# CALFED Drinking Water Quality Conceptual Framework

## Drinking Water Subcommittee
## California Bay-Delta Public Advisory Committee

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The purpose of this document is to provide guidance from the Drinking Water Subcommittee of the CALFED Bay-Delta Public Advisory Committee regarding implementation of the CALFED Water Quality Plan ("CALFED DWQP").

The Subcommittee recognizes that providing good quality drinking water is one of the most important goals for the CALFED Bay-Delta Program. Drinking water quality is influenced by a number of factors. Source water quality and quantity is highly variable. Operation of the water control structures can be directly linked to water quality. Drinking water treatment technologies and methodologies are constantly advancing and in response to new science and new regulations and implementation of these technologies can present new challenges in performance, reliability and disinfection by-products. Drinking water quality standards also evolve in response to changes in technology and better health effects information. Variations in post-treatment distribution systems can also affect drinking water quality at the tap.

Each region of the State, and many sub-regions thereof, due to the variety of source waters they receive and the treatment methods they employ, face different opportunities and challenges in providing good quality drinking water. There is obviously no single answer for the entire Program. The Subcommittee is therefore hereby recommending a strategy to help formulate public policy and incentives to assist drinking water providers determine and implement the most appropriate means of meeting their responsibilities in providing a healthy drinking water supply.

### CALFED Drinking Water Quality Program

The CALFED Drinking Water Quality Program is unique because it attempts to integrate and improve water quality and reliability from source to tap. Improvements generally fall into four broad categories:

a) Source Water Quality - reduce contaminants and salinity that impair Delta water;
b) Storage - enable users to capture higher quality Delta water for drinking water purposes;
c) Exchanges - enable voluntary exchanges or purchases of high quality source waters for drinking water use;
d) Treatment - evaluate alternate approaches to drinking water treatment to address growing concerns over disinfection by-products (DBPs) and salinity.

The State Water Resources Control Board, U.S. Environmental Protection Agency, and the State Department of Health Services are the implementing agencies

for the CALFED Drinking Water Quality Program effective January 1, 2003.[1] Other State and Federal agencies involved in CALFED's water quality improvement effort include the Central Valley Regional Water Quality Control Board, Department of Water Resources, US Bureau of Reclamation, California Department of Food and Agriculture, and the US Geological Survey.

**CALFED Drinking Water Quality Goals, Objectives and Targets**

The CALFED Record of Decision (ROD) adopted general goals and objectives of (1) continuously improving the quality of the waters of the Bay-Delta system, (2) providing good quality water for all beneficial uses, including in-Delta environmental and agricultural uses, and (3) safe, reliable, and affordable drinking water. For the Drinking Water Quality Program (DWQP), the target for providing safe, reliable and affordable drinking water was expressed as either (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 ug/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source water, source control and treatment technologies.

The numerical targets were suggested in 1998 by a panel of experts engaged by the California Urban Water Agencies, based upon predicted changes in drinking water standards set by the federal Environmental Protection Agency, and best-available disinfection techniques. These targets were not, though, the product of a comprehensive risk assessment or watershed management plan that considered the ability to achieve the targets.

By stating the target and alternative, the ROD implicitly recognized that:

1. it might not prove practical/cost-effective to achieve the numeric limits in the Delta;
2. there is uncertainty in the future development of drinking water standards;
3. drinking water disinfection techniques might change, affecting the importance of one or both of these targets, or
4. other sources of water, lower in these constituents, might be available which could be used instead of or blended with Delta water for drinking purposes.

The CALFED drinking water quality improvement targets are a commitment to achieving improved public health protection and reflect the importance of developing and implementing a diversified strategy for achieving CALFED's water quality goals.

**Salinity Management**

Salinity management is another important element of the CALFED water quality program. Walt Pettit, previous Executive Director of the State Water Resources Control Board, has stated that "salinity in the Central Valley and Southern California is probably the biggest water problem in the state that isn't being adequately addressed" (*Western Water*, Water Education Foundation, Sept-Oct 1999). CALFED has not adopted a specific numeric target for salinity, but does have a preliminary objective of reducing the salinity of Delta water supplies (CALFED Bay-Delta Program, Phase II Report, July 2000. Salinity reduction will increase

[1] California Bay Delta Authority Act (SB 1653 Costa) Chaptered September 23, 2002

opportunities for water management programs such as recycling and groundwater storage, increase the capability for blending Delta supplies with other more saline water sources, and reduce the economic impacts associated with elevated salinity levels. As with the drinking water targets, achieving salinity reduction will require implementation of a diversified strategy of salinity reduction measures. However, salinity reduction measures can be expensive, and may be limited by(a) the cost-effectiveness of available control measures within the watershed, (b) the influence of salt water intrusion. Thus, the costs of such measures must be weighed against the benefits. Large-scale salinity removal is usually only feasible if ocean disposal for the waste salt is available nearby.

**An Integrated Resources Plan for Water Quality**

The Drinking Water Subcommittee of the BDPAC was created to provide public input on implementing the ROD drinking water targets. In its deliberations it has recognized that each of the factors denoted above need to be taken into consideration in developing a strategy for implementing the ROD drinking water targets, and that a methodology is needed which incorporates these factors when analyzing "an equivalent level of public health protection" (ELPH) alternative to the numerical targets.

The Subcommittee has reached consensus on several important ideas to consider in development of a Drinking Water Strategy:

- The ROD numeric targets serve as surrogate indicators of the quality of Delta waters as to drinking water supply, based on the best available science, regulations, and technology at the time the ROD was adopted.
- The use of a surrogate also encompasses other drinking water quality issues, such as salinity, which is linked to bromide in Delta waters.
- There is a need to develop a baseline of health risk represented by the numerical objectives for bromide and total organic carbon, covering both chronic and acute risks, which could then serve as a benchmark to achieving an equivalent level of public health protection.
- The strategy should contain tools that are flexible and adaptable to local and regional conditions.
- Incremental steps to improvement should be taken where appropriate, utilizing short term measures while implementing long term measures.
- The strategy should employ a combination of tools that result in solutions that afford equity to all stakeholders, are both robust and cost-effective, and provide multiple benefits to other CALFED program elements. It is also important that these tools be evaluated with supportive and systematic monitoring to determine how well they perform against the CALFED solution criteria (both alone and in combination), and to identify and recommend best management practices (BMPs) and best available technologies, and to create funding mechanisms that allocates the costs equitably among all of the beneficiaries.
- A key component of the strategy is the development of a statewide drinking water policy, consistent with the "ELPH" concept, by the State Water Resources Control Board. Each regional board would then adopt water quality objectives for constituents of concern to drinking water suppliers and users.

The BDPAC Drinking Water Subcommittee has developed the attached schematic to illustrate the composition of potential tools that comprise the recommended strategy for drinking water quality. The recommended strategy is to further develop and analyze these tools to show how individual drinking water providers can begin to identify and analyze the opportunities and challenges pertinent to their individual situations and to determine where CALFED can best invest its resources to achieve the best overall water quality outcome.

The following outline illustrates the structure of the strategy by defining its tools, its relationship to the CALFED program and other factors affecting the quality of the public water supply. The tools of this strategy fall into four broad categories:

1. Delta water quality, source improvement control, conveyance, operations, and storage (which directly influence Delta water source quality, generally north of the Delta - these boxes flow into the box labeled “Delta Water”);
2. Local management of other water sources (which directly influence local water source quality - these boxes flow into the boxes labeled “Other Local Sources,” “Imported Water” and “Local/Regional Exchanges”:
3. Treatment and distribution (from the point of treatment to the consumer) - boxes flowing out of and including “Treatment Options”;
4. “Umbrella factors,” including water use efficiency, education and outreach, and protection of vulnerable subpopulations.

## I. DELTA WATER QUALITY

Water quality at the Delta diversion points is central to the entire DWQP. The diagram is constructed to show the relationship between the major upstream factors, Delta water quality, and the downstream processes influencing tap water quality.

The Sacramento-San Joaquin Delta receives water from its natural tributaries, including subsurface drainage, and wet year runoff from the Tulare Lake Basin. It also receives water from the Trinity River by virtue of the CVP imports into the Sacramento River. The quantity of the inflow to the Delta varies dramatically by season, and by hydrologic year type. The water quality of those inflows also fluctuates dramatically in response to ocean salinity intrusion in periods of low Delta outflow, by natural processes (changes in temperature, organic carbon loads influenced by flood plain returns and breakdown of vegetation, and algae formation), and by erosion and sediment transport.

Delta water quality can be manipulated to some degree through three groups of tools: Source Improvement, Conveyance/Delta Operations, and Storage.

### Delta Source Improvement

Source improvement refers in general to improving the water quality of the source waters to the Delta. Implementation of source improvement projects in the Bay-Delta watershed could reduce the discharge of pollutants from point and non-point sources in urban and rural areas and minimize the water quality imports of increased development and changes in land use on Delta water quality.

Degradation of water quality occurs due to natural processes (changes in temperature, organic carbon and salt loads influenced by flood plain returns and breakdown of vegetation) and to anthropogenic processes (waste loads from municipal, industrial, agricultural, silvacultural, environmental, and recreational uses).

POTW/muni/indust refer to "point sources," which include publicly owned treatment works (POTWs), industrial dischargers, and municipal storm water systems operating under discharge permits issued by the Central Valley Regional Water Quality Control Board (CVRWQCB). Discharge permits must have limits for constituents with "water quality objectives" that have a reasonable potential to impair a listed beneficial use. However, the CVRWQCB Basin Plans do not contain water quality objectives for many constituents that adversely affect drinking water supplies. The CVRWQCB should adopt water quality objectives for these constituents in the basin plan and develop an implementation plan for achieving these objectives. Moreover, there is currently no standard policy on drinking water quality adopted by the CVRWQCB and therefore adopting a policy is a specific tool of the strategy and requirement of the CALFED Record of Decision[2].

Non-point/agric refers to "non-point sources" of pollution which include agriculture, forestry, urban runoff, mining, and construction. Non-point sources are generally addressed by the CVRWQCB through general discharge waivers or through Total Maximum Daily Loads for specific chemical constituents on specific stretches of river. The CVRWQCB is currently going through a process to analyze its general discharge waiver for agricultural runoff and its impact on the environment. Non-point source pollution is historically managed using incentive based, non-regulatory programs, such as best management practices.[i]

Watershed work refers to the restoration of watershed functions, such as base flow capacity, natural filtration and sediment trapping capabilities.

**Delta Conveyance/Delta Operations**

Conveyance and Delta Operations refer to the operation of the State Water Project and Central Valley Project structures in the Delta and its tributaries. Operations, conveyance and storage downstream of the Delta are discussed in a later section.

Because of differences in source water quality, complex hydrology, relatively long transit time, the tendency for the Delta to retain salt water without flushing flows, and its estuarine nature, water quality changes as it moves across the Delta and this is influenced by the flows of its tributaries. Water quality problems associated with existing conveyance practices include sea-water intrusion due to low Delta outflows, short circuiting of lower quality San Joaquin River to the South Delta diversions, discharge of drainage from Delta islands in close proximity to drinking water intakes, and the rapidly increasing urban development adjacent to the Delta, potentially leading to increased wastewater and stormwater runoff.

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[2] The SWRCB has adopted State Water Board Resolution No. 88-63, "Sources of Drinking Water Policy". This is essentially a designation of beneficial uses. It effectively says that, with very limited exceptions, the criteria established to protect sources of drinking water apply to all waters of the State.

Salts (especially bromide and chloride) and dissolved organic matter are the most problematic Delta constituents impairing municipal, agricultural, and industrial uses of Delta water. The Delta is highly eutrophic, which promotes algal growth. The growth of some algae has caused taste and odor problems.

Currently conveyance practices which influence water quality at the major diversion points include timing of reservoir releases, operation of the Delta Cross Channel, timing and rate of SWP and CVP pumping, and installation of temporary barriers in the South Delta.

New modifications refer to potential modifications of operations and construction of new conveyance facilities. Potential modifications include the re-operation of the Delta Cross Channel. Planned conveyance changes include increasing SWP pumping at Banks pumping plant, dredging channels, installing permanent South Delta barriers, installation of an intertie between the CVP and SWP, and evaluation of a screened diversion on the Sacramento River between Hood and Georgiana Slough.[ii] Implementation of conveyance and operations improvements that enhance through-Delta flow, reduce seawater intrusion, and improve system flexibility have the potential to improve Delta water quality.

**Delta Storage**

Storage reservoirs upstream of the Delta capture wet weather flows and spring snowmelt and through controlled releases attenuate the otherwise highly variable Delta flows. Storage reservoirs provide recreation and flood protection, water supply and water quality (through maintenance of Delta outflow levels), and fishery protection. The overall trend has been a reduction in the natural seasonal variation in Delta flows and water quality. Operational changes at existing facilities and potential new storage facilities (surface and conjunctive use of ground water basins) should be evaluated for cost-effective water quality benefits.[iii] The Subcommittee is interested in evaluating additional storage as a tool for managing water quality. Additional surface storage capacity dedicated to water quality management could be operated to enhance Delta outflow and improve Delta water quality, and to store good quality water supplies for later use.

Existing refers to the use of current capacity in upstream reservoirs. Timing of releases can be explored as a means to improve water quality.

New Surface refers to the CALFED studies of new upstream reservoir capacity, for example, increased Shasta Reservoir or North of Delta Storage. New surface water capacity could be allocated to water quality improvements through the release of stored high quality water directly to purveyors or through the release of fresh water to repel ocean salinity intrusion.

Conjunctive Use refers to the term which "denotes a set of water management techniques designed to maximize the complementary use of surface and groundwater storage in order to provide improved water supply reliability"[3]. The concept here is that "surplus surface water is used to recharge groundwater basins in wetter years,

[3] DWR Bulletin 132-00 (December 2001), Chapter 7, Page 85

and the stored groundwater is extracted when needed to augment diminished surface water supplies during dry years."[3] Conjunctive use of groundwater and surface water provides opportunities to optimize the joint use of all water resources in the Delta, and it also can be an effective tool to prevent potential seawater intrusion along the coast and improve water quality as a result of the net increase in groundwater levels over time.

## II. IMPORTED WATER

The majority of Delta water consumers are located south of the Delta and import the water hundreds of miles through the California Aqueduct and Delta Mendota Canal. This conveyance and the location of end use opens up two new groups of tools: Source Water Exchanges and South of Delta Ops and Storage.

### Source Water Exchanges

Source water exchanges are meant to allow water supply agencies to take advantage of high quality water from other sources to improve water quality and reliability.[iv] These "other sources" are currently being used for functions with lower water quality requirements (usually agricultural) than drinking water, so these exchanges are essentially optimizing the use of water quality in California. While exchanges may alter the timing of flows in the system, they are not operated to increase withdrawals. Indirect impacts due to such exchanges must be carefully determined however, to avoid degradation of Delta water quality, and avoid un-redressed third party impacts.

### CWP/SWP Operations and Storage[v]

The SWP and CVP share some facilities south of the Delta, and as a result SWP and CVP water supplies blend at O'Neill Forebay and San Luis Reservoir. Since the water pumped at the CVP Tracy pumping plant is often of poorer quality than SWP water pumped at Banks pumping plant, the blending at O'Neill Forebay degrades the quality of SWP supplies used for drinking water purposes. Operations of the state and federal projects south of the Delta should be evaluated to identify strategies to protect the water quality of Delta water supplies. In addition, floodwater inflows and groundwater pump-ins should be managed to protect water quality.

## OTHER LOCAL SOURCES

Few water supply agencies are entirely dependent on the Delta for their source water needs. Most have some combination of alternative surface water, groundwater and Delta water supplies. Most local sources are faced with challenges different than those listed above for the Delta. Source water protection programs (source improvement), storage and operations all have a bearing on the quality of water from local sources. An advantage of having alternative sources is the ability to improve water quality through supply flexibility and blending, depending on the quality of the alternative source.

Water supply agencies drawing their water from different points in the system and with different combinations of Delta water and local supply, will have unique

water supply and treatment needs. For the purpose of developing regional water quality strategies, Delta water users can be grouped as follows:

1. North Bay Aqueduct
2. Contra Costa Canal
3. South Bay Aqueduct
4. City of Tracy
5. San Felipe Unit
6. San Luis Canal
7. Coastal Branch
8. Kern County Water Agency
9. Antelope Valley - East Kern
10. Southern California (with many subgroups)

Integrated water quality improvement strategies for each of these regions will be unique and need to be articulated as part of the CALFED Drinking Water Quality Strategy. One such regional strategy for the Contra Costa Canal is included as Appendix B.

**Local Options**

Water agencies, especially in Southern California, have made significant progress in defining and cleaning up groundwater basins, opening up tremendous opportunities for recycling and re-use of local supplies as well as conjunctive use of both local and imported wet year supplies, with consequent reduction of reliance upon imports during dry periods.

Local sources have local watersheds and groundwater basins that may contain a variety of point and non-point sources of source water quality degradation. The EPA has already identified the cleanup of local source watersheds in their Multiple Barrier approach for drinking water treatment. Source improvement could include the implementation of AB 3030 plans for groundwater sources, or the institution of BMPs for local land use practices.

Storage can create water quality improvement through storing high quality waters for direct use or blending with lower quality sources. Storage can create water quality improvement by adding flexibility to local agencies water sources. Storage can also provide emergency and drought supplies at times when water quality is most vulnerable. Storage can benefit an individual or a group of agencies within a region. Storage can be surface storage or groundwater storage.

Operational changes may afford local agencies water quality improvements. Water quality degradation is often cyclical, and can occur over seasonal or shorter time periods for local agencies. By examining the timing of water quality degradation, the variety of sources available to local agencies, and the flexibility of the local system, local agencies may be able to improve water quality through operational changes.

Local water agencies may determine, through the production of their individual ELPH strategy, that their baseline of public health is more effectively improved through the control of a contaminant other than bromide or total organic carbon (for example, arsenic) or through some unique project. Local agencies will have the flexibility to make the determination and the most vulnerable populations could be identified and supported.

### Local/Regional Exchanges

Local agencies within a region or sub-region may find that they can improve their water quality through regional exchanges of higher quality water to functions with higher quality needs (for example, drinking water) and lower quality water to functions with lower quality needs (for example, landscaping or agriculture). Essentially waters of particular quality will be matched up with functions needing that particular quality. Conjunctive use (in-lieu recharge) projects are an example of local/regional exchanges.

## III. DELIVERED WATER QUALITY

An equivalent level of public health protection in delivered water quality will be achieved through the balance of source water measures and treatment measures, with a consideration of effectiveness and cost. The CALFED goals of 50 ug/L bromide and 3 mg/L TOC were based on using conventional treatment and incorporating enhanced coagulation or ozone disinfection to meet anticipated drinking water standards at the time the ROD was developed. Treatment technology has continued to advance since the targets were adopted. Some water supply agencies are already using the model treatment that was the basis for 50 and 3. Most other urban water agencies are actively evaluating treatment technology options in preparation for decisions on investments in treatment upgrades, or are currently installing advanced treatment technologies that reduce formation of disinfection byproducts. Treatment technology is typically customized to the source waters used by local agencies.

### Treatment Options

Commonly employed treatment technologies for Delta water users are ozone, chloramines, and conventional chlorine disinfection. Advanced treatment studies, tailored to Delta waters and combinations of local waters, would add significantly to this portfolio. The use of multiple disinfectants and advanced treatment technologies has the potential to significantly control disinfection byproducts caused by ozonation. The knowledge gained through studying advanced technologies would assist CALFED in determining the most effective balance between source improvement and treatment improvement. It is important to note, however, that the removal of salts from water remains an extremely costly process.

### Distribution System

The local distribution system can also be a source of water quality degradation. The local distribution system can also be a source of water quality degradation. Local agencies currently study and improve their individual distribution systems. For example, local distribution systems experience lower use during winter

months, which can cause finished water reservoirs to stratify, potentially resulting in additional disinfectant by-product formation. One way to overcome this problem is to build smaller redundant tanks or add mechanical fixtures to increase the circulation in the reservoirs.

## IV. "UMBRELLA FACTORS"

### Water Use Efficiency

Water use efficiency is a crucial component of the CALFED program in general. The DWQP should coordinate with the WUE program to determine the best way to implement WUE throughout California and to identify opportunities through the ELPH strategy for the multiple benefits of WUE to both water supply and water quality. [vi]

Water use efficiency is an important component of the CALFED program throughout the solution area, and incorporates the many conservation programs being implemented at the local level. [vii] Water use efficiency measures should be thought of in conjunction with local and system wide water management as ways to stretch or modify the availability of higher quality sources both among agencies sources and when employed in concert with an exchange or transfer strategy to obtain higher water quality from other sources. Water use efficiency gains may also offset the need for some portion of existing storage capacity that could then be dedicated to increase Delta outflow during periods of water quality concern.

### Education and Outreach

Education and outreach are important in all elements of the Drinking Water Quality Programs. For example, education is one of the most important tools, even considered a "management measure" or "best measurement practice," available for source water protection. Consumers also need to be knowledgeable about the safety of their water supply to be empowered to make informed decisions about the relative health risks of tap water compared to other waters and compared to other daily activities. Agencies should develop substantive public participation programs that begin early, engage a broad range of affected and interested parties, and which incorporate public values, viewpoints and preferences.

### Vulnerable Subpopulations

State and local agencies must address protection of vulnerable subpopulations and localized water quality problems that may disproportionately impact communities of color or other disadvantaged populations.

## V. PUBLIC POLICY & INVESTMENT STRATEGY

The next steps in the completing this integrated resources plan for water quality include the development and/or establishment of:

1) the tools to implement ELPH;
2) specific regional plans for ELPH investments;
3) roles and responsibilities of CALFED and local agencies; and

4) the financing necessary to implement ELPH statewide.

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[i] ROD commitments directly related to source water quality:

- Assist existing agency programs to reduce turbidity and sedimentation; reduce the impairment caused by low dissolved oxygen conditions; reduce the impacts of pesticides including organ chlorine pesticides; reduce the impacts of trace metals; mercury; and selenium; reduce salt sources to protect water supplies; and increase understanding of toxicity of unknown origin.
- Improve dissolved oxygen conditions in the San Joaquin River near Stockton.
- Water Supply Reliability - allocate Proposition 13 funds dedicated to interim water supply reliability and water quality.
- Address drainage problems in the San Joaquin Valley.
- Implement source controls in the Delta and its tributaries.
- Address water quality problems at the North Bay Aqueduct.
- Develop and implement a plan to meet all existing water quality standards and objectives for the SWP and CVP.

[ii] ROD commitments related to water quality and Conveyance include:

- Restore habitat and hydraulic needs on Frank's Tract in the Delta to optimize improvements in ecosystem restoration, levee stability, and Delta water quality.
- Reduce agricultural drainage in the Delta.
- Evaluate and implement improved operational procedures for the Delta Cross Channel.
- Evaluate a screened through-Delta facility.
- Intertie between SWP and CVP facilities at or near Tracy.
- Bypass canal to the San Felipe Unit at San Luis Reservoir.
- Control runoff into the California Aqueduct and similar conveyances.
- Study recirculation of export water to reduce salinity and improve dissolved oxygen in the San Joaquin River.

[iii] ROD commitments related to water quality and Storage include:

- Expand CVP storage in Shasta Lake by approximately 300 TAF
- Expand Los Vaqueros Reservoir by up to 400 TAF
- In-Delta storage project - 250 TAF
- Evaluation of Sites Reservoir and upper San Joaquin River
- Groundwater storage and management (conjunctive use)

[iv] ROD commitments related to Source Water Exchanges include:

- Establish a Bay Area Blending/Exchange project
- Facilitate water quality exchanges between the eastern San Joaquin Valley and Southern California

[v] ROD commitments related to Operations, Conveyance and Storage south of the Delta include:

- Bypass canal to the San Felipe Unit at San Luis Reservoir
- Control runoff into the California Aqueduct and similar conveyances

[vi] ROD commitment related to treatment and distribution include:

- Invest in treatment technology demonstration project

[vii] ROD commitments related to water quality and the Water Use Efficiency include:

- CALFED Water Use Efficiency Program, incentive based programs in the urban sector
- Water measurement and transfer actions