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Subgroup: Improve Operational Efficiency and Transfers

Chapter 6 System Reoperation

System reoperation means changing existing operation and management procedures for existing reservoirs and conveyance facilities to increase water related benefits from these facilities.

System reoperation may improve the efficiency of existing water uses (e.g., irrigation) or it may increase the emphasis of one use over another. Although reoperation is generally regarded as an alternative to construction of major new water facilities, physical modifications to existing facilities may be needed in some cases to expand the reoperation capability. Legal changes also may be

needed. Changes in water demands and the changing climate are the primary reasons to consider reoperation of existing facilities to increase project yield or address climate change impacts.

System reoperation is a tool available to project owners to willingly make changes in how their project operates to best meet their changing needs.

Box 6-1 Examples of How System Reoperation Could Be Used

- Changing the timing or volume of reservoir water storage and releases to accommodate changing priorities of the project, such as improving or managing instream flow conditions, recreation opportunities, flood management, local water supplies, or water quality.
- Increasing the water storage and flood retention capacity of reservoirs by conveying reservoir water to groundwater banks before the refill season or using surface reservoirs in wetter years in lieu of using groundwater.
- Coordinating and interconnecting water storage, water conveyance, and water delivery systems within a watershed or geographic area to improve benefits to the local watershed area, the regional watershed area, and the state.
- Balancing water supply with the economic and environmental risks that water users and regulatory agencies may be willing to accept. The ability to customize risk tolerances to users may allow a trade-off of gaining additional water supplies in some years with the risk of having shortages in other years or in other water use sectors.

System Reoperation in California

For some water purveyors, their water system may include a single surface water reservoir or groundwater basin – a simple system. For other water purveyors, their water system may be more complex, with many facilities that develop a combination of local, interregional, and interstate water sources and destinations. Therefore, the term “system reoperation” applies to whatever the system may be. Reoperation can be implemented at different scales – for individual facilities or system-wide.

System reoperation is not a new tool for water managers. The State Water Project (SWP) and Central Valley Project (CVP) have integrated operations since the 1970s using annual agreements that were eventually finalized in 1986 with the signing of the Coordinated Operating Agreement. This agreement has led to significant improvement in how the two projects coordinate to provide water to meet consumptive and environmental uses. There are also numerous studies of reoperation and actual operational changes that have been made to California’s water system. The vast majority of these applications of reoperation apply to a portion of the system, a project, or just one facility, not the entire California water system. There are three basic purposes of

reoperation: 1) to address specific existing needs, 2) to improve operational efficiency and water supply reliability, and 3) to anticipate and adapt to future changes.

Reoperation to Address Specific Needs

To date, most assessments and actual reoperations in California solve a specific problem or provide for a specific need. Reoperation is often considered as one strategy in an integrated water management plan or one alternative among a set of alternatives in a feasibility study. Reoperation to address specific needs often applies to a single project or facility, for example:

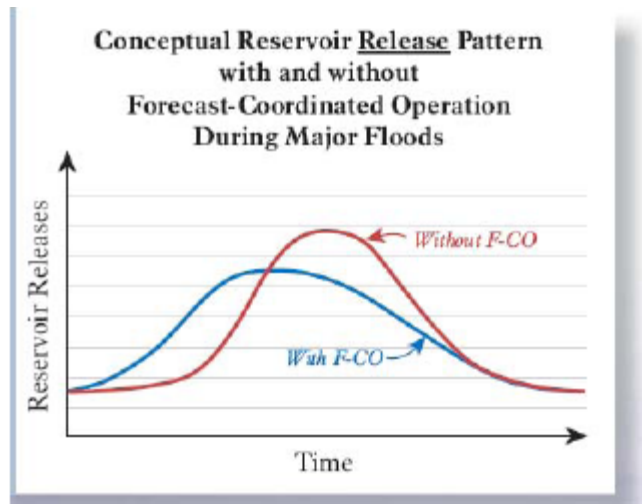
- Shasta Temperature Control Device – Addition of the temperature control device to Shasta Dam allowed passing cold water releases required for downstream spawning salmon through the powerhouse turbines to maintain hydroelectric power generation rather than bypassing water releases around the powerhouse. Water is drawn from different levels of the lake at different times of the year to match the downstream requirements and to manage the cold water reserves behind the reservoir.
- CALSIM Development – Although the CVP and SWP have coordinated their Delta export operations for years, the US Bureau of Reclamation (USBR) and Department of Water Resources (DWR) used two different tools, process simulation (PROSIM) software used extensively by USBR and DWRSIM, a simulation software developed by DWR, to support their long-term planning activities. Differences in the assumptions and methodologies of the two models presented a challenge to optimizing the operations of the CVP and SWP, so the two agencies worked together to build a common allocation model – the California Water Resources Simulation Model or CALSIM.
- EWA – The Environmental Water Account (EWA) is an element of the CALFED Bay-Delta Program's overall management strategy for the Bay-Delta ecosystem. EWA's purpose is to provide greater protection to the fish of the Bay-Delta Estuary than current regulatory requirements through environmentally beneficial changes in the operations of the CVP and SWP at no uncompensated water cost to the projects' users.
- Folsom Dam Reoperation – New facilities at Folsom Dam and reoperation of the reservoir in anticipation of large inflows will provide greater protection to the Sacramento area from large floods and benefit other reservoir users by enabling water storage in part of the current flood storage space through the use of forecast-based operations.
- Delta Cross Channel Reoperation – CALFED has been studying potential changes in the timing of gate operation at the Delta Cross Channel to benefit fish and water quality.
- Recirculation Program – This reoperation would be to use excess capacity from the CVP Jones pumping plant, the Delta Mendota Canal, the SWP Banks pumping plant, or the California Aqueduct to convey water for subsequent release into the San Joaquin River to reduce salinity concentrations. On July 30, 2008, the US Bureau of Reclamation initiated a pilot study to gather information on the effects of releasing up to 250 cubic feet per second of water from the Delta Mendota Canal down the Newman Wasteway to the San Joaquin River.
- San Joaquin River Restoration Program – Restoring salmon to the San Joaquin River between Friant Dam and the Merced River will require changes in Friant Dam operations for agricultural water supply and flows released for the ecosystem. New

Reoperation to Improve Efficiency and water supply reliability

There is great interest in finding ways to reoperate the system for greater efficiency and water supply reliability. These generally involve more of the system when compared to reoperation to address specific needs. Examples include:

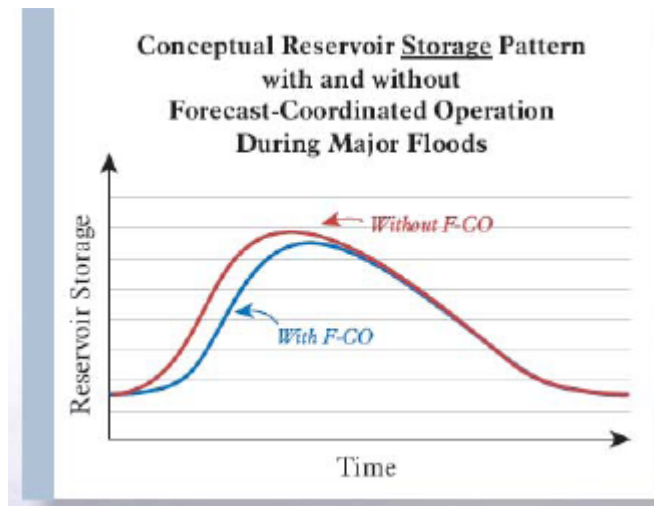
- **Risk-Based Water Deliveries** – A 1976-1977 drought in California prompted many water agencies to move away from the firm-yield approach to operating water projects to a risk-based approach when making system delivery decisions. The firm-yield approach seeks to deliver the same amount every year regardless of water supply conditions while the risk-based approach balances increasing deliveries in a given year with the risk of not meeting full deliveries in a subsequent dry year.
- **Hydroelectric Facility Reoperation Investigation** – CALFED investigated reoperation of private hydroelectric projects to provide additional water supply benefits without affecting power production. CALFED concluded that hydroelectric project reoperation would provide little benefit towards meeting the CALFED goals.
- **Forecast-Coordinated Operations** – Forecast-Coordinated Operations (F-CO) consists of improving tools to forecast precipitation and riverflows to allow drawing down flood management reservoirs (see Figure 6-1) in anticipation of major runoff so more reservoir space is available to control downstream flood releases from a reservoir without impacting water supply. An enhanced Reservoir System Simulation (ResSim) model can simulate a range of reservoir operating conditions and accurately simulate downstream flows at specific control point locations. A multi-agency partnership is working on coordinating Lake Oroville and New Bullards Bar Reservoir for managing major flood events in order to meet a pre-existing common downstream control point.
- **Forecast-Based Operations (FBO)** – an operational concept used to operate a multi-purpose dam and its associated reservoir for flood control and water supply. FBO utilizes advanced forecasts of reservoirs inflows to reduce uncertainty and improve risk management in reservoir system operations. FBO allows dynamic flood storage rule curve used in reservoir operation for better flood protection and greater water supply potential. One example of FBO based reoperation is currently being developed at Folsom Dam and Reservoir. The potential benefits include increased water supply and improved operational flexibility and efficiency, drought preparedness and water quality.

Figure 6-1 Conceptual Reservoir Release Pattern



Unlike reoperation of projects for water supply that result in long-term changes in reservoir storage, reoperation under F-CO is short-term, perhaps in the order of weeks. With F-CO, the reservoir storage following a major storm returns to the same levels that would be present without F-CO (see Figure 6-2).

Figure 6-2 Conceptual Reservoir Storage Pattern



Reoperation in Anticipation of Future Change

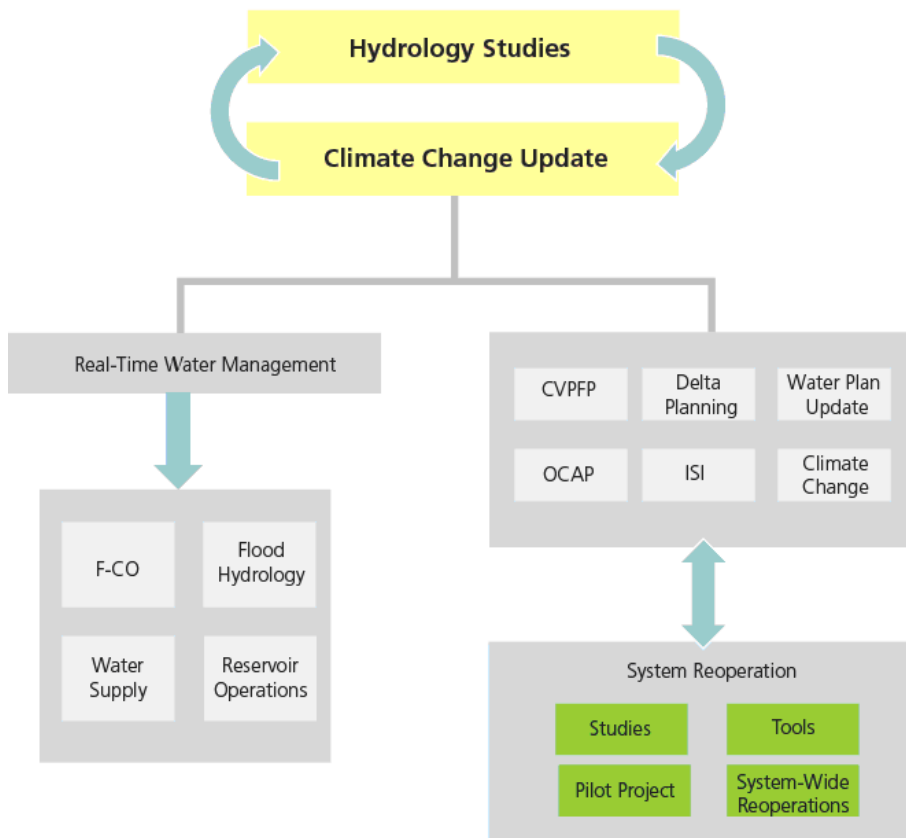
The need to consider system reoperations because of the anticipation of future change is gaining more interest. Future changes such as growing population and climate change will likely require reoperation of the system to adapt to these conditions and help meet California's water needs.

Climate change could result in altered condition in snowpack accumulation and melting, runoff patterns, water supply, sea level, floods and droughts, water demands, water temperature, plant and animal life including livestock, hydroelectric power, wild fires, recreation, water quality, soil moisture, groundwater, and ecosystems. California water managers continue to evaluate climate change and study ways of incorporating flexibility into the system to respond to climate change.

DWR is currently embarking on an assessment of water system reoperation potential, both to improve system efficiency, water supply reliability and to adapt to climate change. Completion of all assessment work is expected by July 2013. To simplify the process, DWR proposes that the assessment of water system reoperation be conducted in a phased approach that incrementally progresses if warranted. Rather than conducting a comprehensive reevaluation of reoperation potential from the start, the approach begins as a reconnaissance study of individual major local projects and transitions to a system-wide analysis of the SWP and CVP together with the individual projects, if sufficient benefits accrue from the reconnaissance study. Appropriate consideration of any initiatives involving Delta restoration and conveyance or additional storage will be made depending on the viability of such an analysis. DWR hopes to gauge realistic potential of existing operations and will incorporate potential future system changes or facilities as resources allow.

Figure 6-3 describes the relationship of hydrology, climate change update and system reoperation. Resulting system reoperation studies will be useful in real-time water management activities and in ongoing and future planning studies.

Figure 6-3 Hydrology, Climate Change Update and System Reoperation Relationship



DWR will work with project owners and operators on reconnaissance studies to explore reoperation opportunities using existing physical components and existing operational requirements, available data, existing local models, and new spreadsheet models if needed. While each study will be tailored to local needs, it is expected that conjunctive management of surface and groundwater storage will be a key component of the evaluations. Existing system-wide models will be used to confirm compliance with downstream flow standards and show the effects of these individual project reoperations on the remainder of the system. Reoperation opportunities are expected to vary significantly by project with some projects providing little or no reoperation potential.

The approach is guided by the following assumptions:

- Water supply benefits resulting from reoperation of local and regional reservoirs will remain with the owners of those projects.
- DWR will perform reoperation studies of regional and local projects with the collaborative and voluntary participation of reservoir owners and operators.
- Reoperation priorities will focus on reducing flood risks and improving water supply, but may also include water quality, recreation, and power production depending on the interests and needs of the project owners.
- Updated hydrology and climate change studies will be incorporated into the reoperations when available.

Given the number of individual projects that are operated for local needs and the fact that conditions are constantly changing, the assessment will look for reasonable benefits from reoperation, not optimization of the whole water system. To help demonstrate reoperation concepts and feasibility, a watershed-scale reoperation pilot project will be initiated with willing local partners.

Potential Benefits of System Reoperation

Statewide benefits of system reoperation are difficult to estimate since the potential benefits are generally project-specific. Over the last 150 years Californians have developed their water system in parts (facilities, projects, regulations, and operating rules), at different times, with various owners and purposes, and with different base data and assumptions, all of which makes it difficult to systematically consider reoperation potential for the entire system.

System reoperation often integrates multiple resource management strategies such as surface storage, conveyance facilities, conjunctive management, water-dependent recreation and ecosystem restoration. System reoperation is a tool available to project owners to willingly make changes in how their project operates to best meet their changing needs. Project owners may choose to consider reoperation for a wide variety of reasons:

- Change the mix of beneficial uses derived from a water system – priorities for water projects often change with time.
- Provide additional flexibility to respond to extreme hydrologic events like flood and drought or catastrophic events like earthquakes.
- Increase water supply reliability.
- Allow the system to adapt to future conditions such as those resulting from climate change.

In some cases, project owners may choose to reoperate their facilities to help meet changing institutional requirements.

Reoperation can be used to help achieve any of the water use objectives for which the water system now operates (see Box 6-2).

Box 6-2 System Reoperation Objectives

Reoperation of the system or a portion of the system may help achieve one or more of the following water use objectives:

- Safety (flood management)
- Water supply reliability and enhancement (consumptive and environmental uses)
- Water quality and ecosystem restoration
- Power generation
- Cultural practices
- Recreation
- Navigation

Potential Costs of System Reoperation

Like the benefits of system reoperation, the potential direct costs for implementing system reoperation are project-specific and are difficult to extrapolate to a statewide estimate. Up-front costs may include performing the feasibility studies, completing California Environmental Quality Act (CEQA) and National Environmental Protection Act (NEPA) analysis and undergoing water rights permitting to implement a proposed change in operation. These studies alone can cost millions of dollars and take several years to complete. Long-term costs may include capital costs for the construction, modification, or removal of facilities, loss of revenue from reduction in sale of hydropower or water supplies, and increased operations and maintenance costs.

Major Issues Facing System Reoperation

Reduced Hydropower Generation

System reoperation has the potential of shifting some water use from hydropower generation to other uses. Preliminary analyses by the California Energy Commission indicate that project-specific and cumulative reductions in hydropower generation associated with Federal Energy Regulatory Commission (FERC) relicensing are not significant on a system-wide basis in California. However, many facilities must still undergo relicensing and the effects of these on energy generation must be evaluated. Improved generating equipment and technology can offset some of this energy reduction. There may be a need to provide for alternative sources of energy to make up any reduction in hydropower generation. If reoperation occurs on a large scale, switching to fossil fuels to offset these reductions in hydropower generation could increase air pollution and greenhouse gases, and reliance on imported energy sources.

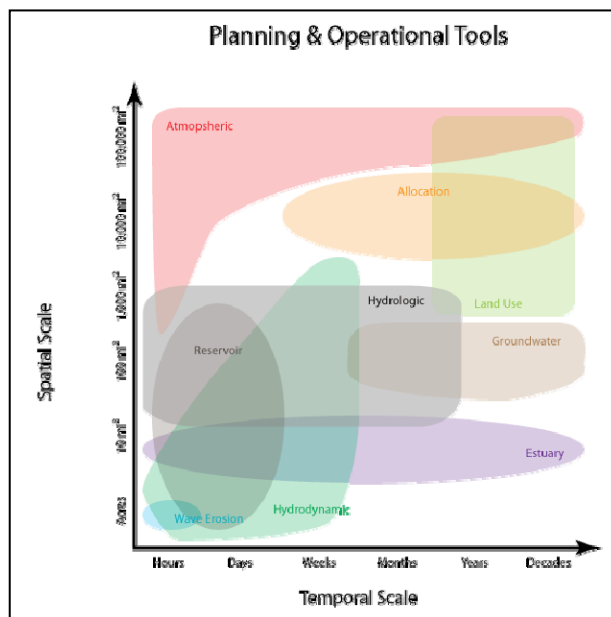
Gaps in Scientific Knowledge and Data

Several significant knowledge gaps should be addressed to improve the likelihood of successful system reoperation. There is a need for greater understanding of the relationships between flow

patterns, the response of aquatic ecosystems, and how these relate to protecting public trust resources. While this area of applied environmental science is developing quickly, there is a need to improve the understanding of the effects of pulsed and ramped flows upon endangered species, other aquatic species, habitats and river morphology. Lack of baseline data and good bio-hydrologic models for some ecological components are limiting factors. Biological opinions issued by the US Fish and Wildlife Service and the National Marine Fisheries Service have provided some guidance on specific changes in operation that are intended to benefit specific endangered species. There is also a gap in the understanding of the specific effects associated with global climate change on local water systems. Changes in the timing and distribution of precipitation and runoff within the state can create greater uncertainty, potentially requiring changes to the management of the water system. There is a need for improved runoff prediction and other scientific information to support water management decisions.

Many different types of planning and operational tools can be used within the system. For example, estuary models that consider hydrodynamics and sea level will be used only in the coastal areas of the state. Atmospheric models will have more widespread application. Figure 6-4 shows the concept of how each type of model may be measured on spatial and temporal scales. Since the analysis can become very complex in developing and using all these tools, feasibility studies of system reoperation potential generally need to use some simplifying assumptions. To better describe the system response resulting from system reoperation most of planning operational tools (Figure 6-4) need to be integrated and the interaction among them need to be defined.

Figure 6-4 Planning & Operational Tools



Competing Beneficial Uses

In some cases, the analysis of reservoir reoperation can be as complex and controversial as that associated with new facility construction. Because many dams and conveyance structures have been operating the same way for decades, it is important to consider the interests of today's beneficiaries before introducing dramatic changes. For example, many reservoirs have existing uses including recreation, summer homes, wetland habitat, and fisheries. In addition, reoperation could have unintended impacts to existing ecological processes; those impacts must be evaluated. There is concern about direct and indirect impacts on other users including downstream water rights, the environment, recreational uses, and energy production.

Physical and Existing Operational Constraints

The capacity of reservoir outlets, storage, pumping and conveyance might limit the ability to perform system reoperation through such things as water transfers, conjunctive management or revised flood operations. Changing operation of federal facilities will likely be considered a change in project purpose and require action by Congress.

Institutional Constraints

While there are numerous institutional arrangements that help water projects function together as a system, the same institutional arrangements present challenges that make it difficult and time consuming to systematically consider reoperation potential for the entire system. In fact, it would be easier to add a new project, such as a groundwater recharge project, to work as part of the existing system than to implement a comprehensive reoperation of the system. Some of the institutional arrangements and the challenges they present include:

- Projects that have different owners who have invested in project development to gain certain benefits that may not be consistent with system reoperation objectives.
- Tradeoffs and competing objectives of reoperation will be difficult to overcome given the scale of the water system due to the perception that there will be winners and losers in the process.
- California's priority system for surface water rights, including area of origin water rights, presents complications for change on a large scale.
- Contractual obligations for water deliveries largely constrain operations of many projects.
- Existing and changing environmental and water quality requirements may reduce the flexibility for reoperation of the system.
- Flood rule curves presented in water control manuals mandate reservation of flood control space during the flood season. Changing water control manuals is a difficult and time consuming process.
- Coordinated operating agreements already govern operation of multiple projects.
- Changes in project purposes for federal projects will require authorization from Congress.

Integrating Water Resource Management

There are many tiers of management of developed water resources. These include facilities that are operated for local, regional or statewide beneficial uses. Implementing system reoperation to obtain wider system benefits can require regulatory actions by several local, State, and federal agencies.

Implementation Costs

Significant up-front and on-going costs can be involved with system reoperation. Costs might include developing monitoring systems, hydrologic models, decision support systems, and collecting data to evaluate benefits and impacts of proposed changes. Other costs are associated with conducting feasibility studies, completing CEQA/NEPA analyses, and constructing new or modifying or removing existing facilities. Agencies might have difficulty raising the needed funds because of existing contracts or regulations that prohibit them from increasing water or energy rates.

Recommendations to Achieve More System Reoperation

The following recommendations can help facilitate reoperation to benefit water supply reliability, flood management, hydropower, water quality, ecosystem, and other needs:

- 1) State, federal and local agencies should collaborate on the system reoperation studies.
- 2) The State should expand the use of forecast-based operations in reservoir reoperations.
- 3) Project owners should consider reoperation along with other resource management strategies in meeting water related needs.
- 4) Establish a baseline hydrology and enhanced description of present water management system components in order to support integrated system analysis and individual component benefit comparisons.
- 5) Include consideration of a consistent climate change hydrology in all reoperation studies to allow for direct comparison of individual climate change studies. This standardized climate change hydrology should be designed with enough detail for the use of any local, State, or federal project.
- 6) An important premise of the assessment should be that there should be no net loss of benefits to local and regional participants.

Box 6-3 Acronyms and Abbreviations Used in this Chapter

OCAP	Operations Criteria and Plan
CVFPP	Central Valley Flood Protection Plan
SSI	Surface Storage Investigation

Selected References

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