue to move up and down the tidal sloughs of the Delta. Notable, was the higher movement of salmon during the daylight hours, rather than at night.

It's tough to determine from the 2016 and 2017 datasets how the Chinook Salmon may respond to a managed flow pulse, as the 2016 flow pulse was during July (well before peak Central Valley fall-run Chinook Salmon migration), and we were also unable to tag fish at temperatures greater than 21 °C. Water temperatures in the Yolo Bypass in the summer and early fall (September) often exceed 21 °C and in-order to ensure we had proper salmon recovery after surgery we chose to wait to tag salmon once temperatures fell below this threshold. Each year we observed a substantial increase in our catch totals in October and this often also followed a drop-in water temperature to 17-18 °C range.

The final detections of tagged salmon in the Bypass varied by year, but there was consistently high residency near weir structures. Both Lisbon Weir and Ag. 4 Crossing seemed to cause salmon to aggregate and hold for longer periods. Due to the construction at Wallace Weir in 2017 the Ag. 4 Crossing acted as a passage barrier for much of the monitoring season, causing fish to aggregate below for long periods. Surprising was the amount of tagged salmon that moved up past the Los Rios Check Dam and migrated up to Putah Creek spawning grounds. The presence of migrating fall-run Chinook Salmon into Putah Creek has been increasing in recent years. Also, many of the tagged salmon were detected leaving the Yolo Bypass and successfully making into the main tributaries (i.e. Sacramento, American, Feather, and Mokelumne Rivers) and some salmon showing up at the hatchery facilities in both years.

It is our intention that this data will help managers determine the areas of highest fish passage concern for migratory salmonids and guide the decisions in design and engineering to modify these structures to reduce stress. This data also suggests that timing of managed flow pulses can greatly reduce the chances of attracting adult fall-run Chinook salmon, summer flow actions may be the best compromise in benefiting Delta Smelt and not harming migratory adult fall-run salmon populations. It also important to note that spring-run adult Chinook salmon migration peaks from May to June (Yoshiyama et al. 1998), so to avoid attraction of these listed salmonids in may be the best water management alternative to augment outflows in the Yolo Bypass in mid-late July or early August.

Task 1-8 Final Summary

In summary, our study results showed that the Yolo Bypass can be a donor habitat for the lower food web during periods of net positive outflow in the summer and fall. The Colusa Basin Drain-Ridge Cut Slough and Upper Yolo Bypass are regions with high phytoplankton biomass and these net outflows help to

transport this standing biomass into the downstream Cache Slough Complex and lower Sacramento River near Rio Vista regions. The composition is also dominated by large-celled and higher-nutritional quality diatom and cryptophyte taxa. This high phytoplankton biomass in these regions seems to be linked to the high residence time, warm water temperatures and high nutrient concentrations. Specifically, the high nitrogen contributions from the city of Woodland and Davis wastewater effluent discharge seem to be more important sources of nutrients than agricultural return water. The CSC region can also be an important contributor to downstream transport of phytoplankton biomass in the Lower Sacramento River, as observed in 2016. In addition, this study provided evidence that preceding conditions, water source and seasonal timing are important factors in the downstream phytoplankton response to managed flow pulses, as results were very different between summer 2016 and fall 2018.

In 2018, additional primary productivity rate measurements suggest that these net positive outflows in the Yolo Bypass and CSC may be a phytoplankton transport process rather than improving conditions for phytoplankton growth. Although, ambient phytoplankton biomass conditions were low leading up to the 2018 flow pulse, measuring primary productivity rates in other years similar to 2016 should be done to better understand phytoplankton growth response. There was variability among years in nitrogen concentration and results showed high NH_4 in the CSC and Lower Sacramento River. This high NH_4 could be an important factor controlling phytoplankton bloom formation during the summer and fall, as prior studies have shown a link to phytoplankton growth inhibition from high Sacramento Regional Wastewater Treatment Plant discharge into the lower Sacramento River.

Our results from zooplankton sampling showed high densities of Cladocera and cyclopoid taxa in the Upper Yolo Bypass. These high densities were exported downstream during net positive flow pulses into the Lower Yolo Bypass and CSC regions in all years. The lower regions of our study area were dominated by calanoid copepods and there was evidence that these taxa were exported from upstream areas in the CSC to the Lower Sacramento River during flow pulse years. In addition, reproductive and growth rate experiments on calanoid copepods in the study area showed a strong correlation to Chl a and rates were highest near $10 \mu\text{gL}^{-1}$. Overall calanoid copepod growth rate was higher in the Yolo Bypass than other areas in the SFE and highest in 2016 during the summer managed flow pulse. These results suggest that Yolo Bypass managed flow pulses in the summer and fall can also be important in exporting higher abundance zooplankton in the upper study regions downstream.

The use of the Yolo Bypass as a corridor to augment outflows to improve the downstream lower food web for Delta Smelt has some big challenges beyond water management. Past research and our study results show that there are high levels of pesticides in the Upper Yolo Bypass and Colusa Basin Drain-Ridge Cut Slough regions. These pesticides are from both agricultural and urban use. Most of the detections of pesticides at benchmark toxicity levels were from urban use and were detected at the RD22 site located just below the Woodland wastewater effluent discharge. Results during the managed flow pulses in 2016 and 2018 showed increases in overall pesticide concentrations into the Lower Yolo Bypass, but concentrations remained indifferent in the lower part of the study area in the CSC and Lower Sacramento River. There were no detections of pesticides at benchmark toxicity levels in the Lower Yolo Bypass, CSC and Lower Sacramento River regions in all years. Results suggest that as Yolo Bypass water sources reach the CSC and Lower Sacramento River there is high dilution in the larger channels and potentially degradation that occurs over time. There was evidence that pesticide concentrations were higher throughout the study area when performing these managed flow pulses using agricultural return water as in fall 2018. Managed flow pulses in the summer using a Sacramento River water source may be a better management strategy to reduce negative impacts from pesticides.

Another challenge is that positive seasonal outflows can attract adult fall-run Chinook Salmon into the Yolo Bypass and result in straying from natal spawning habitat. Our results showed that adult fall-run Chinook Salmon are present in the Yolo Bypass in all years and especially in higher numbers during the fall and peak in October-November when water temperatures cool. Due to the year-round connectivity of the Yolo Bypass to the SFE, it seems as though there is no avoiding the potential to attract migrating adult fall-run Chinook Salmon especially during managed fall flow pulse events, since these flows provided better fish passage beyond the various agricultural barriers in the Yolo Bypass. An alternate strategy maybe to perform these managed flow pulses during the summer to avoid the peak fall-run Chinook Salmon migration period altogether.

Overall, this multi-year study provided key physical, chemical, biological, and modeled flow data to better understand how managed Yolo Bypass outflows function and affect downstream habitats. This study provided key insights into freshwater tidal slough ecosystem function as it relates to positive freshwater outflow and added to our growing scientific understanding of the Yolo Bypass and CSC regions. Most importantly it is our hope that these results will help to improve our future water management strategies to benefit endangered Delta Smelt and other native fish habitats in the SFE.

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Appendix:

Task 7 Table 1. Synthetic pesticide applications of over 1,000 kilograms made in the Yolo Bypass low-flow watershed in the summer/fall of 2016

Application Site	Application (kg)		Pesticide	Application (kg)	Primary Application Sites (In decreasing order, minimum 10% of total)
Rice	466,804		Propanil	406,989	Rice
Almond	144,608		Glyphosate, Potassium Salt	96,527	Almonds, Walnuts, Uncultivated Aq
Walnut	56,955		Glyphosate, Isopropylamine Salt	61,834	Almonds, Uncultivated Aq, Rights of Way, Walnuts
Uncultivated Aq	35,152		Thiobencarb	33,809	Rice
Processing Tomatoes	29,736		Chlorothalonil	21,522	Processing Tomatoes
Rights of Way	19,458		Pendimethalin	19,391	Almonds, Walnuts, Alfalfa
Alfalfa	18,830		Paraquat Dichloride	18,905	Almonds, Walnuts
Public Health	9,432		Methyl Bromide	16,685	Uncultivated Aq, Walnuts
Wine Grapes	9,296		Oxyfluorfen	14,683	Almonds, Walnuts
Pistachio	8,955		Glufosinate-Ammonium	14,430	Almonds, Walnuts
Cucumber	8,137		Triclopyr, Triethylamine Salt	14,372	Rice
Landscape Maintenance	7,106		1,3-Dichloropropene	11,840	Almonds, Tomato
Tomato	4,700		Azoxystrobin	9,834	Rice, Processing Tomatoes
Structural Pest Control	3,626		Chlorpyrifos	7,862	Walnuts, Almonds, Alfalfa
Prune	3,525		Bifenazate	7,773	Almonds, Walnuts
Olive	3,076		Endosulfan, Dipotassium Salt	6,980	Rights of Way, Landscape Maintenance, Water Area
Sunflower	2,467		Bifenthrin	5,968	Almonds, Processing Tomatoes, Walnuts
Corn for Forage	2,396		Naled	5,772	Public Health
Cotton	2,334		Methoxyfenozide	5,273	Almonds, Rice
Watermelon	2,286		Ethephon	5,062	Walnuts, Cotton

Application Site	Application (kg)		Pesticide	Application (kg)	Primary Application Sites (In decreasing order, minimum 10% of total)
Bean, Dried	2,171		Oryzalin	5,043	Almonds
Wheat	1,915		Mancozeb	4,445	Cucumbers, Processing Tomatoes
Sudangrass	1,605		2,4-D, Dimethylamine Salt	3,548	Sudangrass, Almonds, Landscape Maintenance
Forest, Timberland	1,548		Pyraclostrobin	3,170	Processing Tomatoes, Almonds
Water Area	1,154		Piperonyl Butoxide	2,790	Public Health
Corn for Human Consumption	1,120		Glyphosate, Dimethylamine Salt	2,597	Timberland, Rights of Way
Outdoor Plants In Containers	1,051		Methomyl	2,214	Corn for Human Consumption, Watermelon, Cucumber, Squash
Uncultivated Non-Ag	1,014		Chlorantraniliprole	1,970	Almonds, Sunflower, Walnuts
Soil Fumigation	1,002		Fluxapyroxad	1,665	Almonds, Processing Tomatoes
			Cyhalofop Butyl	1,634	Rice
			Carbaryl	1,576	Olives, Melons
			Imidacloprid	1,575	Processing Tomatoes, Wine Grapes, Walnuts, Structural Pest Control
			Diuron	1,441	Alfalfa, Rights of Way, Landscape Maintenance, Walnuts
			Trifluralin	1,372	Wine Grapes
			Malathion	1,346	Walnuts, Cucumbers, Rice
			Propiconazole	1,331	Almonds, Walnuts
			Flubendiamide	1,180	Alfalfa, Processing Tomatoes, Sunflower, Walnuts
			Propargite	1,136	Almonds, Corn for Forage, Wheat
			Clethodim	1,040	Alfalfa, Almonds
			Hexythiazox	1,021	Almonds, Walnuts
			Indoxacarb	1,005	Alfalfa, Processing Tomatoes

Task 7 Table 2. Synthetic pesticide applications of over 1,000 kilograms made in the Sacramento River watershed in the summer/fall of 2016

Application Site	Application (kg)	Pesticide	Application (kg)	Primary Application Sites (In decreasing order, minimum 10% of total)
Rice	659,001	Propanil	585,328	Rice
Walnut	303,516	1,3-Dichloropropene	242,572	Walnuts, Prunes, Peaches
Almond	110,895	Glyphosate, Isopropylamine Salt	135,870	Walnuts, Almonds, Rights of Way
Prune	81,098	Glyphosate, Potassium Salt	95,459	Walnuts, Almonds
Timberland	68,419	Methyl Bromide	77,611	Outdoor Transplants, Soil Fumigation, Commodity Fumigation
Rights Of Way	50,974	Paraquat Dichloride	31,754	Almonds, Walnuts
Soil Fumigation	48,464	Thiobencarb	30,470	Rice
Outdoor Transplants	37,642	Chlorpyrifos	29,756	Walnuts
Landscape Maintenance	34,352	Glyphosate, Dimethylamine Salt	25,056	Timberland, Rights of Way
Peach	32,434	Triclopyr, Triethylamine Salt	24,115	Rice
Public Health	25,610	Ethephon	19,793	Walnuts
Processing Tomatoes	17,092	Naled	17,871	Public Health
Wine Grapes	13,943	Glufosinate-Ammonium	17,374	Walnuts, Almonds, Wine Grapes
Structural Pest Control	13,876	Pendimethalin	17,120	Walnuts, Almonds
Commodity Fumigation	9,224	Oxyfluorfen	13,893	Walnuts, Almonds
Uncultivated Aq	7,693	Azoxystrobin	13,791	Rice
Outdoor Plants In Containers	7,306	Chlorothalonil	13,564	Processing Tomatoes, Landscape Maintenance
Alfalfa	5,050	Oryzalin	13,282	Landscape Maintenance, Almonds, Walnuts
Bean, Dried	4,366	Hexazinone	9,894	Timberland
Pear	4,144	Bifenthrin	7,392	Walnuts, Structural Pest Control, Almonds
Olive	3,857	Bifenazate	7,117	Walnuts, Almonds

Application Site	Application (kg)		Pesticide	Application (kg)	Primary Application Sites (In decreasing order, minimum 10% of total)
Corn for Forage	3,249		2,4-D, Dimethylamine Salt	6,818	Walnuts, Almonds, Right of Way
Strawberry	3,183		Permethrin	6,620	Structural Pest Control, Walnuts
Cotton	2,939		Metam-Sodium	6,204	Rights of Way
Water Area	2,179		Imazapyr, Isopropylamine Salt	6,047	Timberland
Sunflower	2,168		Piperonyl Butoxide	6,037	Public Health, Structural Pest Control
Uncultivated Non-Ag	2,006		Imidacloprid	5,680	Wine Grapes, Regulatory Pest Control, Walnuts, Structural Pest Control
Regulatory Pest Control	1,992		Endothal, Dipotassium Salt	5,483	Rights of Way
Pecan	1,875		Methoxyfenozide	4,584	Almonds, Rice, Walnuts
Pistachio	1,860		Propiconazole	3,728	Walnuts, Rice, Pears
Unspecified Beans	1,419		Cyhalofop Butyl	3,439	Rice
Cucumber	1,403		Carbaryl	3,063	Rice, Pears, Olives
Greenhouse Flower	1,322		Acetamiprid	2,943	Walnuts
Corn, Grain	1,306		Diuron	2,922	Right of Way, Walnuts
Cherry	1,231		Triclopyr, Butoxyethyl Ester	2,886	Right of Way, Timberland, Landscape Maintenance
Wheat	1,160		Chlorantraniliprole	2,871	Walnuts, Almonds
			Mancozeb	2,723	Processing Tomatoes, Cucumbers
			Aminopyralid, Triisopropanolamine Salt	2,649	Timberland, Rights of Way
			Glyphosate, Monoammonium Salt	2,359	Landscape Maintenance
			Propanilite	2,286	Walnuts, Corn for Forage, Almonds
			Hexythiazox	2,193	Walnuts, Corn for Forage
			Dimethoate	2,003	Dried Beans, Cotton, Sorghum/Milo
			(S)-Metolachlor	1,944	Unspecified Beans, Dried Beans, Processing Tomatoes
			Pyraclostrobin	1,943	Walnuts, Almonds

Application Site	Application (kg)		Pesticide	Application (kg)	Primary Application Sites (In decreasing order, minimum 10% of total)
			Malathion	1,904	Walnuts, Wild Rice, Public Health, Cotton
			Diazinon	1,884	Pears
			Acephate	1,813	Dried Beans, Outdoor Plants in Containers
			Diquat Dibromide	1,743	Landscape Maintenance, Water Area
			Deltamethrin	1,725	Structural Pest Control
			Boscalid	1,699	Walnuts
			Dazomet	1,626	Soil Fumigation/Preplant
			Trifluralin	1,575	Processing Tomatoes
			Lambda Cyhalothrin	1,452	Structural Pest Control, Rice
			Tebuconazole	1,386	Walnuts, Wine Grapes, Peaches
			Etoxazole	1,322	Walnuts, Almonds
			Spirodiclofen	1,307	Walnuts
			Sethoxydim	1,298	Almonds, Walnuts
			Bispyribac-Sodium	1,293	Rice
			Ethalfuralin	1,154	Unspecified Beans, Dried Beans
			Simazine	1,136	Walnuts, Wine Grapes
			2,4-D, 2-Ethylhexyl Ester	1,054	Timberland, Landscape Maintenance, Rights of Way
			Fipronil	1,047	Structural Pest Control
			Avermectin	1,040	Walnuts, Almonds

Task 7 Table 4. Method detection limits for pesticides dissolved in water and on suspended sediments measured by the U.S. Geological Survey Organic Chemistry Research Laboratory

Compound	NWIS parameter code	Chemical class	Pesticide type	Method detection limit (ng/L)	Analytical method
Acetamiprid	68302	Neonicotinoid	Insecticide	3.3	LC/MS/MS
Acetochlor	68520	Chloroacetanilide	Herbicide	1.5	GC/MS
Acibenzolar-S-methyl	51849	Unclassified	Fungicide	3.0	GC/MS
Alachlor	65064	Chloroacetanilide	Herbicide	1.7	GC/MS
Allethrin	66586	Pyrethroid	Insecticide	1.0	GC/MS
Atrazine	65065	Triazine	Herbicide	2.3	GC/MS
Azinphos-methyl	65066	Organophosphorus	Insecticide	9.4	GC/MS
Azinphos-methyl oxon	68211	Organophosphorus	Breakdown product	9.4	GC/MS
Azoxystrobin	66589	Strobin	Fungicide	3.1	GC/MS
Benefin (Benfluralin)	51643	2,6-Dinitroaniline	Herbicide	2.0	GC/MS
Benzovindiflupyr	52652	Amide	Fungicide	3.4	GC/MS
Bifenthrin	65067	Pyrethroid	Insecticide	0.7	GC/MS
Boscalid	67550	Anilide	Fungicide	2.8	GC/MS
Bromoconazole	68315	Azole	Fungicide	3.2	GC/MS
Butralin	68545	2,6-Dinitroaniline	Herbicide	2.6	GC/MS
Butylate	65068	Thiocarbamate	Herbicide	1.8	GC/MS
Captan	68322	Thiophthalimide	Fungicide	10.2	GC/MS
Carbaryl	65069	N-Methyl Carbamate	Insecticide	6.5	GC/MS
Carbendazim	68548	Benzimidazole	Fungicide	4.2	LC/MS/MS
Carbofuran	65070	N-Methyl Carbamate	Insecticide	3.1	GC/MS
Carboxin	52765	Anilide	Fungicide	4.5	LC/MS/MS
Chlorantraniliprole	51856	Anthranilic diamide	Insecticide	4.0	LC/MS/MS
Chlorfenapyr	53567	Pyroole	Insecticide	3.3	GC/MS
Chlorothalonil	65071	Substituted Benzene	Fungicide	4.1	GC/MS
Chlorpyrifos	65072	Organophosphorus	Insecticide	2.1	GC/MS
Chlorpyrifos oxon	68216	Organophosphorus	Insecticide	5.0	GC/MS
Clomazone	67562	Unclassified	Herbicide	2.5	GC/MS
Clothianidin	68221	Neonicotinoid	Insecticide	3.9	LC/MS/MS
Coumaphos	51836	Organophosphorus	Insecticide	3.1	GC/MS
Cyantraniliprole	51862	Anthranilic diamide	Insecticide	4.2	LC/MS/MS
Cyazofamid	51853	Azole	Fungicide	4.1	LC/MS/MS
Cycloate	65073	Thiocarbamate	Herbicide	1.1	GC/MS
Cyfluthrin	65074	Pyrethroid	Insecticide	1.0	GC/MS
Cyhalofop-butyl	68360	Aryloxyphenoxy propionic acid	Herbicide	1.9	GC/MS
Cyhalothrin (all isomers)	68354	Pyrethroid	Insecticide	0.5	GC/MS
Cymoxanil	51861	Unclassified	Fungicide	3.9	LC/MS/MS
Cypermethrin	65075	Pyrethroid	Insecticide	1.0	GC/MS
Cyproconazole	66593	Azole	Fungicide	4.7	GC/MS
Cyprodinil	67574	Pyrimidine	Fungicide	7.4	GC/MS
DCPA	65076	Alkyl Phthalate	Herbicide	2.0	GC/MS
DCPMU	68231	Urea	Herbicide Degradate	3.5	LC/MS/MS
DCPU	68226	Urea	Herbicide Degradate	3.4	LC/MS/MS
Deltamethrin	65077	Pyrethroid	Insecticide	0.6	GC/MS
Desmethyl-clothianidin	Pending	Neonicotinoid	Insecticide Degradate	4.6	LC/MS/MS
Desthio-prothioconazole	51865	Unclassified	Fungicide Degradate	3.0	LC/MS/MS
Desulfinylfipronil	66607	Unclassified	Insecticide Degradate	1.6	GC/MS

Compound	NWIS parameter code	Chemical class	Pesticide type	Method detection limit (ng/L)	Analytical method
Desulfinylfipronil Amide	68570	Unclassified	Insecticide Degradate	3.2	GC/MS
Diazinon	65078	Organophosphorus	Insecticide	0.9	GC/MS
Diazoxon	68236	Organophosphorus	Insecticide Degradate	5.0	GC/MS
3,4-Dichloroaniline	66584	Amine	Herbicide Degradate	3.2	LC/MS/MS
3,5-Dichloroaniline	67536	Unclassified	Herbicide Degradate	7.6	GC/MS
Dichlorvos	68572	Organophosphorus	Insecticide	5.1	GC/MS
Difenoconazole	67582	Azole	Fungicide	10.5	GC/MS
Dimethomorph	68373	Morpholine	Fungicide	6.0	GC/MS
Dinotefuran	68379	Neonicotinoid	Insecticide	4.5	LC/MS/MS
Dithiopyr	51837	Pyridinecarboxylic acid	Herbicide	1.6	GC/MS
Diuron	66598	Urea	Herbicide	3.2	LC/MS/MS
EPTC	65080	Thiocarbamate	Herbicide	1.5	GC/MS
Esfenvalerate	65081	Pyrethroid	Insecticide	0.5	GC/MS
Ethaboxam	51855	Unclassified	Fungicide	3.8	LC/MS/MS
Ethalfuralin	65082	2,6-Dinitroaniline	Herbicide	3.0	GC/MS
Etofenprox	67604	Pyrethroid Ether	Insecticide	2.2	GC/MS
Etoxazole	68598	Diphenyl Oxazoline	Insecticide	4.2	GC/MS
Famoxadone	67609	Oxazolidinedione	Fungicide	2.5	GC/MS
Fenamidone	51848	Imidazole	Fungicide	5.1	GC/MS
Fenarimol	67613	Pyrimidine	Fungicide	6.5	GC/MS
Fenbuconazole	67618	Azole	Fungicide	5.2	GC/MS
Fenhexamid	67622	Anilide	Fungicide	7.6	GC/MS
Fenpropathrin	65083	Pyrethroid	Insecticide	0.6	GC/MS
Fenpyroximate	51838	Pyrazole	Insecticide	5.2	GC/MS
Fenthion	51839	Organophosphorus	Insecticide	5.5	GC/MS
Fipronil	66604	Pyrazole	Insecticide	2.9	GC/MS
Fipronil sulfide	66610	Unclassified	Insecticide Degradate	1.8	GC/MS
Fipronil sulfone	66613	Unclassified	Insecticide Degradate	3.5	GC/MS
Flonicamid	51858	Unclassified	Insecticide	3.4	LC/MS/MS
Fluazinam	67636	2,6-Dinitroaniline	Fungicide	4.4	GC/MS
Flubendiamide	68606	Organofluorine	Insecticide	6.2	GC/MS
Fludioxonil	67640	Unclassified	Fungicide	7.3	GC/MS
Flufenacet	51840	Anilide	Herbicide	4.7	GC/MS
Flumetralin	51841	2,6-Dinitroaniline	Plant growth regulator	5.8	GC/MS
Flupicolide	51852	Benzamide Pyridine	Fungicide	3.9	GC/MS
Flupyram	52761	Amide	Fungicide	3.8	GC/MS
Fluxastrobin	67645	Strobin	Fungicide	9.5	GC/MS
Flupyradifurone	52764	Butenolides	Insecticide	3.0	LC/MS/MS
Fluridone	51864	Unclassified	Herbicide	3.7	LC/MS/MS
Flusilazole	67649	Azole	Fungicide	4.5	GC/MS
Flutolanil	51842	Anilide	Fungicide	4.4	GC/MS
Flutriafol	67653	Azole	Fungicide	4.2	GC/MS
Fluxapyroxad	51851	Anilide, Pyrazole	Fungicide	4.8	GC/MS
Hexazinone	65085	Triazinone	Herbicide	6.4	GC/MS
Imazalil	67662	Azole	Fungicide	10.5	GC/MS
Imidacloprid	68426	Neonicotinoid	Insecticide	3.8	LC/MS/MS
Imidacloprid Urea	51859	Neonicotinoid	Insecticide Degradate	4.0	LC/MS/MS

Compound	NWIS parameter code	Chemical class	Pesticide type	Method detection limit (ng/L)	Analytical method
Indaziflam	Pending	Alkylazine	Herbicide	2.1	GC/MS
Indoxacarb	68627	Unclassified	Insecticide	4.9	GC/MS
Ipconazole	52762	Triazole	Fungicide	7.8	GC/MS
Iprodione	66617	Dicarboximide	Fungicide	4.4	GC/MS
Isofetamid	53569	Amide	Fungicide	2.0	GC/MS
Kresoxim-methyl	67670	Strobin	Fungicide	4.0	GC/MS
Malaoxon	68240	Organophosphorus	Insecticide Degradate	5.0	GC/MS
Malathion	65087	Organophosphorus	Insecticide	3.7	GC/MS
Mandipropamid	51854	Amide	Fungicide	3.3	LC/MS/MS
Metalaxyl	68437	Xylitolalanine	Fungicide	5.1	GC/MS
Melconazole	66620	Azole	Fungicide	5.2	GC/MS
Methidathion	65088	Organophosphorus	Insecticide	7.2	GC/MS
Methoprene	66623	Juvenile hormone mimic	Insect growth regulator	6.4	GC/MS
Methoxyfenozide	68647	Diacylhydrazine	Insecticide	2.7	LC/MS/MS
Methyl parathion	65089	Organophosphorus	Insecticide	3.4	GC/MS
Metolachlor	65090	Chloroacetanilide	Herbicide	1.5	GC/MS
Molinate	65091	Thiocarbamate	Herbicide	3.2	GC/MS
Myclobutanil	66632	Azole	Fungicide	6.0	GC/MS
Napropamide	65092	Amide	Herbicide	8.2	GC/MS
Novaluron	68655	Benzoylurea	Herbicide	2.9	GC/MS
Oryzalin	68663	2,6-Dinitroaniline	Herbicide	5.0	LC/MS/MS
Oxadiazon	51843	Unclassified	Herbicide	2.1	GC/MS
Oxathiapiprolin	52766	Pyrazole	Fungicide	3.2	LC/MS/MS
Oxyfluorfen	65093	Diphenyl ether	Herbicide	3.1	GC/MS
p,p'-DDD	65094	Organochlorine	Insecticide Degradate	4.1	GC/MS
p,p'-DDE	65095	Organochlorine	Insecticide Degradate	3.6	GC/MS
p,p'-DDT	65096	Organochlorine	Insecticide	4.0	GC/MS
Paclobutrazol	51846	Azole	Plant growth regulator	6.2	GC/MS
Pebulate	65097	Thiocarbamate	Herbicide	2.3	GC/MS
Pendimethalin	65098	2,6-Dinitroaniline	Herbicide	2.3	GC/MS
Penoxsulam	51863	Triazolopyrimidine	Herbicide	3.5	LC/MS/MS
Pentachloroanisole	66637	Organochlorine	Insecticide Degradate	4.7	GC/MS
Pentachloronitrobenzene	66639	Substituted Benzene	Fungicide	3.1	GC/MS
Penthiopyrad	52769	Pyrazole	Fungicide	3.2	LC/MS/MS
Permethrin	65099	Pyrethroid	Insecticide	0.6	GC/MS
Phenothrin	65100	Pyrethroid	Insecticide	1.0	GC/MS
Phosmet	65101	Organophosphorus	Insecticide	4.4	GC/MS
Picoxystrobin	51850	Strobin	Fungicide	4.2	GC/MS
Piperonyl butoxide	65102	Unclassified	Synergist	2.3	GC/MS
Prodiamine	51844	2,6-Dinitroaniline	Herbicide	5.2	GC/MS
Prometon	67702	Triazine	Herbicide	2.5	GC/MS
Prometryn	65103	Triazine	Herbicide	1.8	GC/MS
Propanil	66641	Anilide	Herbicide	10.1	GC/MS
Propargite	68677	Unclassified	Insecticide	6.1	GC/MS
Propiconazole	66643	Azole	Fungicide	5.0	GC/MS
Propyzamide	67706	Amide	Herbicide	5.0	GC/MS
Pyraclostrobin	66646	Strobin	Fungicide	2.9	GC/MS

Compound	NWIS parameter code	Chemical class	Pesticide type	Method detection limit (ng/L)	Analytical method
Pyridaben	68682	Unclassified	Insecticide	5.4	GC/MS
Pyrimethanil	67717	Pyrimidine	Fungicide	4.1	GC/MS
Pyriproxyfen	68683	Hormone mimic	Insecticide	5.2	GC/MS
Quinoxifen	51847	Quinoline	Fungicide	3.3	GC/MS
Resmethrin	65104	Pyrethroid	Insecticide	1.0	GC/MS
Sedaxane	52648	Anilide, Pyrazole	Fungicide	5.2	GC/MS
Simazine	65105	Triazine	Herbicide	5.0	GC/MS
Sulfoxaflor	52767	Sulfoximine	Insecticide	4.4	LC/MS/MS
tau-Fluvalinate	65106	Pyrethroid	Insecticide	0.7	GC/MS
Tebuconazole	66649	Azole	Fungicide	3.7	GC/MS
Tebufenozide	68692	Moulting hormone agonist	Insecticide	3.0	LC/MS/MS
Tebupirimfos	68693	Organophosphorus	Insecticide	1.9	GC/MS
Tebupirimfos oxon	68694	Organophosphorus	Insecticide Degradate	2.8	GC/MS
Tefluthrin	67731	Pyrethroid	Insecticide	0.6	GC/MS
Tetraconazole	66654	Azole	Fungicide	5.6	GC/MS
Tetradifon	51851	Unclassified	Insecticide	3.8	GC/MS
Tetramethrin	66657	Pyrethroid	Insecticide	0.5	GC/MS
Thiabendazole	67181	Benzimidazole	Fungicide	3.6	LC/MS/MS
Thiacloprid	68485	Neonicotinoid	Insecticide	3.2	LC/MS/MS
Thiamethoxam	68245	Neonicotinoid	Insecticide	3.4	LC/MS/MS
Thiamethoxam Degradate (NOA-355190)	53568	Neonicotinoid	Insecticide Degradate	3.5	LC/MS/MS
Thiamethoxam Degradate (NOA-407475)	53576	Neonicotinoid	Insecticide Degradate	3.4	LC/MS/MS
Thiazopyr	51845	Pyridinecarboxylic acid	Herbicide	4.1	GC/MS
Thiobencarb	65107	Thiocarbamate	Herbicide	1.9	GC/MS
Tolfenpyrad	51866	Pyrazole	Insecticide	2.9	LC/MS/MS
Triadimefon	67741	Azole	Fungicide	8.9	GC/MS
Triadimenol	67746	Azole	Fungicide	8.0	GC/MS
Triallate	68710	Thiocarbamate	Herbicide	2.4	GC/MS
Tribufos	68711	Organophosphorus	Defoliant	3.1	GC/MS
Tricyclazole	52768	Azole	Fungicide	4.1	LC/MS/MS
Trifloxystrobin	66660	Strobin	Fungicide	4.7	GC/MS
Triflumizole	67753	Azole	Fungicide	6.1	GC/MS
Trifluralin	65108	2,6-Dinitroaniline	Herbicide	2.1	GC/MS
Triflconazole	67758	Azole	Fungicide	6.9	GC/MS
Zoxamide	67768	Amide	Fungicide	3.5	GC/MS

Task 7 Table. 5 Pesticide concentrations measured in environmental water samples collected in from sites in the Yolo Bypass and Cache Slough Complex in 2016, 2017, and 2018.

DWR Site Code	Sample Date (mm/dd/yyyy)	Sample Time (h:mm)	Hydrologic Conditions	Acetamiprid [68302]	Atrazine [66065]	Azoxystrobin [66589]	Boscalid [87550]	Carbaryl [66069]	Carbendazim [66448]	Chlorantraniliprole [51856]	Chlorothalonil [66071]	Chlorpyrifos [66072]	Clomazone [67562]	Clothianidin [68221]	Cyprodinil [67574]	DCPMU [68231]	DCPU [68226]	Desulfenylipronil [66607]	Desulfenylipronil Amide [66570]	Diazinon [66078]	3,4-Dichloroaniline [66661]	Dichlorvos [68572]	Dithiopyr [61837]	Diuron [66598]
RCS	06/23/2016	09:42	Pre-Pulse	—	—	321	43.1	—	—	11.0	—	—	515	—	—	4.7	14.5	4.8	—	—	1240	NA	—	—
RD22	06/23/2016	11:05	Pre-Pulse	—	—	201	44.7	—	—	8.1	—	—	561	—	—	5.6	10.6	12.0	—	—	677	NA	—	5.3
LIS	06/23/2016	13:15	Pre-Pulse	—	—	114	44.9	—	—	—	—	—	87.5	—	—	—	—	10.3	—	—	43.1	NA	—	—
BL5	06/23/2016	12:30	Pre-Pulse	—	—	64.3	24.4	—	—	—	—	—	112	—	—	—	—	4.2	—	—	23.4	NA	—	—
RCS	07/19/2016	08:10	Pulse	—	—	169	16.8	(4.0)	—	8.6	—	8.2	54.2	—	—	(2.3)	3.9	—	—	—	811	NA	—	—
RD22	07/19/2016	08:45	Pulse	—	—	170	19.6	(4.2)	—	9.4	—	5.3	56.3	—	—	(2.3)	3.8	—	—	—	742	NA	—	—
LIS	07/19/2016	09:47	Pulse	—	—	178	20.0	(3.5)	—	8.4	—	—	81.5	—	—	3.8	7.6	—	—	—	1290	NA	—	—
BL5	07/19/2016	11:42	Pulse	—	—	96.9	9.7	—	—	—	—	—	23.5	—	—	—	—	—	—	—	42.9	NA	—	—
RCS	07/28/2016	08:10	Pulse	—	—	744	11.4	—	—	9.7	—	—	48.1	—	—	3.7	3.7	—	—	—	599	NA	—	4.9
RD22	07/28/2016	09:35	Pulse	—	—	515	11.1	—	—	9.0	—	—	48.4	—	—	4.8	6.3	—	—	—	475	NA	—	4.6
LIS	07/28/2016	11:16	Pulse	—	—	331	9.8	—	—	6.9	—	—	38.7	—	—	(3.0)	(2.7)	—	—	—	336	NA	—	3.6
BL5	07/28/2016	11:15	Pulse	—	—	67.3	6.1	—	—	(3.9)	—	—	33.1	—	—	(3.2)	(3.3)	—	—	—	116	NA	—	(2.7)
RD22	08/02/2016	07:54	Post-Pulse	—	—	1021	33.3	—	5.3	13.8	—	—	108	—	—	3.5	7.2	3.9	—	—	337	NA	—	4.5
LIS	08/02/2016	09:15	Post-Pulse	—	—	509	9.2	—	—	(3.9)	—	—	26.8	—	—	(3.0)	4.1	—	—	—	269	NA	—	—
BL5	08/02/2016	10:45	Post-Pulse	—	—	101	7.1	—	—	(2.6)	—	—	20.2	—	—	(3.0)	(2.4)	—	—	—	62.8	NA	—	(2.8)
RD22	08/09/2016	08:54	Post-Pulse	(2.6)	—	658	36.7	110	—	17.7	—	—	79.1	—	—	4.5	7.4	—	—	—	1090	NA	—	13.0
LIS	08/09/2016	11:09	Post-Pulse	—	—	537	10.4	—	—	6.6	—	—	23.3	—	—	4.6	7.6	—	—	—	158	NA	—	3.7
BL5	08/09/2016	10:15	Post-Pulse	—	—	32.7	—	—	—	(3.2)	—	—	8.3	—	—	(3.2)	—	—	—	—	23.4	NA	—	5.2
RCS	08/29/2017	09:20	Ambient	—	—	316	39.6	—	105	4.3	—	—	504	—	(7.0)	15.4	11.9	—	—	—	3610	—	—	11.9
LIS	08/28/2017	09:25	Ambient	—	—	198	31.0	—	22.5	13.8	—	—	339	—	—	6.2	—	—	—	—	232	—	—	4.0
BL5	08/28/2017	12:14	Ambient	—	6.3	82.3	14.8	—	—	—	—	—	116	—	—	(3.0)	—	—	—	—	48.3	—	—	(2.0)
RY1	08/28/2017	13:30	Ambient	—	—	55.5	8.1	—	—	—	—	—	63.9	—	—	—	—	—	—	—	94.3	—	—	—
RCS	07/13/2017	08:19	Ambient	—	—	553	24.8	—	49.2	232	—	—	85.7	—	(5.2)	10.3	34.0	—	—	—	1350	—	—	7.8
RD22	07/13/2017	09:33	Ambient	—	—	434	50.5	—	342	130	—	—	208	—	(6.1)	8.6	15.1	7.2	—	—	734	—	—	14.2
LIS	07/13/2017	11:35	Ambient	—	—	173	31.8	—	68.3	24.9	—	—	279	—	—	4.1	(2.9)	—	—	—	115	—	—	—
BL5	07/13/2017	12:00	Ambient	—	—	70.5	13.0	—	66.6	—	—	—	62.2	—	—	—	—	—	—	—	50.1	—	—	—
RY1	07/13/2017	10:59	Ambient	—	—	75.0	7.0	—	91.2	—	—	—	20.7	—	—	—	—	—	—	—	142	—	—	—
RCS	07/27/2017	08:46	Ambient	—	—	734	8.9	—	—	69.4	—	—	37.0	—	(4.1)	(2.0)	5.4	—	—	—	1040	—	—	(2.3)
RD22	07/27/2017	10:16	Ambient	—	—	288	25.2	—	919	56.2	—	—	43.4	—	(3.8)	5.3	13.5	8.7	—	—	290	—	5.6	6.9
LIS	07/27/2017	12:45	Ambient	—	—	52.8	6.1	—	—	5.1	—	—	55.6	—	—	—	—	—	—	—	148	—	—	—
BL5	07/27/2017	11:44	Ambient	—	—	54.3	3.1	—	109	(2.8)	—	—	22.3	—	—	(3.0)	—	—	—	—	128	—	—	—
RY1	07/27/2017	11:00	Ambient	—	—	67.9	—	—	111	(2.6)	—	—	14.7	—	—	—	—	—	—	—	171	—	—	—
RCS	08/10/2017	08:20	Ambient	—	—	2510	6.5	—	—	66.6	—	—	20.0	—	—	—	—	—	—	—	585	25.5	—	—
RD22	08/10/2017	09:40	Ambient	—	—	138	29.6	—	1550	106	—	—	14.6	—	—	4.1	10.4	8.1	—	—	233	39.1	—	5.5
LIS	08/10/2017	11:49	Ambient	—	—	31.6	6.6	—	73.1	21.3	—	—	26.3	—	—	—	—	—	—	—	122	—	—	—
BL5	08/10/2017	11:20	Ambient	—	—	66.1	4.2	—	92.6	5.0	—	—	13.9	—	—	—	—	—	—	—	76.7	—	—	—
RY1	08/10/2017	10:34	Ambient	—	—	141	2.8	—	130	(3.6)	—	—	7.2	—	—	—	—	—	—	—	96.2	—	—	—
RCS	08/31/2017	08:20	Ambient	—	—	2320	14.5	—	—	56.0	—	—	10.5	—	—	—	4.4	—	—	—	561	—	—	—
RD22	08/31/2017	09:54	Ambient	—	—	421	47.1	—	799	17.7	—	—	7.4	—	—	—	8.2	7.7	—	—	96.8	30.6	—	3.9
LIS	08/30/2017	10:21	Ambient	—	—	100	11.4	—	60.1	20.0	—	—	10.7	—	—	—	—	—	—	—	39.1	—	—	—
BL5	08/30/2017	12:41	Ambient	—	—	257	9.0	—	63.5	4.0	—	—	6.4	—	—	—	—	—	—	—	25.2	—	—	—
RY1	08/30/2017	13:47	Ambient	—	—	322	4.4	—	—	(3.9)	—	—	4.2	—	—	—	—	—	—	—	43.6	—	3.2	—
RCS	09/13/2017	08:34	Ambient	—	—	2000	11.4	—	—	38.4	—	—	8.6	—	—	(2.9)	6.0	—	—	—	562	—	—	—
RD22	09/13/2017	10:13	Ambient	—	—	415	35.0	—	331	43.9	—	—	4.5	—	—	(3.4)	5.6	6.5	—	—	161.0	—	—	3.4
LIS	09/13/2017	13:15	Ambient	—	—	410	20.1	—	115	44.6	—	—	8.0	—	—	(3.3)	7.4	3.7	—	—	148.4	—	—	(2.2)
BL5	09/13/2017	12:10	Ambient	—	—	245	7.9	—	38.8	—	—	—	4.2	—	—	—	—	—	—	—	17.6	—	—	—
RY1	09/13/2017	13:15	Ambient	—	—	276	—	—	65.7	(3.2)	—	—	3.3	—	—	—	(2.4)	—	—	—	60.0	—	—	(2.0)

DWR Site Code	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Acetamiprid [68302]	Atrazine [65065]	Azoxystrobin [66589]	Boscalid [67560]	Carbaryl [65069]	Carbendazim [66548]	Chlorantraniliprole [51856]	Chlorothalonil [65071]	Chlorpyrifos [65072]	Clomazone [67562]	Clothianidin [68221]	Cyprodinil [67574]	DCPMU [68231]	DCPU [68226]	Desulfinyflpronil [66607]	Desulfinyflpronil Amide [68670]	Diazinon [65078]	3,4-Dichloroaniline [66584]	Dichlorvos [68572]	Dithiopyr [51937]	Diuron [66598]
RCS	09/20/2017	12:00	Ambient	---	---	1070	4.3	---	---	18.6	---	---	6.1	---	---	---	---	---	---	---	495	---	---	---
RD22	09/20/2017	12:50	Ambient	---	---	120	14.7	---	---	40.9	---	---	---	---	---	(2.3)	---	7.8	---	---	210	---	---	5.6
LIS	09/20/2017	14:30	Ambient	---	---	116	6.5	---	76.3	31.3	---	---	6.2	---	---	---	3.4	---	---	---	101	---	---	---
BL5	09/20/2017	13:12	Ambient	---	---	83.1	---	---	43.5	(2.1)	---	---	---	---	---	---	---	---	---	---	27.3	---	---	---
RY1	09/20/2017	12:40	Ambient	---	---	85.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	37.9	---	---	---
RCS	10/04/2017	13:10	Ambient	---	---	659	12.2	---	---	24.1	---	---	---	---	---	---	---	---	---	---	201	---	4.2	---
RD22	10/04/2017	13:50	Ambient	---	---	273	37.7	---	1190	11.5	---	---	---	---	---	---	---	12.1	---	---	77.8	---	---	6.9
LIS	10/04/2017	15:20	Ambient	---	---	167	6.3	---	51.3	(2.5)	---	---	---	---	---	---	---	---	---	---	31.2	---	---	---
BL5	10/04/2017	13:25	Ambient	---	---	113	---	---	56.6	---	---	---	---	---	---	---	---	---	---	---	19.6	---	---	---
RY1	10/04/2017	13:00	Ambient	---	---	83.3	4.6	---	---	---	---	---	---	---	---	---	---	---	---	---	13.3	---	---	---
RCS	10/18/2017	12:45	Ambient	---	---	392	12.6	---	---	33.4	---	---	---	---	---	---	---	---	---	---	173	---	---	---
RD22	10/18/2017	13:20	Ambient	---	---	82.4	42.7	---	2040	11.1	---	---	---	---	---	---	---	15.2	12.4	---	102	---	3.5	21.6
LIS	10/18/2017	14:55	Ambient	---	---	70.1	6.5	---	---	4.6	---	---	---	---	---	---	---	---	---	---	18.4	---	---	---
BL5	10/18/2017	11:00	Ambient	---	---	46.0	5.2	---	---	(2.7)	---	---	---	---	---	---	---	---	---	---	11.4	---	---	---
RY1	10/18/2017	10:30	Ambient	---	---	30.4	5.0	---	---	(2.1)	---	---	---	---	---	---	---	---	---	---	9.1	---	---	3.2
RCS	11/01/2017	10:10	Ambient	---	---	486	7.9	---	---	14.9	---	---	4.6	---	---	---	---	---	---	13.2	416	---	---	---
RD22	11/01/2017	10:45	Ambient	---	---	55.3	24.4	---	1090	6.4	---	---	---	---	---	---	---	11.8	---	---	148	---	---	12.8
LIS	11/01/2017	12:40	Ambient	---	---	50.2	5.2	---	54.2	(3.8)	---	---	---	---	---	---	---	---	---	6.2	31.7	---	---	---
BL5	11/01/2017	10:40	Ambient	---	---	39.4	4.2	---	66.1	(2.6)	---	---	---	---	---	---	---	---	---	3.9	14.0	---	---	---
RY1	11/01/2017	10:10	Ambient	---	---	34.9	5.3	---	76.2	---	---	---	---	---	---	---	---	---	---	3.9	19.0	---	---	(3.1)
RCS	07/10/2018	09:45	Pre-Pulse	---	---	422	29.1	---	55.6	49.4	---	---	239	---	---	9.6	12.6	---	---	---	1190	---	---	13.3
RD22	07/10/2018	11:02	Pre-Pulse	---	---	72.1	18.5	---	603	6.6	---	---	66.4	18.1	---	4.2	4.2	9.1	---	---	126	---	---	10.4
LIS	07/11/2018	11:11	Pre-Pulse	---	---	201	5.6	---	87.2	(3.4)	---	---	68.9	---	---	(2.7)	(2.5)	2.1	---	---	287	---	---	(3.1)
BL5	07/11/2018	12:09	Pre-Pulse	---	---	47.8	5.4	---	94.3	---	---	---	58.4	---	---	(3.0)	---	---	---	---	31.1	---	---	3.2
RY1	07/11/2018	13:12	Pre-Pulse	---	---	33.8	3.4	---	94.2	---	---	---	24.6	---	---	---	---	---	---	---	85.2	---	---	(2.2)
RCS	07/26/2018	09:13	Pre-Pulse	---	---	782	16.5	---	---	26.9	---	---	23.8	---	---	4.0	6.3	---	---	---	1010	---	---	(3.0)
RD22	07/26/2018	11:09	Pre-Pulse	---	---	266	31.0	---	361	229	---	---	18.4	20.9	---	3.7	5.7	4.9	---	---	831	---	---	6.5
LIS	07/28/2018	13:11	Pre-Pulse	---	---	134	8.9	---	41.8	4.9	---	---	19.7	---	---	---	---	---	---	---	86.1	---	---	---
BL5	07/26/2018	12:45	Pre-Pulse	---	---	55.8	6.6	---	75.3	(2.6)	---	---	11.5	---	---	(2.4)	---	1.9	---	---	37.2	---	---	(3.0)
RY1	07/26/2018	11:30	Pre-Pulse	---	---	86.7	5.3	---	63.2	---	---	---	7.6	---	---	---	---	---	---	---	66.1	8.9	---	---
RCS	08/07/2018	09:15	Pre-Pulse	---	---	419	26.2	---	---	16.9	---	---	35.3	---	---	---	---	6.0	---	---	673	---	---	---
RD22	08/07/2018	10:50	Pre-Pulse	---	---	2210	11.6	---	263	35.7	---	---	11.4	9.9	---	(2.5)	6.4	---	---	---	806	---	---	6.6
LIS	08/08/2018	12:11	Pre-Pulse	---	---	166	8.0	---	65.4	4.1	---	---	14.8	---	---	---	---	---	---	---	115	---	---	---
BL5	08/08/2018	13:08	Pre-Pulse	---	---	131	6.3	---	58.3	(2.9)	---	---	5.7	---	---	---	---	---	---	---	28.2	---	---	---
RY1	08/08/2018	11:43	Pre-Pulse	---	---	311	4.8	---	65.1	(2.1)	---	---	4.4	---	---	---	---	---	---	---	56.2	---	---	---
RCS	09/21/2018	09:43	Pre-Pulse	---	---	8790	10.3	---	---	10.9	5.6	---	5.3	---	---	---	(2.5)	---	---	---	386	---	---	---
RD22	09/21/2018	12:19	Pre-Pulse	---	---	864	21.0	---	468	13.7	5.5	---	15.1	---	(2.5)	---	---	5.9	---	---	201	---	---	3.5
LIS	09/21/2018	09:08	Pre-Pulse	---	---	180	8.4	---	25.3	5.1	4.6	---	6.4	---	---	---	---	---	---	---	76.8	---	---	(2.0)
BL5	09/22/2018	12:50	Pre-Pulse	---	---	344	6.3	---	70.1	4.1	---	---	3.2	---	---	---	---	---	---	---	24.6	---	---	(2.0)
RY1	09/22/2018	11:20	Pre-Pulse	---	---	514	5.1	---	59.3	(3.5)	---	---	3.2	---	---	---	---	---	---	---	34.3	---	---	---
RCS	09/30/2018	10:01	Pulse	---	---	4310	11.7	---	---	14.7	---	---	5.7	---	---	---	---	---	---	---	364	---	---	3.4
RD22	09/30/2018	11:35	Pulse	11.6	---	4330	12.4	---	---	19.5	---	---	5.7	---	---	---	---	---	---	---	280	---	---	(2.2)
LIS	09/30/2018	14:05	Pulse	(2.6)	---	3400	15.4	---	70.1	16.4	---	---	6.6	---	---	(2.3)	(3.0)	---	---	---	254	---	---	(1.9)
BL5	09/30/2018	12:28	Pulse	---	---	326	6.3	---	---	(3.6)	---	---	3.0	---	---	---	---	---	---	---	24.8	---	---	(2.1)
RY1	09/30/2018	10:55	Pulse	---	---	497	5.5	---	42.4	(3.8)	---	---	2.5	---	---	---	---	---	---	---	40.0	---	---	(2.0)
RCS	09/04/2018	13:10	Pulse	---	---	3170	11.4	---	16.1	13.2	(3.9)	---	4.7	---	---	(2.1)	(3.0)	---	---	---	381	---	---	(2.2)
RD22	09/04/2018	14:54	Pulse	---	---	2790	11.6	---	31.1	14.1	---	---	5.0	---	---	---	---	---	---	---	278	---	---	---
LIS	09/04/2018	09:26	Pulse	(2.3)	---	1970	12.9	---	26.8	18.9	8.0	---	5.6	---	---	---	---	---	---	---	290	---	---	(2.1)
BL5	09/05/2018	12:20	Pulse	---	---	324	5.4	---	68.1	5.2	---	---	---	---	---	---	---	---	---	---	47.1	---	---	(2.5)
RY1	09/05/2018	13:15	Pulse	---	---	348	7.2	---	84.3	(3.9)	7.8	---	3.0	---	---	---	---	---	---	---	46.9	---	---	(2.0)

DWR Site Code	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Acetamiprid [68302]	Atrazine [66065]	Azoxystrobin [66588]	Boscalid [67560]	Carbaryl [66069]	Carbendazim [66548]	Chlorantraniliprole [51856]	Chlorothalonil [66071]	Chlorpyrifos [66072]	Clomazone [67562]	Clothianidin [68221]	Cyprodinil [67574]	DCPMU [68231]	DCPU [68226]	Desulfinylfipronil [66607]	Desulfinylfipronil Amide [68570]	Diazinon [66078]	3,4-Dichloroaniline [66584]	Dichlorvos [68572]	Dithiopyr [51837]	Diuron [66598]
RCS	09/18/2018	09:25	Pulse	---	---	1270	15.7	---	---	10.2	---	---	---	---	---	---	---	---	---	---	298	---	---	---
RD22	09/18/2018	10:51	Pulse	---	---	1870	19.4	---	38.9	13.0	---	---	---	---	---	---	---	---	---	---	331	---	---	---
LIS	09/19/2018	10:00	Pulse	---	---	1820	22.0	---	26.2	18.0	---	---	---	---	---	---	---	---	---	---	299	---	---	---
BLS	09/19/2018	12:49	Pulse	---	---	631	13.1	---	40.5	(3.9)	---	---	---	---	---	---	---	---	---	---	67.3	---	---	---
RYI	09/19/2018	10:19	Pulse	---	---	347	8.5	---	---	(3.4)	---	---	---	---	---	---	---	---	---	---	50.3	---	---	---
RCS	10/09/2018	09:34	Post-Pulse	---	---	421	18.5	---	46.6	10.7	---	---	---	---	---	---	---	---	---	---	215	---	---	---
RD22	10/09/2018	11:30	Post-Pulse	---	---	323	44.7	---	718	15.7	---	---	---	---	(2.5)	(2.5)	---	9.1	---	---	183	---	---	11.8
LIS	10/10/2018	08:45	Post-Pulse	---	---	280	17.5	---	70.1	(2.2)	---	---	---	---	---	---	---	---	---	---	28.3	---	---	---
BLS	10/10/2018	12:28	Post-Pulse	---	---	148	10.5	---	---	(2.8)	---	---	---	---	---	---	---	---	---	---	18.1	---	---	---
RYI	10/10/2018	13:38	Post-Pulse	---	---	111	10.2	---	---	(2.9)	---	---	---	---	---	---	---	---	---	---	15.5	---	---	(2.4)
RCS	10/25/2018	08:07	Post-Pulse	---	---	308	15.7	---	12.7	10.4	---	---	---	---	---	---	---	---	---	---	164	---	---	---
RD22	10/25/2018	09:43	Post-Pulse	---	---	216	40.0	---	658	13.2	---	---	---	---	---	(2.6)	---	9.2	---	---	87.4	---	---	13.0
LIS	10/25/2018	13:28	Post-Pulse	---	---	157	---	---	26.2	5.5	---	---	---	---	---	---	---	---	---	---	38.7	---	---	---
BLS	10/25/2018	11:21	Post-Pulse	---	---	111	10.0	---	21.7	(2.9)	---	---	---	---	---	---	---	---	---	---	10.8	---	---	(2.1)
RYI	10/25/2018	12:26	Post-Pulse	---	---	72.3	9.0	---	30.8	(2.2)	---	---	---	---	---	---	---	---	---	---	7.2	---	---	(2.3)
LIS	11/08/2018	12:27	Post-Pulse	---	---	182	15.8	---	---	7.7	---	---	---	---	---	---	---	---	---	---	26.0	---	---	---

DWR Site Code	Sample Date (mm/dd/yyyy)	Sample Time (h:mm)	Hydrologic Conditions	Fipronil [66604]	Fipronil Sulfide [66513]	Fipronil Sulfone [66513]	Fluopyram [52761]	Flupyradiflurone [62764]	Flutolanil [51884]	Flutolanil 51842	Fluspyroxad [51861]	Hexazinone [66066]	Imidacloprid [68426]	Imidacloprid Urea [51865]	Indaziflam [pending]	Methoxyfenozide [66647]	Metolachlor [66006]	Oxadiazon [51843]	Penoxsulam [51863]	Penthiopyrad [62769]	Piprotol butoxide	Propanil [66641]	Propargite [66677]	Propiconazole [66643]	Pyrimethanil [67717]	Quinoxalene [51847]	Simazine [66165]	Tebuconazole [66645]	Thiabendazole [67161]	Thiamethoxam [66246]	Thiobencarb [66107]	Trifloxystrobin [66666]	
RCS	06/23/2016	09:42	Pre-Pulse	5.4	4.6	7.4	32.3	NA	—	14.6	36.6	46.4	—	NA	NA	7.0	66.3	—	70.4	NA	—	675	—	—	—	6.3	—	—	—	—	—	151	11.2
RD22	06/23/2016	11:05	Pre-Pulse	11.7	9.0	15.6	25.7	NA	—	12.4	30.6	45.3	—	NA	NA	6.0	81.1	8.3	105	NA	—	132	—	—	—	5.6	—	—	—	—	—	125	10.9
LB	06/23/2016	13:15	Pre-Pulse	8.4	8.8	14.4	31.4	NA	4.6	13.6	26.7	45.4	—	NA	NA	2.9	77.1	9.7	9.1	NA	—	94.8	—	—	—	6.1	18.0	—	—	—	—	105	14.0
BL5	06/23/2016	12:30	Pre-Pulse	—	—	—	14.0	NA	—	—	10.2	38.0	—	NA	NA	—	33.9	—	—	NA	—	73.9	—	—	—	—	—	—	—	—	—	15.5	—
RCS	07/19/2016	08:10	Pulse	—	—	—	12.9	NA	—	—	11.2	21.7	—	NA	NA	35.8	17.6	—	11.1	NA	72.8	47.3	12.0	—	—	—	—	—	—	—	—	75.7	—
RD22	07/19/2016	08:45	Pulse	4.1	—	—	14.8	NA	—	—	12.5	21.9	—	NA	NA	35.9	28.3	—	6.7	NA	50.1	38.1	10.2	—	—	—	—	—	—	—	—	59.0	—
LB	07/19/2016	09:47	Pulse	5.2	—	—	15.4	NA	—	—	11.5	20.7	—	NA	NA	35.0	21.2	—	18.2	NA	44.5	205	8.4	—	—	—	—	—	—	—	—	49.0	—
BL5	07/19/2016	11:42	Pulse	—	—	—	8.0	NA	—	—	(3.1)	15.6	—	NA	NA	2.8	9.0	—	(2.2)	NA	9.8	(5.4)	—	—	—	—	—	—	—	—	—	—	—
RCS	07/28/2016	06:10	Pulse	—	—	—	—	NA	—	—	5.9	17.7	—	NA	NA	81.6	27.5	—	8.4	NA	19.0	27.0	—	—	—	—	—	—	—	—	—	60.3	—
RD22	07/28/2016	09:35	Pulse	—	—	—	—	NA	—	—	5.8	19.4	—	NA	NA	75.6	17.3	—	8.5	NA	16.3	30.4	—	—	—	—	—	—	—	—	—	50.5	—
LB	07/28/2016	11:16	Pulse	—	—	—	—	NA	—	—	6.0	19.9	(2.0)	NA	NA	60.2	11.0	—	6.7	NA	32.1	—	—	—	—	—	—	—	—	—	—	32.6	—
BL5	07/28/2016	11:15	Pulse	—	—	—	—	NA	(3.4)	—	(2.8)	9.4	—	NA	NA	19.0	9.6	—	5.1	NA	—	—	—	—	—	—	—	—	—	—	—	—	—
RD22	08/02/2016	07:54	Post-Pulse	(1.9)	—	—	—	NA	—	—	12.7	28.3	4.0	NA	NA	58.7	35.4	—	9.0	NA	45.9	—	—	—	—	—	—	—	—	—	—	36.0	—
LB	08/02/2016	09:15	Post-Pulse	—	—	—	—	NA	—	—	(3.3)	16.2	—	NA	NA	43.8	18.5	—	24.4	NA	14.7	—	—	—	—	—	—	—	—	—	—	27.0	—
BL5	08/02/2016	10:45	Post-Pulse	—	—	—	—	NA	—	—	(3.1)	12.7	—	NA	NA	19.7	6.0	—	—	NA	—	—	—	—	—	—	—	—	—	—	—	—	—
RD22	08/09/2016	08:54	Post-Pulse	5.4	—	—	—	NA	—	—	11.6	24.5	9.7	NA	NA	44.1	40.3	—	6.7	NA	55.0	—	—	—	—	—	—	—	—	8.2	—	—	
LB	08/09/2016	11:09	Post-Pulse	—	—	—	—	NA	—	—	9.0	14.7	5.1	NA	NA	40.5	33.0	—	15.7	NA	—	—	—	—	—	—	—	—	—	—	—	—	—
BL5	08/09/2016	10:15	Post-Pulse	—	—	—	—	NA	—	—	—	12.8	—	NA	NA	15.6	—	—	(2.7)	NA	—	—	—	—	—	—	—	—	—	—	—	—	—
RCS	08/29/2017	09:20	Ambient	—	—	—	31.2	—	—	—	28.5	29.3	18.1	—	NA	9.8	157	—	122	—	20.4	734	—	—	38.7	9.2	—	16.5	—	—	—	254	—
LB	08/29/2017	09:25	Ambient	—	—	—	18.2	—	(3.2)	—	18.9	19.7	33.5	—	NA	5.9	204	—	81.1	—	—	—	—	17.6	4.3	—	15.7	626	—	—	—	17.1	—
BL5	08/29/2017	12:14	Ambient	—	—	—	—	—	—	—	24.8	—	—	—	NA	—	55.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RY1	08/29/2017	13:30	Ambient	4.1	—	—	—	—	50.6	—	—	22.9	—	—	NA	—	29.8	—	—	—	—	6.1	26.4	—	8.2	—	—	—	—	—	—	7.4	—
RCS	07/13/2017	08:19	Ambient	—	—	—	22.4	—	—	—	32.2	24.1	10.2	—	NA	1500	40.3	—	259	—	69.2	49.4	—	—	19.0	5.6	—	11.0	—	—	—	114	—
RD22	07/13/2017	09:33	Ambient	5.6	—	—	29.8	—	(2.8)	—	25.9	23.6	23.3	6.8	NA	433	93.6	—	186	—	47.9	—	—	27.9	9.5	—	—	—	3.9	6.0	78.7	—	
LB	07/13/2017	11:35	Ambient	—	—	—	23.4	—	11.4	—	18.4	24.1	—	—	NA	15.7	150	—	48.1	—	—	—	—	—	4.9	—	14.3	—	—	—	—	—	—
BL5	07/13/2017	12:00	Ambient	—	—	—	9.2	—	90.0	—	—	23.1	—	—	NA	3.5	24.0	—	7.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RY1	07/13/2017	10:59	Ambient	—	—	—	—	—	95.4	—	—	19.1	—	—	NA	18.3	12.2	—	5.3	—	7.5	24.1	—	—	—	—	—	—	—	—	—	—	—
RCS	07/27/2017	08:46	Ambient	—	—	—	9.4	(2.9)	—	—	11.7	30.6	(3.2)	—	NA	776	18.7	—	45.6	—	—	86.3	43.9	—	—	4.2	—	—	—	—	—	76.0	—
RD22	07/27/2017	10:16	Ambient	6.4	—	—	12.3	—	19.4	—	9.8	25.7	6.0	—	NA	272	112	—	37.1	—	—	30.8	—	—	—	6.7	—	—	5.6	—	—	20.1	—
LB	07/27/2017	12:45	Ambient	—	—	—	5.4	—	68.7	—	12.9	20.0	—	—	NA	52.8	70.1	—	—	—	—	12.9	—	—	—	—	—	—	—	—	—	6.5	—
BL5	07/27/2017	11:44	Ambient	—	—	—	—	—	205	—	—	20.4	—	—	NA	53.3	17.1	—	(3.1)	—	—	—	—	—	—	—	—	—	—	—	—	4.2	—
RY1	07/27/2017	11:00	Ambient	—	—	—	—	—	112	—	—	22.9	—	—	NA	86.9	13.9	—	(3.3)	—	12.8	18.0	—	—	—	—	—	—	—	—	—	4.7	—
RCS	08/10/2017	08:20	Ambient	—	—	—	—	—	—	—	19.1	39.2	—	—	NA	548	22.4	—	29.0	—	24.0	—	—	—	—	—	—	—	—	—	—	60.7	—
RD22	08/10/2017	09:40	Ambient	8.4	—	3.7	—	—	3.9	—	21.5	29.2	8.0	—	NA	518	370	—	21.0	—	—	—	—	—	7.0	—	—	—	7.6	—	—	17.5	—
LB	08/10/2017	11:49	Ambient	—	—	—	—	—	108	—	—	26.4	—	—	NA	34.7	40.2	(3.0)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BL5	08/10/2017	11:20	Ambient	—	—	—	—	—	177	—	—	26.6	—	—	NA	74.9	9.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RY1	08/10/2017	10:34	Ambient	—	—	—	—	—	95.7	—	—	26.7	—	—	NA	84.8	7.1	(2.5)	—	—	—	—	—	—	—	—	—	—	—	—	—	4.0	—
RCS	08/31/2017	08:20	Ambient	—	—	—	13.5	4.6	—	—	10.3	31.4	—	—	NA	403	7.3	—	11.2	—	61.6	—	—	—	(3.0)	—	—	—	—	—	—	—	—
RD22	08/31/2017	09:54	Ambient	5.2	3.5	—	15.5	—	5.5	—	11.9	28.0	—	—	NA	108	186	—	3.9	—	21.6	—	—	—	—	6.3	—	—	8.1	—	—	—	—
LB	08/30/2017	10:21	Ambient	—	—	—	10.1	—	94.3	—	6.3	18.8	—	—	NA	50.9	30.3	—	4.7	—	—	—	—	—	—	—	—	6.6	—	—	—	—	—
BL5	08/30/2017	12:41	Ambient	—	—	—	9.9	—	151	—	5.0	19.3	—	—	NA	65.4	6.5	(2.1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RY1	08/30/2017	13:47	Ambient	—	—	—	7.5	—	41.6	—	—	21.9	—	—	NA	72.2	5.2	—	—	—	6.6	—	—	—	—	—	—	—	—	—	—	—	—
RCS	09/13/2017	08:34	Ambient	—	—	—	11.5	8.9	—	—	9.5	34.9	3.8	—	NA	206	8.9	—	8.2	—	13.8	—	—	—	(2.8)	—	—	—	—	—	—	—	—
RD22	09/13/2017	10:13	Ambient	5.5	3.1	—	18.9	—	19.1	—	11.7	24.5	—	—	NA	96.2	73.8	—	3.5	—	—	—	—	—	—	5.4	—	—	—	—	—	—	—
LB	09/13/2017	13:15	Ambient	—	—	—	13.8	—	31.1	—	9.5	24.1	—	—	NA	84.9	40.7	—	4.2	—	7.1	—	—	—	(2.7)	—	6.7	—	—	—	—	—	—
BL5	09/13/2017	12:10	Ambient	—	—	—	9.3	—	72.2	—	6.1	24.4	—	—	NA	29.6	6.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RY1	09/13/2017	13:15	Ambient	—	—	—	5.1	—	43.9	—	—	26.4	—	—	NA	39.7	4.5	—	—	—	6.4	—	—	—	—	—	—	—	—	—	—	—	—

DWR Site Code	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Fipronil [66646]	Fipronil Sulfide [66610]	Fipronil Sulfone [66613]	Flupyrad [52761]	Flupyrad flurone [52764]	Fluridone [51864]	Flutolanil 51842	Fluxapyroxad [51865]	Hexazinone [66068]	Imidacloprid [66426]	Imidacloprid Urea [51889]	Indaziflam [pending]	Methoxyflorfen [66647]	Metolachlor [66090]	Oxalixeton [51843]	Panoxsulam [51863]	Penthiopyrad [52769]	Piperonyl butoxide [66102]	Propanil [66641]	Propargite [66677]	Propiconazole [66642]	Pyrimethanil [67717]	Quinoxifen [51847]	Simazine [66106]	Tebuconazole [66649]	Thiabendazole [67161]	Thiamethoxam [66246]	Thiobencarb [66107]	Trifloxystrobin [66660]					
RCS	09/20/2017	12:00	Ambient	---	---	---	---	3.5	---	---	9.2	27.8	---	---	NA	310	7.4	---	(2.3)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RD22	09/20/2017	12:50	Ambient	6.2	3.9	---	---	---	---	---	8.7	22.4	(3.2)	---	NA	87.6	87.1	---	(2.0)	---	---	---	---	10.7	---	---	---	---	---	---	---	---					
LB	09/20/2017	14:30	Ambient	---	---	---	---	---	40.0	---	7.1	16.0	(3.1)	---	NA	79.3	33.7	---	---	---	---	---	---	---	---	---	---	7.8	---	---	---	---					
BL5	09/20/2017	13:12	Ambient	---	---	---	---	---	112	---	---	17.6	---	---	NA	46.9	6.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	09/20/2017	12:40	Ambient	---	---	---	---	---	111	---	---	16.3	---	---	NA	36.5	10.3	---	---	---	---	4.2	---	---	---	---	---	---	---	---	---	---	---				
RCS	10/04/2017	13:10	Ambient	---	---	---	---	---	---	---	16.3	37.4	---	---	NA	134	13.8	---	(2.1)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RD22	10/04/2017	13:50	Ambient	7.6	4.2	---	---	---	---	---	7.2	34.7	---	---	NA	46.9	36.6	---	(2.4)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
LB	10/04/2017	15:20	Ambient	---	---	---	---	---	91.8	---	---	27.2	---	---	NA	41.9	12.3	---	---	---	---	---	---	---	---	---	---	---	---	---	6.6	(3.2)	---	---			
BL5	10/04/2017	13:25	Ambient	---	---	---	---	---	90.1	---	---	25.5	---	---	NA	22.9	15.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	10/04/2017	13:00	Ambient	---	---	---	---	---	84.1	---	---	27.4	---	---	NA	13.2	21.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	10/19/2017	12:45	Ambient	---	---	---	---	(2.6)	---	---	12.4	26.1	---	---	NA	276	7.2	---	5.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RD22	10/19/2017	13:20	Ambient	19.7	7.4	10.1	---	---	---	---	7.7	21.5	7.6	9.9	NA	16.2	12.5	---	(2.1)	---	---	---	---	---	---	---	---	---	---	---	12.8	---	---				
LB	10/19/2017	14:55	Ambient	---	---	---	---	---	89.8	---	(4.6)	21.4	---	---	NA	16.7	7.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	10/19/2017	11:00	Ambient	---	---	---	---	---	85.6	---	---	19.8	---	---	NA	10.3	6.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	10/19/2017	10:30	Ambient	---	---	---	---	---	88.9	---	---	16.3	---	---	NA	5.8	4.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	11/01/2017	10:10	Ambient	---	---	---	9.8	---	---	---	10.3	17.7	---	---	NA	88.7	4.3	---	(3.0)	---	---	---	---	---	---	---	---	---	---	---	---	---	5.8	---			
RD22	11/01/2017	10:45	Ambient	20.4	2.8	(2.9)	---	---	---	---	(4.4)	13.4	10.2	6.2	NA	10.2	10.9	---	---	---	---	---	---	---	---	---	---	---	---	---	6.3	---	---				
LB	11/01/2017	12:40	Ambient	---	---	---	---	---	86.5	---	---	15.1	---	---	NA	16.2	5.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	11/01/2017	10:40	Ambient	---	---	---	---	---	77.6	---	---	14.8	---	---	NA	10.9	3.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	11/01/2017	10:10	Ambient	---	---	---	---	---	80.8	---	---	14.2	---	---	NA	8.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	07/10/2018	09:45	Pre-Raise	---	---	---	20.7	11.3	---	---	17.7	16.3	5.2	---	---	93.5	42.4	---	101	10.2	---	193	79.8	---	---	---	(3.7)	---	---	---	---	4.2	69.9	---			
RD22	07/10/2018	11:02	Pre-Raise	13.1	2.8	(3.2)	10.3	---	4.3	---	(4.4)	9.2	---	---	---	28.9	31.7	---	5.5	---	---	13.1	---	---	---	---	---	---	---	7.3	3.6	26.2	---				
LB	07/11/2018	11:11	Pre-Raise	---	---	---	7.0	---	184	---	(3.1)	16.2	---	---	---	11.0	11.5	---	4.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	07/11/2018	12:09	Pre-Raise	---	---	---	6.3	---	210	---	(2.7)	9.4	---	---	---	8.8	9.5	---	(2.5)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	07/11/2018	13:12	Pre-Raise	(2.6)	---	---	---	---	195	---	---	10.7	---	---	---	15.1	5.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	07/26/2018	09:13	Pre-Raise	---	---	---	14.3	4.2	---	---	12.0	20.8	(2.3)	---	---	373	16.0	---	33.4	---	---	27.6	36.1	---	---	---	---	---	---	---	---	---	69.4	---			
RD22	07/26/2018	11:09	Pre-Raise	5.6	2.0	---	13.0	---	---	---	12.6	17.3	13.6	---	23.7	142	67.7	---	16.0	---	---	22.3	39.8	---	---	---	---	---	---	(3.3)	3.4	35.1	---				
LB	07/26/2018	13:11	Pre-Raise	---	---	---	7.9	---	165	---	(4.0)	16.4	---	---	---	15.3	25.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	07/26/2018	12:45	Pre-Raise	---	---	---	5.1	---	177	---	---	13.9	---	---	---	32.4	5.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	07/26/2018	11:30	Pre-Raise	---	---	---	4.1	---	113	---	---	14.9	---	---	---	44.3	5.9	---	---	---	---	5.3	16.7	---	---	---	---	---	---	---	---	---	---				
RCS	09/07/2018	09:15	Pre-Raise	11.4	---	---	16.2	7.7	---	---	13.9	17.0	---	---	---	249	57.0	---	(3.0)	---	---	27.3	---	---	---	---	---	---	---	---	---	---	(2.1)	---			
RD22	09/07/2018	10:50	Pre-Raise	11.4	---	---	12.6	---	---	---	11.6	25.5	13.9	---	---	98.9	11.2	---	10.6	---	---	33.7	---	---	---	---	---	---	---	---	---	---	---				
LB	09/09/2018	12:11	Pre-Raise	15.3	---	---	7.0	---	116	---	(3.5)	15.7	---	---	---	29.7	25.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	09/09/2018	13:06	Pre-Raise	(2.6)	---	---	4.9	---	105	---	---	15.1	---	---	---	42.7	4.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	09/09/2018	11:43	Pre-Raise	---	---	---	4.7	---	95.2	---	---	15.6	---	---	---	86.5	4.3	---	---	---	---	8.1	---	---	---	---	---	---	---	---	---	---	---				
RCS	09/21/2018	09:43	Pre-Raise	---	---	---	10.8	4.0	---	---	8.6	15.9	---	---	---	148	---	---	(3.4)	---	---	25.2	---	---	---	---	---	---	---	---	---	---	35.2	---			
RD22	09/21/2018	12:19	Pre-Raise	12.8	---	---	12.9	---	---	---	13.2	12.3	---	---	---	67.8	8.4	---	(2.2)	---	---	8.1	---	---	---	---	---	---	---	---	---	---	---				
LB	09/21/2018	09:08	Pre-Raise	8.9	---	---	8.8	---	94.7	---	(3.9)	14.3	---	---	---	44.9	19.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	09/22/2018	12:50	Pre-Raise	---	---	---	9.9	---	86.1	---	(2.9)	12.4	---	---	---	47.7	3.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	09/22/2018	11:20	Pre-Raise	---	---	---	8.4	---	39.4	---	(2.5)	13.0	---	---	---	49.4	4.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	09/30/2018	10:01	Raise	---	---	---	12.7	4.1	---	---	10.2	16.2	---	---	---	170	---	---	---	---	---	12.4	---	---	---	---	---	---	---	---	---	---	44.0	---			
RD22	09/30/2018	11:35	Raise	---	---	---	13.0	3.6	---	---	11.2	19.7	---	---	---	156	5.9	---	---	---	---	24.0	---	---	---	---	---	---	---	---	---	---	---	24.8	---		
LB	09/30/2018	14:05	Raise	---	---	---	13.9	3.9	(2.4)	---	11.5	20.0	---	---	---	153	11.2	---	(3.2)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	09/30/2018	12:28	Raise	---	---	---	9.9	---	50.7	---	(3.1)	15.5	---	---	---	46.2	4.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	09/30/2018	10:05	Raise	---	---	---	---	---	24.0	---	(2.7)	14.1	---	---	---	50.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	09/04/2018	13:10	Raise	---	---	---	12.1	4.6	---	---	11.5	21.2	---	---	---	137	6.0	---	---	---	---	7.3	---	---	---	---	---	---	---	---	---	---	---				
RD22	09/04/2018	14:54	Raise	---	---	---	11.7	4.9	---	---	10.8	18.4	---	---	---	144	5.9	---	(3.0)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
LB	09/04/2018	09:26	Raise	---	---	---	11.5	6.9	3.9	---	10.1	16.8	---	---	---	142	15.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	09/05/2018	12:20	Raise	---	---	---	---	---	90.5	---	(2.8)	13.4	---	---	---	63.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RY1	09/05/2018	13:15	Raise	---	---	---	---	---	17.8	---	(3.3)	12.9	---	---	---	55.4	4.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
RCS	09/04/2018	13:10	Raise	---	---	---	12.1	4.6	---	---	11.5	21.2	---	---	---	137	6.0	---	---	---	---	7.3	---	---	---	---	---	---	---	---	---	---	---				
RD22	09/04/2018	14:54	Raise	---	---	---	11.7	4.9	---	---	10.8	18.4	---	---	---	144	5.9	---	(3.0)	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
LB	09/04/2018	09:26	Raise	---	---	---	11.5	6.9	3.9	---	10.1	16.8	---	---	---	142	15.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---				
BL5	09/05/2018	12:20	Raise	---	---	---	---	---	90.5	---	(2.8)	13.4	---	---	---	63.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---						

DWR Site Code	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Fipronil [66664]	Fipronil Sulfide [66610]	Fipronil Sulfone [66613]	Fluopyram [52761]	Flupyradiflurene [52764]	Fluridone [51864]	Flutolanil [51842]	Fluxapyroxad [51861]	Hexazinone [50068]	Imidacloprid [66426]	Imidacloprid Urea [51889]	Indaziflam [pending]	Methoxyflorazole [66647]	Metolachlor [66090]	Oxarizone [51843]	Penoxsulam [51863]	Penthiopyrad [52769]	Piperonyl butoxide [66102]	Propanil [66641]	Propargite [66677]	Propiconazole [66643]	Pyrimethanil [67717]	Quinoxifen [51847]	Simazine [66105]	Tebuconazole [66649]	Thiabendazole [67161]	Thiamethoxam [66245]	Thiobencarb [66107]	Trifloxystrobin [66660]	
RCS	09/19/2018	09:25	Rise	---	---	---	11.3	---	---	---	14.3	---	---	---	---	112	---	---	(3.3)	---	---	---	---	---	37.0	---	---	---	---	---	---	---	---
R022	09/19/2018	10:51	Rise	---	---	---	14.3	---	---	---	16.6	24.7	---	---	---	132	---	---	5.4	---	---	---	---	---	47.1	---	---	---	---	---	---	---	---
LB	09/19/2018	10:00	Rise	---	---	---	13.7	---	(2.7)*	---	16.0	24.4	---	---	---	143	8.3	---	5.7	---	---	---	---	---	43.2	---	---	---	---	---	---	---	---
BL5	09/19/2018	12:49	Rise	---	---	---	11.1	---	49.9	---	(4.6)	19.2	---	---	---	25.2	---	---	(2.4)	---	---	---	---	---	17.7	---	---	---	---	---	---	---	---
RVT	09/19/2018	10:19	Rise	---	---	---	---	---	123*	---	(3.1)	16.2	---	---	---	42.5	---	---	---	---	---	---	---	---	9.2	---	---	---	---	---	---	---	---
RCS	10/09/2018	09:34	Post-Pulse	---	---	---	12.0	---	---	---	14.2	17.4	---	---	---	56.6	---	---	(3.0)	---	---	---	---	---	78.5	---	---	---	---	---	---	---	---
R022	10/09/2018	11:30	Post-Pulse	10.1	---	---	14.8	---	---	---	18.9	16.2	---	---	---	71.4	6.0	3.3	(2.6)	---	---	---	---	---	---	---	---	---	---	6.4	---	---	---
LB	10/10/2018	08:45	Post-Pulse	---	---	---	8.8	---	27.5	---	9.7	17.7	---	---	---	16.9	7.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BL5	10/10/2018	12:28	Post-Pulse	---	---	---	---	---	65.4	---	---	13.5	---	---	---	16.7	7.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RVT	10/10/2018	13:38	Post-Pulse	---	---	---	---	---	66.0	---	---	141	---	---	---	13.4	11.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RCS	10/25/2018	06:07	Post-Pulse	---	---	---	---	---	---	---	6.9	11.6	---	---	---	42.3	---	---	---	---	---	---	---	---	22.4	---	---	---	---	---	---	---	---
R022	10/25/2018	09:43	Post-Pulse	12.7	3.2	6.4	---	---	---	---	10.7	11.4	---	---	---	62.3	4.7	---	---	---	---	---	---	---	---	---	---	---	---	7.5	---	---	---
LB	10/25/2018	13:28	Post-Pulse	---	---	---	---	---	80.9	---	(3.9)	14.1	---	---	---	29.6	5.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BL5	10/25/2018	11:21	Post-Pulse	---	---	---	---	---	119	---	(2.5)	12.4	---	---	---	14.1	7.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RVT	10/25/2018	12:26	Post-Pulse	(2.0)	---	---	---	---	267	---	---	12.9	---	---	---	7.5	6.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LB	11/08/2018	12:27	Post-Pulse	---	---	---	---	---	69.4	---	6.9	15.3	---	---	---	31.9	7.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. Results in parenthesis () are below method detection limits and are estimates. The following compounds were analyzed but were not detected in any samples: Acetochlor, Acibenzar-methyl, Alachlor, Allethrin, Azinphos Methyl, Azinphos Methyl oxon, Benfluralin, Benzovindiflupyr, Bifenthrin, Bromuconazole, Butralin, Butylate, Captan, Carbofuran, Carboxin, Chlorfenapyr, Chlorpyrifos oxon, Coumaphos, Cyantraniliprole, Cyazofamid, Cycloate, Cyfluthrin, Cyhalofop-butyl, Cyhalothrin, Cymoxanil, Cypermethrin, Cyproconazole, DCPA, Deltamethrin, Desmethyl-clothianidin, Desthio-prothioconazole, Diazoxon, 3,5-Dichloroaniline, Difenconazole, Dimethomorph, Dinotefuran, EPTC, Esfenvalerate, Ethaboxam, Ethalfluralin, Etofenprox, Etoxazole, Famoxadone, Fenamidone, Fenarimol, Fenbuconazole, Fenhexamide, Fenpropathrin, Fenpyroximate, Fenthion, Flonicamid, Fluazinam, Flubendiamide, Fludioxinil, Flufenacet, Flumetralin, Fluopicolide, Fluoxastrobin, Flusilazole, Flutriafol, Imazalil, Indoxacarb, Ipconazole, Iprodione, Isfetamid, Kresoxim-methyl, Malaoxon, Malathion, Mandipropamid, Metalaxyl, Metconazole, Methidathion, Methoprene, Methyl Parathion, Molinate, Myclobutanil, Napropamide, Novaluron, Oryzalin, Oxythiapiiprolin, Oxyfluorfen, p,p'-DDD, p,p'-DDE, p,p'-DDT, Paclobutrazol, Pebulate, Pendimethalin, Pentachloroanisole, Pentachloronitrobenzene, Permethrin, Phenothrin, Phosmet, Picoxystrobin, Prodiamine, Prometon, Prometryn, Propyzamide, Pyraclostrobin, Pyridaben, Pyriproxyfen, Resmethrin, Sedaxane, Sulfoxaflo, tau-Fluvalinate, Tebufenozide, Tebupirimfos, Tebupirimfos oxon, Tefluthrin, Tetraconazole, Tetradifon, Tetramethrin, Thiachloprid, Thiamethoxam Degradate (NOA-355190), Thiamethoxam Degradate (NOA-407475),Thiazopyr, Tolfenpyrad, Triadimefon, Triadimenol, Triallate, Tribufos, Tricyclazole, Triflumizole, Trifluralin, Triticonazole, and Zoxamide. Abbreviations: DWR, Department of Water Resources; hh:mm, hours:minutes; mm/dd/yyyy, month/day/year; ---, not detected; NA, not analyzed; *, values coded in NWIS as "V" analyte detected in laboratory blank]

Task 7 Table 6. Pesticide concentrations measured in environmental suspended sediment samples collected in from sites in the Yolo Bypass and Cache Slough Complex in 2016, 2017, and 2018.

DWR Site Code	USGS station name	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Azoxystrobin [66589]	Bifenthrin [65067]	Clomazone [67562]	Fenpropathrin [65083]	Fluoxastrobin [67645]	Thiobencarb [65107]
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	06/23/2016	09:42	Pre-Pulse	—	2.2	9.9	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	06/23/2016	11:05	Pre-Pulse	—	1.8	12.7	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	06/23/2016	13:15	Pre-Pulse	—	3.3	4.1	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	06/23/2016	12:30	Pre-Pulse	—	4.2	4.9	—	—	—
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	07/19/2016	08:10	Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	07/19/2016	08:45	Pulse	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	07/19/2016	09:47	Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	07/19/2016	11:42	Pulse	—	—	—	—	—	—
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	07/28/2016	08:10	Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	07/28/2016	09:35	Pulse	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	07/28/2016	11:16	Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	07/28/2016	11:15	Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/02/2016	07:54	Post-Pulse	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/02/2016	09:15	Post-Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/02/2016	10:45	Post-Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/09/2016	08:54	Post-Pulse	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/09/2016	11:09	Post-Pulse	—	—	—	—	—	—

DWR Site Code	USGS station name	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Azoxystrobin [66589]	Bifenthrin [65067]	Clomazone [67562]	Fenpropathrin [65083]	Fluoxastrobin [67645]	Thiobencarb [65107]
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/09/2016	10:15	Post-Pulse	—	—	—	—	—	—
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	06/29/2017	09:20	Ambient	—	—	6.8	—	—	5.8
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	06/28/2017	09:25	Ambient	—	—	4.7	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	06/28/2017	12:14	Ambient	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	06/28/2017	13:30	Ambient	—	—	—	—	—	—
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	07/13/2017	08:19	Ambient	—	2.3	—	—	—	5.6
RD22	TULE CANAL A RD 22 NR WOODLAND CA	07/13/2017	09:33	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	07/13/2017	11:35	Ambient	—	—	4.7	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	07/13/2017	12:00	Ambient	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	07/13/2017	10:59	Ambient	—	—	—	—	—	—
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	07/27/2017	08:46	Ambient	—	3.0	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	07/27/2017	10:16	Ambient	—	3.2	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	07/27/2017	12:45	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	07/27/2017	11:44	Ambient	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	07/27/2017	11:00	Ambient	—	—	—	—	—	—
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	08/10/2017	08:20	Ambient	11.4	3.2	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/10/2017	09:40	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/10/2017	11:49	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/10/2017	11:20	Ambient	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	08/10/2017	10:34	Ambient	—	—	—	—	—	—

DWR Site Code	USGS station name	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Azoxystrobin [66589]	Bifenthrin [65067]	Clomazone [67562]	Fenpropathrin [65083]	Fluoxastrobin [67645]	Thiobencarb [65107]
RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	08/31/2017	08:20	Ambient	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/31/2017	09:54	Ambient	—	3.1	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/30/2017	10:21	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/30/2017	12:41	Ambient	—	—	—	—	—	—
RY1	CACHE SLOUGH A RYER ISLAND	08/30/2017	13:47	Ambient	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	09/13/2017	08:34	Ambient	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	09/13/2017	10:13	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	09/13/2017	13:15	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	09/13/2017	12:10	Ambient	—	—	—	—	—	—
RY1	CACHE SLOUGH A RYER ISLAND	09/13/2017	13:15	Ambient	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	09/20/2017	12:00	Ambient	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	09/20/2017	12:50	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	09/20/2017	14:30	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	09/20/2017	13:12	Ambient	—	—	—	—	—	—
RY1	CACHE SLOUGH A RYER ISLAND	09/20/2017	12:40	Ambient	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	10/04/2017	13:10	Ambient	—	2.6	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	10/04/2017	13:50	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	10/04/2017	15:20	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	10/04/2017	13:25	Ambient	—	—	—	—	—	—
RY1	CACHE SLOUGH A RYER ISLAND	10/04/2017	13:00	Ambient	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	10/18/2017	12:45	Ambient	—	2.6	—	—	—	—
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DWR Site Code	USGS station name	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Azoxystrobin [66589]	Bifenthrin [65067]	Clomazone [67562]	Fenpropathrin [65083]	Fluoxastrobin [67645]	Thiobencarb [65107]
RD22	TULE CANAL A RD 22 NR WOODLAND CA	10/18/2017	13:20	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	10/18/2017	14:55	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	10/18/2017	11:00	Ambient	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	10/18/2017	10:30	Ambient	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	11/01/2017	10:10	Ambient	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	11/01/2017	10:45	Ambient	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	11/01/2017	12:40	Ambient	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	11/01/2017	10:40	Ambient	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	11/01/2017	10:10	Ambient	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	07/10/2018	09:45	Pre-Pulse	(2.8)	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	07/10/2018	11:02	Pre-Pulse	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	07/11/2018	11:11	Pre-Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	07/11/2018	12:09	Pre-Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	07/11/2018	13:12	Pre-Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	07/26/2018	09:13	Pre-Pulse	—	—	—	4.8	48.2	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	07/26/2018	11:09	Pre-Pulse	—	—	—	21.7	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	07/26/2018	13:11	Pre-Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	07/26/2018	12:45	Pre-Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	07/26/2018	11:30	Pre-Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	08/07/2018	09:15	Pre-Pulse	22.5	—	—	—	42.2	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/07/2018	10:50	Pre-Pulse	6.1	—	—	—	142.4	—

DWR Site Code	USGS station name	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Azoxystrobin [66589]	Bifenthrin [65067]	Clomazone [67562]	Fenpropathrin [65083]	Fluoxastrobin [67645]	Thiobencarb [65107]
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/08/2018	12:11	Pre-Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/08/2018	13:08	Pre-Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	08/08/2018	11:43	Pre-Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	08/21/2018	09:43	Pre-Pulse	12.6	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/21/2018	12:19	Pre-Pulse	7.8	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/21/2018	09:08	Pre-Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/22/2018	12:50	Pre-Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	08/22/2018	11:20	Pre-Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	08/30/2018	10:01	Pulse	6.8	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	08/30/2018	11:35	Pulse	11.0	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	08/30/2018	14:05	Pulse	4.9	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	08/30/2018	12:28	Pulse	9.2	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	08/30/2018	10:55	Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	09/04/2018	13:10	Pulse	5.8	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	09/04/2018	14:54	Pulse	6.5	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	09/04/2018	09:26	Pulse	—	—	—	—	—	—
BL5	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	09/05/2018	12:20	Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	09/05/2018	13:15	Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	09/18/2018	09:25	Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	09/18/2018	10:51	Pulse	15.3	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	09/19/2018	10:00	Pulse	5.5	—	—	—	—	—

DWR Site Code	USGS station name	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Hydrologic Conditions	Azoxystrobin [66589]	Bifenthrin [65067]	Clomazone [67562]	Fenpropathrin [65083]	Fluoxastrobin [67645]	Thiobencarb [65107]
BLS	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	09/19/2018	12:49	Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	09/19/2018	10:19	Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	10/09/2018	09:34	Post-Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	10/09/2018	11:30	Post-Pulse	—	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	10/10/2018	08:45	Post-Pulse	—	—	—	—	—	—
BLS	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	10/10/2018	12:28	Post-Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	10/10/2018	13:38	Post-Pulse	—	—	—	—	—	—

RCS	KNIGHTS LANDING RIDGE CUT A KNIGHTS LANDING CA	10/25/2018	08:07	Post-Pulse	—	—	—	—	—	—
RD22	TULE CANAL A RD 22 NR WOODLAND CA	10/25/2018	09:43	Post-Pulse	13.3	—	—	—	—	—
LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	10/25/2018	13:28	Post-Pulse	—	—	—	—	—	—
BLS	PROSPECT SLOUGH A PROSPECT ISLAND NR RYDE CA	10/25/2018	11:21	Post-Pulse	—	—	—	—	—	—
RYI	CACHE SLOUGH A RYER ISLAND	10/25/2018	12:28	Post-Pulse	—	—	—	—	—	—

LIS	TOE DRAIN NR BABEL SLOUGH NR FREEPORT CA	11/08/2018	12:27	Post-Pulse	—	—	—	—	—	—
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Task 7 Table 7. Detection frequencies and maximum concentrations of dissolved pesticides and pesticide degradates detected in water samples collected from the Yolo Bypass and Cache Slough Complex in 2016, 2017, and 2018.

Pesticide or Pesticide Degradate	Pesticide Type	2016 Detection Frequency (percent)	2016 Maximum Concentration (ng/L)	2017 Detection Frequency (percent)	2017 Maximum Concentration (ng/L)	2018 Detection Frequency (percent)	2018 Maximum Concentration (ng/L)	Overall Detection Frequency (percent)
Acetamiprid	Insecticide	6	(2.6)	ND	ND	7	11.6	4
Atrazine	Herbicide	ND	ND	2	6.3	ND	ND	1
Azoxystrobin	Fungicide	100	1,020	100	2,510	100	8,870	100
Boscalid	Fungicide	94	44.9	90	50.5	98	44.7	94
Carbaryl	Insecticide	22	110	ND	ND	ND	ND	4
Carbendazim	Fungicide	6	5.3	63	2,040	76	718	59
Chlorantraniliprole	Insecticide	83	17.7	82	232	93	229	87
Chlorothalonil	Fungicide	ND	ND	ND	ND	13	8.0	5
Chlorpyrifos	Insecticide	11	8.2	ND	ND	ND	ND	2
Clomazone	Herbicide	100	581	65	504	63	239	70
Clothianidin	Insecticide	ND	ND	ND	ND	7	20.9	3
Cyprodinil	Fungicide	ND	ND	10	(7.0)	4	(2.5)	6
DCPMU	Herbicide Degradate	83	5.8	31	15.4	26	9.6	37
DOPU	Herbicide Degradate	78	14.5	27	34.0	20	12.6	32
Desulfinylfipronil	Insecticide Degradate	28	12.0	22	15.2	17	9.2	21
Desulfinylfipronil Amide	Insecticide Degradate	ND	ND	2	12.4	ND	ND	1
Diazinon	Insecticide	ND	ND	8	13.2	ND	ND	4
3,4-Dichloroaniline	Herbicide Degradate	100	1,280	100	3,610	100	1,190	100
Dichlorvos	Insecticide	NA	NA	6	39.1	2	8.9	4
Dithiopyr	Herbicide	ND	ND	8	5.6	ND	ND	4
Diuron	Herbicide	58	13.0	37	21.6	57	13.3	48
Fipronil	Insecticide	39	11.7	20	20.4	26	15.3	26
Fipronil Sulfide	Insecticide Degradate	17	9.0	12	7.4	9	3.2	12
Fipronil Sulfone	Insecticide Degradate	17	15.6	6	10.1	4	6.4	7
Fluopyram	Fungicide	44	32.3	41	31.2	72	20.7	54
Flupyradifurone	Insecticide	NA	NA	10	8.9	22	11.3	16
Fluridone	Herbicide	11	4.8	71	205	63	267	58
Flutolanil	Fungicide	17	14.6	ND	ND	ND	ND	3
Fluxapyroxad	Fungicide	94	36.6	57	32.2	83	18.9	73
Hexazinone	Herbicide	100	46.4	100	39.2	98	141	99
Imidacloprid	Insecticide	22	9.7	24	33.5	9	13.9	18
Imidacloprid Urea	Insecticide Degradate	NA	NA	6	9.9	ND	ND	3

Pesticide or Pesticide Degradate	Pesticide Type	2016 Detection Frequency (percent)	2016 Maximum Concentration (ng/L)	2017 Detection Frequency (percent)	2017 Maximum Concentration (ng/L)	2018 Detection Frequency (percent)	2018 Maximum Concentration (ng/L)	Overall Detection Frequency (percent)
Indaziflam	Herbicide	NA	NA	NA	NA	2	23.7	2
Methoxyfenozide	Insecticide	94	81.6	96	1,500	100	373	97
Metolachlor	Herbicide	94	81.1	98	370	78	57.7	89
Oxadiazon	Herbicide	11	8.7	ND	ND	2	3.3	3
Penoxsulam	Herbicide	94	103	59	259	53	101	58
Penthiopyrad	Fungicide	NA	NA	ND	ND	2	10.2	1
Piperonyl butoxide	Synergist	56	72.8	39	86.3	41	193	42
Propanil	Herbicide	56	675	12	734	15	79.8	20
Propargite	Insecticide	17	12.0	ND	ND	ND	ND	3
Propiconazole	Fungicide	ND	ND	14	38.7	50	146	27
Pyrimethanil	Fungicide	ND	ND	33	9.2	7	(3.7)	17
Quinoxifen	Fungicide	17	6.8	ND	ND	ND	ND	3
Simazine	Herbicide	6	18.0	14	16.5	ND	ND	7
Tebuconazole	Fungicide	ND	ND	2	626	ND	ND	1
Thiabendazole	Fungicide	6	8.2	16	12.8	13	8.3	13
Thiamethoxam	Insecticide	ND	ND	4	6.0	9	4.2	5
Thiobencarb	Herbicide	67	191	27	254	20	69.4	30
Trifloxystrobin	Fungicide	17	14.0	2	17.1	ND	ND	4

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/19/2021 4:43:51 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Spranza, John [john.spranza@hdrinc.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: NGO Outreach meetings

I've put together a draft table that identifies the NGO EIR/EIS outreach meetings and attendees and provides a list of comments/concerns from my notes. I still have some work to do but I'm hoping that you all can augment and provide edits from your notes. The table is located here on SharePoint:

 <https://sitesreservoirproject.sharepoint.com/:w:/r/EnvPlanning/Meetings/NGO%20meetings/NGO%20Outreach%20Meeting%20Notes.docx?d=we66053978cfb41aeb81e409c1d22b5e2&csf=1&web=1&e=wsNZet>

Please note that this is a table and not formal meeting notes. If we need formal notes, I can get this info put into the meeting notes template.

We also need to develop a list of the NGOs that we have met with for the consultation section of the RDEIR/SDEIS. The following is a preliminary list of attendees from our recent meetings. Please let me know if I missed anyone and/or add affiliation where needed.

- 1) Tom Stokely, Save California Salmon
- 2) John McManus, Golden Gate Salmon Association
- 3) Hank Seemann, Humboldt County
- 4) James Broback, AquAlliance
- 5) Doug Obegi, NRDC
- 6) Rachel Zwillinger, Defenders of Wildlife
- 7) Greg Reis, The Bay Institute
- 8) Ellen Wehr, Grassland Water District
- 9) Joe Polos
- 10) Anthony Saracino, Environmental Defense Fund
- 11) Craig Tucker
- 12) Rebecca Wu
- 13) Regina Chichizola, Save California Salmon
- 14) Frankie Myers, Yurok Tribe
- 15) Ron Stork, Friends of the River
- 16) Chris Shutes, CA Sport Fishing
- 17) David Zelinsky, Motherload Chapter Sierra Club
- 18) D Lucero, Butte County

Let me know if you have any questions.

Thanks,

Laurie

Laurie Warner Herson
Principal/Owner


Environmental Planning

916.201.3935

laurie.warner.herson@phenixenv.com

State of California Small Business (#1796182)

Supplier Clearinghouse Women Business Enterprise (#16000323)

<http://phenixenv.com/>

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/20/2021 7:49:58 AM
To: Marcia Kivett [MKivett@sitesproject.org]
Subject: FW: GPPT sentence on phases
Attachments: Workshop 2 Governance v3.pdf

These are final.

From: Charles Gardiner <Charles@catalystgroupca.com>
Date: Monday, April 19, 2021 at 10:27 PM
To: Jerry Brown <jbrown@sitesproject.org>, Gary Darling <gary@darlingh2o.com>
Cc: JP Robinette <jrobinette@brwnald.com>
Subject: RE: GPPT sentence on phases

Attached is a pdf of the final draft slides for the governance discussion. I think we are consistent with the phase language. Let me know if you see anything to revise before Friday.

Charles

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Monday, April 19, 2021 8:54 PM
To: Charles Gardiner <Charles@catalystgroupca.com>; Gary Darling gary@darlingh2o.com
Subject: FW: GPPT sentence on phases

JP reminded me that the current program has defined "phases" of work. I don't think we need to change anything that we're doing with the governance discussion for Friday but I wanted to remind you both about these as I had forgotten they existed.

From: JP Robinette <JRobinette@BrwnCald.com>
Date: Monday, April 19, 2021 at 4:23 PM
To: Jerry Brown <jbrown@sitesproject.org>
Subject: GPPT sentence on phases

The Project is being developed in phases including (1, *complete*) formation and state funding award, (2, *in progress*) certification of environmental impact report and statement and acquisition of key permits, (3) final design and right-of-way acquisition, (4) construction and commissioning, and (5) project close-out and operations.

JP Robinette, PE*
Brown and Caldwell
JRobinette@brwnald.com
T 916.853.5312 | C 801.819.4306
*Professional Registration in Specific States

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/20/2021 10:45:34 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: FW: American River question

See below, I didn't realize you two were not on the email.

John Spranza

D 916.679.8858 M 818.640.2487

From: Briard, Monique <Monique.Briard@icf.com>
Sent: Friday, April 16, 2021 10:08 AM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: Lecky, Jim <jim.lecky@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Hendrick, Mike <mike.hendrick@icf.com>; Unger, Sophie <Sophie.Unger@icf.com>
Subject: RE: American River question

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.

Hi John, I just uploaded some additional analysis that both Sophie and Rick have completed on the American for our discussion next week. Thanks, Monique

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, April 15, 2021 11:01 AM
To: Briard, Monique <Monique.Briard@icf.com>
Cc: Lecky, Jim <Jim.Lecky@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Hendrick, Mike <Mike.Hendrick@icf.com>; Unger, Sophie <Sophie.Unger@icf.com>
Subject: RE: American River question

Thanks Monique.

I discussed this with Erin and Ali at our weekly coordination call this morning and Erin seems to think the Feather issue can be addressed through reoperations of Sites. Ali wanted to set up a meeting early next week to discuss and I'll be sending an email here soon.

As a heads up, we are going to need a few more meetings over the next month, here's what we are looking at.

- Call to set agenda for NGO fish meeting
- Cass to discuss how we are going to operate to or manage
 - Pulse Flow operations, how to operate to it, how we are proposing to ramp up/down
 - Critically dry year identification and change in operations to avoid effects
 - Fremont Weir notch effect monitoring (how is sites going to justify effects of our weir operation criteria in the real world)
 - Fishery monitoring program creation
- Discuss agenda for net Aquatics Workgroup

It's a lot, I know, but they are on the list of hop topics.

Thanks.

John

John Spranza

D 916.679.8858 M 818.640.2487

From: Briard, Monique <Monique.Briard@icf.com>

Sent: Thursday, April 15, 2021 10:01 AM

To: Spranza, John <John.Spranza@hdrinc.com>

Cc: Lecky, Jim <jim.lecky@icf.com>; Wilder, Rick <Rick.Wilder@icf.com>; Williams, Nicole <Nicole.Williams@icf.com>; Hendrick, Mike <mike.hendrick@icf.com>; Unger, Sophie <Sophie.Unger@icf.com>

Subject: American River question

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John,

I've uploaded the 2 tables to the SP folder below that we discussed yesterday along with a pdf of our internal email chain. Nicole and I committed to providing a response to Laurie and Ali that I'm assuming you will now be closing the loop on for us.

Rick is working on addressing the questions that Jim posed in the email and we can have a response for you by the end of the week that I can upload to the same folder.



<https://sitesreservoirproject.sharepoint.com/envpermitting/Working%20Documents/Forms/AllItems.aspx?newTargetListUrl=%2Fenvpermitting%2FWorking%20Documents&viewpath=%2Fenvpermitting%2FWorking%20Documents%2FForms%2FAllItems%2Easpx&viewid=4797e7a5%2D545e%2D4646%2Daeff%2Dec8ada9df12a&id=%2Fenvpermitting%2FWorking%20Documents%2FAmerican%20River>

Thanks,
Monique

From: Fisher, Linda [Linda.Fisher@hdrinc.com]
Sent: 4/20/2021 3:30:32 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Spranza, John [john.spranza@hdrinc.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: RE: Next Sites Ad Hoc Env. Planning and Permitting Work Group Prep Meeting

Hi Ali,

I wanted to follow back up with you on this and see if I can move forward with scheduling the next Ad Hoc EPP Work Group prep meeting on April 29th from 1-2pm. In talking with Laurie this morning we think Nicole should be included in the prep meeting since she will likely be presenting part of the EIR/EIS Part 2 Briefing. John – if you have an idea of who should be included from the ICF permitting team please let me know.

Thank you, Linda

Linda Fisher, M.S.
D 916.817.4962 M 530.400.3212

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From: Fisher, Linda
Sent: Friday, April 16, 2021 3:12 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson (laurie.warner.herson@phenixenv.com) <laurie.warner.herson@phenixenv.com>
Subject: Next Sites Ad Hoc Env. Planning and Permitting Work Group Prep Meeting

Hi Ali,

I am looking at scheduling the prep mtg for our May 17th Ad Hoc Work Group Meeting on Thursday, April 29th from 1-2pm so we can get it on the calendar. Based on the topics we said we would talk about (EIR/EIS Part 2, BA/ITP, water right, mitigation cost estimate) I was thinking of listing most of the ICF team as optional for the meeting with the exception of Monique and then including a note in the invitation letting everyone know that Integration Leads will be in touch regarding who should attend. Do you think that is appropriate? I could invite all and we could sort it out that day, just didn't want to have folks call in that don't need to.

Thanks, Linda

Linda Fisher, M.S.
Environmental Project Manager

HDR
2365 Iron Point Road, Suite 300
Folsom, California 95630
D 916.817.4962 M 530.400.3212
linda.fisher@hdrinc.com

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From: Darin Reintjes [dreintjes@pcwa.net]
Sent: 4/20/2021 5:05:43 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Brett Ewart [bewart@cityofsacramento.org]; Leaf, Rob/SAC [Rob.Leaf@jacobs.com]; steve.micko@jacobs.com; Marks, Jason [JTMarks@roseville.ca.us]; Benjamin Barker [bbarker@pcwa.net]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Thayer, Reed/SAC [Reed.Thayer@jacobs.com]; Underwood, Dave [underwoodd@SacCounty.NET]; Joseph, Trevor [TJoseph@roseville.ca.us]; Sakamoto, Matt [MSakamoto@roseville.ca.us]; Spranza, John [john.spranza@hdrinc.com]
Subject: RE: Sites Project - American River Final Modeling Results

Hi Ali,

I'm a little late as well. At our meeting a couple of weeks ago I promised to look into the preferred months to assess storage and temperature conditions modeled on the American. The intent was to see the full picture and not just a single month. I think that it would be beneficial to see all months to get the full story, but for reporting we typically look at end of May, September, and December for storage comparisons.

I reached out to Chris Hammersmark, who is a consultant for the Sacramento Water Forum, for recommendations on the analysis of temperature conditions in the Lower American River. Here's what he provided:

Temperature is typically a concern July-November. Sometimes as early as June (this year May). In particular, August or September, as those months tend to be when we see a temperature bottleneck (low flows because ag demand drops off, but still high air temps), and then also November, as that's when the Chinook spawning activity peaks.

As we discussed in the meeting, understanding acceptable temperatures in the summer months is going to be important. The increased temperatures results that we saw in July, although they may appear to be an impact, may be acceptable and there could be tradeoffs that provide a greater benefit (such as improved temperatures in August or November). I think it'll be important to have a fisheries biologist who is familiar with Folsom operations and the species in the American weigh in on this to craft the appropriate message if we determine that there is no net impact.

Regards,

Darin Reintjes, PE | PCWA
Director of Resource Management
(530) 823-4891 (o)
(530) 906-8162 (c)
dreintjes@pcwa.net

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, April 20, 2021 4:59 PM
To: Brett Ewart <bewart@cityofsacramento.org>; Leaf, Rob/SAC <Rob.Leaf@jacobs.com>; steve.micko@jacobs.com; Marks, Jason <JTMarks@roseville.ca.us>; Benjamin Barker <bbarker@pcwa.net>; Heydinger, Erin <erin.heydinger@hdrinc.com>; Thayer, Reed/SAC <Reed.Thayer@jacobs.com>; Underwood, Dave <underwoodd@SacCounty.NET>; Joseph, Trevor <TJoseph@roseville.ca.us>; Sakamoto, Matt <MSakamoto@roseville.ca.us>; Darin Reintjes <dreintjes@pcwa.net>; Spranza, John <john.spranza@hdrinc.com>
Subject: RE: Sites Project - American River Final Modeling Results

Hi all – I am a little tardy in getting out this email out. We would like to schedule a follow up meeting to close the loop on the changes we were seeing in the American River in Alternative 3. Below is a doodle poll to schedule this call.

https://www.doodle.com/poll/wn8n68b8w4hazhrz?utm_source=poll&utm_medium=link

We are confirming with Reclamation and others, but I think we have a good outcome here that we'll walk through on our call.

John, please forward to anyone from the fisheries team that you think should attend.

Ali

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

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-----Original Appointment-----

From: Alicia Forsythe

Sent: Thursday, March 18, 2021 3:31 PM

To: Alicia Forsythe; Brett Ewart; Leaf, Rob/SAC; steve.micko@jacobs.com; Marks, Jason; Benjamin Barker (bbarker@pcwa.net); Heydinger, Erin; Thayer, Reed/SAC; Underwood, Dave; Joseph, Trevor; Sakamoto, Matt

Cc: Darin Reintjes; Andy Fecko

Subject: Sites Project - American River Final Modeling Results

When: Thursday, April 8, 2021 1:00 PM-2:30 PM (UTC-08:00) Pacific Time (US & Canada).

Where: Microsoft Teams Meeting

Closing the loop on final Sites Project model results. Agenda to follow.

Please forward to anyone that should be included.

Microsoft Teams meeting

Join on your computer or mobile app

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Or call in (audio only)

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From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/20/2021 6:08:18 PM
To: Kevin Spesert [kspesert@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Local Agency Outreach - Follow up with ICF

Hi Kevin and Ali,

I had a brief discussion with Nicole at ICF yesterday regarding the meetings with the fire and school districts. We talked about the concerns expressed by each district and updates to the project description will be needed to outline the non-CEQA issues and the Authority's commitment to work with local agencies to address the need for funding for additional facilities and staffing (fire district).

We also talked about traffic-related impacts. According to Nicole, the draft transportation/traffic chapter addresses level of service and vehicle miles traveled and concludes that there is no significant impact. **There is currently no discussion of traffic-related safety issues.** This is an impact that needs to be addressed somewhere in the EIR/EIS so we will need to think of the appropriate approach and, perhaps, think outside of the standard CEQA checklist questions. (By the way, Caltrans has recent guidance for addressing traffic safety impacts under CEQA

(<https://www.jdsupra.com/legalnews/caltrans-releases-new-interim-guidance-68447/> and <https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-07-01-interim-ldigr-safety-guidance-a11y.pdf>). It is geared more towards land use projects and effects to state highways but does provide some useful guidance.)

We would like to reach out to Mike Azevedo to discuss traffic safety and whether the County has already identified transportation projects in the Maxwell area. We would also like to reach out to Summer regarding the potential for impacts to school bus travel time, specifically whether the school district has any specific policy related to bus travel time that could be referenced in the document.

Let me know if I should reach out directly to Mike and/or Summer.

Thanks,

Laurie

Laurie Warner Herson
Principal/Owner



Environmental Planning

916.201.3935
laurie.warner.herson@phenixenv.com
State of California Small Business (#1796182)
Supplier Clearinghouse Women Business Enterprise (#16000323)

<http://phenixenv.com/>

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/21/2021 9:04:28 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Local Agency Outreach - Follow up with ICF

Thanks Ali - I have to get my lenses replaced on my glasses this morning but can call you at 12:30.

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, April 21, 2021 7:16 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Kevin Spesert <kspesert@sitesproject.org>
Subject: RE: Local Agency Outreach - Follow up with ICF

Hi Laurie – I am comfortable with you contacting Mike on traffic safety projects. I'd like to chat prior to you talking with Summer. I'd like to get a sense of what you're thinking. Adding more significance criteria into the document makes me a little nervous as it can be a slippery slope.

I am available to chat from 11:30 AM to 1 PM today if there's a time that works for you.

Ali

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

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From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Tuesday, April 20, 2021 6:08 PM
To: Kevin Spesert <kspesert@sitesproject.org>; Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Local Agency Outreach - Follow up with ICF

Hi Kevin and Ali,

I had a brief discussion with Nicole at ICF yesterday regarding the meetings with the fire and school districts. We talked about the concerns expressed by each district and updates to the project description will be needed to outline the non-CEQA issues and the Authority's commitment to work with local agencies to address the need for funding for additional facilities and staffing (fire district).

We also talked about traffic-related impacts. According to Nicole, the draft transportation/traffic chapter addresses level of service and vehicle miles traveled and concludes that there is no significant impact. **There is currently no discussion of traffic-related safety issues.** This is an impact that needs to be addressed somewhere in the EIR/EIS so we will need to think of the appropriate approach and, perhaps, think outside of the standard CEQA checklist questions. (By the way, Caltrans has recent guidance for addressing traffic safety impacts under CEQA (<https://www.jdsupra.com/legalnews/caltrans-releases-new-interim-guidance-68447/> and <https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-07-01-interim-lidgr-safety-guidance-a11y.pdf>). It is geared more towards land use projects and effects to state highways but does provide some useful guidance.)

We would like to reach out to Mike Azevedo to discuss traffic safety and whether the County has already identified transportation projects in the Maxwell area. We would also like to reach out to Summer regarding the potential for impacts to school bus travel time, specifically whether the school district has any specific policy related to bus travel time that could be referenced in the document.

Let me know if I should reach out directly to Mike and/or Summer.

Thanks,

Laurie

Laurie Warner Herson
Principal/Owner



Environmental Planning

916.201.3935

laurie.warner.herson@phenixenv.com

State of California Small Business (#1796182)

Supplier Clearinghouse Women Business Enterprise (#16000323)

<http://phenixenv.com/>

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/21/2021 10:21:51 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Williams, Nicole (Nicole.Williams@icf.com) [Nicole.Williams@icf.com]; Huber, Anne [Anne.Huber@icf.com]; steve.micko@jacobs.com
Subject: FW: Sites Project Water Quality Group Discussion-Materials
Attachments: 20210407_Water Quality Discussion_Presentation_Final.pptx; Alternatives Description.png

Another email to discuss.

John Spranza

D 916.679.8858 M 818.640.2487

-----Original Message-----

From: jimb@aqualliance.net <jimb@aqualliance.net>
Sent: Tuesday, April 13, 2021 10:48 AM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: chicojerry@yahoo.com; Ron Stork <RStork@friendsoftheriver.org>; Deirdre Des Jardins <ddj@cah2oresearch.com>
Subject: Re: Sites Project Water Quality Group Discussion-Materials

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.

John,
I am reviewing the attachments and the "future topics" suggestions.

Sites Project Water Quality Group Discussion slides:

Slide 6; The map shows maximum inundation. In order to predict post-inundation erosion potential we need a map showing minimum

(pre-refilling) inundation and acreage of exposed soils, locations of salt springs and salt lake and Erodibility Index for these areas. While we are most concerned about denuded soil water erosion the potential for wind erosion [the process of detachment and transport of soil by wind] that may pose dust air pollution is also worthy of analysis.

Slide 14; The Main Data Sources data for metals does not specify the timing of the data collection which must focus on high runoff events, especially for the Cottonwood Creek Drainage.

Slide 15; The chart does not specify data collection timing which must focus on high runoff events. The "Sacramento Intake" data does not specify data collection timing and combines the data for the Red Bluff intake and the Hamilton City intake. You mentioned that the majority of source water will be pulled from the Red Bluff intake which will not be diluted with cleaner Cascade streams that enter the river below Red Bluff.

Topics for future discussion:

"Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of reservoir." To be clear; The increased erosion on the denuded banks of the dewatered reservoir associated with both precipitation and surface wave action on the naked banks must be considered.

"Discuss Sites effect on the anti-degradation policy." To be clear; Will the anti-degradation policy of California prevent Sites water from being put back in the Sacramento River and will the tainted Sites water be used in Colusa/Yolo agriculture/refuge to replace DWR and USBR "operational exchange" reservoir releases? I notice that Alt 1&3 seems to limit Sites releases exclusively "into new Dunnigan Pipeline to Colusa Basin Drain."

What soil, wildlife and crop impacts can be expected from repeated application of Sites water on Colusa Drain acreage under Alternative 1?

Looking forward to our next discussion,
Jim Brobeck, Water Policy Analyst, AquAlliance

On 2021-04-09 15:55, Spranza, John wrote:

> Hello,

>

> Thank you for attending our Water Quality Discussion on Wednesday. I
> wanted to follow up and provide the presentation and the supplemental
> figures for Metals, Nutrients, and Pesticides that we discussed, they
> are attached.

>

> I will follow up on the Action Items below in a separate email, please
> let me know if you have any additions.

>

> * Discussion of the Preferred Alternative selection

> * Provide a table with data details such as location, timing and

> number of data points
> * Schedule 90 minute meeting in May
>
> Lastly, the following are future agenda topics that were identified
> during our meeting:
>
> * Water quality effects to Stone Corral and Funks Creeks from
> the annual/semiannual filling and emptying of the reservoir.
> * Effects of arsenic on rice as it relates to Sites' releases.
> * Discuss Sites effect on the anti-degradation policy.
> * Mercury releases and effects on rice and water
> * Exchanges between Sites and DWR
>
> Please let me know if you have any questions.
>
> Regards,
>
> John
>
> John Spranza, MS, CCN
>
> _Senior Ecologist / Regulatory Specialist_
>
> HDR
>
> 2379 Gateway Oaks Drive, Suite 200
> Sacramento, CA 95833
> D 916.679.8858 M 818.640.2487
> john.spranza@hdrinc.com
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> Links:
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> https://nam12.safelinks.protection.outlook.com/?url=http%3A%2F%2Fhdrinc.com%2Ffollow-us&data=04%7C01%7Cjohn.spranza%40hdrinc.com%7C3b7c1dad8b4e470a08e708d8fea441a2%7C3667e201cbdc48b39b425d2d3f16e2a9%7C0%7C0%7C637539329060231791%7CUnknown%7CTWFpbGZsb3d8eyJWIjojMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6IklhYWwiLCJXVCi6Mn0%3D%7C1000&sdata=9EcXoM8jXJ1iyhoyG1eHojdQidbP1zo954VoHdvigT0%3D&reserved=0

Alternatives Summary

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 use of 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

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/21/2021 11:17:23 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Sites Project Water Quality Group Discussion-Materials

Here you go.

John Spranza

D 916.679.8858 M 818.640.2487

From: Spranza, John
Sent: Friday, April 16, 2021 8:38 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

How about this?

Hi Greg,

I spoke with the water quality team and the general consensus is yes, the high values in February, May, August, and November are due to the water quality sampling pattern, especially for Colusa Basin Drain (CBD). Similar to the ongoing North Delta Flow Action that redirects a late-summer pulse of agricultural drainage or Sacramento River flow into the Yolo Bypass to enhance the quantity and quality of food for Delta Smelt, Sites' WSIP Ecosystem Benefit water would also be sent to the Yolo Bypass via the CBD for similar purposes at approximately the same time.

With respect to Sites' water being used to irrigate contaminated soils, while Sites participants may use the water for agriculture in the Sacramento Basin, the runoff from irrigated fields is regulated by the Irrigated Lands Regulatory Program, which sets limits for runoff that would need to be met by irrigators. You can find some additional information on the Program here: <https://www.svwqc.org/>. It's also worth noting that Sites' winter releases via the CBD would generally have the effect of diluting constituent concentrations in CBD, such as Diazinon, which is mostly a winter problem.

I hope this answers your questions, but if not please let me know and we can discuss further.

Thanks.

John Spranza

D 916.679.8858 M 818.640.2487

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, April 14, 2021 1:03 PM
To: Huber, Anne <Anne.Huber@icf.com>; Spranza, John <John.Spranza@hdrinc.com>
Cc: Williams, Nicole <Nicole.Williams@icf.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

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.

John – I think we can massage Anne’s response to get it to Greg. Maybe we ask him if there is a particular area he is concerned about with regard to irrigating contaminated soils?

Let me know if you’d like me to take a look at a response before you send it.

Ali

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

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From: Huber, Anne <Anne.Huber@icf.com>
Sent: Wednesday, April 14, 2021 8:40 AM
To: Spranza, John <john.spranza@hdrinc.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>; Williams, Nicole <Nicole.Williams@icf.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

Hi John,

I would say yes, the high values in February, May, August, and November are due to the sampling pattern, especially for CBD. It is correct that the habitat flows will put some of the CBD water on the Yolo Bypass, but Sites water will generally have the effect of diluting constituent concentrations in CBD. Diazinon is mostly a winter problem and Sites would not be increasing CBD flow to the Yolo Bypass during the winter.

I’m not sure about Greg’s concern regarding irrigating contaminated soils. Sites may increase water for agriculture, but I doubt it would mean irrigation would newly extend into contaminated lands. Maybe he is concerned about increased runoff from existing fields, but more water for agriculture doesn’t necessarily mean increased contaminant load in runoff and runoff is regulated by the Irrigated Lands Regulatory Program.

I hope this helps,
-Anne

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Wednesday, April 14, 2021 8:01 AM
To: Huber, Anne <Anne.Huber@icf.com>
Cc: [aforsythe \(aforsythe@sitesproject.org\)](mailto:aforsythe@sitesproject.org) <aforsythe@sitesproject.org>
Subject: FW: Sites Project Water Quality Group Discussion-Materials

Hi Anne,
Any thoughts on Greg’s questions?

John Spranza

D 916.679.8858 M 818.640.2487

From: Greg Reis <reis@bayecotarium.org>
Sent: Monday, April 12, 2021 11:09 AM

To: Spranza, John <John.Spranza@hdrinc.com>

Subject: RE: Sites Project Water Quality Group Discussion-Materials

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.

Thanks John, I'm sorry I missed the meeting. A quick question—is the Feb, May, Aug, Nov pattern of high concentrations evident for many constituents an effect of a quarterly sampling protocol? Or is this due to the timing of draining fields? These attachments show there are clear water quality problems due to agricultural drainage, and I'd hope that Sites operations wouldn't contribute to these (esp. by sending water to irrigate contaminated soils, or directing high-Diazinon water to Yolo Bypass without adequate dilution—examples where Sites operations could have a big negative effect).

I hope I'm able to make the next meeting.

Thanks,

Greg

Greg Reis

Staff Hydrologist, The Bay Institute

Email: reis@bay.org Mobile: 415-342-6390



The Bay Institute | Aquarium of the Bay | EcoCenter at Heron's Head Park
Sea Lion Center | The Bay Academy | Bay Model Alliance

*Our mission is to protect, restore, and inspire conservation of San Francisco Bay
and its watershed, from the Sierra to the Sea™*

From: Spranza, John [<mailto:John.Spranza@hdrinc.com>]

Sent: Friday, April 9, 2021 2:56 PM

To: tstokely@att.net; jimb@aqualliance.net; dobegi@nrdc.org; Greg Reis <reis@bayecotarium.org>; rzwillinger@defenders.org; DLucero@ButteCounty.net; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com; regina@californiasalmon.org; Huber, Anne <Anne.Huber@icf.com>; Williams, Nicole (Nicole.Williams@icf.com) <Nicole.Williams@icf.com>; Micko, Steve/SAC (Steve.Micko@jacobs.com) <Steve.Micko@jacobs.com>; David Zelinsky <zelinsky.david@gmail.com>; asanchez@calwild.org; Ron Stork <RStork@friendsoftheriver.org>

Cc: [aforsythe \(aforsythe@sitesproject.org\)](mailto:aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Davis, Ryan A <rdavis@usbr.gov>; Dekar, Melissa D <mdekar@usbr.gov>; King, Vanessa M <vking@usbr.gov>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; Morgan, Joseph <Morgan.Joseph@epa.gov>; Gordon, Stephanie (Skophammer) <GORDON.STEPHANIES@EPA.GOV>; Wolder, Natalie L <nwolder@usbr.gov>; Deeds, Daniel A <ddeeds@usbr.gov>

Subject: Sites Project Water Quality Group Discussion-Materials

Hello,

Thank you for attending our Water Quality Discussion on Wednesday. I wanted to follow up and provide the presentation and the supplemental figures for Metals, Nutrients, and Pesticides that we discussed, they are attached.

I will follow up on the Action Items below in a separate email, please let me know if you have any additions.

1. Discussion of the Preferred Alternative selection
2. Provide a table with data details such as location, timing and number of data points
3. Schedule 90 minute meeting in May

Lastly, the following are future agenda topics that were identified during our meeting:

- Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of the reservoir.
- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

John

John Spranza, MS, CCN

Senior Ecologist / Regulatory Specialist

HDR

2379 Gateway Oaks Drive, Suite 200

Sacramento, CA 95833

D 916.679.8858 M 818.640.2487

john.spranza@hdrinc.com

hdrinc.com/follow-us

hdrinc.com/follow-us

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/21/2021 11:29:59 AM
To: Williams, Nicole (Nicole.Williams@icf.com) [Nicole.Williams@icf.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Huber, Anne [Anne.Huber@icf.com]; steve.micko@jacobs.com
CC: Heydinger, Erin [erin.heydinger@hdrinc.com]
Subject: Water Quality NGO Follow Up
Attachments: Water Quality Comments - Sites Town Hall_Bruce H Comments_20210201.pdf

Hi All,
Here is the email Bruce sent over after the January Town Hall.

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
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Sacramento, CA 95833
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john.spranza@hdrinc.com

hdrinc.com/follow-us
hdrinc.com/follow-us

From: [Bruce Houdesheldt](#)
To: [Jerry Brown](#)
Subject: Water Quality Comments - Sites Town Hall
Date: Tuesday, February 2, 2021 4:08:07 PM

There has not been a chlorpyrifos exceedance in Walker Creek or Freshwater Creek in over a decade. And that one was related to spray drift. Here is the State Water Resource Control Board's Water Quality Report Cards for [Walker Creek Chlorpyrifos and C. dubia toxicity](#) released in October 2018 and Chlorpyrifos and Diazinon within [Sacramento River Tributaries](#) (November 2017) that include Butte Slough and the Sacramento Slough (at the bottom of the Colusa Basin Drain).

Bruce Houdesheldt

Director Water Quality
Northern California Water Association
455 Capitol Mall, Suite 703
Sacramento, California 95814
(916) 442-8333 (office)
(916) 952-1287 (mobile)

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Tuesday, February 2, 2021 3:48 PM
To: Bruce Houdesheldt <bruceh@norcalwater.org>
Subject: Re: 10am tomorrow....SGMA Consultant Coordination - Sacramento River Basin

Thanks Bruce. And below is the chat from the town hall that I referenced describing the water quality comments received. Don't hesitate to reach out if you think of anything else.

Jerry

Approximately (with counting the phone numbers as independent individuals)

- 154 attendees in the beginning
- 137 at 11:20
- 19 participants
- 18 Agent/Consultants

from James Brobeck (Aqualliance) to everyone: 10:30 AM

EIR Needs:

- Obtain additional metals data from source waters targeting high flows from which diversions would occur
- Provide information on the water quality impacts from other chemical contaminants that adversely affect water quality in the Sacramento River (including chlorpyrifos, diazinon, chlordane, DDT, mercury, PCBs, and dieldrin) and contaminants in sewer outfalls (such as pharmaceuticals) and other discharges (such as industrial discharges)
- Evaluate the contributions of metals from local tributaries (i.e., Funks Creek and Stone Corral Creek) to the proposed reservoir
- Provide information on the contribution from leaching of metals from the inundation area of the proposed reservoir

EIR needs

- Evaluate effects of metals to beneficial uses within the proposed reservoir
 - o fisheries,
 - o wildlife (including state and federal species listed as threatened or endangered),
 - o recreation
- Evaluate effects of metals to beneficial uses due to releases from the reservoir, agricultural supply water,
 - o effects of metals on crops including incorporation of metals by crops (e.g., arsenic uptake in rice),
 - o effects of metals on plants grown for support of wildlife (such as in wildlife refuges),
 - o drinking water supplies, fisheries, wildlife (including state and federal species listed as threatened or endangered),

- Evaluate combined toxicity of multiple metals
- Evaluate contributions of metals in reservoir releases related to the SWRCB antidegradation policy
- Evaluate impacts from mercury bioaccumulation in aquatic life (especially fish) in the proposed reservoir, and effects to wildlife that feed on fish from the reservoir and recreational opportunities (i.e., sport fishing)

- Evaluate physical conditions expected in the reservoir, including thermal stratification and hypolimnetic anoxia, and effects on reservoir and downstream aquatic resources

Saline water has been observed to seep from underground salt springs in the vicinity of the Salt Lake fault along the slopes above the valley and along the valley floor within the proposed inundation area of Sites Reservoir. The water from the underground springs accumulates along the trough of the valley and forms Salt Lake" (USGS, 1915).

Extremely high concentrations of metals are present in the small streams in the reservoir footprint, which occur due to the nature of the soils in the area of the proposed reservoir. Sites Reservoir would inundate these soils resulting in leaching of metals and further incremental loading of metals to the proposed reservoir. There is no discussion in the EIR about the potential impacts of metals leaching from the soils that would be inundated by the proposed reservoir.

Please do not avoid the questions on salts and heavy metals presented by Jerry Boles and others. Investors on this webinar need to be made aware of the metal/salt loading in the source water and the inundation footprint soils.

Jerry Boles, retired Chief of the Water Quality and Biology Section of the Northern District of the Department of Water Resources in Red Bluff, submitted comments on the proposed Sites Reservoir Draft Environmental Impact Report.

Boles explains that during his tenure with DWR he collected data that showed elevated levels of aluminum, arsenic, cadmium, iron, chromium, copper, lead, manganese, mercury, nickel, selenium, and zinc in the Sacramento River with the highest levels coming from tributary flows.

from james Brobeck to everyone: 11:16 AM

The poor quality of the source water will certainly be further degraded if the water is impounded in the proposed off-stream reservoir. Boles explains, ""Extremely high concentrations of metals are present in the small streams in the reservoir footprint, which occur due to the nature of the soils in the area of the proposed reservoir. Sites Reservoir would inundate these soils resulting in leaching of metals and further incremental loading of metals to the proposed reservoir."

from Ali Forsythe to everyone: 11:22 AM

Jim Brobeck - Thank you for all this great information. We are working to address all of these considerations, really based off of Jerry Boles' comments on the 2017 EIR/EIS as part of the Revised Draft EIR/Supplemental Draft EIS. I also expect water quality to be a small group topic. Please feel free to contact me at aforsythe@sitesproject.org if you'd like to part of the upcoming water quality small group discussions.

from James Brobeck to everyone: 11:24 AM

The "right size" does not change the metal/salt comments by Boles and others. I would be happy to forward the Boles comments to interested parties including investors. jimb@aqualliance.net

from Dennis and Joe to everyone: 10:51 AM

What is the status of the discussions with the Regulatory Agencies for use of the water allocated for environmental purposes.

Will there be alternatives in the EIS/EIR that reflect a range of diversion criteria/thresholds from the Sacramento River through the two canals? Ron Stork

from Debra Lucero to everyone: 11:01 AM

Has this project taken into consideration Jerry Boles (former DWR employee) comments about high concentrations of metals - both in the river and possibly at the storage site. I sent this question in via email after reading his lengthy comments to the current EIR.

from Debra Lucero to everyone: 11:02 AM

Who will oversee the water quality of this project?

from Eric Christen to everyone: 11:49 AM

Thank you for staff's response to my union PLA question. So just to be clear, when you put in your presentations that you have as a goal "diversity" and "inclusion"

from Kim Witten to everyone: 11:49 AM

Can you put your email here so I can contact you. Thanks

from Sarah Rossetto to everyone: 11:50 AM

jbrown@sitesproject.org

to Kim Witten (privately): 11:50 AM

jbrown@sitesproject.org or call him at 925-260-7417

from Eric Christen to everyone: 11:50 AM

that you really do not.

from Eric Christen to everyone: 11:50 AM

Non-union workers and apprentices are not welcome on your projects.

from Marguerite Patil - CCWD to everyone: 11:59 AM

Thanks Sites Team! Great Town Hall.

from Anjanette Shadley to everyone: 12:00 PM

Very informative, thank you! Great job! #BuildSites

From: Bruce Houdesheldt <bruceh@norcalwater.org>

Date: Tuesday, February 2, 2021 at 3:35 PM

To: Jerry Brown <jbrown@sitesproject.org>

Subject: FW: 10am tomorrow....SGMA Consultant Coordination - Sacramento River Basin

Bruce Houdesheldt

Director Water Quality

Northern California Water Association

455 Capitol Mall, Suite 703

Sacramento, California 95814

(916) 442-8333 (office)

(916) 952-1287 (mobile)

From: Lisa Porta <lporta@elmontgomery.com>

Sent: Monday, February 1, 2021 4:32 PM

To: David Guy <dguy@norcalwater.org>; Bruce Houdesheldt <bruceh@norcalwater.org>

Subject: RE: 10am tomorrow....SGMA Consultant Coordination - Sacramento River Basin

David, Bruce,

Have you seen this new groundwater quality report from DWR-NRO?

This is not new data; they used data from wells they monitored between 2015 to 2019 and did a bit of an analysis by Subbasin.

Useful information to add to GSPs. I also asked them if they intend to continue monitoring these wells; and they said they are reviewing their monitoring plan.

Talk to you tomorrow.

Lisa

Lisa Porta, P.E.

MONTGOMERY & ASSOCIATES

(916) 701-0398 (mobile)

lporta@elmontgomery.com

www.elmontgomery.com

From: David Guy <dguy@norcalwater.org>

Sent: Monday, February 1, 2021 4:16 PM

To: 'Byron Clark (byron@davidsengineering.com)' <byron@davidsengineering.com>; 'Eddy Teasdale (eteasdale@lsce.com)' <eteasdale@lsce.com>; 'Jim Blanke (jblank@woodardcurran.com)'

<jblanke@woodardcurran.com>; 'Joe Turner (jturner@geosyntec.com)' <jturner@geosyntec.com>;
'Lee Bergfeld (bergfeld@mbkengineers.com)' <bergfeld@mbkengineers.com>; Lisa Porta
<lporta@elmontgomery.com>; 'Richard Shatz (rshatz@geiconsultants.com)'
<rshatz@geiconsultants.com>; 'Satya Gala (sgala@geiconsultants.com)'
<sgala@geiconsultants.com>; Bruce Houdesheldt <bruceh@norcalwater.org>;
'peter.lawson@jacobs.com' <peter.lawson@jacobs.com>; 'Christina Buck (CBuck@buttecounty.net)'
<CBuck@buttecounty.net>; Leslie Dumas <ldumas@woodardcurran.com>; John a. McHugh
<jmchugh@lsce.com>; 'Christina Buck' <buck.christinar@gmail.com>; Rodriguez, Larry
<lrodriguez@geiconsultants.com>; Ali Taghavi (ataghavi@woodardcurran.com)
<ataghavi@woodardcurran.com>; 'Kelly Peterson (kpeterson@buttecounty.net)'
<kpeterson@buttecounty.net>

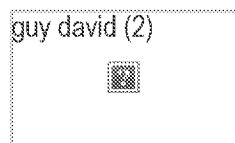
Cc: jim@cafwd.org

Subject: 10am tomorrow....SGMA Consultant Coordination - Sacramento River Basin

For the discussion tomorrow at 10:00am, we will discuss:

- **GSP** Development, Coordination
- **GDE's.** As we discussed at the last meeting, TNC is confirmed for our March 2 (10am) meeting. We will discuss how to best structure this discussion to make it productive for you all. Lee has prepared the attached outline to help frame the issues based on our past conversations. Please take a look at this document and we will discuss this in more detail tomorrow.
- **UR 6** – Approach, Monitoring (surface and groundwater)
- **Water Quality Update**
- **Other Issues**

See you tomorrow morning.....



David J. Guy
President
Northern California Water Association
(916) 442-8333

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Associate Members (NON-VOTING)

GREG JOHNSON, WESTERN CANAL WATER DISTRICT
JAMIE TRAYNHAM, TC 4 DISTRICTS

Notice: Pursuant to Executive Orders N-25-20 & N-33-20, issued by Governor Newsom on March 12, 2020, and guidance by the California Department of Public Health dated March 11, 2020, this meeting will be conducted by teleconference. The public may attend the meeting and offer public comments by phone, using the call-in number provided below. Members of the Board will participate by teleconference from other locations.

April 21, 2021 1:30 p.m.

Sites Project Authority

Agenda

Teleconference: **1-213-379-5743** Conference ID: **323 473 526 #** [Click here to join the meeting](#)

Welcome to a meeting of the Sites Joint Powers Authority. If you are scheduled to address the Board, please state your full name for the record. Regularly numbered items may be considered at any time during the meeting. All items are listed in accordance with the Ralph M. Brown Act. We invite all members of the public to attend.

ROLL CALL & CALL TO ORDER:

- Introductions.
- Pledge of Allegiance.
- Approval of April 21, 2021 Agenda.
- Announcement of Closed Session.
- Period for Public Comment.

1. Consent Agenda:

Approximate start time 1:40 pm

The Executive Director reviewed the following items. To his knowledge, there is no opposition to the action. The items can be acted on in one consolidated motion as recommended or may be removed from the Consent Calendar and separately considered at the request of any person.

1.1 Consider approval of the March 24, 2021 Joint Authority Board & Reservoir Committee Meeting Minutes. **(Attachments A & B)**

1.2 Consider approval of the Sites Project Authority Treasurer's Report. **(Attachment A)**

1.3 Consider approval of the Payment of Claims. **(Attachments A, B & C)**

2. **Action Items:** Approximate start time 1:45 pm

2.1 Consider approval of the Principles for the Storage, Delivery and Sale of Sites Reservoir Project Water (formerly referred to as the Storage Policy). **(Attachments A, B & C)**

2.2 Consider approval of the recommended methodology for allocating storage space in Sites Reservoir to each local Storage Partner using the final proposed formulaic approach of 1 acre-foot Amendment 2 participation to 6.234 acre-feet of storage space. **(Attachment A)**

3. **Discussion and Information Items:** Approximate start time 2:00 pm

3.1 Review and comment on the CEQA process, the status of the RDEIR/SDEIS introductory chapters, and the status of outreach efforts to non-governmental organizations.

3.2 Review and comment on the Financing Action Plan progress including updated financing alternatives, an outline of the Water Storage and Supply Services Contract (Contract) Guiding Principles and Preliminary Terms, and updated Road Map. **(Attachments A)**

3.3 Review and comment on the Amendment 3 working draft Organization Chart, updated objectives and timeline being used to prepare the work plan. **(Attachments A, B & C)**

4. **Reports:** Approximate start time 3:15 pm

4.1 **Member's Reports:**

4.1.1 **Chairpersons' Report:**

This time is set aside to allow the Chair/Co-Chair an opportunity to disclose/discuss items related to the Sites Project.

4.1.2 **Committee Chairpersons' Report:**

This time is set aside to allow the Committee Chairpersons' an opportunity to disclose/discuss items related to the Sites Project.

4.1.3 Authority Board Participant Reports:

This time is set aside to allow Representatives or their Alternates an opportunity to disclose/discuss items related to the Sites Project.

4.2 Executive Director's Reports:

- Monthly status report. **(Attachment A)**
- Work Plan Key Deliverables Report. **(Attachment B)**
- Meetings Action Items Summary. **(Attachment C)**

5. Closed Session:

Approximate start time 3:30 pm

5.1 Negotiations Concerning Sites Project operation terms, conditions, and agreements with the State of California, Department of Fish and Wildlife (Govt. Code §§54956.9(c) and 54956.9(d)(4))

5.2 Conference with Real Property Negotiators (Govt. Code §§54956.8)

Property: Glenn Colusa Irrigation District Canal, Tehama Colusa Canal rights of way and associated conveyance facilities.

Agency Negotiator: Jerry Brown, Kevin Spesert, JP Robinette; Negotiating parties: Glenn-Colusa Irrigation District, Tehama Colusa Canal Authority and Bureau of Reclamation.

Under Negotiation: Price and terms of payment for facilities lease/common use agreement.

5.3 Negotiations Concerning Sites Project operation terms, conditions and agreements with the State of California, Department of Water Resources and the United States Bureau of Reclamation (Govt. Code 54956.9(c) and 54956.9(d)(4)).

6. Report from Closed Session

Approximate start time 4:00 pm

7. Recap:

Approximate start time 4:05 pm

7.1 Suggested Future Agenda Items.

7.2 Upcoming Meetings:

Finance & Governance Alternatives Joint Workshop:

Friday, April 23, 2021, 9:30 AM – 12:00 PM

Reservoir Committee:

Thursday, May 20, 2021, 1:30 PM – 4:00 PM

Authority Board:

Wednesday, May 26, 2021 – 1:30 to 4:00 PM

Virtual Information will be provided prior to all meetings at [Sitesproject.org](https://sitesproject.org).

ADJOURN

PERIOD OF PUBLIC COMMENT: Any person may speak about any subject of concern, provided it is within the jurisdiction of the Reservoir Committee and is not already on today's agenda. The total amount of time allotted for receiving such public communication shall be limited to a total of 10 minutes per issue and each individual or group will be limited to no more than 3 minutes each within the 10 minutes allocated per issue. **Note:** No action shall be taken on comments made under this comment period.

ADA COMPLIANCE: Upon request, agendas will be made available in alternative formats to accommodate persons with disabilities. In addition, any person with a disability who requires a modification or accommodation to participate or attend this meeting may request necessary accommodation. Please make your request to the Board Clerk, specifying your disability, the format in which you would like to receive this Agenda and any other accommodation required no later than 24 hours prior to the start of the meeting.

This meeting will be recorded.

Authority Board Meeting

Agenda Item 3-1, CEQA Process, Status of
Introductory Chapters, Outreach to
Non-governmental Organizations

April 21, 2021



Draft - Preliminary Working Document - For Discussion Purposes Only

Agenda

- California Environmental Quality Act
 - CEQA Background
 - Authority Role as Lead Agency for CEQA
 - CEQA Process and Authority Decision
- Revised Draft EIR/Supplemental Draft EIS
 - Introductory Chapter Status
- NGO Outreach
 - Workshops
 - Small Group Meetings

California Environmental Quality Act (CEQA)



CEQA – What is it?

- CEQA is intended to provide decision makers and the public with information about a proposed project's **significant** effects on the environment and to:
 - Prevent significant, avoidable damage to the environment
 - Foster informed public decision making
 - Ensure transparency in governmental decision-making process
 - Encourage public participation
- CEQA Statutes (PRC § 21000) and Guidelines (CCR § 15000)
 - Periodically modified by Legislature
 - Interpreted by the Courts
- CEQA is a Process - Not a Permit

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Speaker: Laurie

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When Does CEQA Apply?

- California governmental agencies
- Discretionary approvals by an agency
 - Discretionary: “exercise of judgment or deliberation when the public agency or body decides to approve or disapprove a particular activity, as distinguished from situations where the public agency or body merely has to determine whether there has been conformity with applicable statutes, ordinances or regulations.”
- Applies to “projects”
 - An activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment
 - The activity approved by the public agency, not each individual permit or approval

Speaker: Laurie

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Agency Roles under CEQA

- **Lead Agency – Authority**
 - Principle responsibility for carrying out or approving a project
 - Prepares CEQA document: Notice of Exemption, Negative Declaration, Environmental Impact Report (EIR)
- **Responsible Agency – Permitting Agencies, Reservoir Committee Members**
 - Discretionary approval authority over project
 - Typically relies on the CEQA document prepared by the Lead Agency
- **Trustee Agency**
 - State Agency with jurisdiction by law over natural resources held in trust for the people of California

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Speaker: Laurie

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Determination of Impacts

- Agency must consider direct and indirect effects
- Impacts determined by comparison to baseline physical conditions
- Impact determinations:
 - No impact – No change
 - Less-than-significant impact – No substantial adverse change
 - Less than significant with mitigation – Implementation of one or more mitigation measures would reduce the impact to a less-than-significant level
 - Significant and unavoidable impact – A potentially substantial adverse change in the physical conditions of the environment would result AND mitigation is not feasible or would not reduce impact to less than significant

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Speaker: Laurie

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Types of CEQA Documents

- Exemption
 - Statutory and Categorical Exemptions identified in CEQA Guidelines
 - Generally common activities that typically have no significant impacts associated with them
- Negative Declaration / Mitigated Negative Declaration
 - Projects with no significant impacts or all impacts can be mitigated to less than significant
- EIR
 - Prepared for projects that may or will have significant impacts that cannot be mitigated to less than significant

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Speaker: Laurie

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Environmental Impact Report Process

Typical EIR Process	Sites Reservoir Project EIR Process
Issue Notice of Preparation	Issue Notice of Preparation
Conduct Scoping	Conduct Scoping
Prepare Draft EIR	Prepare Draft EIR
Public and Agency Review	Public and Agency Review
Prepare Final EIR	Prepare and Recirculate Revised Draft EIR
Review by Commenting Agencies	Public and Agency Review
Authority Decision	Prepare Final EIR
Prepare Findings, Statement of Overriding Considerations, and Mitigation Monitoring Plan	Review by Commenting Agencies
File Notice of Determination	Authority Decision
	Prepare Findings, Statement of Overriding Considerations, and Mitigation Monitoring Plan
	File Notice of Determination

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Speaker: Laurie

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CEQA Process Leading to Decision

- Ongoing - Administrative RDEIR/SDEIS chapters and appendices currently being prepared
- May 2021 - All Administrative RDEIR/SDEIS chapters to be submitted to Authority in May
- June 2021 - Review by Authority and Reclamation
 - Select Chapters to CEQA Responsible and NEPA Cooperating Agencies for review
- July 2021 - Request approval from the Reservoir Committee and Authority Board for release of the public RDEIR in August
- August 2021 - Release of RDEIR
 - Schedule assumes parallel review and release of SDEIS as joint document
- June/July 2022 – Final EIR and NOD

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Speaker: Laurie

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Introductory Chapter Status



Introductory Chapter Status

- Introductory Chapters
 - Ch. 1, Introduction
 - Ch. 2, Project Description and Alternatives
 - Ch. 3, Environmental Analysis
 - Ch. 4, Regulatory and Environmental Compliance
- Chapter 2 posted to the Authority's website
 - Will be updated due to minor changes to the Project and other input
- Chapters 1-4 have been sent to CEQA Responsible and NEPA Cooperating Agencies
 - Any input will be considered when chapters are submitted with complete Administrative Draft RDEIR/SDEIS in May

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Speaker: Laurie

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Next Steps

- Ongoing Preparation of RDEIR/SDEIS
 - Key findings and outcomes will be presented to the Board in 2 additional parts at meetings in May and June
 - Final briefing and recommendation for release in July
- Public Draft release August 26, 2021

Speaker: Laurie

NGO Outreach



Outreach to NGOs

- Conducted General Workshops in December
 - Workshop 1 – December 14, 2020
 - Workshop 2 –December 16, 2020
- Conducted Survey
 - In January 2021, workshop participants were asked to participate in an online survey to identify topics to be addressed in technical small group meetings
- Formed 6 Technical Small Groups
 - More focused, technical discussions
 - Small groups were formed based on survey responses and workshops questions

Speaker: Ali

Technical Small Group Status

Technical Small Group	Key Topics Areas (examples, not intended to be all inclusive)	Meetings	Status
Fisheries Protections and Effects	1. Diversion criteria, bypass flows, minimum flows 2. Modeling approach, including baseline 3. Fisheries effects (Sacramento River and Delta) 4. Temperature of releases 5. Sites Operations Plan 6. Other topics as identified by the group	Currently scheduling first meeting	Currently scheduling first meeting
Project Benefits - Proposition 1 - WSIP Benefits	1. Timing, amount, and target species/activities 2. Management of benefit water 3. Ensuring benefits are realized 4. Other topics as identified by the group	March 11 and March 24	Completed
Terrestrial Species Effects	1. Impacts (species and acres) 2. Mitigation approach 3. Other topics as identified by the group	March 26	Scheduling follow on meeting

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Speaker: Ali

Technical Small Group Status

Technical Small Group	Key Topics Areas (examples, not intended to be all inclusive)	Meetings	Status
Trinity River Effects	1. CalSim modeling for the Trinity River 2. Next Steps for Trinity River considerations 3. Other topics as identified by the group	March 22	Scheduling follow on meeting
Water Quality	1. Source water quality (Sacramento River and local watersheds) 2. Reservoir water quality 3. Release water quality 4. Salt seepage in reservoir 5. Other topics as identified by the group	April 7	Scheduling follow on meeting
Water Rights	1. Water right approach and key application parameters 2. Water right schedule 3. Other topics as identified by the group	February 23 and March 23	Completed – Follow up in August timeframe

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Speaker: Ali

Key Areas of Feedback and Questions to Date

- Reclamation level of participation
 - How will Reclamation determine its preferred alternative
 - Potential for CVP water to be stored in Sites Reservoir
- Potential for Trinity River impacts
 - Consideration of the Humboldt County 1959 contract in the modeling and cumulative
 - Need for assurances/protection for the Trinity River system and Trinity River resources
- Request to expand Tribal consultation
- Need to consider area of origin water rights along with potential future instream flow requirements from the State Board and how those might affect the Project
- Changes to Prop 1 benefits allocation and amounts as a result of the final CWC award and due to changes to project
- Project flood control benefits and design considerations

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Speaker: Ali

Key Areas of Feedback and Questions to Date (cont)

- Lack of recent habitat and species surveys due to lack of property access
- Comparison of giant garter snake impacts from 2017 to 2021
- Gray Lodge Biological Opinion giant garter snake measures should be reviewed and considered for the Project
- Consider Sutter Buttes Land Trust for mitigation opportunities
- Water quality data is limited and may not have been collected during higher flow conditions when the Project would be diverting water
- Water quality analysis should be considering the higher concentrations and not using averages
- Mercury and arsenic could be important considerations for rice farmers and wildlife use of rice fields

Speaker: Ali

Next Steps

- Follow on meetings being scheduled
 - Trinity River
 - Terrestrial Biological Resources
 - Water Quality Considerations
- First meeting being scheduled for Fishery Protections and Effects

Speaker: Ali

Listed Species Considered in the RDEIR/SDEIS & BA/ITP



2017 vs 2021 Listed Terrestrial Species

Listed Species	Affected in 2017	Affected in 2021
Keck's checker-mallow	✓	✓
Palmate-bracted bird's beak	✓	✓
Vernal pool crustaceans	✓	✓
Valley elderberry longhorn beetle	✓	✓
California red-legged frog	✓	✓
Giant garter snake	✓	✓
Tricolored blackbird	✓	✓
Swainson's hawk	✓	✓
Western yellow-billed cuckoo	✓	TBD
Bank swallow	✓	TBD
Crotch and western bumblebees*		✓

Notes: *Not listed in 2017

Speaker: Ellen

2017 vs 2021 Listed Fish Species

Listed Species	Affected in 2017	Affected in 2021
Delta smelt	✓	✓
Longfin smelt	✓	✓
Green Sturgeon	✓	✓
Steelhead	✓	✓
Fall-run/Late Fall-run Chinook	**	**
Spring-run Chinook	✓	✓
Winter-run Chinook	✓	✓

Notes: *Not listed not listed, ESA consultation for the purposes of Essential Fish Habitat

Speaker: Ellen

Questions and Discussion





From: Jeffrey Mount [mount.jeffrey@gmail.com]
Sent: 4/21/2021 1:26:53 PM
To: Jerry Brown [jbrown@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: the one-pager
Attachments: Summary Storing Water for the Environment in California_041921.pdf

Jerry and Ally,

Here is a final copy of our one-page project description. Soon, we hope to start scheduling discussions with various members of the water user and NGO community along with agencies.

I checked in with Ellen extensively on the issue of how much Sites will figure into this project. She wants us to use Sites as an example of off-stream storage, but is reluctant to have us do a full blown case study of it (something that would be an appendix to the report). However, expect it to figure prominently in our discussions of operations and governance. When I have a more firm understanding of what we are going to write about (after I talk to the author team in May) I will for sure let you know.

Hope this finds you well.

Jeff

--

Jeffrey Mount
Public Policy Institute of California and UC Davis
mount.jeffrey@gmail.com

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/21/2021 2:57:23 PM
To: Marcia Kivett [MKivett@sitesproject.org]
Subject: Re: Question



Sent from my iPhone

On Apr 21, 2021, at 2:18 PM, Marcia Kivett <MKivett@sitesproject.org> wrote:

Thank you!

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Wednesday, April 21, 2021 2:16 PM
To: Marcia Kivett <MKivett@sitesproject.org>
Subject: RE: Question

He was making the point that CDFW is a Trustee Agency and will have the ability to influence the outcome of the EIR analysis. (This was in response to Ali saying that Trustee Agencies don't have a yes/no decision). I think he wants that point to be acknowledged in the EIR/EIS.

From: Marcia Kivett <MKivett@sitesproject.org>
Sent: Wednesday, April 21, 2021 2:12 PM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Question

I think you are listening to the board meeting. Was there an Action Item from Jeff Sutton?

From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/22/2021 8:33:22 AM
To: mount.jeffrey@gmail.com; Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Re: the one-pager

Thanks for the update Jeff. Your one pager looks great and Sites would like to be involved to the extent you all see fit. I can see a scenario where Sites takes your output and prepares its own case study accompanied by contract language Sites would propose to CDFW for inclusion in the Prop 1 benefit agreement.

One suggestion for you to consider as you enter discussions with outside parties and we would be happy to be a sounding board for you on this – consider separating the academic/regulatory perspective from the water user/operator/practioner perspective and see if you can meld the two to arrive at an implementable solution that works from both perspectives.

Would it be okay to share your one pager with the group of Prop 1 managers as a heads up that this is coming?

Jerry

From: Jeffrey Mount <mount.jeffrey@gmail.com>
Reply-To: "mount.jeffrey@gmail.com" <mount.jeffrey@gmail.com>
Date: Wednesday, April 21, 2021 at 1:27 PM
To: Jerry Brown <jbrown@sitesproject.org>, Alicia Forsythe <aforsythe@sitesproject.org>
Subject: the one-pager

Jerry and Ally,

Here is a final copy of our one-page project description. Soon, we hope to start scheduling discussions with various members of the water user and NGO community along with agencies.

I checked in with Ellen extensively on the issue of how much Sites will figure into this project. She wants us to use Sites as an example of off-stream storage, but is reluctant to have us do a full blown case study of it (something that would be an appendix to the report). However, expect it to figure prominently in our discussions of operations and governance. When I have a more firm understanding of what we are going to write about (after I talk to the author team in May) I will for sure let you know.

Hope this finds you well.

Jeff

--

Jeffrey Mount
Public Policy Institute of California and UC Davis
mount.jeffrey@gmail.com

From: Jeffrey Mount [mount.jeffrey@gmail.com]
Sent: 4/22/2021 8:37:13 AM
To: Jerry Brown [jbrown@sitesproject.org]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Re: the one-pager

Thanks Jerry. And thanks for the suggestion, it is much appreciated.

For certain, this one pager is intended for circulation as you see fit. That's why we put the PPIC logo on it.

Jeff

On Thu, Apr 22, 2021 at 8:33 AM Jerry Brown <jbrown@sitesproject.org> wrote:

Thanks for the update Jeff. Your one pager looks great and Sites would like to be involved to the extent you all see fit. I can see a scenario where Sites takes your output and prepares its own case study accompanied by contract language Sites would propose to CDFW for inclusion in the Prop 1 benefit agreement.

One suggestion for you to consider as you enter discussions with outside parties and we would be happy to be a sounding board for you on this – consider separating the academic/regulatory perspective from the water user/operator/practioner perspective and see if you can meld the two to arrive at an implementable solution that works from both perspectives.

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From: Jeffrey Mount <mount.jeffrey@gmail.com>
Reply-To: "mount.jeffrey@gmail.com" <mount.jeffrey@gmail.com>
Date: Wednesday, April 21, 2021 at 1:27 PM
To: Jerry Brown <jbrown@sitesproject.org>, Alicia Forsythe <aforsythe@sitesproject.org>
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Hope this finds you well.

Jeff

--

Jeffrey Mount
Public Policy Institute of California and UC Davis
mount.jeffrey@gmail.com

--

Sent from my not-so-smart phone

From: Marcia Kivett [MKivett@sitesproject.org]
Sent: 4/22/2021 9:33:03 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Timeline of Significant NGO Engagement - 2017 to Present

Ali, I think these are two separate but similar request we discussed yesterday.

- 1 – the below email from Jerry.
- 2 – the request from the AB/RC meetings on the workshops.  04-02C Action Items from April's Reservoir Committee & Authority Board Meetings.docx

From: Marcia Kivett
Sent: Monday, April 19, 2021 8:26 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; 'Kevin Spesert' <kspesert@sitesproject.org>; 'Ali Forsythe' <aforsythe@sitesproject.org>
Cc: John Spranza <john.spranza@hdrinc.com>
Subject: FW: Timeline of Significant NGO Engagement - 2017 to Present

Per our conversation at the RC meeting when Jerry and Ali were in closed session.

Kevin, Jerry said it was not necessary to pull your past meetings. This is a list that we just need to add the recent activities.

Laurie/Ali – it is helpful, I can see if I am missing any recent activity from Jerry from this list:  Non-Governmental Organization Meeting and Action Items.docx

From: Jerry Brown <jbrown@sitesproject.org>
Sent: Friday, April 9, 2021 7:01 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Marcia Kivett <MKivett@sitesproject.org>
Subject: FW: Timeline of Significant NGO Engagement - 2017 to Present

Can you ask John and Laurie to continue to update this chronology to current conditions including the NGO workshops already held? We spent quite a bit of time a couple months ago building this and I want to keep it up to date. I'm already getting inquiries from RC members about our outreach efforts. Need by end of April. Thanks

Marcia – please make sure this is on the chairs meeting agenda for May.



<https://sitesreservoirproject.sharepoint.com/:f/r/reservoircommittee/Shared%20Documents/Administrative%20Information/Executive%20Management%20and%20Administrative/Jerry%27s%20Working%20Documents/Timeline%20of%20Significant%20NGO%20Engagement%20-%202017%20to%20present?csf=1&web=1&e=WqVkl8>

From: Leaf, Rob/SAC [Rob.Leaf@jacobs.com]
Sent: 4/22/2021 9:57:50 AM
To: steve.micko@jacobs.com; Spranza, John [john.spranza@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Lecky, Jim [jim.lecky@icf.com]; Hendrick, Mike [mike.hendrick@icf.com]; Hassrick, Jason [jason.hassrick@icf.com]; Heydinger, Erin [erin.heydinger@hdrinc.com]; Wilder, Rick [rick.wilder@icf.com]; Greenwood, Marin [Marin.Greenwood@icf.com]
CC: Monique Briard (monique.briard@icf.com) [monique.briard@icf.com]
Subject: RE: Aquatics NGO and Agency Workshop Prep

And me

From: Micko, Steve/SAC <Steve.Micko@jacobs.com>
Sent: Thursday, April 22, 2021 9:50 AM
To: Spranza, John <john.spranza@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Lecky, Jim <jim.lecky@icf.com>; Hendrick, Mike <mike.hendrick@icf.com>; Hassrick, Jason <jason.hassrick@icf.com>; Heydinger, Erin <erin.heydinger@hdrinc.com>; Wilder, Rick <rick.wilder@icf.com>; Greenwood, Marin <Marin.Greenwood@icf.com>; Leaf, Rob/SAC <Rob.Leaf@jacobs.com>
Cc: Monique Briard (monique.briard@icf.com) <monique.briard@icf.com>
Subject: RE: Aquatics NGO and Agency Workshop Prep

No worries! All those times work for me!

Steve

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, April 22, 2021 9:45 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Lecky, Jim <jim.lecky@icf.com>; Hendrick, Mike <mike.hendrick@icf.com>; Micko, Steve/SAC <Steve.Micko@jacobs.com>; Hassrick, Jason <jason.hassrick@icf.com>; Heydinger, Erin <erin.heydinger@hdrinc.com>; Wilder, Rick <rick.wilder@icf.com>; Greenwood, Marin <Marin.Greenwood@icf.com>; Leaf, Rob/SAC <Rob.Leaf@jacobs.com>
Cc: Monique Briard (monique.briard@icf.com) <monique.briard@icf.com>
Subject: [EXTERNAL] Aquatics NGO and Agency Workshop Prep

Sorry about my network fail, I'd like go over the draft slides next Monday or Tuesday as the meeting with the NGO's is Thursday. Can you please let me know your availability:

Monday

3-4

4-5

Tuesday

3-4

4-5

Presentation Outline: 20 slides

1. Introduction Purpose - John
 - a. Schedule and agenda of meetings
- i. Expectations for this meeting
 - b. Meeting norms
2. Proposed Project- John
3. Overview of Project Operations - Jacobs
4. Modeling, Baseline and how we used the model results (feel free to rearrange) –

- a. Calsim
- b. DSM2
- c. OBAN/IOS
- d. HEC5Q
- e. Anderson-Martin
- f. SALMOD
- g. Other?
- 5. Questions and Next Meeting Topics

I have also started a folder on SharePoint at the link below.

<https://sitesreservoirproject.sharepoint.com/:f/r/EnvPlanning/Meetings/NGO%20meetings/Fishery?csf=1&web=1&e=qXYt1j>

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8858 M 818.640.2487
john.spranza@hdrinc.com

hdrinc.com/follow-us
hdrinc.com/follow-us

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Environmental Public Involvement Kick-off Meeting Agenda



Sites Reservoir Project

Date: April 23, 2021

Location: Microsoft Teams (link in meeting invite)

Time: 2:30-4 p.m.

Leader: Sara Katz

Recorder: Sarah Rossetto

Agenda Item

Lead

- | Agenda Item | Lead |
|---|---------------------------------------|
| 1. Team Introductions | All |
| 2. Recap of Environmental Review Process and Public Involvement To Date | Ali Forsythe and Kevin Spesert |
| 3. Project Updates <ul style="list-style-type: none">• NGO Briefings Status• Draft Document Status• Other Current Activities• Anticipated Schedule | Ali Forsythe and Laurie Warner-Herson |
| 4. Situational Awareness Discussion <ul style="list-style-type: none">• Key Stakeholders• Key Issues• Messaging | Ali Forsythe and Laurie Warner-Herson |
| 5. Public Involvement Scope Review | Sara Katz |
| 6. Near-term Action Items and Priorities | All |

From: Cheyanne Harris [CHarris@BrwnCald.com]
Sent: 4/22/2021 12:42:58 PM
To: Jerry Brown [jbrown@sitesproject.org]; Brian Grubbs [grubbs@montaguederose.com]; Luu, Henry [henry.luu@hdrinc.com]; Marcia Kivett [MKivett@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]; JP Robinette [jrobinette@brwncald.com]
Subject: RE: Value Planning Affordability Pre-Meeting
Attachments: Sites VP FM Cases - 2021-04-22_ch.xlsx

Brian,

Couple of clarifications (first 3 are noted in the attached in red):

- Added VP7 as a baseline (per Jerry's email below)
- Confirm the 'current' interest rate on the long term municipal bonds (I thought it was 3.5% per the Financial Alternatives Memo, not 3% as currently indicated)
- Just so we're all on the same page, I specified the total WSIP funds (incl. the inflation adjustment)
- To confirm, the project subscription will remain as that from Value Planning? (i.e., stays 192,892 not 167,620 as it is today)

Thanks.

Cheyenne Harris

Brown and Caldwell | Sacramento, CA

CHarris@brwncald.com

T 916.853.5349

Pronouns: she/her/hers



From: Jerry Brown <jbrown@sitesproject.org>
Sent: Thursday, April 22, 2021 11:49 AM
To: Brian Grubbs <grubbs@montaguederose.com>; Luu, Henry <henry.luu@hdrinc.com>; Marcia Kivett <MKivett@sitesproject.org>; Alicia Forsythe <aforsythe@sitesproject.org>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; JP Robinette <JRobinette@BrwnCald.com>; Cheyanne Harris <CHarris@BrwnCald.com>
Subject: Re: Value Planning Affordability Pre-Meeting

Yes

And, we will also need the base case which would be VP results for 1.5MAF (option 7) and the VP 1.3MAF.

From: Brian Grubbs <grubbs@montaguederose.com>
Date: Thursday, April 22, 2021 at 11:41 AM
To: "Luu, Henry" <Henry.Luu@hdrinc.com>, Marcia Kivett <MKivett@sitesproject.org>, Jerry Brown <jbrown@sitesproject.org>, Alicia Forsythe <aforsythe@sitesproject.org>, "Heydinger, Erin" <erin.heydinger@hdrinc.com>, JP Robinette <jrobinette@brwncald.com>, Cheyanne Harris <CHarris@brwncald.com>
Subject: RE: Value Planning Affordability Pre-Meeting

Henry,
Got your edits. Thanks.

JP/Cheyenne,
Does this spreadsheet reflect the cases you're looking for?

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

From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Thursday, April 22, 2021 11:03 AM
To: Marcia Kivett <mkivett@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>; Alicia Forsythe <aforsythe@sitesproject.org>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; JP Robinette <JRobinette@BrwnCald.com>; Brian Grubbs <grubbs@montaguederose.com>; Cheyanne Harris <CHarris@BrwnCald.com>
Subject: RE: Value Planning Affordability Pre-Meeting

Hello everyone,

I apologize...there was a formula error in the cost estimate spreadsheet that did not capture the emergency release structure deduction of \$95M in 2019 dollars. This has been updated on the attached summary.

Brian – please use the attached cost numbers in your analysis.

Thank you,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Luu, Henry
Sent: Wednesday, April 21, 2021 4:24 PM
To: Marcia Kivett <MKivett@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>; Alicia Forsythe <aforsythe@sitesproject.org>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; JP Robinette <JRobinette@BrwnCald.com>; Brian Grubbs <grubbs@montaguederose.com>; Cheyanne Harris <CHarris@BrwnCald.com>
Subject: RE: Value Planning Affordability Pre-Meeting

Hi Brian,

For your use please reference the attached spreadsheet for benefits and cost numbers; feel free to contact Erin or I if there are questions. Also, I think we can forgo the 4.2% risk factor with these updated costs.

Thanks,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

-----Original Appointment-----

From: Marcia Kivett <MKivett@sitesproject.org>
Sent: Monday, April 19, 2021 1:48 PM
To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Luu, Henry; JP Robinette; Brian Grubbs; Cheyanne Harris

Subject: Value Planning Affordability Pre-Meeting

When: Wednesday, April 21, 2021 9:00 AM-10:00 AM (UTC-08:00) Pacific Time (US & Canada).

Where: Microsoft Teams Meeting

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.

Ali/Erin, you have a schedule conflict at 9:30. Sorry I could not make this fit everyone's schedules.

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From: Jerry Brown [jbrown@sitesproject.org]
Sent: 4/22/2021 1:34:06 PM
To: Brian Grubbs [grubbs@montaguederose.com]; Cheyanne Harris [CHarris@brwnald.com]; Luu, Henry [henry.luu@hdrinc.com]; Marcia Kivett [MKivett@sitesproject.org]; Alicia Forsythe [aforsythe@sitesproject.org]; Heydinger, Erin [erin.heydinger@hdrinc.com]; JP Robinette [jrobinette@brwnald.com]
Subject: Re: Value Planning Affordability Pre-Meeting

See in red below. thanks

From: Brian Grubbs <grubbs@montaguederose.com>
Date: Thursday, April 22, 2021 at 1:26 PM
To: Cheyanne Harris <CHarris@brwnald.com>, Jerry Brown <jbrown@sitesproject.org>, "Luu, Henry" <henry.luu@hdrinc.com>, Marcia Kivett <MKivett@sitesproject.org>, Alicia Forsythe <aforsythe@sitesproject.org>, "Heydinger, Erin" <erin.heydinger@hdrinc.com>, JP Robinette <jrobinette@brwnald.com>
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New file attached

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

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Sent: Thursday, April 22, 2021 12:43 PM
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D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

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To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Luu, Henry; JP Robinette; Brian Grubbs; Cheyanne Harris

Subject: Value Planning Affordability Pre-Meeting

When: Wednesday, April 21, 2021 9:00 AM-10:00 AM (UTC-08:00) Pacific Time (US & Canada).

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Attachments: image001.gif; image002.png

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From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/22/2021 1:54:55 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Aquatics NGO and Agency Workshop Prep

Do you want to give the operations overview?

Discussion Topic	Topic Leader	Time Allotted
1. Introductions	John	5 mins
2. Approach to Meetings	John	5 mins
3. Proposed Project	John	5 min
4. Overview of Operations	Ali?	10 min
5. Modeling and Baseline	Steve Miko	25 mins
a. Models used and how applied		
6. Schedule and Future Meeting Topics	John/Group	10 mins
7. Adjourn		

John Spranza

D 916.679.8858 M 818.640.2487

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, April 22, 2021 12:31 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: RE: Aquatics NGO and Agency Workshop Prep

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Monday 3-4 PM works. Tuesday times also work and are a little better for me.

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

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, April 22, 2021 9:45 AM

To: Alicia Forsythe <aforsythe@sitesproject.org>; Lecky, Jim <jim.lecky@icf.com>; Hendrick, Mike <mike.hendrick@icf.com>; steve.micko@jacobs.com; Hassrick, Jason (Jason.Hassrick@icf.com) <Jason.Hassrick@icf.com>; Heydinger, Erin <erin.heydinger@hdrinc.com>; Wilder, Rick <Rick.Wilder@icf.com>; Greenwood, Marin <Marin.Greenwood@icf.com>; Leaf, Rob/SAC (Rob.Leaf@jacobs.com) <Rob.Leaf@jacobs.com>
Cc: Monique Briard (monique.briard@icf.com) <monique.briard@icf.com>
Subject: Aquatics NGO and Agency Workshop Prep

Sorry about my network fail, I'd like go over the draft slides next Monday or Tuesday as the meeting with the NGO's is Thursday. Can you please let me know your availability:

Monday

3-4

4-5

Tuesday

3-4

4-5

Presentation Outline: 20 slides

1. Introduction Purpose - John
 - a. Schedule and agenda of meetings
- i. Expectations for this meeting
 - b. Meeting norms
2. Proposed Project- John
3. Overview of Project Operations - Jacobs
4. Modeling, Baseline and how we used the model results (feel free to rearrange) –
 - a. Calsim
 - b. DSM2
 - c. OBAN/IOS
 - d. HEC5Q
 - e. Anderson-Martin
 - f. SALMOD
 - g. Other?
5. Questions and Next Meeting Topics

I have also started a folder on SharePoint at the link below.

<https://sitesreservoirproject.sharepoint.com/:f:/r/EnvPlanning/Meetings/NGO%20meetings/Fishery?csf=1&web=1&e=qXYt1j>

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8858 M 818.640.2487
john.spranza@hdrinc.com

hdrinc.com/follow-us
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From: Luu, Henry [Henry.Luu@hdrinc.com]
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Subject: RE: Value Planning Affordability Pre-Meeting

Brian,

Alternative 2 is similar to VP5. We can delete VP6 from this exercise; VP6 is the same as VP5 with the exception of the Dunnigan Pipeline extending to the Sacramento River.

Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

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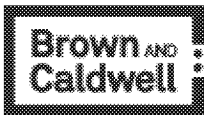
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Subject: RE: Value Planning Affordability Pre-Meeting

Hello everyone,

I apologize...there was a formula error in the cost estimate spreadsheet that did not capture the emergency release structure deduction of \$95M in 2019 dollars. This has been updated on the attached summary.

Brian – please use the attached cost numbers in your analysis.

Thank you,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Luu, Henry
Sent: Wednesday, April 21, 2021 4:24 PM
To: Marcia Kivett <MKivett@sitesproject.org>; Jerry Brown <jbrown@sitesproject.org>; Alicia Forsythe <aforsythe@sitesproject.org>; Heydinger, Erin <Erin.Heydinger@hdrinc.com>; JP Robinette <JRobinette@BrwnCald.com>; Brian Grubbs <grubbs@montaguederose.com>; Cheyanne Harris <CHarris@BrwnCald.com>
Subject: RE: Value Planning Affordability Pre-Meeting

Hi Brian,

For your use please reference the attached spreadsheet for benefits and cost numbers; feel free to contact Erin or I if there are questions. Also, I think we can forgo the 4.2% risk factor with these updated costs.

Thanks,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

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-----Original Appointment-----

From: Marcia Kivett <MKivett@sitesproject.org>

Sent: Monday, April 19, 2021 1:48 PM

To: Marcia Kivett; Jerry Brown; Alicia Forsythe; Heydinger, Erin; Luu, Henry; JP Robinette; Brian Grubbs; Cheyanne Harris

Subject: Value Planning Affordability Pre-Meeting

When: Wednesday, April 21, 2021 9:00 AM-10:00 AM (UTC-08:00) Pacific Time (US & Canada).

Where: Microsoft Teams Meeting

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.

Ali/Erin, you have a schedule conflict at 9:30. Sorry I could not make this fit everyone's schedules.

This is the link to the draft presentation. Jerry has placed a blue star on the slides that he thinks we need to start from in looking at affordability analysis for the April 29th meeting. He also said there needs to be a reference to the VP7 values for each item.



https://sitesreservoirproject.sharepoint.com/:p:/g/reservoircommittee/EYiGFxHt9U9Fu4Bn_GbfNg0B9_Qos_a6wE1IMzi9Pg0SVaA?email=Brian.Grubbs%40SitesReservoirProject.onmicrosoft.com&e=xwbWiQ

Microsoft Teams meeting

Join on your computer or mobile app

[Click here to join the meeting](#)

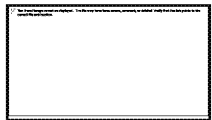
Or call in (audio only)

[+1 213-379-5743,,327180053#](#) United States, Los Angeles

[\(888\) 404-2493,,327180053#](#) United States (Toll-free)

Phone Conference ID: 327 180 053#

[Find a local number](#) | [Reset PIN](#)



A Brown and Caldwell Teams meeting has been created for this event.

[Learn More](#) | [Help](#) | [Meeting options](#)

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/22/2021 3:12:15 PM
To: Bruce Houdesheldt [bruceh@norcalwater.org]; Alicia Forsythe [aforsythe@sitesproject.org]
CC: David Guy [dguy@norcalwater.org]
Subject: RE: Sites Reservoir - Water Quality Questions

Hi Bruce, here you go. If you need more detail please let me know.

Constituent Group	Data Source	Location
Metals Electrical Conductivity Nutrients	DWR Water Data Library (WDL) Data collected May 2003 through November 2017	Sacramento River below Red Bluff Sacramento River at Hamilton City Sacramento River above CBD CBD near Knights Landing Stone Corral Creek near Sites
Flow	USGS WDL CA Data Exchange Center	Sacramento River at Keswick Sacramento River above Bend Bridge
Pesticides	CA Dept of Pesticide Regulation Surface Water Database (CDPR SURF)	Sacramento River near Hamilton City Sacramento River at Colusa CBD above Knights Landing Yolo Bypass Toe Drain near Babel Slough

John Spranza

D 916.679.8858 M 818.640.2487

From: Bruce Houdesheldt <bruceh@norcalwater.org>
Sent: Thursday, April 22, 2021 7:06 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Spranza, John <John.Spranza@hdrinc.com>; David Guy <dguy@norcalwater.org>
Subject: Re: Sites Reservoir - Water Quality Questions

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Please send list of sources of water quality information you are currently using.

Bruce Houdesheldt
Director of Water Quality
Northern California Water Association
(916) 952-1287 mobile

On Apr 22, 2021, at 6:19 AM, Alicia Forsythe <aforsythe@sitesproject.org> wrote:

Thanks Bruce. Much appreciated. I just sent an invite for Tuesday. We can chat and then I can reach out to Tim and/or Roberta.

Ali

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

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From: Bruce Houdesheldt <bruceh@norcalwater.org>
Sent: Wednesday, April 21, 2021 1:45 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Spranza, John <john.spranza@hdrinc.com>; David Guy <dguy@norcalwater.org>
Subject: RE: Sites Reservoir - Water Quality Questions

I am available

April 26 1-2 PM
April 27 11 AM until 1 PM
April 29 4 to 5 PM

I would suggest Tim Johnson and/or Roberta Firoved of the California Rice Commission be contacted as well about the arsenic and temperature issues for rice. Ted Trimble also can lend insight on these two topics.

Email addresses are tjohnson@calrice.org and rfiroved@calrice.org

David Guy is at a workshop on Sacramento River Temperature and can lend valuable insight.

Bruce Houdesheldt
Director Water Quality
Northern California Water Association
455 Capitol Mall, Suite 703
Sacramento, California 95814
(916) 442-8333 (office)
(916) 952-1287 (mobile)

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Wednesday, April 21, 2021 1:06 PM
To: Bruce Houdesheldt <bruceh@norcalwater.org>
Cc: Spranza, John <john.spranza@hdrinc.com>
Subject: Sites Reservoir - Water Quality Questions

Hi Bruce – We have been working with NGOs on their water quality concerns with regard to the Project. We had a few topics come up that we'd like to pick your brain on. Would you have an hour next week to chat with John and I? Below are a few dates/times that work for us. Let me know what works for you.

Monday, April 26 – 1 to 2 PM
Tuesday, April 27 – any time after 11 am
Thursday, April 29 – 3 to 4 PM; 4 to 5 PM

A few of the topics that have come up:

1. Arsenic and Mercury and rice production – would water from Sites be okay for rice production?
2. Water quality monitoring and available monitoring data
3. Optimal water temperature for rice at different times of year – this is for our internal analysis and has not yet been brought up by the NGO community

John – please feel free to add to this list.

Ali

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

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From: jsutton@tccanal.com [jsutton@tccanal.com]
Sent: 4/22/2021 3:38:27 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Jerry Brown [jbrown@sitesproject.org]
Subject: FW: Water Samples
Attachments: 2020 TCCA General Water Quality.pdf

Ali,

See attached, four years (2017-2020) of data with a spectrum of water quality testing results of TC water quality that was diverted at Red Bluff. This testing is conducted twice a year, early spring and early fall, at one location near the headworks and at another location south of Funks Reservoir.

Hope this is helpful to you. We will be doing our early spring testing soon, will share those results once received.

Jeffrey P. Sutton
General Manager
Tehama-Colusa Canal Authority
5513 State Highway 162
PO Box 1025
Willows, CA 95988
Office (530) 934-2125
Mobile (530) 301-1030
jsutton@tccanal.com

Tehama-Colusa Canal Authority

General Water Quality Data

T-C Canal

North End

Date	Time	EC (dS/m)	Ca (meq/L)	Mg (meq/L)	Na (meq/L)	SAR	Adjusted SAR	Cl (meq/L)	CO ₃ +HCO ₃ (meq/L)	SO ₄ (meq/L)	Boron (mg/L)	NO ₃ -N (mg/L)	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	L.I. (calc)	lbs N/Ac-ft
1-May-17	NR	0.11	0.54	0.37	0.2	0.3	0.20	ND<0.1	1.0	ND<0.1	ND<0.05	0.10	ND<0.05	ND<0.1	ND<0.02	7.8	-0.7	0.3
8-Aug-17	14:25	0.11	0.53	0.38	0.2	0.3	0.20	ND<0.1	1.0	ND<0.1	ND<0.05	ND<0.1	ND<0.05	ND<0.1	ND<0.02	8.2	-0.4	0.0
7-May-18	8:30	0.14	0.54	0.42	0.2	0.3	0.3	ND<0.1	1.2	ND<0.1	ND<0.05	0.2	0.06	ND<0.1	ND<0.02	7.7	-0.8	0.5
19-Sep-18	NR	0.13	0.49	0.38	0.3	0.5	0.4	ND<0.1	1.3	ND<0.1	ND<0.05	0.2	0.08	0.18	ND<0.02	7.8	-0.7	0.5
2-May-19	10:40	0.12	0.56	0.42	0.3	0.4	0.4	ND<0.1	1.1	ND<0.1	ND<0.05	0.1	ND<0.05	ND<0.1	ND<0.02	8.0	0.4	0.3
25-Sep-19	11:55	0.12	0.51	0.4	0.3	0.4	0.3	ND<0.1	1.1	ND<0.1	ND<0.05	ND<0.1	ND<0.05	0.20	ND<0.02	8.8	0.3	0.0
29-Jun-20	12:40	0.13	0.48	0.4	0.3	0.4	0.4	ND<0.1	1.2	ND<0.1	ND<0.05	ND<0.1	-	ND<0.10	ND<0.02	7.8	-0.7	0.0

South End

Date	Time	EC (dS/m)	Ca (meq/L)	Mg (meq/L)	Na (meq/L)	SAR	Adjusted SAR	Cl (meq/L)	CO ₃ +HCO ₃ (meq/L)	SO ₄ (meq/L)	Boron (mg/L)	NO ₃ -N (mg/L)	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	L.I. (calc)	lbs N/Ac-ft
1-May-17	NR	0.11	0.50	0.34	0.2	0.3	0.2	ND<0.1	1.0	ND<0.1	ND<0.05	ND<0.1	ND<0.05	ND<0.1	ND<0.02	7.8	-0.8	0.0
8-Aug-17	NR	0.10	0.46	0.36	0.2	0.3	0.2	ND<0.1	1.0	ND<0.1	ND<0.05	0.2	ND<0.05	ND<0.1	ND<0.02	7.8	-0.8	0.5
7-May-18	10:30	0.14	0.54	0.42	0.4	0.6	0.5	0.1	1.2	ND<0.1	ND<0.05	0.1	0.1	0.27	ND<0.02	8.2	-0.3	0.3
18-Sep-18	NR	0.13	0.53	0.41	0.3	0.4	0.4	ND<0.1	1.3	ND<0.1	ND<0.05	ND<0.1	0.06	0.11	ND<0.02	8.7	0.2	0.0
2-May-19	15:32	0.15	0.69	0.52	0.4	0.5	0.6	0.2	1.3	0.2	ND<0.05	ND<0.1	ND<0.05	ND<0.1	ND<0.02	8.8	0.5	0.0
25-Sep-19	13:40	0.14	0.64	0.45	0.3	0.4	0.4	ND<0.1	1.3	ND<0.1	ND<0.05	ND<0.1	ND<0.05	0.21	ND<0.02	8.4	0.0	0.0
30-Jun-20	15:00	0.13	0.60	0.49	0.3	0.5	0.5	ND<0.1	1.2	ND<0.1	ND<0.05	ND<0.1	-	ND<0.10	ND<0.02	8.2	-0.1	0.0

Check 26

Date	Boron (mg/L)	Mn (mg/L)
3-May-18	0.05	NR
18-Sep-18	ND<0.05	NR
25-Sep-19	ND<0.05	ND<0.02

General Ag Irrigation Water Ranges

	Total Salts (EC)	Ca (meq/L)	Mg (meq/L)	Na (meq/L)	Sodium Abs. Ratio SAR	Adjusted SAR	Cl (meq/L)	CO ₃ +HCO ₃ (meq/L)	SO ₄ (meq/L)	Boron (mg/L)	NO ₃ -N (mg/L)	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	L.I. (calc)
Low	<0.50	<4.00	-	-	-	-	-	-	-	-	-	-	-	-	<6.5	<-0.5
Normal	0.60-1.50	5.00-10.00	1.1-5.0	<4.0	0.1-4.0	0.1-4.0	0.1-1.5	0.1-2.5	0.1-5.0	0.01-0.40	0.1-5.0	-	<0.20	<0.20	6.8-7.9	-0.3 - 0.5
High for Sensitive Crops	1.51-2.20	> 10.00	> 5.0	4.1-7.0	4.1-9.0	4.1-9.0	1.6-3.5	2.5-3.5	-	0.41-0.59	5.1-7.0	-	0.21-0.40	0.21-0.40	8.0-8.4	0.6-0.7
High for Tolerant Crops	> 2.20	-	-	> 7.0	> 9.0	> 9.0	> 3.5	> 3.5	-	> 0.60	> 7.0	-	> 0.40*	> 0.40*	> 8.4	> 0.9*

Notes:

Many of the above parameters need specific adjustment for crops, uses, irrigation procedures, etc. Check report for specifics.

LI 0.4+ Problematic for drip system deposits. LI < -0.3 corrosive to plumbing

When sodium is greater than calcium (or high SAR), the water is considered sodic or "alkali".

*= High levels can cause plumbing deposits.

Water analysis data generated by Dellavalle Laboratory, Inc.

ND - analyte not detected (ND) above the Method Reporting Limit

NR - not recorded

Adjusted SAR - SAR adjusted for the calcium in the water that may not be in solution due to precipitaton of calcium carbonate.

Nitrogen for agricultural use value calculated using nitrate-N concentration.

Key:	Black = Normal
Red = High	Green = Sl. Low
Purple = Sl. High	Blue = Low

From: jsutton@tccanal.com [jsutton@tccanal.com]
Sent: 4/22/2021 4:33:27 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Jerry Brown [jbrown@sitesproject.org]; Spranza, John [john.spranza@hdrinc.com]
Subject: RE: Water Samples

I am sure we do, but need to check with Blankenship (folks that do our NPDES monitoring and reporting) on that. I will see what I can find out. If not, we are starting our own program of regular monitoring of PH and shouldn't be hard to start gathering that information along with the other.

Jeffrey P. Sutton
General Manager
Tehama-Colusa Canal Authority
5513 State Highway 162
PO Box 1025
Willows, CA 95988
Office (530) 934-2125
Mobile (530) 301-1030
jsutton@tccanal.com

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, April 22, 2021 3:54 PM
To: jsutton@tccanal.com
Cc: Jerry Brown <jbrown@sitesproject.org>; Spranza, John <john.spranza@hdrinc.com>
Subject: RE: Water Samples

This is fantastic Jeff. Thank you so much!

Quick question for you – do you have any water temperature data for the canal?

Ali

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

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From: jsutton@tccanal.com <jsutton@tccanal.com>
Sent: Thursday, April 22, 2021 3:38 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Jerry Brown <jbrown@sitesproject.org>
Subject: FW: Water Samples

Ali,

See attached, four years (2017-2020) of data with a spectrum of water quality testing results of TC water quality that was diverted at Red Bluff. This testing is conducted twice a year, early spring and early fall, at one location near the headworks and at another location south of Funks Reservoir.

Hope this is helpful to you. We will be doing our early spring testing soon, will share those results once received.

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General Manager

Tehama-Colusa Canal Authority

5513 State Highway 162

PO Box 1025

Willows, CA 95988

Office (530) 934-2125

Mobile (530) 301-1030

jsutton@tccanal.com

From: Janis Offermann [janis@horizonh2o.com]
Sent: 4/23/2021 7:14:57 AM
To: Risse, Danielle [Danielle.Risse@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Spranza, John [john.spranza@hdrinc.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
CC: Lloyd, John [John.Lloyd@hdrinc.com]; Susan Lassell - ICF [Susan.Lassell@icf.com]; Wolf, Barbara [Barbara.Wolf@icf.com]
Subject: RE: Sites - AB52 Geographic Scope Memo

Importance: High

Hi, everyone

I have been reading the PD for information about impacts to the Feather River. All I have really been able to find are that there would be water exchanges with the State Water Project that would modify the timing of releases from Oroville when water was available in Sites Reservoir. Do you know if this is what Ali was referring to or is there something more?

If this is the case, then there are similar exchanges proposed with Shasta and Folsom reservoirs, which leads me to think that we should include the Sacramento River up to Shasta and the American River up to Folsom. I would appreciate your thoughts, as that somewhat affects the number of tribes that need to be included in this overview.

Thanks
janis

From: Risse, Danielle <Danielle.Risse@hdrinc.com>
Sent: Thursday, April 22, 2021 12:52 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF (Susan.Lassell@icf.com) <Susan.Lassell@icf.com>; Janis Offermann <janis@horizonh2o.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: RE: Sites - AB52 Geographic Scope Memo

Great – thanks Ali!

Danielle Risse, M.A.
Office 916-679-8796 Mobile 707-372-5007

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, April 22, 2021 12:41 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF (Susan.Lassell@icf.com) <Susan.Lassell@icf.com>; Janis Offermann <janis@horizonh2o.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: RE: Sites - AB52 Geographic Scope Memo

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Hi all – This scope looks good to me. Thank you all!

Ali

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

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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, April 22, 2021 7:59 AM
To: Risse, Danielle <Danielle.Risse@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF (<Susan.Lassell@icf.com> <Susan.Lassell@icf.com>); Janis Offermann <janis@horizonh2o.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: RE: Sites - AB52 Geographic Scope Memo

Hi Danielle,
The scope looks reasonable to me, but as this is really a CEQA issue I'll defer to Laurie and Ali.

John Spranza

D 916.679.8858 M 818.640.2487

From: Risse, Danielle <Danielle.Risse@hdrinc.com>
Sent: Wednesday, April 21, 2021 4:59 PM
To: 'Alicia Forsythe' <aforsythe@sitesproject.org>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF (<Susan.Lassell@icf.com> <Susan.Lassell@icf.com>); Janis Offermann <janis@horizonh2o.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: Sites - AB52 Geographic Scope Memo

Hi Ali, John, and Laurie,
The CR team met today to discuss the AB52 Geographic Scope memo. We have developed the following outline for the memo and want to run it by you three to confirm we are on the right track with what you are hoping to get from the memo.

1. Description of potential project impacts:
 - a. Impacts from regulation of water flow
 - b. Physical/visual/auditory impacts (our current AB 52 efforts cover this)
2. Geographic extent of potential project impacts:
 - a. Impacts from regulation of water flow
 - b. Physical/visual/auditory impacts
3. Identify the tribes potentially affected by project impacts (by county, waterway reach, or other):
 - a. Impacts from regulation of water flow
 - b. Physical/visual/auditory impacts
4. Implications

Are there any specific questions you are hoping we will answer, or any other information you would like us to include?

Thanks, Danielle

Danielle Risse, M.A.
Office 916-679-8796 Mobile 707-372-5007

From: Janis Offermann [janis@horizonh2o.com]
Sent: 4/23/2021 7:49:45 AM
To: Spranza, John [john.spranza@hdrinc.com]; Risse, Danielle [Danielle.Risse@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
CC: Lloyd, John [John.Lloyd@hdrinc.com]; Susan Lassell - ICF [Susan.Lassell@icf.com]; Wolf, Barbara [Barbara.Wolf@icf.com]
Subject: RE: Sites - AB52 Geographic Scope Memo

Thanks, John.

Ali, unless you think otherwise, I will go ahead and include the American River to Folsom in our discussion of potential geographic extent.

Thanks

janis

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Friday, April 23, 2021 7:46 AM
To: Janis Offermann <janis@horizonh2o.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF <Susan.Lassell@icf.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: RE: Sites - AB52 Geographic Scope Memo

Janis,

The project does include exchanges with the SWP and CVP which would include changes in the timing and volumes of flows below Oroville, Folsom and Shasta.

John Spranza

D 916.679.8858 M 818.640.2487

From: Janis Offermann <janis@horizonh2o.com>
Sent: Friday, April 23, 2021 7:15 AM
To: Risse, Danielle <Danielle.Risse@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF <Susan.Lassell@icf.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: RE: Sites - AB52 Geographic Scope Memo
Importance: High

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Hi, everyone

I have been reading the PD for information about impacts to the Feather River. All I have really been able to find are that there would be water exchanges with the State Water Project that would modify the timing of releases from Oroville when water was available in Sites Reservoir. Do you know if this is what Ali was referring to or is there something more?

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Thanks
janis

From: Risse, Danielle <Danielle.Risse@hdrinc.com>
Sent: Thursday, April 22, 2021 12:52 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Cc: Lloyd, John <John.Lloyd@hdrinc.com>; Susan Lassell - ICF (<Susan.Lassell@icf.com> <Susan.Lassell@icf.com>); Janis Offermann <janis@horizonh2o.com>; Wolf, Barbara <Barbara.Wolf@icf.com>
Subject: RE: Sites - AB52 Geographic Scope Memo

Great – thanks Ali!

Danielle Risse, M.A.
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From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, April 22, 2021 12:41 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Risse, Danielle <Danielle.Risse@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
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Subject: RE: Sites - AB52 Geographic Scope Memo

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Hi all – This scope looks good to me. Thank you all!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 |
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From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Thursday, April 22, 2021 7:59 AM
To: Risse, Danielle <Danielle.Risse@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
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Subject: RE: Sites - AB52 Geographic Scope Memo

Hi Danielle,

The scope looks reasonable to me, but as this is really a CEQA issue I'll defer to Laurie and Ali.

John Spranza

D 916.679.8858 M 818.640.2487

From: Risse, Danielle <Danielle.Risse@hdrinc.com>

Sent: Wednesday, April 21, 2021 4:59 PM

To: 'Alicia Forsythe' <aforsythe@sitesproject.org>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>

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Subject: Sites - AB52 Geographic Scope Memo

Hi Ali, John, and Laurie,

The CR team met today to discuss the AB52 Geographic Scope memo. We have developed the following outline for the memo and want to run it by you three to confirm we are on the right track with what you are hoping to get from the memo.

1. Description of potential project impacts:
 - a. Impacts from regulation of water flow
 - b. Physical/visual/auditory impacts (our current AB 52 efforts cover this)
2. Geographic extent of potential project impacts:
 - a. Impacts from regulation of water flow
 - b. Physical/visual/auditory impacts
3. Identify the tribes potentially affected by project impacts (by county, waterway reach, or other):
 - Impacts from regulation of water flow
 - Physical/visual/auditory impacts
4. Implications

Are there any specific questions you are hoping we will answer, or any other information you would like us to include?

Thanks, Danielle

Danielle Risse, M.A.

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5.4.2 Program-Level Analysis

Construction-related actions analyzed at a program level would not affect groundwater resources. Short-term construction dewatering may be required in certain areas; however, groundwater resources would likely return to a preconstruction status following construction and cessation of dewatering pumping.

5.5 Indian Trust Assets

5.5.1 Project-Level Effects

Potential changes in erosion or quality of land or sites of religious or cultural importance to a federally recognized Indian tribe

Project-level components of Alternatives 1 through 4 are primarily operations based and would not involve the use of any land or sites of religious or cultural importance to Native Americans. As described in Appendix X, *Geology and Soils Technical Appendix*, no changes in peak flows are expected under Alternatives 1 and 2. Small changes (approximately 4% during the month of January) in peak flows are anticipated under Alternative 3. Therefore, stream channel erosion under Alternatives 1 and 2 would be the same as under the No Action Alternative. Stream channel erosion under Alternative 3 would not be substantial.

Increased releases and reduced water deliveries would occur in the Sacramento River, Clear Creek, Feather River, and American River under Alternative 4. No changes are expected in peak flow for the San Joaquin or Stanislaus Rivers under Alternative 4. Under Alternative 4, an almost 10% increase in outflow could occur and would result in greater levels of water moving through the Delta; however, the area miles of shoreline in the Delta are significant and the increase in outflow would likely not be sufficient enough for notable erosion to occur.

Therefore, under Alternative 4, an increase in releases from Sacramento Valley tributaries will occur, but these releases would be well within the standard bounds of operational peak flows. Delta outflow will also increase, but overall the differences are expected to result in negligible differences in the potential for increased erosion from outflow. There may be an increase in erosion under Alternative 4; however, erosion may occur primarily due to crop reduction as a result of reduced water deliveries and would not affect land or sites of religious or cultural importance.

There would not be subsequent degradation of land or sites of religious or cultural importance as a result of increases in erosion due to project-level activities.

Potential changes in quality of water utilized by a federally recognized Indian tribe

As described in Appendix G, changes in flow in the study area rivers due to changes in the operation of CVP/SWP under Alternatives 1 and 4 relative to the No Action Alternative would not result in increased frequency of exceedances of water quality standards. Changes in flow in Clear Creek and the Stanislaus River due to changes in the operation of CVP/SWP under Alternatives 2 and 3 would result in increased frequency of exceedances of water quality standards. However, there are no known Indian Trust Assets (ITAs) identified in the vicinity of Clear Creek and the Stanislaus River. Therefore, there would be no degradation of water quality and subsequent effects on federally recognized tribes.

Potential changes to salmonid populations

Any detrimental effects on salmonid populations, which are an important resource to ITAs, would result in an adverse effect on federally recognized Indian tribes that have fishing rights. Effects on salmonids vary in each river in the study area and are summarized by region below. For detailed analysis of the potential impacts on salmonid populations of the project, please refer to Appendix O:

5.5.1.1 Trinity River

Modeled maximum water temperatures in September and October under all alternatives would exceed the 55°F USEPA (2003) recommendation for spawning, egg incubation, and fry emergence and could compromise salmonid reproductive success. In addition, modeled water temperatures in September under Alternatives 1 through 3 exceed the temperatures under the No Action Alternative. Modeled water temperatures in October under Alternatives 1 and 2 are lower than under the No Action Alternative, and water temperatures under Alternative 3 are similar to under the No Action Alternative. Spawning by Spring-Run Chinook Salmon in the Trinity River commences in late September and peaks in October, while spawning by Fall-Run Chinook Salmon commences in October and peaks in November. Trinity River Coho Salmon primarily spawn in November and December, while Steelhead and Coastal Cutthroat Trout spawn from January–April and September–April respectively. Thus, although a relatively small proportion of the spring-run Chinook spawners that spawn in September would be negatively affected by increased water temperature, the majority of spring-run Chinook that spawn in October, and some fall-run chinook that spawn in October, would benefit from lowered water temperatures that month compared to the No Action Alternative.

Modeled maximum water temperatures under the action alternatives would be at or below the 55°F recommendation for spawning, egg incubation, and fry emergence (USEPA 2003) from December through May (Figure 5.9-4), which would provide substantial protection for these life stages of Coho Salmon, which begin spawning in November, and Steelhead and Coastal Cutthroat Trout, which begin spawning in January and September respectively. While water temperatures under the action alternatives would equal or exceed the No Action Alternative in some months during this period, no adverse effects are expected.

Modeled maximum water temperatures during November, however, would slightly exceed the 55°F criterion under Alternative 1 (55.2°F), Alternative 2 (55.1°F), and Alternative 4 (55.1°F) and would substantially exceed the criterion under Alternative 3 (59.3°F), which could compromise spawning success for Fall-Run Chinook Salmon, Spring-Run Chinook Salmon, Coho Salmon, and Coastal Cutthroat Trout during November. The modeled water temperature exceedances under Alternatives 1, 2, and 4 are negligible relative to both the USEPA (2003) recommendations and the No Action Alternative (54.8°F) and are likely much less than the uncertainty associated with model results. Consequently, no adverse effects are expected. Under Alternative 3, however, modeled maximum November water temperatures would substantially exceed both the USEPA (2003) recommendations and the No Action Alternative, likely resulting in adverse effects on Fall-Run Chinook Salmon, Spring-Run Chinook Salmon, Coho Salmon, and Coastal Cutthroat Trout. The magnitude of the November water temperature exceedance under Alternative 3 could substantially reduce spawning success and year-class recruitment, but the expected frequency of occurrence cannot be determined using available modeling data and the likelihood of population-level effects is therefore uncertain. Spawning Steelhead would not be affected by the November water temperatures, as they begin spawning in January.

5.5.1.2 Clear Creek

In Clear Creek below Whiskeytown Dam, CalSim II modeling results indicate that average flows in most water year types under Alternative 1 would be similar or the same as under the No Action Alternative, and average flows in all water year types under Alternatives 2 and 3 would be less than the No Action Alternative. Average flows in all water year types under Alternative 4 would be higher than under the No Action Alternative from November to May and would be similar or the same as under the No Action Alternative from June to October.

In all water year types, Alternative 1 and 4 would improve instream habitat conditions throughout the year compared to Alternative 2 and Alternative 3, but Alternative 1 would be similar to the No Action Alternative.

Modeled maximum water temperatures under Alternative 1 would be nearly identical to the No Action Alternative in most months but would be substantially less than the No Action Alternative in October, slightly less in August, and slightly greater in September. Modeled maximum water temperatures under Alternative 4 would be nearly identical to the No Action Alternative in most months but would be slightly less than the No Action Alternative in September and substantially less in October. Increases in water temperature under Alternatives 2 and 3 relative to the No Action Alternative and the NMFS (2009) criteria could compromise Spring-Run Chinook Salmon holding and rearing success and potentially lead to increased incidence of disease and physiological stress in holding adults and reduced survival of rearing juveniles, reduced juvenile production, and reduced spawning success of adults. These effects would be most likely to occur in June to August, when water temperatures are predicted to be highest.

5.5.1.3 Sacramento River

Changes in summer/fall water temperature management operations under Alternative 1, especially with respect to the Shasta temperature control device (TCD), are expected to improve temperature and dissolved oxygen conditions experienced by incubating Winter-Run Chinook Salmon eggs and alevins.

Alternatives 2 and 3 would likely not result in reduced temperature-related mortality of Winter-Run Chinook Salmon eggs and alevins relative to the No Action Alternative because these action alternatives protect no better than the No Action Alternative against a depleted cold water pool (Appendix O, Figure O.3-18 - HEC-5Q Sacramento River Water Temperatures at Keswick Dam under the No Action Alternative, Alternative 1, Alternative 2, Alternative 3 and Alternative 4; October). In contrast, Alternative 4 is expected to provide a similar level of protection to Alternative 1 (Appendix O, Figures O.3-18 and O.3-20 - HEC-5Q Sacramento River Water Temperatures at Keswick Dam under the No Action Alternative, Alternative 1, Alternative 2, Alternative 3 and Alternative 4; September).

The proposed improved TCD under Alternative 1, as well as Rice Decomposition Smoothing, Spring Management of Spawning Locations, Battle Creek Restoration, and Intake Lowering near Wilkins Slough, would further facilitate increased cold water storage, resulting in greater protection of the Winter-Run and Spring-Run Chinook Salmon population.

5.5.1.4 Feather River

Average flows under Alternatives 1 through 3 are slightly greater than under the No Action Alternative from December to March, so the effects on eggs and rearing juveniles would be negligible and potentially beneficial because of the increased availability of habitat for these life stages. Increased flows under the action alternatives from May to June, during Spring-Run Chinook Salmon migration and holding, would provide potential temperature and fish passage benefits.

Modeled maximum water temperatures under the action alternatives and the No Action Alternative would exceed the recommended 55°F criterion for spawning, egg incubation, and rearing (USEPA 2003) from September to November, a period of Spring-Run Chinook Salmon egg incubation and juvenile rearing, which could reduce survival of these life stages.

Overall, simulated flows under the Alternative 4 and No Action Alternative scenarios are similar, but flows under the No Action Alternative are higher in September of wet and above normal years, and flows under Alternative 4 are higher in April and May of wet water years, from March through June of above normal water years, from January through May of below normal and dry water years, and in June of critically dry water years

Winter-Run Chinook are not likely to be affected by changes in flow under Alternative 4 compared to the No Action Alternative due to their limited distribution in the Feather River. Flow-related actions under Alternative 4 would have beneficial effects on Spring-Run Chinook Salmon and Fall-Run Chinook Salmon.

5.5.1.5 Stanislaus River

Alternative 1 and 4 flows would be slightly reduced but generally similar to the No Action Alternative. Flows under Alternatives 2 and 3 are the same and would be substantially reduced below Goodwin Dam from February through September, and at the mouth of the Stanislaus River from March through May compared to the No Action Alternative. Reduced flows under Alternatives 2 and 3 would likely result in reductions to suitable habitat area for juvenile salmonids.

Compared to the No Action Alternative, Alternatives 1 through 4 increase the annual storage and, therefore, the size of the cold water pool in New Melones Reservoir, with the largest storage quantities occurring under Alternatives 2 and 3. Temperature modeling for the Stanislaus River at Ripon shows that there is a small increase in overall annual water temperature for Alternatives 1 through 4 relative to the No Action Alternative. Reduced flows in above normal water years and normal water years may increase water temperatures in these less critical hydrologic conditions, however, this promotes additional storage at New Melones Dam for potential future droughts and preserves the cold water pool to benefit downstream salmonids.

Under Alternative 1, the proposed dissolved oxygen compliance point is protective of salmonids because the majority of salmonid eggs, alevin, and/or fry are found in locations where summer dissolved oxygen levels would be expected to be maintained at or near 7 mg/L, although it reduces the area of suitable dissolved oxygen as compared to the No Action Alternative. However, based on the typical seasonal occurrence of the adult life stages in the river (July to October), adult migrating salmonids would potentially be exposed to the effects of relaxing dissolved oxygen requirements at Ripon.

5.5.1.6 San Joaquin River

Analyses of flow for Alternatives 1 through 4 compared to the No Action Alternative show that releases in the San Joaquin River below Millerton Reservoir would remain the same for all scenarios. Therefore, no change to salmonid populations is anticipated as a result in the upper San Joaquin River.

5.5.1.7 Bay-Delta

Under Alternatives 1, 2, and 3, CVP and SWP exports increase during the migration window for juvenile Winter-Run, Spring-Run, and Fall-Run Chinook Salmon as compared to the No Action Alternative whereas exports under Alternative 4 are similar to the No Action Alternative. Salvage and loss of juvenile

Winter-Run, Spring-Run, and Fall-Run Chinook have been shown to increase as exports increase. However, only a small proportion of the total population is lost at the export facilities. Increased flow in the Sacramento River mainstem would occur under all action alternatives, and higher flow has been shown to increase through-Delta survival of juvenile Chinook Salmon and reduce routing into the interior Delta at Georgiana Slough. The Sacramento River mainstem is the primary migration route for juvenile Winter-Run, Spring-Run, and Fall-Run Chinook Salmon, thus a much greater proportion of the population would be exposed to the positive effects of greater Sacramento River flows than would be exposed to the negative effects of increased exports. Under all action alternatives flows in the Sacramento River would be greater during the Winter-Run migration period which would increase survival and reduce routing into the interior Delta at Georgiana Slough (Perry et al. 2015). San Joaquin River-origin juvenile Spring-Run Chinook Salmon are likely to be entrained at the salvage facilities at higher rates under Alternatives 1 through 3 and similar under Alternative 4 as compared to the No Action Alternative. San Joaquin River-origin juvenile Fall-Run Chinook Salmon are likely to be entrained at the salvage facilities at higher rates under all action alternatives as compared to the No Action Alternative.

5.5.2 Program-Level Effects

Potential changes in erosion or quality of land or sites of religious or cultural importance to federally recognized Indian tribe

As described in Appendix X, no changes in peak flows are expected as a result of program-level actions for Alternatives 1, 3, and 4. Therefore, stream channel erosion under Alternatives 1, 3, and 4 would be the same as under the No Action Alternative. Proposed restoration components have the potential to be implemented on land or sites of religious or cultural importance. The magnitude of effect would depend upon the size, location, and type of restoration implemented at the land or site and will be examined and evaluated in subsequent analyses. Alternative 3 has the greatest potential to affect ITAs as a result of habitat restoration of 25,000. There are no program-level components proposed for Alternative 2.

Potential changes in quality of water utilized by a federally recognized Indian tribe

As described in Appendix G, program-level actions and construction activities under Alternatives 1, 3, and 4 could have water quality implications. These include increased turbidity, mercury and selenium bioaccumulation, dissolved organic carbon, and increased sedimentation. However, adverse effects on water quality and violations to water quality standards are not expected from the Alternatives 1, 3, and 4 program-level activities. There are no program-level components proposed for Alternative 2.

Potential to change salmonid populations.

Alternative 4 proposes to implement program-level water use efficiency measures that would improve agricultural and municipal and industrial water use efficiency. Implementation of these measures could reduce reliance upon water supply deliveries, which would reduce need for exports and provide more water for salmonids in the rivers that supply water to the CVP and SWP. This benefit is as yet undefined, however, and would need to be quantified in subsequent analysis. Proposed restoration components under Alternatives 1 and 3 are not anticipated to be implemented on any federally recognized tribe's reservation and therefore would have no impact to the fishing rights of federally recognized tribes in the project area. It is not anticipated that there would be any construction-related effects on salmonids as a result of implementation of Alternative 4. There are no program-level components proposed for Alternative 2.

5.5.3 Mitigation Measures

In the event implementation of habitat restoration in the study area under Alternative 1 and Alternative 3 could affect ITAs, which are not identifiable at this time in the programmatic action phase, the following mitigation measures have been identified as potential measures to avoid and minimize potential effects on ITAs:

- Mitigation Measure ITA-1: Consult with Tribal Entities Consistent with Secretarial Order 3175
- Mitigation Measure WQ-1: Implement a Spill Prevention, Control, and Countermeasure Plan
- Mitigation Measure WQ-2: Implement a Stormwater Pollution and Prevention Plan
- Mitigation Measure WQ-3: Develop a Turbidity Monitoring Program
- Mitigation Measure WQ-4: Develop a Water Quality Mitigation and Monitoring Program

5.6 Air Quality

5.6.1 Project-Level Effects

Potential changes in emissions from fossil-fueled powerplants

The action alternatives would change operations of the CVP and SWP, which could change river flows and reservoir levels. These changes could affect the amount hydroelectric generation at the CVP and SWP facilities. As discussed in Appendix U, *Power and Energy Technical Appendix*, Alternatives 1, 2, and 3 would increase both power generation and energy use for the CVP compared to the No Action Alternative. In contrast, Alternative 4 would decrease both power generation and energy use for the CVP compared to the No Action Alternative.

Under all of the action alternatives, the CVP would generate more power than it uses. Although the CVP would generate more energy than it uses, its energy use would be increased. For the SWP, Alternatives 1, 2, and 3 would also increase both power generation and energy use compared to the No Action Alternative, whereas Alternative 4 would decrease both power generation and energy use. Under all of the action alternatives, the SWP would use more power than it produces. Under Alternatives 1, 2, and 3, although the CVP by itself would produce more power than it uses, the CVP and SWP combined would use more power than they produce. The SWP would purchase power from the regional electric system (the grid) to meet demand for power. To the extent that the additional purchased power would be generated by fossil-fueled powerplants, emissions from these plants would increase. Under Alternative 4, the CVP and SWP combined would produce more power than they use. To the extent that the power sold to the grid would have been generated by fossil-fueled powerplants, emissions from these plants would decrease. Although the specific power purchases and sales that the CVP and SWP may make in the future are not known, approximately 50% of the grid electricity in California was generated by fossil-fueled plants in 2016 (USEPA 2018). Air quality effects associated with changes in hydropower generation, and consequently in grid power, were evaluated on a project-wide basis in terms of air pollutant emissions from fossil-fueled powerplants. For the details of the power modeling on which the air quality analysis was based, see Appendix U, Attachment 1. For the details of the air quality analysis see Appendix L, *Air Quality Technical Appendix*. Table 5.6-1, Emissions Associated with Grid Energy Generation, presents the estimated emissions associated with grid power generation for an average year. Figure 5.6-1, Emissions from Grid Power Generation, and Figure 5.6-2, Emissions from Grid Power Generation Compared to the No Action Alternative, show the emissions of each pollutant and the changes compared to the No Action Alternative for grid power generation, respectively. Table 5.6-1 and Figure 5.6-1 show

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Sent: 4/23/2021 8:39:32 AM
To: Spranza, John [john.spranza@hdrinc.com]; Greg Reis [reis@bayecotarium.org]
CC: Alicia Forsythe [aforsythe@sitesproject.org]; Huber, Anne [Anne.Huber@icf.com]
Subject: RE: Sites Project Water Quality Group Discussion-Materials

Thanks John, that is very helpful.
Greg

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: "Spranza, John" <John.Spranza@hdrinc.com>
Date: 4/23/21 7:50 AM (GMT-08:00)
To: Greg Reis <reis@bayecotarium.org>
Cc: "aforsythe (aforsythe@sitesproject.org)" <aforsythe@sitesproject.org>, "Huber, Anne" <Anne.Huber@icf.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

Hi Greg,

I spoke with the water quality team and the general consensus is yes, the high values in February, May, August, and November are due to the water quality sampling pattern, especially for Colusa Basin Drain (CBD). Similar to the ongoing North Delta Flow Action that redirects a late-summer pulse of agricultural drainage or Sacramento River flow into the Yolo Bypass to enhance the quantity and quality of food for Delta Smelt, Sites' WSIP Ecosystem Benefit water would also be sent to the Yolo Bypass via the CBD for similar purposes at approximately the same time.

With respect to Sites' water being used to irrigate contaminated soils, while Sites participants may use the water for agriculture in the Sacramento Basin, the runoff from irrigated fields is regulated by the Irrigated Lands Regulatory Program, which sets limits for runoff that would need to be met by irrigators. You can find some additional information on the Program here: <https://www.svwqc.org/>. It's also worth noting that Sites' winter releases via the CDB would generally have the effect of diluting constituent concentrations in CBD, such as Diazinon, which is mostly a winter problem.

I hope this answers your questions, but if not please let me know and we can discuss further.

Thanks.

John Spranza

D 916.679.8858 M 818.640.2487

From: Greg Reis <reis@bayecotarium.org>
Sent: Monday, April 12, 2021 11:09 AM
To: Spranza, John <John.Spranza@hdrinc.com>
Subject: RE: Sites Project Water Quality Group Discussion-Materials

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Thanks John, I'm sorry I missed the meeting. A quick question—is the Feb, May, Aug, Nov pattern of high concentrations evident for many constituents an effect of a quarterly sampling protocol? Or is this due to the timing of draining fields? These attachments show there are clear water quality problems due to agricultural drainage, and I'd hope that Sites operations wouldn't contribute to these (esp. by sending water to irrigate contaminated soils, or directing high-Diazinon water to Yolo Bypass without adequate dilution—examples where Sites operations could have a big negative effect).

I hope I'm able to make the next meeting.

Thanks,
Greg

Greg Reis

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The Bay Institute | Aquarium of the Bay | EcoCenter at Heron's Head Park
Sea Lion Center | The Bay Academy | Bay Model Alliance

*Our mission is to protect, restore, and inspire conservation of San Francisco Bay
and its watershed, from the Sierra to the Sea™*

From: Spranza, John [<mailto:John.Spranza@hdrinc.com>]

Sent: Friday, April 9, 2021 2:56 PM

To: tstokely@att.net; jimb@aqualliance.net; dobegi@nrdc.org; Greg Reis <reis@bayecotarium.org>; rzwillinger@defenders.org; DLucero@ButteCounty.net; rebeccadawnwu@yahoo.com; chicojerry@yahoo.com; regina@californiasalmon.org; Huber, Anne <Anne.Huber@icf.com>; Williams, Nicole (Nicole.Williams@icf.com) <Nicole.Williams@icf.com>; Micko, Steve/SAC (Steve.Micko@jacobs.com) <Steve.Micko@jacobs.com>; David Zelinsky <zelinsky.david@gmail.com>; asanchez@calwild.org; Ron Stork <RStork@friendsoftheriver.org>

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Subject: Sites Project Water Quality Group Discussion-Materials

Hello,

Thank you for attending our Water Quality Discussion on Wednesday. I wanted to follow up and provide the presentation and the supplemental figures for Metals, Nutrients, and Pesticides that we discussed, they are attached.

I will follow up on the Action Items below in a separate email, please let me know if you have any additions.

1. Discussion of the Preferred Alternative selection
2. Provide a table with data details such as location, timing and number of data points
3. Schedule 90 minute meeting in May

Lastly, the following are future agenda topics that were identified during our meeting:

- Water quality effects to Stone Corral and Funks Creeks from the annual/semiannual filling and emptying of the reservoir.
- Effects of arsenic on rice as it relates to Sites' releases.
- Discuss Sites effect on the anti-degradation policy.
- Mercury releases and effects on rice and water
- Exchanges between Sites and DWR

Please let me know if you have any questions.

Regards,

John

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

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From: Luu, Henry [Henry.Luu@hdrinc.com]
Sent: 4/23/2021 11:22:13 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites Project - Follow Up on Flood Control Question

Hi Ali,

At the Land Management Committee meeting this past Tuesday it was recommended the project remove consideration of the emergency release structures (ERS) at Saddle Dams 3 and 5 as a value engineering measure for a project cost savings of about \$95M. This was well received by the LMC and the engineering team will update the Feasibility Cost Estimate with this saving; it's straight forward on the cost estimate, but I'm not sure how this change will impact the environmental team's ongoing effort. If acceptable, it may be beneficial if we can chat during our Monday leadership meeting before you respond to Ron.

Other than removal of the ERS, the only thing I recommend changing in your response is deleting reference to controlled emergency releases at Saddle Dam 8B spillway. The spillway release will be uncontrolled other than constraints from its sizing, however we do not anticipate the need for its use based on the set crest elevation to accommodate the PMF.

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From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Friday, April 23, 2021 9:46 AM
To: Luu, Henry <Henry.Luu@hdrinc.com>
Subject: Sites Project - Follow Up on Flood Control Question

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Henry – I need to close this one out as its been hanging out there for a while (my bad). See the write up below. I realize that things have changed recently, so wanted to make sure that I am sending the most accurate information. Can you review this and let me know if I should make any changes? Thank you! This email will go to Ron Stork with Friends of the River.

Ali

Hi Ron – I wanted to follow up on one of your questions on spillways. My apologies for the delay in getting back to you on this.

We have spillways described in the Preliminary Draft Project Description that we released in February (attached). See page 2-79 for a discussion of emergency releases, as the Project will also include emergency releases into Funks and Stone Corral Creeks through low-level releases in both Sites and Golden Gate Dams in addition to the spillway structures described below.

All of the alternatives will have a spillway in Saddle Dam 8B. Here's the description from the Project Description for this facility (see the file for the schematic).

Saddle Dam 8B would contain the reservoir spillway (see Figure 2-31). The crest width for the dam would be designed to accommodate a 16-foot-wide crest road with suitable concrete or metal guardrails on both sides. The length of the spillway crest section would be based on flood routing analyses, and the crest elevation would be based on the size of the reservoir and normal operating water surface elevation. This elevation would allow storage of the PMF without spilling and have sufficient capacity to pass the volume of over-pumping water in the unlikely event that over-pumping occurred for more than 10 days; it would also enable controlled emergency releases to the local receiving drainage, Hunters Creek. See Figure 2-31, Saddle Dam 8B Spillway, for a schematic of the spillway.

Alternative 1 and 3, the 1.5 million acre-foot reservoir, will also include emergency release structures on Saddle Dams 3 and 5. Here's the description from the Project Description for these facilities.

Saddle Dams 3 and 5 would be designed to release emergency flows. Therefore, these two saddle dams would have an intake in the reservoir, a tunnel under the ridge, and an outlet structure to provide energy dissipation and controlled emergency releases of water to the local receiving drainage, Hunters Creek. The intake would be a reinforced concrete structure of appropriate length (approximately 65 linear feet with trashracks). The tunnel would be reinforced concrete with a steel liner; its diameter is expected to range from 10 to 12 feet, and it would be approximately 830 linear feet. The energy dissipation structure would be a reinforced concrete structure containing one or multiple energy dissipation valves within steel-lined chambers to contain spray and provide controlled release of water to Hunters Creek. The size of the energy dissipation chambers would be determined based on manufacturer recommendations. A riprap-lined basin would extend for a minimum of 100 feet downstream of the energy dissipation structure to transition the discharge to the receiving channel.

Hopefully this helps. Let me know if there is more information you would like on spillways.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 |
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CC: Susan Lassell - ICF (Susan.Lassell@icf.com) [Susan.Lassell@icf.com]; Janis Offermann [janis@horizonh2o.com]; Wolf, Barbara [Barbara.Wolf@icf.com]; Lloyd, John [John.Lloyd@hdrinc.com]
Subject: Sites - AB52 Geographic Scope Memo
Attachments: Ramifications of Expanding the Geographic Limits Required Under_AB52_04232021.docx

Hello,

Please find attached the AB52 Geographic Scope Memo prepared by Janis and Barbara. I think this memo does an excellent job of describing the different geographic scopes we have been considering and the general implications of each.

Please let us know if you have any questions or require any further info before next weeks' call. Thanks, Danielle

Danielle Risse, M.A.
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**Consideration of Expanding the Geographic Limits Required Under Assembly Bill 52
for the Sites Reservoir Project
April 26, 2021**

This memorandum serves to provide information related to identifying tribes that may be potentially affected by the Sites Reservoir Project (project), as prescribed under the requirements of the California Environmental Quality Act and Public Resources Code (PRC) Section 21080.3.1 (commonly referred to as Assembly Bill 52 [AB52]). This memo provides a comparison of different geographic scopes for the Sites Reservoir Project and how a focused or expansive scope definition relates to the identification of potentially affected Native American tribes and tribal cultural resources (TCRs). The premise of this memorandum is that defining the scope of the Sites Reservoir Project analysis, in turn, directly affects the geographic area covered by the project and the subsequent list of Native American tribes that may be affected.

There are four parts to this memorandum: 1) a description of potential project impacts to tribal cultural resources (TCRs); 2) the geographic extent of potential project impacts; 3) the identification of tribes potentially affected by project impacts; and 4) the implications and ramifications of expanding the geographic scope of tribes that have been notified about the project, to date. Topics 1 through 3 provide information that addresses the direct impacts of project construction (physical, visual, auditory), as well as impacts from the regulation of water flow.

1. Potential project impacts to tribal cultural resources

Under AB 52, TCRs can be comprised of *“Sites, features, places, cultural landscapes, sacred places, and objects with cultural value...”*, as listed under PRC Section 21074(a). The following lists identify how TCRs could be potentially impacted.

- A. Direct impacts due to project construction (physical/visual/auditory impacts):
 - Direct physical impacts that could damage or destroy TCRs; primarily the construction of facilities and the filling of Sites Reservoir.
 - Physical impacts that change the character or integrity of a place associated with events or the lives of persons important to one or more California Native American tribes.
 - Physical impacts that interfere with a place’s potential to yield information important to the history or prehistory of an area important to one or more California Native American tribes.
 - Loss of access to important sites or landscape features (E.g., safety fencing to keep people out of potential flooding or maintenance areas).
 - Auditory or visual disturbance at sacred sites that require solitude or involve a particular viewshed or vista.
 - Noise that disturbs or drives away wildlife considered culturally important.
 - Introduction of invasive species, or use of herbicides or pesticides, that significantly impacts the survival, abundance, or distribution of culturally important biological resources.
 - Changes that might attract visitors or activities that could damage culturally important landscapes, locations, or resources; or interfere with traditional uses.
- B. Impacts from regulation of water flow:
 - Loss of access to traditional fishing or gathering areas.

- Harm to traditional subsistence aquatic resources (wildlife or plant) from changes in flow or water levels.
- Harm or loss of access to riparian resources, such as basketry or medicinal plants, along main stem and/or tributaries, from too little or too much water.
- Obstruction, damage, or destruction of sacred sites or other types of culturally important sites on shore by higher flows or water levels.
- Exposure of buried or underwater sites or artifacts by lower or fluctuating water levels, making them vulnerable to damage, theft, and vandalism.
- Reduction of water supply or water quality that supports TCRs or tribal activities.

2. Geographic extent of potential project impacts

The construction of new facilities for the project that could have a direct physical, visual, or auditory impact to TCRs extends from the Red Bluff Pumping Plant on the Sacramento River in Tehama County in the north (though technically, this is already built), south into Yolo County with the construction of the Dunnigan Pipeline and the Colusa Basin Drain Outlet or the Sacramento Discharge Facility. Most of the direct impacts will be in Colusa County by constructing the dams to contain Sites Reservoir and all the appurtenant facilities (permanent and temporary) as described in the project description for the Revised Environmental Impact Report (EIR). A small portion of the reservoir and the northernmost saddle dams will be in Glenn County. Improvements to the Glenn-Colusa Irrigation District Main Canal will occur in Glenn and Colusa counties.

Counties with direct impacts from the project include **Tehama, Glenn, Colusa, and Yolo**.

Operations of the project would alter the way water is currently managed for the Sacramento River from just below Keswick in Shasta County, south to include the Yolo Bypass in Yolo County. The possibility of exchanges of water with the Central Valley Project and State Water Project involves water held in Shasta, Oroville, and Folsom reservoirs that would affect the timing of water releases during years when Sites Reservoir contains sufficient water to augment these other sources. Under the expanded geographic scope of the project, these potential water exchanges would extend the geographic area of the project north along the Sacramento River from Keswick to Shasta Dam, all in Shasta County; along the length of the Feather River from Oroville Dam in Butte County to the confluence of the Feather River with the Sacramento River at the Sutter/Yolo County line (note that the river also forms the boundary between Sutter and Yuba counties); and the American River from Folsom Dam to its mouth at the Sacramento River in Sacramento County.

Counties with potential impacts from managing water flow include **Shasta, Tehama, Glenn, Colusa, Yolo, Butte, Sutter, Yuba, Sacramento, and Solano**.¹

3. Identification of tribes potentially affected by project impacts

Seven Native American tribes were contacted under AB 52 for the Draft EIR in 2017, and these same seven tribes were notified about the revised EIR in 2020. These tribes are highlighted in Table 1; they are also the tribes that would be most affected by the direct impacts of project construction. Two of the

¹ The reservoirs behind each of these dams were not included in this review. If included, tribes in Placer and El Dorado counties (Folsom Reservoir) would also be under consideration.

tribes, Colusa and Yocha Dehe, are currently in formal AB 52 consultation with the Authority. None of the other five tribes have responded to letters or emails with requests for comments, concerns, or information about TCRs, or the desire for AB 52 consultation. Table 1, further, lists those additional tribes that border the Sacramento, Feather, and American rivers that could have TCRs impacted by changes in water flows. The addition of these river reaches adds an additional nine tribes to the list. None of these additional nine tribes have been formally contacted, to date.

Four more tribes (beyond the nine noted above) would be included if all tribes in all affected counties are taken into account (see Table 2).

4. Implications and ramifications of expanding tribal contacts

To date, the Authority has followed the standard, established protocol for AB 52, which is to contact all tribes identified by the Native American Heritage Commission within the geographic area associated with direct project impact. This outreach has resulted in formal AB 52 consultation with the Colusa and Yocha Dehe tribes. Text in the Legislative Counsels' Digest associated with AB 52 also notes that consultation about TCRs should be with tribes who are *"traditionally and culturally affiliated with the geographic area of the proposed project..."* By not expanding the current AB 52 outreach effort, it can be argued that the Authority has fulfilled both the requirements as well as the intent of the law.

The definition of a TCR is critical to the expansion of the geographic scope of AB 52 outreach. As previously noted, the definition of a TCR under PRC Section 21074(a) includes *"Sites, features, places, cultural landscapes, sacred places, and objects with cultural value..."* This implies that TCRs are specific tangible places or items. Entities who have proposed expanding the geographic area to include river reaches with modified water flows have indicated that natural elements such as water and fish could possibly be considered TCRs. This would also be precedent setting, as these elements of nature are not tied to a specific geographic location, seemingly in contrast to the language used to define a TCR. It could be compared to saying that air is a TCR; it moves around or by us but does not stay in one place.

Expanding the AB 52 outreach to tribes along river reaches subject to modified water flows, but where no physical modifications would be made, would set a precedent for expanding the geographic extent of a project area beyond potential areas of physical, visual, and auditory impacts from construction. Furthermore, it is important to remember that Section 11(b) of AB 52 allows any California Native American tribe or individual to participate in the CEQA process on any issue of concern as an interested California Native American tribe, person, citizen, or member of the public without formal consultation under AB 52.

Possible ramifications for expanding the geographic limits AB 52 consultation include the following:

- Precedent setting in expanding the geographic limits of a project beyond the geographic area of the project footprint.
- Precedent setting by including tribes not associated with the geographic area of the project footprint.
- Precedent setting in expanding the definition of a TCR.
- Involving additional tribes in AB 52 consultation would likely be time-consuming and may delay the resolution of AB 52 consultation, relative to the current schedule for completing the public Revised EIR and/or the Final Revised EIR.

- Involving additional tribes in AB 52 consultation could result in proposed mitigation that conflicts with the mitigation recommendations from tribes who have a long-established consultation history with the Authority.
- Involving additional tribes beyond the project foot print in AB 52 consultation could erode the trust relationship between the Authority and tribes who have already entered into consultation.

TABLE 1: Tribes Potentially Affected by Project Impacts

TRIBE	COUNTY	GEOGRAPHIC ASSOCIATION with the Sites Project (a. Physical/visual/auditory impacts)	GEOGRAPHIC ASSOCIATION with the Sites Project (b. Impacts from regulation of water flow)
Cachil Dehe Band of Wintun Indians	Colusa Glenn Yolo	Sites Reservoir Funks Reservoir Terminal Regulating Reservoir Transmission Lines Road Construction Tehama Colusa Intake Dunnigan Pipeline Colusa Basin Drain Outlet Sacramento River Discharge	West bank of the Sacramento River from around Princeton to at least the mouth of the Feather River, and likely into the Yolo Bypass
Yocha Dehe Wintun Nation	Colusa Glenn Yolo	Sites Reservoir Funks Reservoir Terminal Regulating Reservoir Transmission Lines Road Construction Tehama Colusa Intake Dunnigan Pipeline Colusa Basin Drain Outlet Sacramento River Discharge	West bank of the Sacramento River from around Princeton to at least the mouth of the Feather River, and likely into the Yolo Bypass
Cortina Indian Rancheria of Wintun Indians	Colusa Glenn Yolo	Sites Reservoir Funks Reservoir Terminal Regulating Reservoir Transmission Lines Road Construction Tehama Colusa Intake Dunnigan Pipeline Colusa Basin Drain Outlet Sacramento River Discharge	West bank of the Sacramento River from around Princeton to at least the mouth of the Feather River, and likely into the Yolo Bypass
Grindstone Indian Rancheria of Wintun-Wailaki	Colusa Glenn	Sites Reservoir Funks Reservoir Road Construction	N/A, This tribe represents communities associated with the North Coast Ranges and foothills
Paskenta Band of Nomlaki Indians	Glenn Tehama Butte	Red Bluff Pumping Plant	Both sides of the Sacramento River from Cottonwood Creek to about Corning
Estom Yumeka Maidu Tribe of the Enterprise Rancheria	Glenn Tehama Butte	GCID Main Canal Head Gate Structure	Both sides of the Sacramento River from about Corning to Princeton, though their actual ancestral territory is the Middle Fork of the Feather River above Oroville Dam.*
Mechoopda Indian Tribe	Glenn Tehama Butte	GCID Main Canal Head Gate Structure	Both sides of the Sacramento River from about Corning to Princeton
Wintu Tribe of Northern California	Shasta		Both sides of the Sacramento River from Keswick to near Cottonwood Creek; also from Keswick north to Shasta Dam.

Redding Rancheria	Shasta		Both sides of the Sacramento River from Keswick to near Cottonwood Creek, and the east side of the river from Cottonwood to near Corning. (This tribe includes Wintu and Yana descendent.) Also, from Keswick north to Shasta Dam.
United Auburn Indian Community of the Auburn Rancheria	Sutter Sacramento Yolo Yuba		Both sides of the Sacramento River from at least the mouth of the Feather River to near the Cosumnes River. Both sides of the Feather River from around the Butte/Yuba County line to the Sacramento River. Both sides of the American River from Folsom Dam to the Sacramento River.
Shingle Springs Band of Miwok Indians	Sutter Sacramento Yolo Yuba		Both sides of the Sacramento River from at least the mouth of the Feather River to near the Cosumnes River. Both sides of the Feather River from around the Butte/Yuba County line to the Sacramento River. Both sides of the American River from Folsom Dam to the Sacramento River.
Ione Band of Miwok Indians	Sacramento		Both sides of the Sacramento River from at least the mouth of the Feather River to Suisun Bay. Both sides of the American River from Folsom Dam to the Sacramento River.
Wilton Rancheria	Sacramento		Both sides of the Sacramento River from at least the mouth of the Feather River to Suisun Bay.
Konkow Valley Band of Maidu	Butte Sutter		Both sides of the Sacramento River from about Corning to Princeton Both sides of the Feather River from Oroville Dam to around the Butte/Yuba County line
Moortown Rancheria of the Maidu Indians of California	Butte		South Fork Feather River above Oroville Dam*
The Berry Creek Rancheria of Maidu Indians of California (Tyme Maidu Tribe	Butte		North Fork Feather River above Oroville Dam*
Notes: Shaded tribes are those that were identified by the Native American Heritage Commission and who were contacted for the Draft EIR, as well as for the Revised EIR. The ancestral territory of the Winnemem Tribe is the upper Sacramento above Shasta Dam and the McCloud River and, therefore, is not included here. Similarly, the Pit River Tribes are along the Pit River. *The traditional ancestral lands of the Berry Creek, Enterprise, and Mooretown Maidu are the North Fork, Middle Fork, and South Fork of the Feather River above Oroville Dam, respectively. However, they would all likely claim the Feather River below Oroville Dam. These three tribes are federally recognized and have casinos below the dam in Oroville or elsewhere, while the Konkow Valley Band of Maidu is not federally recognized.			

If the approach elects to include all tribes within a particular county, the following tribes would be included.

TABLE 2. Additional Tribes in Affected Counties

COUNTY	TRIBES
Shasta	Winnemem
Tehama	Greenville Rancheria
Butte	Pakan'yani Maidu of Strawberry Valley
Sacramento	Nashville Enterprise Miwok-Maidu-Nishinam Tribe

From: Thayer, Reed/SAC [Reed.Thayer@jacobs.com]
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CC: steve.micko@jacobs.com; Leaf, Rob/SAC [Rob.Leaf@jacobs.com]
Subject: Sensitivity Analysis of Alternative 1B with no Lake Oroville Exchange Operation
Attachments: _SA_noOroville.7z

Erin and Ali,

I have attached a summary of our sensitivity analysis of Alternative 1B with no Lake Oroville exchange operation. Please let me know if you have any questions.

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CVP/SWP Deliveries Table

Deliveries (TAF/year) (change from No Project Alternative conditions) ^a	ALT 1B 011221		ALT 1B 011221 SA No Oroville	
	Average	Dry and Critical	Average	Dry and Critical
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	
CVP Deliveries	11	29	8	27
NOD Ag	0	5	0	4
NOD M&I	0	0	0	0
SOD Ag	10	24	8	22
SOD M&I	1	0	0	0
Subtotal - CVP Operational Flexibility (Diff from Alt A1 CVP values)	8	19	6	17
CVP Refuge Water Supply	1	2	1	1
NOD (Level 2)	1	2	1	1
SOD (Level 2)	0	0	0	0
SWP Deliveries	-2	0	2	-4
SWP SOD Ag (Table A)	0	1	0	0
SWP SOD M&I (Table A)	-1	1	-3	-5
SWP SOD Interruptible (Article 21)	-1	-1	4	1
Total change in CVP/SWP Deliveries with CVP Operational Flexibility	10	31	11	24
Total change in CVP/SWP Deliveries without CVP Operational Flexibility	2	12	5	7

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)

Authority Deliveries Table

Deliveries (TAF/year) (change from No Project Alternative conditions) ^a	ALT 1B 011221		ALT 1B 011221 SA No Oroville	
	Average	Dry and Critical	Average	Dry and Critical
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	
Authority PWA Deliveries	119	286	117	282
NOD	29	60	29	60
SOD	91	226	88	222
CVP Operational Flexibility	8	19	6	17
Sub-Total Supplemental Deliveries for Water Supply	127	305	123	299
Refuge Water Supply	20	34	20	33
NOD (Level 4)	5	6	5	6
SOD (Level 4)	15	27	15	27
Yolo Bypass Habitat Water Supply	36	21	36	17
Total Authority Deliveries	184	359	179	349
Percentage of Total Authority Deliveries				
Authority PWA Deliveries - North of Delta	16%	17%	16%	17%
Authority PWA Deliveries - South of Delta	49%	63%	49%	64%
CVP Deliveries - Operational Flexibility	4%	5%	3%	5%
Refuge Water Supply	11%	9%	11%	9%
Yolo Bypass Habitat Water Supply	20%	6%	20%	5%

Consideration of Incidental Change to CVP and SWP Deliveries				
Incidental Change to CVP and SWP Deliveries without CVP Operational Flexibility	2	12	5	7
Total Authority, CVP and SWP Deliveries	186	371	184	357
Incremental Change as a Percentage of Total Authority Deliveries	1%	3%	3%	2%
Incremental Change as a Percentage of Total Authority, CVP and SWP Deliveries	1%	3%	3%	2%

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)

Storage Table

Storage Increases (TAF) (above No Project Alternative conditions) ^a	ALT 1B 011221		ALT 1B 011221 SA No Oroville	
	Average	Dry and Critical	Average	Dry and Critical
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	
Additional end-of-September storage	50	72	38	52
Trinity	0	0	0	0
Shasta	28	39	30	45
CVP Storage	25	31	27	36
Subtotal - CVP OpFlex Storage (Diff from Alt A1 CVP values)	18	21	20	26
Storage exchanged from Sites	3	9	3	8
Oroville	12	21	-2	-5
SWP Storage	-6	-16	-2	-5
Sites Delta Participants Storage	17	36	0	0
Folsom	9	12	9	12
Subtotal - CVP OpFlex Storage (Diff from Alt A1 CVP values)	6	7	6	7
Percentage of Total Additional End-of-September Storage				
Portion of total additional end-of-September storage				
Trinity	0%	0%	0%	0%
Shasta	57%	55%	80%	86%
Oroville	24%	29%	-5%	-9%
Folsom	19%	16%	25%	23%

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)

Sites Releases Table

Releases (TAF/year)	ALT 1B 011221		ALT 1B 011221 SA No Oroville	
	Average	Dry and Critical	Average	Dry and Critical
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	
Releases for Authority PWA Deliveries - North of Delta	29	60	29	60
Assumed transfer from North of Delta to South of Delta	6	6	6	6
Releases for Authority PWA Deliveries - South of Delta	105	250	100	239
Releases for CVP Deliveries - Operational Flexibility	28	26	28	28
Releases for Refuge Water Supply	24	38	24	37
Releases for Yolo Bypass Habitat Water Supply	41	24	41	20
Total Releases	234	404	229	390
Percentage of Total Releases from Sites				
Releases for Authority PWA Deliveries - North of Delta	12%	15%	13%	15%
Assumed transfer from North of Delta to South of Delta	3%	2%	3%	2%
Releases for Authority PWA Deliveries - South of Delta	45%	62%	44%	61%
Releases for CVP Deliveries - Operational Flexibility	12%	7%	12%	7%
Releases for Refuge Water Supply	10%	9%	11%	10%
Releases for Yolo Bypass Habitat Water Supply	18%	6%	18%	5%

Notes:

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

Sites Fills Table

Fills (TAF/year)	ALT 1B 011221		ALT 1B 011221 SA No Oroville	
	Average	Dry and Critical	Average	Dry and Critical
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	
Fills for Authority PWA Deliveries - North of Delta	43	16	42	16
Fills for Authority PWA Deliveries - South of Delta	115	43	112	43
Fills for CVP Deliveries - Operational Flexibility	29	16	29	17
Fills for Refuge Water Supply	26	11	25	10
Fills for Yolo Bypass Habitat Water Supply	43	18	43	18
Total Fill	255	104	252	104
Percentage of Total Fills				
Fills for Authority PWA Deliveries - North of Delta	17%	15%	17%	15%
Fills for Authority PWA Deliveries - South of Delta	45%	41%	44%	41%
Fills for CVP Deliveries - Operational Flexibility	11%	16%	12%	16%
Fills for Refuge Water Supply	10%	11%	10%	10%
Fills for Yolo Bypass Habitat Water Supply	17%	17%	17%	17%

Notes:

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

Sites Storage Allocation Table

Storage Volumes (TAF)	ALT 1B 011221	ALT 1B 011221 SA No Oroville
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD) Historic Climate
Authority PWA Deliveries - North of Delta	256	256
TCCA	138	138
GCID	31	31
RD108	25	25
Other Sacramento Valley	62	62
Authority PWA Deliveries - South of Delta	788	788
CVP Deliveries - Operational Flexibility	91	91
Refuge Water Supply	124	124
Yolo Bypass Habitat Water Supply	120	120
Dead Pool Storage	120	120
Total Storage	1499	1499
Percentage of Total Storage Capacity		
Authority PWA Deliveries - North of Delta	17%	17%
Authority PWA Deliveries - South of Delta	53%	53%
CVP Deliveries - Operational Flexibility	6%	6%
Refuge Water Supply	8%	8%
Yolo Bypass Habitat Water Supply	8%	8%
Dead Pool Storage	8%	8%

Notes:

Results are dependent on storage allocations

Ratios Table

Ratios	ALT 1B 011221			ALT 1B 011221 SA No Oroville		
	Releases/ Fills	Deliveries/ Releases	Estimated Salinity Cost Factor	Releases/ Fills	Deliveries/ Releases	Estimated Salinity Cost Factor
Alternative Facilities	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)			1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)		
Ratios for Authority PWA Deliveries - North of Delta	68%	100%		68%	100%	
Ratios for Authority PWA Deliveries - South of Delta	96%	81%	19%	95%	83%	17%
Ratios for CVP Deliveries - Operational Flexibility	98%	28%		98%	21%	
Ratios for Refuge Water Supply	95%	84%	16%	95%	84%	16%
Ratios for Yolo Bypass Habitat Water Supply	97%	87%		96%	87%	
Overall	92%	79%		91%	78%	

From: Alicia Forsythe [ali@forsythe-group.com]
Sent: 4/26/2021 12:44:08 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Sites Reservoir: Water Quality & Agriculture

Alicia Forsythe | Forsythe Group | 916.880.0676 | ali@forsythe-group.com

From: Williams, Nicole <Nicole.Williams@icf.com>
Sent: Monday, April 26, 2021 11:10 AM
To: John Spranza <John.Spranza@hdrinc.com>; Alicia Forsythe <ali@forsythe-group.com>
Cc: Huber, Anne <Anne.Huber@icf.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Sites Reservoir: Water Quality & Agriculture

Hello John and Ali,

Thank you for sending the information associated with TC water quality.

I understand you may be following up with others regarding temperature and other water quality constituents (e.g., arsenic) as it relates to rice/potential agricultural effects.

Would it be possible for you to obtain the following type of information to assist with our analysis and interpretation of the temperature results that Jacobs provided:

- Do rice growers currently test water quality/(rice?) for temperature/arsenic? I didn't see this in the results for the TC, but maybe I missed it?
- What are actual in-field requirements/standards for temperature/arsenic (presumably requirements/standards would be based on production)?
- What are the current in-field/off-field best management practices used to control temperature/arsenic related to rice cultivation?
- Describe temporal concerns/realities for rice related to water temperature (e.g., what times of the year and part of the growing cycle are most important to maintain temperature standards/requirements).

Many thanks for your help and please let me know if you have questions.

Cheers, Nicole

NICOLE L. WILLIAMS
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From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, April 22, 2021 3:50 PM
To: John Spranza <John.Spranza@hdrinc.com>; Huber, Anne <Anne.Huber@icf.com>
Subject: FW: Water Samples

Water quality info from Jeff Sutton. See his message below.

John – This brings back up the question to me of whether we would want to put a temperature probe (or a few probes) in the TC Canal and CBD this year. We should talk about this again.

Ali

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

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From: jsutton@tccanal.com <jsutton@tccanal.com>
Sent: Thursday, April 22, 2021 3:38 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Jerry Brown <jbrown@sitesproject.org>
Subject: FW: Water Samples

Ali,

See attached, four years (2017-2020) of data with a spectrum of water quality testing results of TC water quality that was diverted at Red Bluff. This testing is conducted twice a year, early spring and early fall, at one location near the headworks and at another location south of Funks Reservoir.

Hope this is helpful to you. We will be doing our early spring testing soon, will share those results once received.

Jeffrey P. Sutton
General Manager
Tehama-Colusa Canal Authority
5513 State Highway 162
PO Box 1025
Willows, CA 95988
Office (530) 934-2125
Mobile (530) 301-1030
jsutton@tccanal.com

File Provided Natively

Water Quality Group Discussion Agenda



Our Core Values – Safety, Trust and Integrity, Respect for Local Communities, Environmental Stewardship, Shared Responsibility and Shared Benefits, Accountability and Transparency, Proactive Innovation, Diversity and Inclusivity
Our Commitment – To live up to these values in everything we do

Meeting Information:

Date: April 29, 2021 **Location:** Microsoft Teams
Or call in (audio only)
(833) 255-2803,,156125785#

Start Time: 2:00 p.m. **Finish Time:** 3:00 p.m.

Purpose: Overview and discussion of the Sites Project's aquatic modeling and EIR/S analysis approach

Meeting Invitees:

André Sanchez	Rebecca Wu	Laurie Warner Herson
Dave Zelinski	Regina Chichizola	Jason Hassrick
Debra Lucero	Ron Stork	Jim Lecky
Doug Obegi	Stephanie Gordon	Marin Greenwood
Greg Reis	Suzanne Manugian	Melissa Dekar
Jerry Boles	Tom Stokely	Mike Hendrick
Jim Brobeck	Ali Forsythe	Natalie Wolder
Joe Morgan	Dan Deeds	Nicole Williams
Rachel Zwillinger	Erin Heydinger	Steve Micko
	John Spranza	Vanessa King

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductions	John	5 mins
2. Approach to Meetings	John	5 mins
3. Proposed Project	John	5 min
4. Overview of Operations	Ali	10 min
5. Modeling and Baseline	Steve Miko	25 mins
a. Models used and how applied		
6. Schedule and Future Meeting Topics	John/Group	10 mins
7. Adjourn		

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 4/27/2021 5:16:48 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Doodle Poll - Debrief and Discussion of CDFW WISP Yolo Bypass Concerns
Attachments: 2020_orlando_et_al.pdf

Good Morning,
Gould you take a second and fill this out so I can get it set?
Thanks.

John Spranza

D 916.679.8858 M 818.640.2487

From: Spranza, John
Sent: Monday, April 26, 2021 1:24 PM
To: Micko, Steve/SAC (Steve.Micko@jacobs.com) <Steve.Micko@jacobs.com>; Lecky, Jim <Jim.Lecky@icf.com>; Monique Briard (monique.briard@icf.com) <monique.briard@icf.com>; Erin Heydinger (Erin.Heydinger@hdrinc.com) <Erin.Heydinger@hdrinc.com>; aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Hendrick, Mike (Mike.Hendrick@icf.com) <Mike.Hendrick@icf.com>; Hassrick, Jason (Jason.Hassrick@icf.com) <Jason.Hassrick@icf.com>; Huber, Anne <Anne.Huber@icf.com>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Williams, Nicole (Nicole.Williams@icf.com) <Nicole.Williams@icf.com>
Subject: Doodle Poll - Debrief and Discussion of CDFW WISP Yolo Bypass Concerns

I'd like to get this group together to talk about what CDFW discussed in a recent call regarding the flows through the Yolo Bypass and their concerns with the effects on water quality and fish. Please use the following link

https://doodle.com/poll/8wnzh8w6hhncq3bc?utm_source=poll&utm_medium=link

Here are some of the points Jonathan Williams sent over, as well as resent pesticide report he provided.

Yolo Bypass Pulse Flow impacts of concern:

- Increased stray rates into the Yolo Bypass of fall-run Chinook and Steelhead. This is primarily a concern when pulses are provided in September and October.
- Temperature impacts, due to reservoir releases to the Yolo Bypass. Temperature is likely a significant driver of the lethal and sub-lethal impacts to fish that we observe in the Yolo Bypass.
- Water quality impacts, associated with delivering water through the Colusa Basin Drain. Samples collected as part of the NDFA have consistently detected concentrations of certain pesticides that exceed EPA's chronic invertebrate toxicity benchmarks. The study is currently looking into how contaminants may be affecting fish health.
- Capacity limitations in moving water through the Yolo Bypass, during the late-summer and fall period. Is there sufficient capacity to move the volumes of water that Sites is proposing, through the Yolo Bypass, given that agricultural drainage is often taking place at around the same time?

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833

D 916.679.8858 M 818.640.2487
john.spranza@hdrinc.com

hdrinc.com/follow-us
hdrinc.com/follow-us

Requested Action:

Approve release of the RDEIR/SDEIS Project Description (with Operations) to regulatory agencies and interested parties, including posting on the Authority's website, to improve Project transparency and facilitate more detailed Project discussions.

Detailed Description/Background:

At the Reservoir Committee and Board meetings in June, September and December 2020, staff provided an overview of the alternatives under consideration for the Revised Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS). Staff has continued to refine the alternatives and, with the consulting team, is nearing completion of a draft of the RDEIR/SDEIS project description.

The project description comprises Chapter 2 of the RDEIR/SDEIS. The project description includes a summary overview of the alternatives screening and selection process, an overview of the action alternatives and the no action alternative along with a detailed description for each of the three action alternatives. Also included in the project description are best management practices and environmental commitments that would be implemented under all the alternatives.

The project description continues to include three alternatives as discussed with the Reservoir Committee and Board in prior meetings. Table 1 provides a high-level summary of the three alternatives. Attachment A provides a more expansive summary table of the alternatives. The key changes to the alternatives that have been made since the previous presentations to the Reservoir Committee and Board are as follows:

- Hydropower – All alternatives include power generation incidental upon release up to 40 megawatts at Funks Reservoir and up to 40 megawatts at the Terminal Regulating Reservoir. Staff has conferred with staff at the Federal Energy Regulatory Commission (FERC) and believes that incidental power generation at these two separate facilities would qualify for separate FERC exemptions. With this generation capacity built into the Project, power consumption for Project operations will be partially self-generated renewable energy. It is expected that the remaining operating power needs will be met with renewable sources to ensure no net increase in greenhouse gas emissions from the operations of the Project.
- Regulatory Required Emergency Drawdown and Release Flows, Alternative 2 – Refinements to emergency drawdown and release locations have been made to Alternative 2. Emergency releases under this alternative would occur at the Inlet/Outlet Works, Sites Dam, and Saddle Dam 8B into Hunters Creek watershed. On net the frequent flood control benefits far outweigh the very low risk of infrequent, if ever, emergency releases. To improve understanding of the risk and the potential scale of these rare emergency events, an inundation review encompassing the potential release areas will be conducted.

- **Stored water Release Location, Alternative 3** – The release location for Alternative 3 will be the Colusa Basin Drain as it was determined that the Colusa Basin Drain likely has sufficient capacity to handle the flows.
- **Diversion Criteria and More Detailed Operations Criteria** – Diversion criteria were refined, and more detailed operations criteria were added to all the alternatives. The team conducted an extensive analysis of different possible diversion criteria, including an extensive review of the current scientific literature. Through these efforts, the diversion criteria have been shifted upstream into the Sacramento River to allow for practical operations at the diversion locations. Additional pulse protections to protect migrating juvenile salmonids have also been added. While the species effects analysis and modeling is being completed in January and February, the team believes that the revised diversion criteria are more protective of migrating juvenile salmonids throughout the Sacramento River and Delta and also result in little changes in Sacramento River flows in downstream locations, such as Freeport, and little changes to Delta flows, including net Delta outflow index and Delta salinity. The team will be sharing the outcomes of the species effects analyses in the coming months.

Table 1. Summary of the Alternatives In the RDEIR/SDEIS Project Description

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, Funding Partner up to 25% investment
DWR Involvement	Operational Exchanges with Oroville and use of 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

The project description identifies Alternative 1 as the Authority's proposed project based on the alternative meeting the intent and the goals of the Value Planning effort, its close alignment with VP-7, and its ability to meet the project objectives.

Staff recommends posting the RDEIR/SDEIS project description on the Authority's website. The project description would be posted for informational purposes to aid in the discussion of permitting approaches with regulatory agencies and in discussions with non-governmental organizations. It is important to note that the Authority is not taking public comments nor responding to comments on the project description and a preamble to the project description would make this clear to the reader. Making the project description available to the public increases transparency and provides a common foundation for regulatory agencies, non-governmental agencies, and other interested stakeholders to understand the project components. Refinements would continue to be made to the project description after posting on the Authority's website until the release of the RDEIR/SDEIS and any significant or material changes would be brought back to the Reservoir Committee and Authority Board for consideration before the change is made.

Prior Action:

December 18, 2020: Reviewed and commented on option to add Alternative 3 with Reclamation at 25% investment to EIR/EIS project description.

September 17, 2020: Approved to designate Alternative 1, based on VP-7 of the Sites Project Value Planning Alternatives Appraisal Report (Value Planning Report), as the Authority's preferred project for the purposes of the RDEIR analysis and for the purposes of the Biological Assessment and State Incidental Take Permit applications.

April 22, 2020: The Authority directed staff to revise and recirculate a Draft EIR to analyze the environmental effects of the options identified in the Final Sites Project Value Planning Alternatives Appraisal Report dated April 2020, including VP7.

April 22, 2020: The Authority accepted: the final report titled "Sites Project Value Planning Alternatives Appraisal Report, dated April 13, 2020" and the recommendations presented within, and a recommendation to the Sites Project Authority to approve the final report titled "Sites Project Value Planning Alternatives Appraisal Report, April 13, 2020" and the recommendations presented within.

February 26, 2020: The Authority approved a recommendation to re-start efforts on the EIR for the Sites Reservoir Project and assess the most appropriate approach for completing the EIR pursuant to the California Environmental Quality Act.

July 20, 2017: The Reservoir Committee approved a recommendation to forward the Draft EIR/EIS to the Authority Board for its consideration to formally receive and adopt the document for inclusion in the Authority's Water Storage Investment Project application.

July 31, 2017: The Authority approved the release of the Draft EIR for public and agency review, in connection with the Authority's application to the California Water Commission by August 14, 2017. The document was published as joint Draft EIR/EIS by the Authority under the California Environmental Quality Act and Reclamation under the National Environmental Policy Act.

December 19, 2016: The Authority approved release of a Supplemental Notice of Preparation (released February 2, 2017) to transfer the California Environmental Quality Act lead agency status from the Department of Water Resources to the Sites Project Authority. Public scoping meetings were conducted on February 14 and 15, 2017.

Fiscal Impact/Funding Source:

Staff reported in December that sufficient funds to incorporate Alternative 3 into the RDEIR/SDEIS were included in the Amendment 2 Work Plan (Budget), which was approved by the Authority at its August 26, 2020 Board meeting. Since that time, staff has become aware of additional fisheries analysis and document formatting needs that will be necessary to incorporate Alternative 3 into the RDEIR/SDEIS. Staff is working with ICF to understand these potential costs and will determine how to incorporate these costs into the Amendment 2

Work Plan within existing revenue sources. Staff is also working with Reclamation to include these costs in an amendment to the existing Financial Assistance Agreement that will incorporate a portion of the \$13.7 million Federal Appropriation signed into law last month. The February 2021 update to the Reservoir Committee and Authority Board on the Amendment 2 Work Plan (Budget) will reflect these changes and these added costs will not impact the second cash call amount to Reservoir Committee Members.

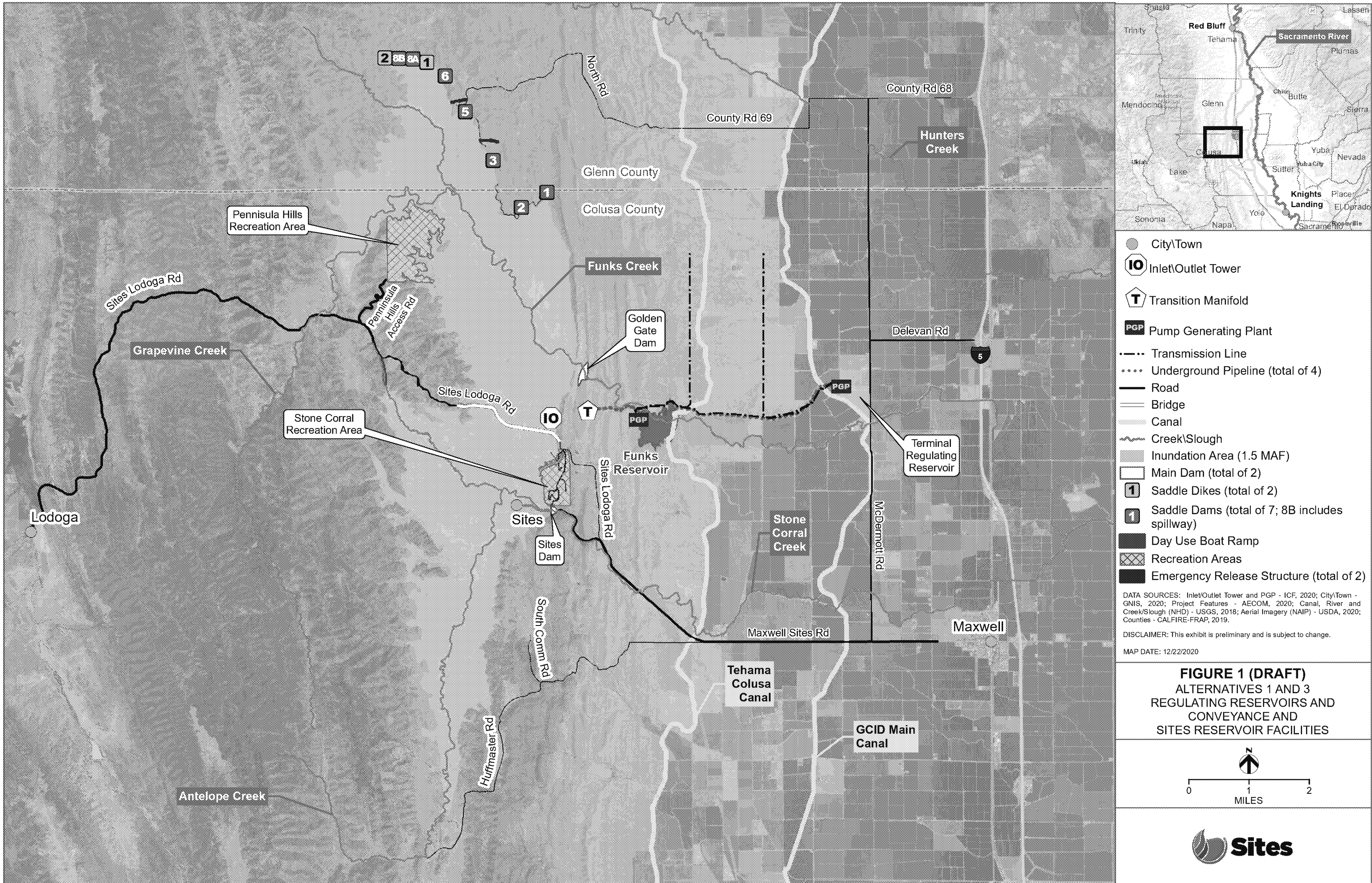
Costs to complete and circulate the Final EIR/EIS will be considered in a future Work Plan.

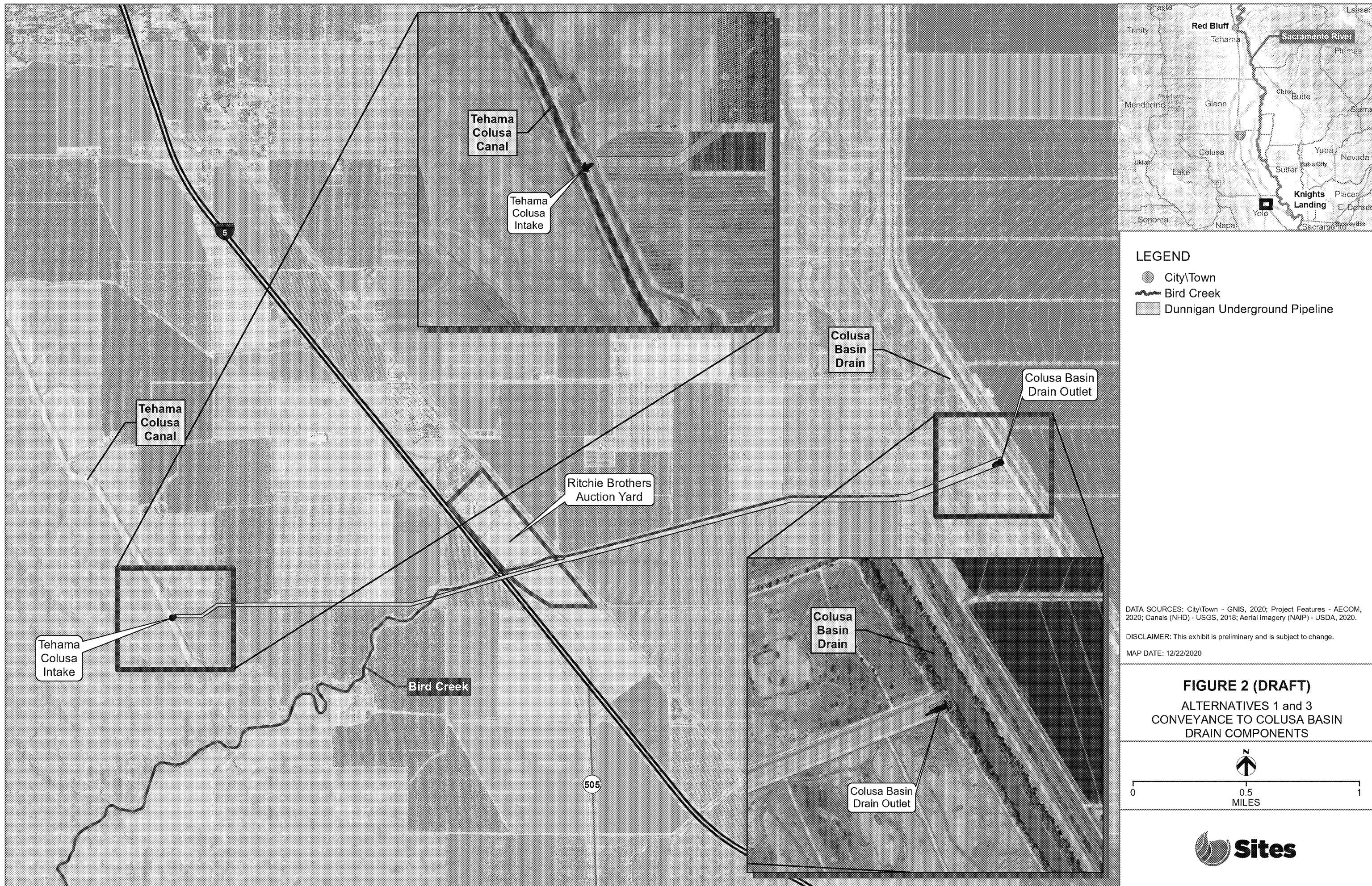
Staff Contact:

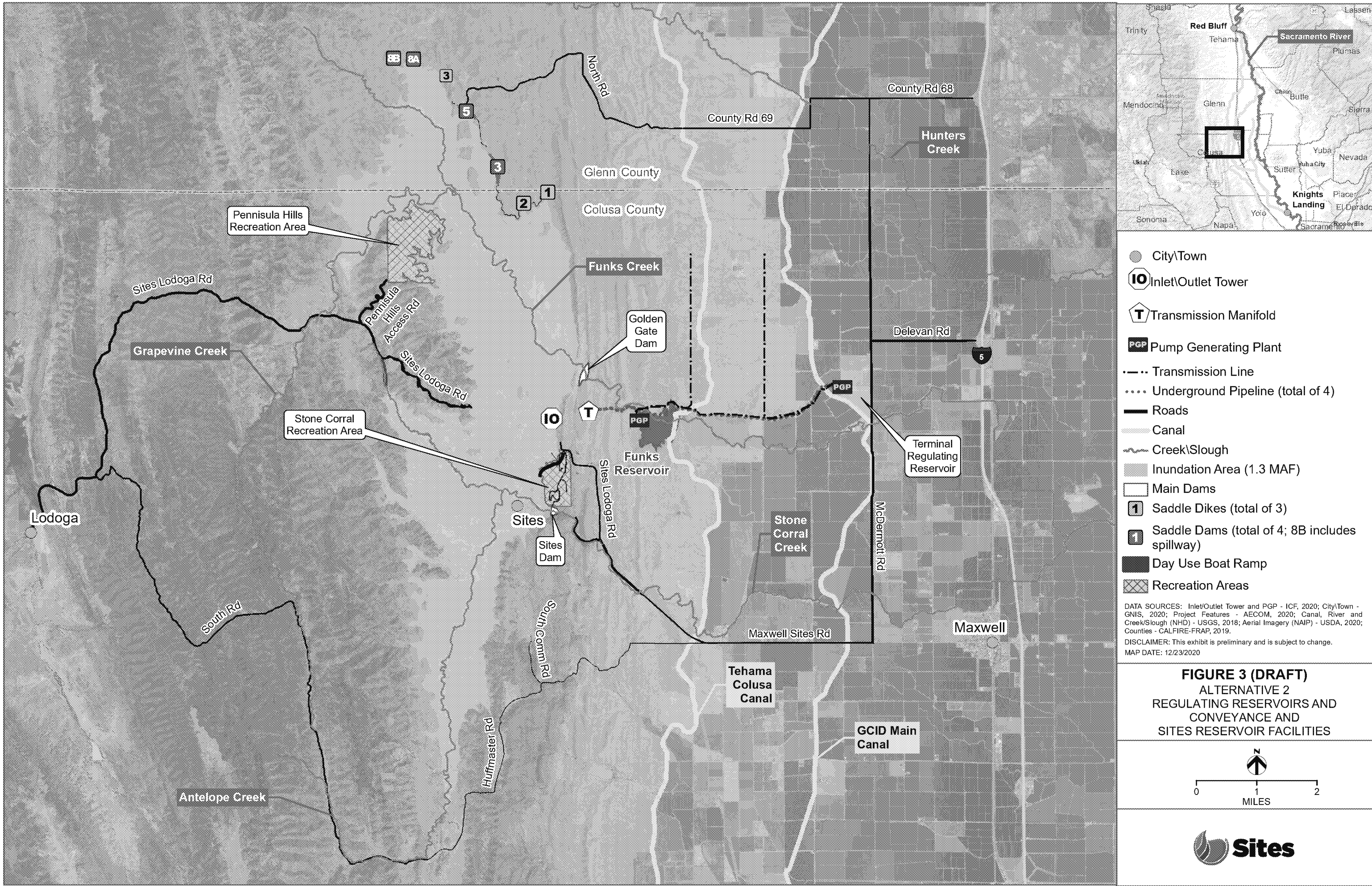
Ali Forsythe

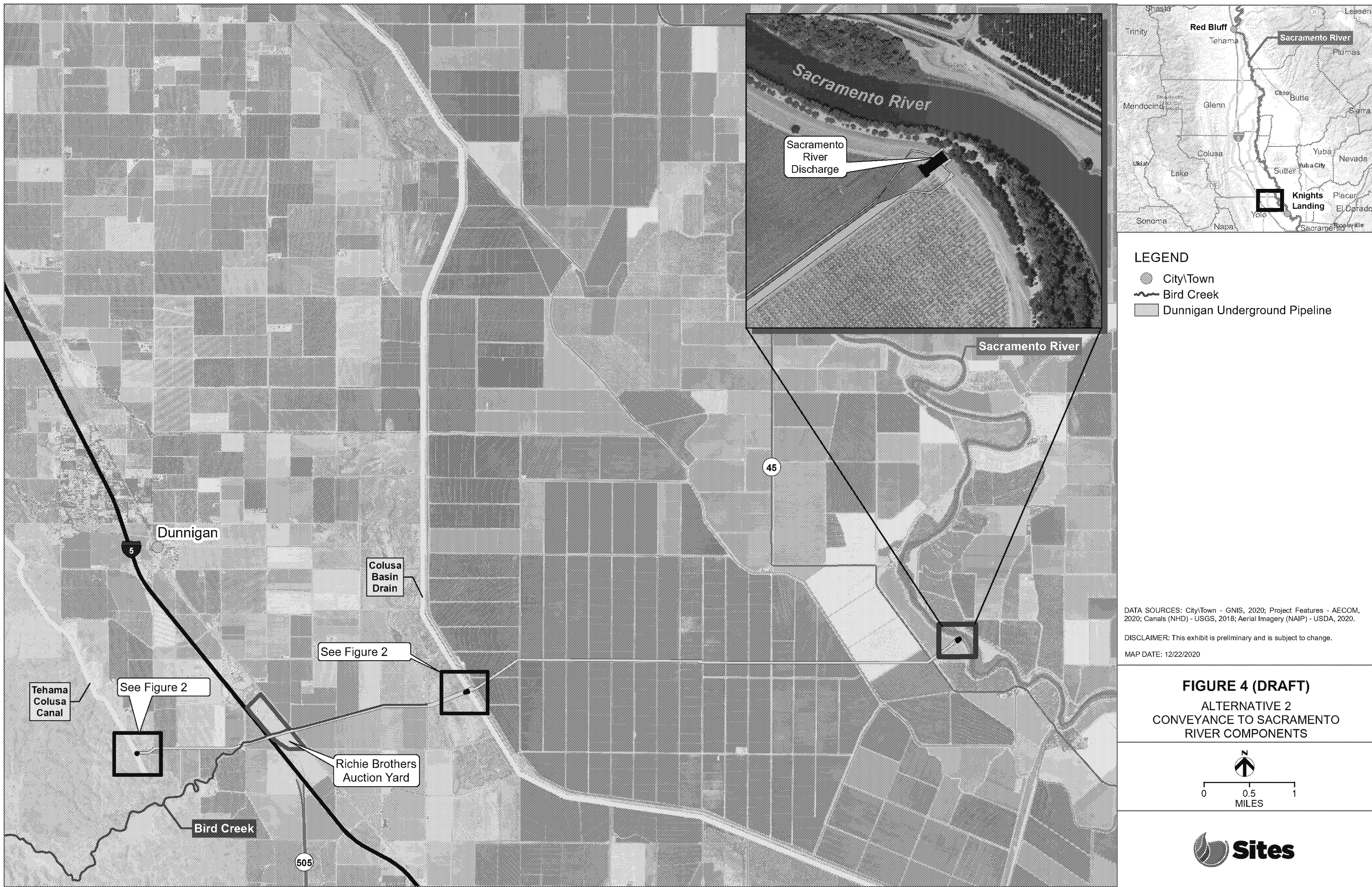
Attachments:

Attachment A – Sites Reservoir Project, Revised Draft EIR/Supplemental Draft EIS Project Alternatives









PATH: \\P000000000000\PROJECTS_1\1\SITES_PA\00528_20\FIGURES\DOCS\1\DEIR\01_ADEIR\CHAPTER2\FIG2-2B_ALT2_CONV_SAC_RIVER.MXD - USER: 19105 - DATE: 12/22/2020

From: Luu, Henry [Henry.Luu@hdrinc.com]
Sent: 4/27/2021 5:47:28 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
CC: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: RE: Sites Project - Follow Up on Flood Control Question

Hi Ali,

That's a good idea. It may be helpful to understand what Ron's objective is prior to this meeting. I anticipate a couple of folks from AECOM – Jeff Herrin, Joe Barnes, and/or Mike Forrest. Would you like to hold this meeting in the next couple of weeks? I can ask the AECOM folks to provide availabilities (Mike Forrest is out this week).

Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, April 27, 2021 2:50 PM
To: Luu, Henry <Henry.Luu@hdrinc.com>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: FW: Sites Project - Follow Up on Flood Control Question

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Henry – I am wondering if it would be best to have a call with whomever is our flood expert and Ron to answer these questions. I suspect our answers may result in more questions, so a call might be the best to just answer them all. What do you think on this? Would this be someone from AECOM?

Ali

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

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From: Ron Stork <RStork@friendsoftheriver.org>
Sent: Tuesday, April 27, 2021 10:19 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

With regard to normal operating level and full pool in the PMF discussion. Is there a difference? What is the difference? Is full pool defined by the elevation of the lip of the emergency spillway? Will the emergency spillway have operational gates?

Ron

From: Ron Stork
Sent: Tuesday, April 27, 2021 9:58 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

Thank, Alicia. Do you have modeled PMF inflows from local creeks? In peak cfs and critical-period volumes?

With regard to floodwater management inflows (not the same as above), don't you need some kind of operating criteria? Or are you just relying on the statistical chance that the reservoir will have freeboard when it is needed? The statistical argument may be a nice one in annual flood-risk world, but it doesn't wash all that well when it's not just mother nature but operational decisions that would keep inflows from matching outflows.

Ron

From: Alicia Forsythe [<mailto:aforsythe@sitesproject.org>]
Sent: Tuesday, April 27, 2021 9:10 AM
To: Ron Stork <RStork@friendsoftheriver.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Sites Project - Follow Up on Flood Control Question

Hi Ron – I wanted to follow up on one of your questions on spillways. My apologies for the delay in getting back to you on this.

We have spillways described in the Preliminary Draft Project Description that we released in February (attached). See page 2-79 for a discussion of emergency releases. The Project will include emergency releases into Funks and Stone Corral Creeks through low-level releases in both Sites and Golden Gate Dams in addition to the spillway structure described below.

All of the alternatives will have a spillway in Saddle Dam 8B. Here's the description from the Project Description for this facility (see the file for the schematic).

Saddle Dam 8B would contain the reservoir spillway (see Figure 2-31). The crest width for the dam would be designed to accommodate a 16-foot-wide crest road with suitable concrete or metal guardrails on both sides. The length of the spillway crest section would be based on flood routing analyses, and the crest elevation would be based on the size of the reservoir and normal operating water surface elevation. This elevation would allow storage of the PMF without spilling and have sufficient capacity to pass the volume of over-pumping water in the unlikely event that over-pumping occurred for more than 10 days; it would also enable emergency releases to the local receiving drainage, Hunters Creek. See Figure 2-31, Saddle Dam 8B Spillway, for a schematic of the spillway.

In the attached Project Description, we also included emergency release structures on Saddle Dams 3 and 5 under Alternative 1 and 3. Upon further analysis, we don't believe that these structures will be needed to meet DSOD's emergency release criteria and we plan to eliminate them from the Project.

Hopefully this helps. Let me know if there is more information you would like on spillways and flood control and we can set up a discussion with our engineering team.

Ali

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

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From: Alicia Forsythe [ali@forsythe-group.com]
Sent: 4/29/2021 6:34:05 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Sites Project - Follow Up on Flood Control Question
Attachments: 20040812SitesPMFRasmussenJKF.pdf

Alicia Forsythe | Forsythe Group | 916.880.0676 | ali@forsythe-group.com

From: Herrin, Jeff <jeff.herrin@aecom.com>
Sent: Wednesday, April 28, 2021 8:50 AM
To: Luu, Henry <Henry.Luu@hdrinc.com>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Alicia Forsythe <ali@forsythe-group.com>
Subject: FW: Sites Project - Follow Up on Flood Control Question

You probably want this for the administrative record.

From: Barnes, Joseph <joseph.barnes@aecom.com>
Sent: Wednesday, April 28, 2021 8:36 AM
To: Herrin, Jeff <jeff.herrin@aecom.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

Jeff – Attached is the August 2004 DWR Memorandum that documents the PMF study that was performed for Sites Reservoir.

The study uses Hydrometeorological Reports (HMR) 58 and 59 to develop rainfall over the basin for the PMF. This rainfall is then applied to the basin and runoff to the reservoir is estimated using HEC-HMS program. Runoff is estimated by breaking the basin into sub areas and determining soil related runoff characteristics using Soil Conservation Service curves to estimate infiltration and vegetation retention. Runoff lag time is estimated as described in the report. All of this is input to HEC-HMS to develop the runoff actually reaching the reservoir as a function of time. Runoff is estimated assuming the PMF is a 72-hour event.

The overall approach and use of HMR 58 and 59 is reasonable practice that is used by FERC. HMR 58 and 59 were adopted around 2000 to replace a previous method. It caused a lot of grief at the time for dam owners on the western slope of the Sierra because it significantly increased the runoff. Just about all dams under FERC jurisdiction had to be reevaluated by the owners leading to a lot of repair work to expand spillway capacities or elevate crest elevations for the higher flood events to preserve freeboard. For example, Indian Valley Dam to the west of Sites had to be raised 3 feet due to the new analysis and a lot of engineering was needed to show that the spillway was still adequate. Spillway flows from routing the PMF went from about 28,000 cfs to about 38,000 cfs as I remember. Collings Reservoir and Camp Far West Reservoir were also impacted. I mention this to indicate that the method is still used and, in my judgment, is conservative and provides results that are applicable. The alternative is a site specific storm development and storm centering study (not cheap). This has been considered on other projects, but as a method to reduce the rainfall/runoff to minimize required repairs/upgrades for spillways. In our case, the storm is small, and more expensive study options are not warranted.

For our recent studies or alternative reservoir sizes, the total reservoir inflow (78,422 AF), peak inflow (68,500 cfs) and the inflow hydrograph from the attached report (Figure 5) were preserved and applied. For full PMF storage, simply take the starting reservoir elevation, add 78,400 AF, and get the new elevation from the area capacity curve. Where there is a spillway passing water during the PMF in some of our cases, the inflow hydrograph was routed through the reservoir

with the spillway rating curve to determine max spillway outflow and max associated reservoir water levels. These are the numbers that appear in the project description.

Hope this helps.

Joseph H. Barnes, P.E
Principal Civil Engineer
D 1-916-679-2329
joseph.barnes@aecom.com

AECOM
2020 L Street, Suite 400
Sacramento, CA 95811
aecom.com

From: Herrin, Jeff <jeff.herrin@aecom.com>
Sent: Wednesday, April 28, 2021 7:29 AM
To: Barnes, Joseph <joseph.barnes@aecom.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

Thank you.

From: Barnes, Joseph <joseph.barnes@aecom.com>
Sent: Wednesday, April 28, 2021 7:25 AM
To: Herrin, Jeff <jeff.herrin@aecom.com>
Subject: Re: Sites Project - Follow Up on Flood Control Question

Yes. I have a copy on my machines as well.

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From: Herrin, Jeff <jeff.herrin@aecom.com>
Sent: Wednesday, April 28, 2021 7:20:36 AM
To: Barnes, Joseph <joseph.barnes@aecom.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

Joe,

Can you track down the memo? I don't recall that file.

Jeff

From: Barnes, Joseph <joseph.barnes@aecom.com>
Sent: Tuesday, April 27, 2021 8:00 PM
To: Herrin, Jeff <jeff.herrin@aecom.com>; Zarchi, Idit <Idit.Zarchi@aecom.com>; Smith, Michael (orange) <michael.g.smith@aecom.com>
Subject: Re: Sites Project - Follow Up on Flood Control Question

PMF development is well documented in a DWR Memorandum. There is a copy in the file that includes model input and output. It is based on HMR 58 and HMR 59 that are still applicable today fo estimating PMF.

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From: Herrin, Jeff <jeff.herrin@aecom.com>

Sent: Tuesday, April 27, 2021 5:59:58 PM

To: Barnes, Joseph <joseph.barnes@aecom.com>; Zarchi, Idit <Idit.Zarchi@aecom.com>; Smith, Michael (orange) <michael.g.smith@aecom.com>

Subject: FW: Sites Project - Follow Up on Flood Control Question

All,

We have a question on the publicly released Project Description regarding how the PMF was established for the reservoir and the Authority is trying to set up a call to respond to the question. Who on our team is most knowledgeable regarding how this is addressed in the current design?

Thank you,

Jeff Herrin

Water Resources Planner, Water Business Unit, Sacramento, CA

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M +1-916-432-0956

Jeff.Herrin@aecom.com

AECOM

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T +1-916-414-5800

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From: Luu, Henry <Henry.Luu@hdrinc.com>

Sent: Tuesday, April 27, 2021 3:05 PM

To: Herrin, Jeff <jeff.herrin@aecom.com>

Cc: Forrest, Michael <michael.forrest@aecom.com>

Subject: [EXTERNAL] FW: Sites Project - Follow Up on Flood Control Question

Hi Jeff,

See email chain below. Am I correct in assuming Joe Barnes is the person most suited to participate in a meeting with Mr. Stork? Maybe you, Joe, Laurie, myself, and Ali?

Thanks,

Henry H. Luu, PE

D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>

Sent: Tuesday, April 27, 2021 2:50 PM

To: Luu, Henry <Henry.Luu@hdrinc.com>

Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>

Subject: FW: Sites Project - Follow Up on Flood Control Question

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Henry – I am wondering if it would be best to have a call with whomever is our flood expert and Ron to answer these questions. I suspect our answers may result in more questions, so a call might be the best to just answer them all. What do you think on this? Would this be someone from AECOM?

Ali

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

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From: Ron Stork <RStork@friendsoftheriver.org>
Sent: Tuesday, April 27, 2021 10:19 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

With regard to normal operating level and full pool in the PMF discussion. Is there a difference? What is the difference? Is full pool defined by the elevation of the lip of the emergency spillway? Will the emergency spillway have operational gates?

Ron

From: Ron Stork
Sent: Tuesday, April 27, 2021 9:58 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

Thank, Alicia. Do you have modeled PMF inflows from local creeks? In peak cfs and critical-period volumes?

With regard to floodwater management inflows (not the same as above), don't you need some kind of operating criteria? Or are you just relying on the statistical chance that the reservoir will have freeboard when it is needed? The statistical argument may be a nice one in annual flood-risk world, but it doesn't wash all that well when it's not just mother nature but operational decisions that would keep inflows from matching outflows.

Ron

From: Alicia Forsythe [<mailto:aforsythe@sitesproject.org>]
Sent: Tuesday, April 27, 2021 9:10 AM
To: Ron Stork <RStork@friendsoftheriver.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Sites Project - Follow Up on Flood Control Question

Hi Ron – I wanted to follow up on one of your questions on spillways. My apologies for the delay in getting back to you on this.

We have spillways described in the Preliminary Draft Project Description that we released in February (attached). See page 2-79 for a discussion of emergency releases. The Project will include emergency releases into Funks and Stone Corral Creeks through low-level releases in both Sites and Golden Gate Dams in addition to the spillway structure described below.

All of the alternatives will have a spillway in Saddle Dam 8B. Here's the description from the Project Description for this facility (see the file for the schematic).

Saddle Dam 8B would contain the reservoir spillway (see Figure 2-31). The crest width for the dam would be designed to accommodate a 16-foot-wide crest road with suitable concrete or metal guardrails on both sides. The length of the spillway crest section would be based on flood routing analyses, and the crest elevation would be based on the size of the reservoir and normal operating water surface elevation. This elevation would allow storage of the PMF without spilling and have sufficient capacity to pass the volume of over-pumping water in the unlikely event that over-pumping occurred for more than 10 days; it would also enable emergency releases to the local receiving drainage, Hunters Creek. See Figure 2-31, Saddle Dam 8B Spillway, for a schematic of the spillway.

In the attached Project Description, we also included emergency release structures on Saddle Dams 3 and 5 under Alternative 1 and 3. Upon further analysis, we don't believe that these structures will be needed to meet DSOD's emergency release criteria and we plan to eliminate them from the Project.

Hopefully this helps. Let me know if there is more information you would like on spillways and flood control and we can set up a discussion with our engineering team.

Ali

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

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From: Herrin, Jeff [jeff.herrin@aecom.com]
Sent: 4/29/2021 6:53:19 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Luu, Henry [Henry.Luu@hdrinc.com]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: RE: Sites Project - Follow Up on Flood Control Question

I will do that.

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Thursday, April 29, 2021 6:36 AM
To: Herrin, Jeff <jeff.herrin@aecom.com>; Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: [EXTERNAL] FW: Sites Project - Follow Up on Flood Control Question

This is great! Thanks Jeff.

I do think it would be best to have a call with Ron Stork to explain all of this. He will likely have a few more questions and I read through the memo, but feel like someone from AECOM would be better to answer these.

Jeff, can you ID who from your team would be best to do this and get a few dates/times next week for this? I can coordinate with Ron on his availability.

Ali

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

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From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Wednesday, April 28, 2021 8:54 AM
To: Herrin, Jeff <jeff.herrin@aecom.com>; Luu, Henry <Henry.Luu@hdrinc.com>
Cc: Alicia Forsythe <ali@forsythe-group.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

Thanks Jeff !

From: Herrin, Jeff <jeff.herrin@aecom.com>
Sent: Wednesday, April 28, 2021 8:50 AM
To: Luu, Henry <Henry.Luu@hdrinc.com>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Alicia Forsythe <ali@forsythe-group.com>
Subject: FW: Sites Project - Follow Up on Flood Control Question

You probably want this for the administrative record.

From: Barnes, Joseph <joseph.barnes@aecom.com>
Sent: Wednesday, April 28, 2021 8:36 AM

To: Herrin, Jeff <jeff.herrin@aecom.com>

Subject: RE: Sites Project - Follow Up on Flood Control Question

Jeff – Attached is the August 2004 DWR Memorandum that documents the PMF study that was performed for Sites Reservoir.

The study uses Hydrometeorological Reports (HMR) 58 and 59 to develop rainfall over the basin for the PMF. This rainfall is then applied to the basin and runoff to the reservoir is estimated using HEC-HMS program. Runoff is estimated by breaking the basin into sub areas and determining soil related runoff characteristics using Soil Conservation Service curves to estimate infiltration and vegetation retention. Runoff lag time is estimated as described in the report. All of this is input to HEC-HMS to develop the runoff actually reaching the reservoir as a function of time. Runoff is estimated assuming the PMF is a 72-hour event.

The overall approach and use of HMR 58 and 59 is reasonable practice that is used by FERC. HMR 58 and 59 were adopted around 2000 to replace a previous method. It caused a lot of grief at the time for dam owners on the western slope of the Sierra because it significantly increased the runoff. Just about all dams under FERC jurisdiction had to be reevaluated by the owners leading to a lot of repair work to expand spillway capacities or elevate crest elevations for the higher flood events to preserve freeboard. For example, Indian Valley Dam to the west of Sites had to be raised 3 feet due to the new analysis and a lot of engineering was needed to show that the spillway was still adequate. Spillway flows from routing the PMF went from about 28,000 cfs to about 38,000 cfs as I remember. Collings Reservoir and Camp Far West Reservoir were also impacted. I mention this to indicate that the method is still used and, in my judgment, is conservative and provides results that are applicable. The alternative is a site specific storm development and storm centering study (not cheap). This has been considered on other projects, but as a method to reduce the rainfall/runoff to minimize required repairs/upgrades for spillways. In our case, the storm is small, and more expensive study options are not warranted.

For our recent studies or alternative reservoir sizes, the total reservoir inflow (78,422 AF), peak inflow (68,500 cfs) and the inflow hydrograph from the attached report (Figure 5) were preserved and applied. For full PMF storage, simply take the starting reservoir elevation, add 78,400 AF, and get the new elevation from the area capacity curve. Where there is a spillway passing water during the PMF in some of our cases, the inflow hydrograph was routed through the reservoir with the spillway rating curve to determine max spillway outflow and max associated reservoir water levels. These are the numbers that appear in the project description.

Hope this helps.

Joseph H. Barnes, P.E
Principal Civil Engineer
D 1-916-679-2329
joseph.barnes@aecom.com

AECOM
2020 L Street, Suite 400
Sacramento, CA 95811
aecom.com

From: Herrin, Jeff <jeff.herrin@aecom.com>

Sent: Wednesday, April 28, 2021 7:29 AM

To: Barnes, Joseph <joseph.barnes@aecom.com>

Subject: RE: Sites Project - Follow Up on Flood Control Question

Thank you.

From: Barnes, Joseph <joseph.barnes@aecom.com>

Sent: Wednesday, April 28, 2021 7:25 AM

To: Herrin, Jeff <jeff.herrin@aecom.com>

Subject: Re: Sites Project - Follow Up on Flood Control Question

Yes. I have a copy on my machines as well.

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From: Herrin, Jeff <jeff.herrin@aecom.com>

Sent: Wednesday, April 28, 2021 7:20:36 AM

To: Barnes, Joseph <joseph.barnes@aecom.com>

Subject: RE: Sites Project - Follow Up on Flood Control Question

Joe,

Can you track down the memo? I don't recall that file.

Jeff

From: Barnes, Joseph <joseph.barnes@aecom.com>

Sent: Tuesday, April 27, 2021 8:00 PM

To: Herrin, Jeff <jeff.herrin@aecom.com>; Zarchi, Idit <ldit.Zarchi@aecom.com>; Smith, Michael (orange) <michael.g.smith@aecom.com>

Subject: Re: Sites Project - Follow Up on Flood Control Question

PMF development is well documented in a DWR Memorandum. There is a copy in the file that includes model input and output. It is based on HMR 58 and HMR 59 that are still applicable today for estimating PMF.

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From: Herrin, Jeff <jeff.herrin@aecom.com>

Sent: Tuesday, April 27, 2021 5:59:58 PM

To: Barnes, Joseph <joseph.barnes@aecom.com>; Zarchi, Idit <ldit.Zarchi@aecom.com>; Smith, Michael (orange) <michael.g.smith@aecom.com>

Subject: FW: Sites Project - Follow Up on Flood Control Question

All,

We have a question on the publicly released Project Description regarding how the PMF was established for the reservoir and the Authority is trying to set up a call to respond to the question. Who on our team is most knowledgeable regarding how this is addressed in the current design?

Thank you,

Jeff Herrin

Water Resources Planner, Water Business Unit, Sacramento, CA

D +1-916-679-2084 IPT 264-679-2084

M +1-916-432-0956

Jeff.Herrin@aecom.com

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Sacramento, CA 95811, United States

T +1-916-414-5800

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From: Luu, Henry <Henry.Luu@hdrinc.com>
Sent: Tuesday, April 27, 2021 3:05 PM
To: Herrin, Jeff <jeff.herrin@aecom.com>
Cc: Forrest, Michael <michael.forrest@aecom.com>
Subject: [EXTERNAL] FW: Sites Project - Follow Up on Flood Control Question

Hi Jeff,

See email chain below. Am I correct in assuming Joe Barnes is the person most suited to participate in a meeting with Mr. Stork? Maybe you, Joe, Laurie, myself, and Ali?

Thanks,
Henry H. Luu, PE
D 916.679.8857 M 916.754.7566

hdrinc.com/follow-us

From: Alicia Forsythe <aforsythe@sitesproject.org>
Sent: Tuesday, April 27, 2021 2:50 PM
To: Luu, Henry <Henry.Luu@hdrinc.com>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: FW: Sites Project - Follow Up on Flood Control Question

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.

Henry – I am wondering if it would be best to have a call with whomever is our flood expert and Ron to answer these questions. I suspect our answers may result in more questions, so a call might be the best to just answer them all. What do you think on this? Would this be someone from AECOM?

Ali

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

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From: Ron Stork <RStork@friendsoftheriver.org>
Sent: Tuesday, April 27, 2021 10:19 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Luu, Henry <Henry.Luu@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Sites Project - Follow Up on Flood Control Question

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To: Alicia Forsythe <aforsythe@sitesproject.org>

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Subject: RE: Sites Project - Follow Up on Flood Control Question

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Sent: Tuesday, April 27, 2021 9:10 AM

To: Ron Stork <RStork@friendsoftheriver.org>

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aforsythe@sitesproject.org | www.SitesProject.org

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From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 4/29/2021 7:50:24 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: [EXTERNAL] Sites Reservoir WQ sampling

FYI – info from Reclamation regarding WQ sampling for metals.

From: Dekar, Melissa D <mdekar@usbr.gov>
Sent: Thursday, April 29, 2021 7:47 AM
To: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: FW: [EXTERNAL] Sites Reservoir WQ sampling

Good morning, Laurie,

Here is some info on sampling costs that might be helpful. Let me know if you have more questions or needs that I can look into.

Melissa

From: Dodgen, Laurel K <ldodgen@usbr.gov>
Sent: Wednesday, April 28, 2021 3:56 PM
To: Dekar, Melissa D <mdekar@usbr.gov>
Subject: Re: [EXTERNAL] Sites Reservoir WQ sampling

Hi Melissa,

CGB-157 doesn't have many investigations that look at metals in reservoirs (more commonly we measure temperature profiles). We do have several investigations that measure metals in wildlife refuges. Among Reclamation generally, I know that Lower Colorado collects a variety of water samples (mostly physical analytes and nutrients) and that Mary Suppiger at Shasta has some water monitoring investigations as well.

I can give you some round numbers for our cost, with the caveat that actual budget will vary depending on 1) shoreline samples (cheaper) vs boat samples (more expensive) 2) number of sites 3) number of analytes 4) frequency of collection 5) what rigor of QC/QA is included 6) what level of reporting is included (just data vs simple report vs water quality assessment).

At a minimum (just for having a lab measure the analytes), it'll cost about \$30/analyte per sample.

For one of our investigations, we measure 10 metal and physical analytes twice a year at 9 shoreline locations. We include QC samples and do QA assessment and write a simple report. This investigation costs \$25,000 per year.

Let me know if you need more info. Regards,

From: Dekar, Melissa D <mdekar@usbr.gov>
Sent: Wednesday, April 28, 2021 2:09 PM
To: Dodgen, Laurel K <ldodgen@usbr.gov>
Subject: FW: [EXTERNAL] Sites Reservoir WQ sampling

Hi Laurel,

Another monitoring question for you. ☺ Do you know if Reclamation has any metal monitoring plans or programs on reservoirs? If so, could you share anything that might be helpful Sites' request below?

Thank you,
Melissa

Melissa Dekar
Natural Resources Specialist
Environmental Compliance and Conservation Branch, CGB-152
2800 Cottage Way, Sacramento, CA, 95825
Interior Region 10, Bureau of Reclamation
916-978-6153 mdekar@usbr.gov

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Sent: Wednesday, April 28, 2021 1:36 PM
To: Dekar, Melissa D <mdekar@usbr.gov>
Subject: [EXTERNAL] Sites Reservoir WQ sampling

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Hi Melissa,

ICF is suggesting that there will need to be monthly testing for metals in the reservoir in the initial years. This would include grab samples at various depths. Does Reclamation have similar programs at reservoirs that we could use as an example for scope and associated costs?

Thanks,

Laurie

Laurie Warner Herson
Principal/Owner



Environmental Planning

916.201.3935
laurie.warner.herson@phenixenv.com
State of California Small Business (#1796182)
Supplier Clearinghouse Women Business Enterprise (#16000323)

<http://phenixenv.com/>

From: Heydinger, Erin [Erin.Heydinger@hdrinc.com]
Sent: 4/30/2021 2:46:18 PM
To: Westcot, Cathy [Cathy.Westcot@hdrinc.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: JacobsLOE-Amend3-20210423 SM.xlsx
Attachments: JacobsLOE-Amend3-20210423 SM.xlsx

Hi Cathy,

Please see attached for updates based on my discussion with Jacobs.

Ali, FYI, major changes include:

- Updated Sites with DCP analysis to also include a baseline update if needed
- Added refining daily operations and Delta water quality analysis as a permitting support task
- Slightly augmented ESA support

This results in Jacobs overall spend increasing by ~\$500k. I think they raise some good points and am okay with these changes for now. The DCP analysis is coming in around \$700k which will beg the question of whether DCP or SWP contractors could bear some of these costs. Let me know if you are okay increasing for now going into our meeting with Jerry next week.

Thanks,
Erin