CALFED BAY-DELTA PROGRAM

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To: Delta Vision Blue Ribbon Task Force

From: Sam Harader
CALFED Water Quality Program

Subject: Drinking Water from a Changing Delta

Introduction

Treating Delta water for municipal use has always been a challenge due to the presence of organic carbon, bromide, pathogens, salinity, nutrients, and algae. Water at the southern and central Delta intakes varies in quality but is moderately high in organic carbon and is very high in bromide. Water at the North Bay Aqueduct intake in the northwestern Delta has very high concentrations of organic carbon and moderate concentrations of bromide. When Delta water is disinfected during water treatment to remove bacteria, viruses, and other pathogens, organic carbon and bromide react with the disinfectants to form harmful disinfection byproducts. Seawater is the primary source of bromide. Organic carbon comes from natural processes, agriculture, and other human sources in the Delta watershed.

The salinity of Delta water contributes to taste problems, limits recycling and groundwater recharge opportunities, and is closely linked to bromide concentration. Although seawater is the primary source of salinity, agricultural and urban discharges in the watershed also contribute to the salt load.

Nutrients (primarily nitrogen and phosphorus) in Delta water leads to algal growth in reservoirs and conveyance structures. Algae produce chemicals that impart tastes and odors in treated water and clog filters or otherwise interfere with water treatment. Agricultural and urban discharges are the primary sources of nutrients in the Delta watershed.

CALFED Water Quality Program efforts to reduce organic carbon and bromide concentrations have largely focused on monitoring studies to better understand sources and planning studies of potential water quality improvement actions, and as a result, these efforts have not substantially changed water quality at the drinking water intakes. Agencies that treat Delta water have invested hundreds of millions of dollars in advanced water treatment processes to meet current drinking water standards. It is likely that drinking water standards will become increasingly stringent in the future and there is also concern that Delta water quality will degrade and pose additional treatment challenges. While problematic for drinking water, variable salinity and high organic carbon are natural characteristics of estuaries. There is a trade-off between the desire to withdraw high quality water for drinking from the Delta and maintaining its function as an estuarine ecosystem.

Potential Conflict with Ecosystem Restoration

While the Water Quality Program is implementing projects to reduce organic carbon loadings, Ecosystem Restoration Program projects to restore wetland habitat may have the opposite effect. Recent analysis of the sources of organic carbon by USGS scientists has identified shallow tidal wetlands in the Delta as significant sources of organic carbon at certain times of year. A preliminary estimate is that restoration of 30,000 acres of such wetlands could increase springtime organic carbon concentrations in water diverted at the southern Delta pumps by up to 0.5 mg/L. This is roughly a 15% increase from current levels and could have a significant impact on drinking water treatment. While increasing wetland habitat and organic carbon production are essential elements of ecosystem restoration it must be recognized that they may increase the expense and technical difficulty of using the current Delta conveyance and intake locations for drinking water supply. Our ecosystem restoration goals are in conflict with our drinking water quality goals.

Climate Change and Population Growth Impacts

Many of the potential impacts of climate change and population increase point to a Delta that will be an even more challenging and expensive drinking water supply. Rising sea level will increase the forces driving seawater intrusion and changing runoff patterns will reduce supplies available to repel seawater in the critical summer and fall months. The population of the Delta watershed is growing rapidly. The population of the Sacramento Valley is projected to increase by 53 percent between 2000 and 2020, and the population of the San Joaquin Valley is projected to increase by 118 percent during this period. Unless we do a better job of controlling urban runoff and wastewater discharges, population increase will lead to increased loads of organic carbon, nutrients, pathogens, and other pollutants. New modeling tools are needed to refine projections of the timing, distribution, and magnitude of climate and population driven water quality changes.

The Cost of Treating Delta Water

An example of how drinking water agencies have adapted to the combination of increasingly stringent regulations and Delta water quality is the approach taken by Metropolitan Water District of Southern California (MWD). MWD provides water to approximately 18 million of the 25 million people who get some or all of their water from the Delta. MWD investigated a number of alternative treatment methods and chose disinfection with ozone as the preferred alternative. Two of the five MWD treatment plants have been retrofitted to use ozone as the primary disinfectant. These two plants treat 100 percent State Water Project water from the Delta. A third plant is currently in the process of being converted to ozone and the remaining two are planned to be converted in the near future. Ozone is similar in cost to the most common feasible treatment alternative for treating Delta water (enhanced coagulation) and has the advantage of more effective disinfection and aesthetic quality of finished water.

The down side is that ozone disinfection equipment is expensive and there are significant energy and chemical demands. MWD estimated the capital cost to convert all five of its plants to ozone to be approximately $900 million with nearly $14 million in additional annual operating and maintenance costs (2002 dollars). $60 million of the funding required for ozone disinfection at the three remaining MWD plants is being provided from Prop 50 by the Department of Public Health. The 20 year annualized additional cost for ozone treatment was estimated at $47 per acre-foot of water. All treatment plants getting 50% or more of their water supply from the Delta have likely experienced similar or greater treatment cost increases.

Continuing Treatment Challenges

Treating Delta water is a delicate balancing act due to the need to adequately disinfect the water to remove pathogens while preventing the formation of disinfection byproducts. Although, at considerable expense, municipal water agencies have been able to comply with current drinking water regulations, treatment is not a panacea for a low quality water supply. All known combinations of primary and secondary disinfection produce harmful byproducts. Even with ozone as a primary disinfectant, water systems need to use chlorine or another chemical disinfectant to maintain a protective disinfectant residual in the distribution system. The high levels of organic carbon, salinity, and bromide in Delta water are a difficult combination. Out of necessity, Delta water users in the Bay Area and Southern California have become research leaders in the treatment of estuarine water.

Ozone disinfection, while greatly reducing the concentrations of the most common organic disinfection byproducts, results in the formation of bromate from bromide. Bromate, like the other regulated disinfection byproducts, is a suspected human carcinogen. To date, bromate formation control with pH adjustment has been successful at complying with current federal and state drinking water standards. Acid addition for bromate control, and subsequent neutralization with caustic soda for corrosion control increase the salinity of the product water. While current efforts to control bromate formation have been successful, there is concern that in the future, during a prolonged drought, Delta bromide levels will increase substantially and the control of bromate formation will be even more challenging.

Other advanced treatment technologies such as ultraviolet light, alternative disinfection chemicals, and membrane treatment have been investigated alone and in various combinations and some are being used. All have various advantages and disadvantages for disinfection, byproduct formation, and residuals management. All are much more expensive than basic conventional treatment with costs ranging as high as $400 per acre- foot or more for membrane treatment. Significant degradation of Delta water quality from current levels will increase operations costs using existing treatment systems and will steer more water utilities towards expensive advanced treatment.

A more thorough study of Delta drinking water treatment methods, costs, and sensitivity to water quality changes would be a useful tool in the development of a Delta strategy.

Current Delta Drinking Water Quality

The CALFED Bay-Delta Program established a target for providing safe, reliable, and affordable drinking water in a cost-effective way, which is to achieve either average concentrations at Delta drinking water intakes of 3 mg/L TOC and 50 µg/L bromide, or an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies. Water quality at the Delta drinking water intakes is above the 3.0 mg/L target for organic carbon and, at most intakes, is several times the 50 µg/L bromide target. The following are the 1990-2006 median concentrations for these constituents at the Banks Pumping Plant in the southern Delta, the North Bay Aqueduct (NBA) intake on Barker Slough in the northwest Delta, and, for purposes of comparison, at the Sacramento River at Hood.

Location	Total Organic Carbon (mg/L)	Bromide (µg/L)
Sacramento River at Hood	1.9	10
North Bay Aqueduct Intake	5.9	50
Banks Pumping Plant	3.5	180

The increase in organic carbon crossing the Delta from Hood to the Banks Pumping Plant is due to mixing with San Joaquin River water and in-Delta additions from agriculture and wetlands. The very high concentrations of organic carbon at the NBA intake are due to the overwhelming influence of runoff from the local watershed. Although it varies seasonally, approximately 15-50% of the organic carbon loading at the south Delta pumps comes from within the Delta. The bromide increase is due to seawater intrusion both directly from the bay or recirculated through the San Joaquin Valley by way of irrigation water supplied from the Delta.

Source Improvement Actions

Although the CALFED Water Quality Program has focused a considerable amount of the available resources on projects to improve the Delta as a source of drinking water, achieving any measurable improvement within the program time frame has proven difficult. Grants, managed by US Environmental Protection Agency, the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCB), have implemented projects and programs to reduce pollutant loadings from agricultural and urban sources. The Central Valley RWQCB is developing a Drinking Water Policy that will establish more effective regulatory tools addressing the drinking water constituents of concern but this policy will not be in effect until at least the end of 2009 and implementation of the policy will take many more years. Incentive based and regulatory source water quality improvement is likely to be gradual and incremental. Given the program time frame, size, and complexity of the Delta watershed and the dominant roles of hydrology, land use, and water project operations in determining Delta water quality, the lack of discernable water quality change at the pumps is not surprising.

Conveyance and Flow

The Water Quality Program Plan and CALFED Record of Decision (ROD) targets recognized that improvement at the pumps would be challenging and that alternative source waters and treatment technology would also be necessary tools. The ROD also acknowledged that changes to conveyance might ultimately be necessary to achieve the drinking water quality goals. Studies conducted by the Department of Water Resources on the potential for water quality improvement by changing Delta conveyance have shown that there are some promising options. Studies of the various alternatives for controlling flow in and around Franks Tract have shown that salinity reductions of up to 18% could be achieved at times. Studies of changing operation of the Delta Cross Channel or constructing a screened diversion from the Sacramento River near Hood have indicated that similar levels of water quality improvement are possible with these through-Delta conveyance alternatives.

Another way to change Delta conveyance is to relocate an intake to a location with better water quality. This option is currently being pursued by Contra Costa Water District and users of the North Bay Aqueduct.

Although a thorough discussion of the influence of Delta inflow, outflow, and diversions on drinking water quality is beyond the scope of this paper, we know that it is extremely important. In general, increasing Delta outflow improves water quality, particularly salinity and bromide concentrations. Wet years have generally better water quality than dry years. However, the relationship of Delta flows to water quality is complex. Much depends on the pollutant, the source of the flow, the quality of each source, the volume relative to other flows, and how water mixes and moves through the Delta. Department of Water Resources "fingerprints" identifying the sources of water reaching the southern Delta pumps show that its composition can vary from nearly 98% San Joaquin River water to almost 90% Sacramento River water. Projections of water quality under flow or conveyance conditions that diverge significantly from historic patterns must be based on the best available science and modeling. Predictions of drinking water quality for different flow and conveyance scenarios must recognize that water quality is more than just salinity and must also include, at a minimum, organic carbon, bromide, nutrients, and pathogens.

Conclusions

While investments in treatment system improvements have allowed utilities to continue supplying drinking water that is palatable and safe, this has come at a price. A Delta with increased levels of organic carbon, bromide, and other pollutants will increase the cost of treating drinking water and possibly increase public health risk. Any degradation of Delta water quality for the drinking water constituents of concern would be a setback for the CALFED Water Quality Program and will weaken an important barrier protecting public health. Improving the quality of the Delta municipal water supply would increase public health protection and reduce drinking water operational costs and possibly prevent future investments in even more advanced treatment processes. Our current understanding of the sources of organic carbon, bromide, salt, and nutrients suggests that changes to Delta conveyance are likely to be the most durable and effective means of improving drinking water quality.

References

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