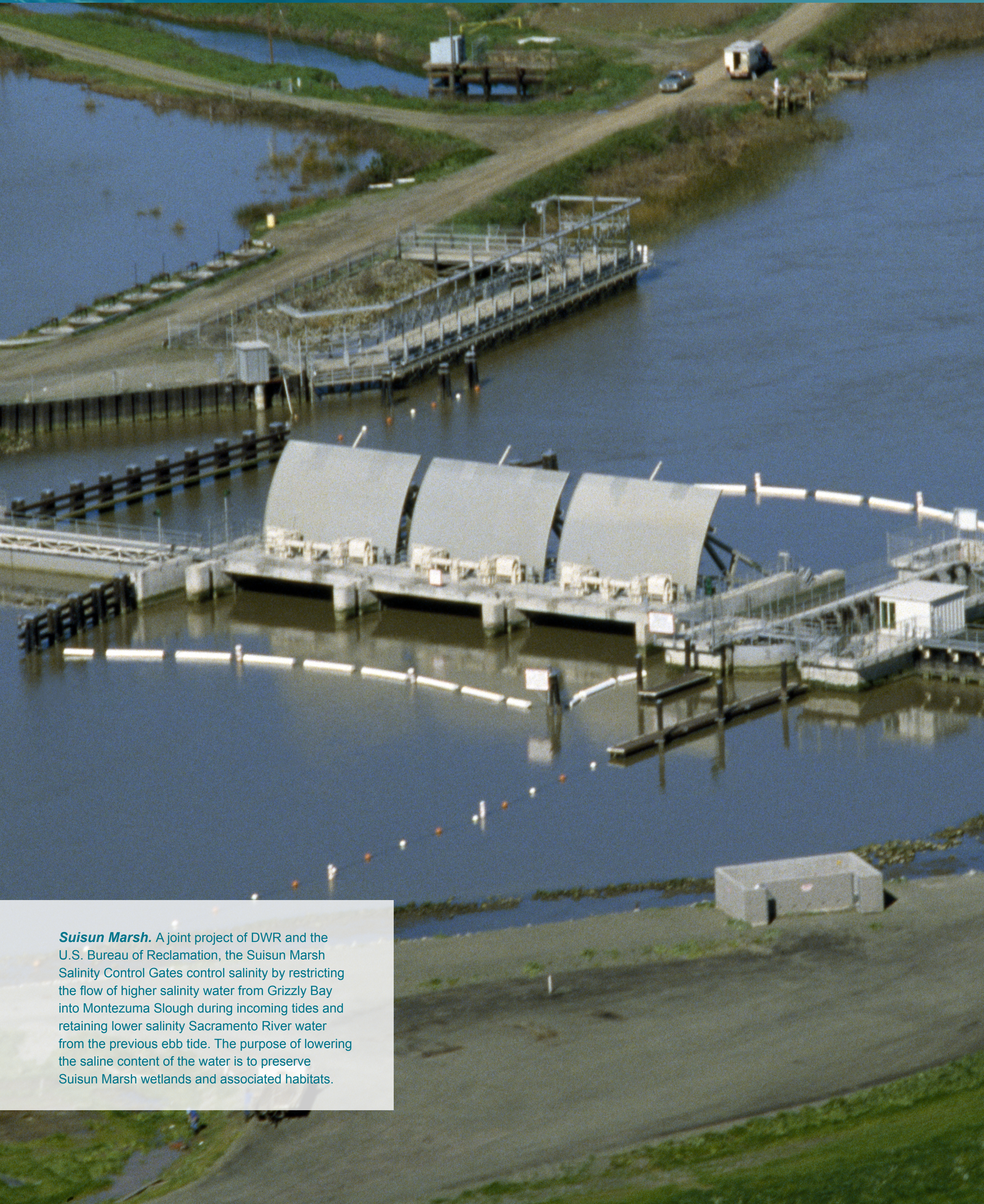
VOLUME 3 - RESOURCE MANAGEMENT STRATEGIES

CHAPTER 17

Matching Water Quality to Use



Suisun Marsh. A joint project of DWR and the U.S. Bureau of Reclamation, the Suisun Marsh Salinity Control Gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. The purpose of lowering the saline content of the water is to preserve Suisun Marsh wetlands and associated habitats.

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Chapter 17. Matching Water Quality to Use

Matching water quality to use is a management strategy that recognizes that not all water uses require the same water quality. One common measure of water quality is its suitability for an intended use; a water quality constituent often is only considered a contaminant when that constituent adversely affects the intended use of the water. High-quality water sources can be used for drinking and industrial purposes that benefit from higher quality water and lesser quality water can be adequate for some uses. For example, a water supplier chooses to use a groundwater source for municipal use, which requires less treatment before delivery, rather than a natural stream. The potential benefit to the municipal user could be reduced disinfection byproducts in the delivered drinking water source and a secondary benefit would accrue to the natural riparian system because water would be left instream. Further, some new water supplies, such as recycled water, can be treated to a wide range of purities that can be matched to different uses. The use of other water sources, like recycled water, can serve as a new source of water that substitutes for uses not requiring potable water quality. Instream uses are directly influenced by discharges from wastewater treatment and stormwater flows and these source discharges can provide benefits and challenges to uses such as aquatic life and recreation.

Matching Water Quality to Use in California

As part of the nine regional water quality control boards basin planning efforts, up to 25 water quality beneficial use categories for water have been identified for mostly human and instream uses (see the definition of "Beneficial Use," with regard to water quality and water rights, in the Update 2013 Glossary). For this strategy, the beneficial uses discussed are primarily water quality-related beneficial uses. A second definition of beneficial uses of water is also defined by the California Code of Regulations for the purposes of applying for a water right to appropriate water. These two definitions of beneficial uses overlap, but differ enough so that one needs to be aware of the distinction (see California Code of Regulations, Title. 23, Sections 659-672).

Human uses are categorized as consumptive (e.g., municipal, agricultural, and industrial supplies) and non-consumptive (e.g., navigation, hydropower generation, and recreation). Instream uses include aquatic ecosystem uses, fish migration, spawning, and preservation of rare, threatened, and endangered species. Matching water quality to most of these uses is important because water is generally used as is (i.e., without treatment) except for municipal and industrial uses. In addition, aquatic organisms are more sensitive to some pollutants than humans. For example, the presence of dissolved metals at low concentrations can be lethal to sensitive fish species.

Matching Water Quality to Agricultural Use

Farmers currently match crops to the available water quality. In general, irrigation water should contain levels of constituents, such as salinity and boron, which will not inhibit the yields of some of the crops. Conversely, agricultural water supplies that have low levels of salts may require adding gypsum to improve percolation. Agricultural water supplies may require filtration to remove particulate matter that could clog low pressure irrigation systems and reduce soil infiltration rates. For example, the Imperial Irrigation District runs all water that it diverts from the Colorado River at Imperial Dam through siltation basins to remove suspended particulates before the water is released into the All American Canal. In setting objectives for the reasonable protection of agricultural use in the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, the State Water Resources Control Board reviewed the suitability of soils to determine anticipated crop types and set the salinity objectives to meet the needs of these crop types.

Matching Water Quality to Instream and Ecosystem Use

Ambient, instream water must be suitable to support a wide range of aquatic habitats and conditions. Thus, water quality for instream ecosystem uses generally must meet physical, chemical, and microbial parameters specific to the habitat and instream needs. One particular water quality objective that greatly affects fisheries is temperature. An example of an effort made to match water quality to an environmental use for temperature is the Temperature Control Device at Shasta Dam, which was built to make a better match of water temperature to the reproductive needs of salmonid fish downstream. When viewed from a watershed level, decisions about whether to use instream versus out-of-stream sources, such as groundwater and recycled water, to meet future municipal and agricultural demands may result in the decision to leave water instream in favor of using out-of-stream alternatives.

Matching Water Quality to Drinking Water Use

In order to avoid the additional cost of treatment and to provide multiple protection barriers for public health, it is best that drinking water supplies start with the highest quality source water reasonably possible. Historically, California's urban coastal communities — Los Angeles, San Francisco, Oakland, and Berkeley — constructed major aqueducts to sources such as Hetch Hetchy, Owens Valley, and the Mokelumne River. Later, water supplies of lesser quality, such as the Sacramento-San Joaquin Delta and the Colorado River, were also tapped for domestic water supplies. In response, many utilities already manage water quality by blending higher quality water supplies with those of lower quality, as well as matching treatment processes to source water quality, as required by regulation. For example, Metropolitan Water District of Southern California (MWD) dilutes high salinity Colorado River water with lower salinity water from the Sacramento-San Joaquin Delta (Delta). This improves the public's acceptance of tap water, as well as facilitating groundwater recharge and wastewater recycling projects. At the same time, MWD dilutes the higher bromide and organic carbon levels in Delta water with Colorado River water to help reduce disinfection byproducts in treated water. In Solano County, higher quality, less variable Lake Berryessa water is blended with lower quality, highly variable North Bay Aqueduct water from the Delta. Likewise, many water suppliers have the capability to blend groundwater, local surface water, and imported supplies to achieve a desired water quality, although some utilities may choose to use water supplies based upon cost minimization or water rights considerations instead. Some water agencies even blend water and water quality from different levels of the same reservoir by using different intake levels. Many water management actions, such as conjunctive use, water banking, water use efficiency, and water transfers, intentionally or unintentionally result in one type of water quality traded for, or blended with, another.

In the Upper Santa Ana River Water Basin, matching water quality to its effective use has been ongoing through a complex watershed-wide method. With the addition of the Seven Oaks

Dam, water quality from the reservoir has improved, while at the same time, effluent flow downstream of the reservoir has increased. By using the increased flow of lower quality effluent for groundwater recharge, the region could increase its dry year sources while using the higher quality reservoir water for direct delivery of water for municipal uses.

Matching Water Quality to Industrial and Commercial Use

Businesses also match water quality to use. For instance, ultra-pure water is needed in many manufacturing processes in the Silicon Valley and San Francisco Bay Area. To produce ultra-pure water, manufacturers prefer higher quality (low total dissolved solids) Hetch Hetchy water over Delta or groundwater supplies that are also available in the region. The West Basin Municipal Water District offers different qualities of recycled water at different costs that are tailored to different uses, including process water for petroleum refining. At least one concrete plant in San Francisco captures and reuses its low-quality stormwater runoff for concrete production. The use of saline water and wastewater for power plant cooling has been promoted by the State Water Resources Control Board, as described in its Power Plant Cooling Policy adopted on June 19, 1975 (State Water Resources Control Board 1975), and implemented by the regional water quality control boards.

Water Quality Exchange Projects

There are potential regional opportunities to exchange water to make a better match of the water quality needs of the constituent service areas. This would result in lower treatment costs and associated energy and greenhouse gas (GHG) emissions.

The CALFED Bay-Delta Program (CALFED) identified two potential water quality exchange projects, the San Joaquin Valley-Southern California Water Quality Exchange Program and the Bay Area Water Quality and Supply Reliability Program, to improve water quality and water supply reliability, as well as disaster preparedness, on a regional basis. These programs could promote matching water quality to water use with potentially no degradation to the ultimate use of the water. For instance, a local water agency in the Bay Area with access to a water supply of relatively lower water quality could fund water recycling or water conservation projects in another agency's service area that has a higher quality water supply in exchange for the higher quality water saved by those projects. This concept is being pursued under the Bay Area Integrated Regional Water Management Plan (IRWMP) — *Water Supply and Water Quality Functional Area Document* (RMC 2006).

Under the San Joaquin Valley-Southern California Water Quality Exchange Program, MWD is working with both the Friant Water Users Authority and the Kings River Water Association to investigate the feasibility of exchanging water supplies. MWD is interested in these exchanges to secure higher quality Sierra water supplies that could lower their cost of treatment and increase their ability to meet more stringent drinking water quality regulations. In return for participating in the water quality exchange, Friant and Kings are interested in securing infrastructure improvements, financed by MWD, which will increase water supply reliability for their members. In this type of exchange, however, increased salinity levels are the largest water quality issue. If water is drawn from a poorer quality supply and the basin has no outlet, then the salinity level in the groundwater will increase (for further discussion, see Chapter 19, "Salt and Salinity Management," in this volume). This program is still being pursued as part of the September 2006

San Joaquin River Settlement (refer to *NRDC et al. v. Rogers et al.* 2006) (San Joaquin River Restoration Program 2009).

Statutory Language

Several sections of the California Water Code and the California Code of Regulations provide guidance for the use of water, as well as specify legal and regulatory requirements, and thus define the potential for utilizing this strategy.

- The use of potable domestic water sources for nonpotable use is considered a waste and unreasonable use if recycled water of adequate quality is available (Water Code Section 13550).
- Existing water rights holders are free to use recycled water, desalinated water, or water polluted by waste to a degree which affects the water for other water quality beneficial uses over their normal higher quality water source, without fear of losing their water right due to non use (Water Code Section 1010).

Potential Benefits

Agriculture

For agricultural and instream uses, water quality matching is an integral part of water quality management because there is generally no treatment of these water supplies prior to their use.

Drinking Water

For drinking water, appropriately matching high-quality source waters can reduce the levels of pollutants and pollutant precursors that cause health concerns in drinking water. In addition, less costly treatment options can be used when water utilities start with higher quality source waters. In turn, this increases water supply reliability and assures multiple barriers of protection for public health.

Municipal and Industrial

For municipal and industrial customers, using water high in salinity can damage plumbing fixtures, water-using devices, and equipment all of which increases costs. A 1999 study conducted by the U.S. Department of the Interior and MWD found that for every decrease of 100 milligrams-per-liter in salinity, there is an economic benefit of $95 million annually to MWD's customers (Bookman-Edmonston 1999).

Instream/Ecosystem Benefits

For instream uses, maintaining water temperature suitable for fish and aquatic organisms is an integral part of managing instream water quality for the benefit of the ecosystem. Temperature control devices, as used on Shasta Dam, provide reservoir operators with a mechanism to adjust the water temperature of reservoir outlet flows to meet the needs of the downstream ecosystem better.

Opportunities for Blending of Sources

Improved treated water quality and water supply reliability are also potential benefits of water quality matching for those agencies that have access to a diverse water supply portfolio. One example is the Santa Clara Valley Water District, its retail agencies, and other water suppliers along the South Bay Aqueduct which have access to Delta water, Hetch Hetchy, local surface water, and groundwater. During droughts, seawater intrusion increases the level of salinity, including bromide, in Delta water supplies. In such an event, agencies and regions with water source flexibility could use more groundwater or local surface water, if available, both of which are relatively bromide-free. When water with high levels of bromide is disinfected, there may be additional treatment costs incurred to minimize the formation of potentially carcinogenic disinfection byproducts.

Avoided Treatment Costs

Water that contains lower levels of salinity is a better match for domestic water quality uses and for irrigating salt-intolerant crops such as strawberries and avocados. As previously noted, some agencies blend water supplies to achieve a desired water quality, including salinity levels. If low salinity water supplies are unavailable, water utilities may have to treat high salinity water supplies to achieve a desired water quality. In the Chino basin, utilities already desalinate groundwater for domestic use. In the San Francisco Bay Region, the Zone 7 Water Agency and Alameda County Water District (ACWD) also desalinate groundwater for domestic use. For example, the capital costs alone of ACWD's new groundwater desalting project in Newark were $1.3 million per acre-foot per day of capacity, with operations and maintenance costs of $500 per acre-foot.

No-Cost Water Quality Exchange

In 2003, a no-cost water quality exchange was implemented between the Environmental Water Account (EWA), Kern Water Bank, and MWD. Under the exchange, EWA had purchased groundwater in the Kern Water Bank, seeking to avoid a storage fee for leaving the purchased water in the bank. MWD offered to receive EWA's purchased water in exchange for providing the EWA with a surface water supply later in the year when EWA could use the water. MWD benefited from the exchange because it received groundwater supplies with low total organic carbon and bromide levels during a period when MWD was unable to blend total organic carbon levels down with Colorado River supplies.

Another example of a no-cost exchange is when an urban water user provides agricultural water users with surface supplies during the peak agricultural water demand period. During these periods, agricultural users would otherwise be forced to use groundwater and might face pumping constraints. In return for access to surface supplies, the agricultural user returns a similar amount of pumped groundwater during the fall-winter period when there is excess groundwater pumping capacity and there are undesirable levels of bromide and total dissolved solids in Delta surface supplies.

In addition to water-supply benefits, the use of Delta water in groundwater recharge and banking operations may provide water quality benefits as well as substantially reducing levels of turbidity, pathogens, and organic carbon upon withdrawal. Recharge and banking will result in better quality water with respect to these pollutants if the water is percolated.

Climate Change

As precipitation patterns change, water scarcity is likely to increase. Increased conflict over how to use available water might arise. Matching water quality to use allows for multiple uses below drinking water standards (and a few above those standards) and could increase water supply reliability for urban systems, agriculture, and the environment. Climate change may have an overall negative effect on water quality; climate change impacts such as sea level rise, droughts, and floods additionally would affect water quality.

Adaptation

Generally, treating less water to higher standards may increase adaptive capacity by increasing supply reliability for drinking water. If, for example, more buildings use recycled water for toilets and irrigation, the overall demand for potable water will decrease, making urban systems more resilient when faced with diminished supplies due to climate change impacts. Taking steps such as changing plumbing codes, increasing recycled water production, and allowing for greater flexibility for agricultural irrigation system water quality can help to protect critical drinking water supplies.

Mitigation

Matching water quality to use has mitigation benefits and drawbacks. There are energy benefits from treating less water to a higher quality than is needed for the intended use. Increased energy use, however, may result from increased treatment of municipal wastewater that is sometimes necessary to make that recycled water available for safe, non-potable uses. Moreover, new distribution infrastructure will be necessary in certain instances, and the construction of that infrastructure would result in GHG emissions.

Linkages to Other Resource Management Strategies

Pollution Prevention

This strategy has a direct link to the pollution prevention strategy because maintaining water to its highest quality through pollution prevention allows greater potential uses of the water. The higher the quality of water, the greater potential there is to match quality to use.

Municipal Recycled Water

Water quality is matched to use when municipal wastewater is treated to recycled water standards for non-potable use such as irrigation. This allows greater flexibility in the use of local water supplies and reduces the amount of potable water needed for a community if recycled water replaces potable water that is used for irrigation.

Salt and Salinity Management

As water is used and reused, the potential for buildup of salts in the water makes the water less suitable for reuse. Salinity management is necessary to preserve the maximum potential uses of the water.

Groundwater/Aquifer Remediation

Matching water quality to use can be used as a management tool for aquifer protection. One example of this is in the Salinas groundwater basin where recycled water will be supplied to agriculture in lieu of groundwater. This in-lieu recharge is used to combat further seawater intrusion.

Potential Costs

Water Exchange Costs

CALFED estimated that water quality exchanges could cost nearly $100 million (in 2004 dollars) during Stage 1 implementation. These costs can be broken down into costs to build the infrastructure that matches quality to use, the long-term conveyance costs, administrative costs (negotiation costs), swapping place of use, and institutional costs.

Infrastructure and Conveyance Costs

In most cases, costs for matching water quality to use will also include new conveyance systems to connect source waters different from those currently being used. Matching quality to use involves moving water from where it is available to where it is needed, incurring costs for energy, capacity, and hydraulic losses. These costs can come in the form of incentive payments for participants (e.g., the incentive for the Friant/Kings-MWD programs is MWD's willingness to invest in local infrastructure that will benefit the exchange partners).

Major Implementation Issues

Water Quality Exchanges

Water quality exchanges face similar regulatory, institutional, and third-party impact issues that water supply transfers face (for further discussion, see Chapter 8, "Water Transfers," in this volume). In particular, water supplies are generally governed by place-of-use restrictions that must be addressed when exchanging water supplies. Moreover, water quality exchanges could have adverse third-party impacts such as increasing the salinity of local groundwater, reducing the availability of higher quality instream water needed for fisheries, and limiting agriculture to salt-tolerant crops. These water quality exchanges should be evaluated for their impact on energy use and GHG emissions, in addition to the increase in supply and satisfaction of increased demand.

Effluent-Dominated Streams

Many streams in California have become dominated by effluent releases from wastewater and stormwater releases resulting from diversions of water out of streams and lakes for beneficial human uses. In addition, many streams in the semi-arid West that were naturally and seasonally intermittent or ephemeral have become perennial due to wastewater discharges or nuisance flows from stormwater systems. The conversion from intermittent/ephemeral stream types has changed the type of ecosystem being supported. For example, the native red-legged frog thrives in ephemeral stream systems. When these systems are converted to perennial streams, bull frogs, predators of the red-legged frog, can thrive and expatriate the red-legged frog from its habitat. Water pollution reduction is typically directed at eliminating the discharge of water coming from wastewater and stormwater. This strategy could restore some native intermittent/ephemeral ecosystems, but would also remove the "created" perennial ecosystems. In fact, the opposite may occur: where effluent has replaced perennial flows, the removal of the effluent could convert historically perennial systems into ephemeral systems unless natural flows could be restored.

As water is withdrawn from streams and lakes in the rain-fed watershed, effluent discharges have been increasing. While effluent discharges might be seen as replacing the natural sources of water in some watersheds, the timing and quality of the water is much different from natural conditions. For example, the effluent is typically warmer than the natural flow from formerly snowmelt-fed or groundwater-fed streams and may contain more salts and other contaminants. This situation typically benefits non-native fish species over native species.

Usability of Water

There is often a high cost incurred by water supplies that become either unsuitable for certain uses, or very expensive to use because of contamination. An example is the contamination of water supplies by methyl tertiary-butyl ether (MTBE, a gasoline additive that may cause cancer), which initially closed 80 percent of Santa Monica's drinking water wells, determined in a study by the Environment California Research and Policy Center (Jahagirdar 2003). This contamination forced the city to increase its dependence on imported water sources and later to install treatment facilities to reduce MTBE levels.

Another example, a study by the University of California, Davis, on nitrate contamination in the Tulare Lake basin and Salinas Valley, found that many small drinking water systems in these areas that rely on groundwater have nitrate contamination that exceeds the drinking water standard. One solution that matches water quality to use is to switch from the nitrate contaminated groundwater to surface water (Harter et al. 2012).

Salinity

Agricultural drainage, imported Colorado River water, seawater intrusion in the Delta, and coastal aquifers all contribute to increasing salinity in all types of water supplies which can adversely affect many beneficial uses including irrigation, fish and wildlife, and domestic use. The primary tool to reduce salinity impacts is matching water quality to use because many sources of salinity, such as seawater intrusion, are natural and treatment to remove salinity is relatively expensive. If the source water has less salinity, the discharge after use will also have less salinity. Further, water supplies that are high in salinity increase the cost of recycling or recharging them into aquifers for subsequent reuse. The State Water Resource Control Board adopted a Recycled Water Policy in 2009 (State Water Resources Control Board 2009-0011) that directed stakeholders to develop salt and nutrient management plans. In addition, the regional water quality control boards have recognized the need to develop salt management strategies to prevent high-quality waters from being degraded due to salt discharges. The Santa Ana Regional Water Quality Control Board has adopted a salt management plan, and the Central Valley Regional Water Quality Control Board is working on a salt management strategy.

Operations Criteria for Storage and Conveyance

Most reservoirs and other projects, such as water transfers and the EWA described above, operate to achieve goals and objectives related to water supply, power production, flood control, fish and wildlife protection, and even recreation — but not water quality. In the Delta, there are water quality standards for salinity and temperature in project operations that protect agricultural, instream, and municipal and industrial uses. However, these ambient water quality standards do not reflect water user demand for lower salinity water supplies.

Upstream and Downstream Partnerships

Few partnerships presently exist between upstream source water areas, downstream water users, and the water users in between that affect water quality, resulting in a critical disconnect in the overall system. Such partnerships could lead to pollution prevention or trading opportunities that could create more efficient water quality protection. For example, a downstream partner with an interest in protecting water quality may wish to pay for projects or initiatives in the upstream partner's area of influence. California encourages these partnerships through grants funded by various bond measures to develop and implement an IRWMP.

Ecosystem Restoration and Drinking Water Supplies

Some ecosystem restoration projects, such as wetlands restoration, may improve habitat and even some aspects of water quality, but at the same time may degrade other aspects of water quality, such as the increase of mercury or organic carbon, from a drinking water perspective. The CALFED Ecosystem Restoration program has reviewed this potential conflict in matching water quality to use in the Delta (California Department of Fish and Game 2009).

Recommendations

1. The State should facilitate and streamline water quality exchanges that are tailored to make better matches of water quality to use, while mitigating any adverse third-party impacts of such transfers, including the increase or decrease in net energy use and greenhouse gas emissions.

2. The State, local agencies, and regional planning efforts should review potential impacts on streams by projects aimed at eliminating discharge of wastewater or causing changes to the natural timing and quality of water and make recommendations on how to mitigate these impacts.

3. The State should facilitate water reuse downstream by encouraging upstream users to minimize the impacts of non-point urban and agricultural runoff and treated wastewater discharges.

4. The State should support the development of salt management plans for all watersheds where salt is a constituent of concern.

5. The State and local agencies should better incorporate water quality into reservoir, Delta, and local water supply operations, as well as facility reoperation and construction. For example, the timing of diversions from the Delta, and thereby the concentrations of salinity and organic carbon in those waters, could be better matched to domestic, agricultural, and environmental uses. Alternatively, the timing and location of urban and agricultural discharges to water sources, including the Delta, could also be coordinated with the eventual use of water conveyed by potentially impacted diversions. Facilities conveying municipal and industrial water could also be separated from those conveying water for irrigation.

6. The State, local water agencies, and regional planning efforts should manage water supplies to optimize and match water quality to the highest possible use (e.g., drinking water) and to the appropriate treatment technology.

7. Consistent with the watershed-based source-to-tap strategy recommended in “Pollution Prevention,” Chapter 18 in this volume, the State should facilitate systemwide partnerships between upstream watershed communities and downstream users along the flow path in order to find ways to make better matches of water quality to use. Ongoing integrated regional water management planning efforts are facilitating systemwide partnerships to make better matches of water quality to use.

8. The State should support research for solutions to the potential conflicts between ecosystem restoration projects and water quality for drinking water.

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