December 2002

Sacramento and San Joaquin River Basins Comprehensive Study

TECHNICAL STUDIES DOCUMENTATION

APPENDIX A

INFORMATION PAPERS

THE RECLAMATION BOARD PUBLIC SAFETY WITH FLOOD PROTECTION STATE OF CALIFORNIA

US Army Corps of Engineers
Sacramento District

APPENDIX A
INFORMATION PAPERS

This appendix includes a collection of short, informational papers and technical memoranda relating to various technical issues encountered during the Comprehensive Study. The purpose of the information papers varies, from documenting research or findings about key planning topics to providing simplified summaries of complex technical issues. These papers are for informational purposes only and do not intend to recommend or promote specific flood damage reduction or environmental restoration measures, indicate the importance of specific issues, or represent every issue brought to the attention of the study. Instead, they document information and preliminary findings that may be useful for future studies. The information papers included in this appendix are listed below, in the order of appearance:

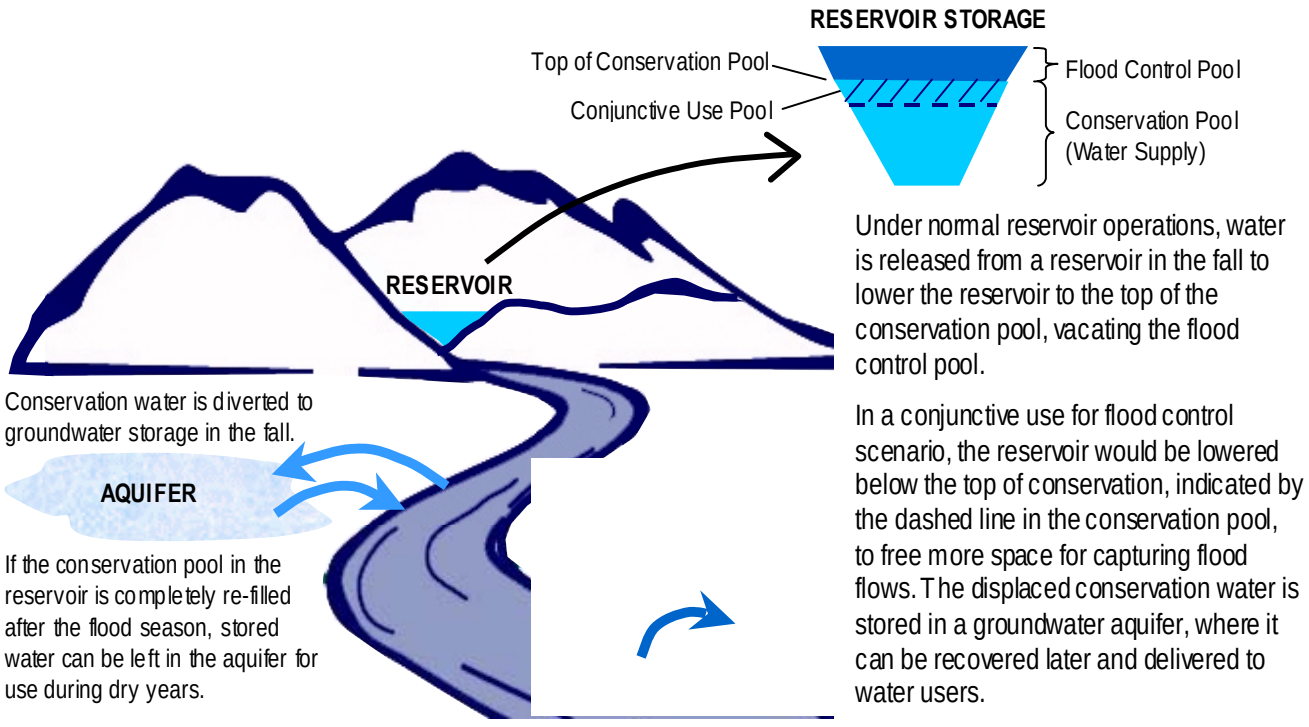
- Conjunctive Use for Flood Control
- Upper Sacramento River HEC-RAS Model
- Preliminary Simulation of Flood Conditions in the Sacramento - San Joaquin Delta
- Global Warming
- Subsidence in the Central Valley
- Technical Evaluation Process
- Vegetation and the Flood Management System

COMPREHENSIVE STUDY INFORMATION PAPER:

CONJUNCTIVE USE FOR FLOOD PROTECTION

Conjunctive Use is the cooperative management of both surface water (reservoirs, rivers, and canals) and groundwater (aquifer) resources to expand the utility of both systems. While flood protection might not be the first priority of conjunctive use operations in California, the U.S. Army Corps of Engineer's Hydrologic Engineering Center (HEC), at the request of the Comprehensive Study, pursued an investigation that evaluated conjunctive use reservoir operations focused on providing guaranteed flood protection.

Under normal operating conditions, reservoirs make releases in the fall to vacate the flood control pool and make room for storing flood flows, bringing the reservoir to the top of the conservation (water supply) pool. With conjunctive use operations aimed to increase flood protection, the reservoir storage level is lowered below the flood control pool, and the displaced conservation water is transferred to groundwater storage. This transfer not only vacates additional space in the reservoir to intercept seasonal flood flows, but also conserves that water in another location. Thus, the "conjunctive use pool" represents reservoir volume that serves the dual purpose of flood protection and conservation storage. The conjunctive use pool is transferred to groundwater via groundwater injection wells or recharge (percolation) basins. Suitable aquifers for conjunctive use operations are those that are overdrawn and thus have room for storage, those that have recharge potential, those that are in proximity to a reservoir or river, and those that are in proximity to the water users.



Under normal reservoir operations, water is released from a reservoir in the fall to lower the reservoir to the top of the conservation pool, vacating the flood control pool.

In a conjunctive use for flood control scenario, the reservoir would be lowered below the top of conservation, indicated by the dashed line in the conservation pool, to free more space for capturing flood flows. The displaced conservation water is stored in a groundwater aquifer, where it can be recovered later and delivered to water users.

HEC developed a conceptual model to represent conjunctive use reservoir-aquifer operations focused on maximizing guaranteed flood protection. The conceptual model simulates transfers between reservoirs, aquifers, agricultural demand, and additional end users within six sub-basins. The sub-basins were selected based on the need for additional reservoir flood control space and the presence of favorable aquifer sites downstream from the reservoirs. The sub-basins are:

1. Oroville Reservoir on the Feather River
2. New Bullards Bar Reservoir on the Yuba River
3. Folsom Reservoir on the American River
4. New Don Pedro Reservoir on the Tuolumne River
5. Lake McClure (New Exchequer Dam) on the Merced River
6. Millerton Lake (Friant Dam) on the San Joaquin River

HEC used the conceptual model to size the optimal conjunctive use pool in each reservoir and determine the amount of new yield generated from conjunctive use operations considering four infrastructure scenarios. These scenarios were:

Scenario #1 (Maximum Infrastructure) - maximum amount of space in the recharge basin and uses full-sized recharge rate at each aquifer site.

Scenario #2 (Half-Size Recharge Basins) – uses only half of the recharge basin assumed for Scenario #1, but still uses full recharge/extraction rate.

Scenario #3 (Reduced Canal Capacity) – River to aquifer conveyance capacity is reduced but uses a full sized recharge basin.

Scenario #4 (Minimum Infrastructure) – Minimum level of infrastructure needed, assumes half of the recharge basin and reduced river to aquifer conveyance capacity.

TABLE 1
ADDITIONAL FLOOD STORAGE AND YIELD FROM CONJUNCTIVE USE

Reservoir	Normal Flood Pool (10^3 ac-ft)	Additional CU Pool		Volume of New Yield			
		Scenario 1,3 (10^3 ac-ft)	Scenario 2,4 (10^3 ac-ft)	Scenario 1 (10^3 ac-ft)	Scenario 2 (10^3 ac-ft)	Scenario 3 (10^3 ac-ft)	Scenario 4 (10^3 ac-ft)
Sacramento Basin							
Oroville	480	138	100	148	74	148	58
New Bullards Bar	170	120	73	120	59	131	55
Folsom	451	142	85	211	133	178	127
San Joaquin Basin							
Don Pedro	340	124	61	160	109	124	100
McClure / New Exch	350	98	64	92	60	49	45
Millerton / Friant	171	121	120	322	247	250	240

Table 1 represents the additional flood storage space (Additional CU Pool) in the reservoirs and the new yield generated from modeling the four scenarios. For the full-sized recharge basin scenarios (Scenarios 1&3), conjunctive use operations that focused on flood protection were able to secure between 98,000 acre-feet and 142,000 acre-feet of additional guaranteed

flood protection space. When recharge basin sizes were reduced by half (Scenarios 2 & 4), conjunctive use pool sizes decreased up to 50% compared to the full-basin scenarios. This decrease was due to decreased storage capacity and ability to extract stored water represented by the smaller project area. Hence, the volume of new yield is more sensitive to recharge basin size than conveyance capacity.

Cost estimates to implement these conjunctive use operations range from $69 million to $300 million per sub-basin when considering land purchase, conveyance structure construction, extraction facility construction and well field operation and maintenance costs. HEC's findings include:

- New Exchequer and Friant Dams have the potential to provide the largest amount of new yield for the least cost.
- New Exchequer, New Bullards Bar and Friant Dams appear to provide the largest percentage increase in flood storage space for the least cost.
- Conjunctive use operation at Folsom and the three San Joaquin reservoirs provide the most significant flood protection as seen by the reduction in peak flows.

Because of the significant volume of reservoir storage space that could be made available, HEC determined that conjunctive use for flood protection merits further study. A strict management arrangement represents the simplest but costliest type of conjunctive use operations scheme, one that requires an active involvement by the Corps. An alternative to strict management would focus on contractual arrangements, which would allow for more local control but would require balancing flood control with new yield and habitat management goals.

The current system of surface water and groundwater laws establishes groundwater management and conjunctive use as highly decentralized and locality-specific. Any type of conjunctive use project will require basin-specific collaborative approaches that link reservoir water providers, landowners and end-users in a division of benefits. The projects should be sited as close as possible to surface water reservoirs and end water users and encourage participation from surface and groundwater users who reside within the affected floodplains.