

December 21, 2001

Mr. Walt Pettit  
Executive Director  
California Urban Water Agencies  
455 Capitol Mall, Suite 705  
Sacramento, CA 95814

Re: Review of Expert Panel Report

Dear Mr. Pettit:

This letter summarizes the expert panel's review of our June 1998 report entitled "Bay-Delta Water Quality Evaluation." The expert panel, consisting of Phillippe Daniel, Scott Summers and Doug Owen (chair), were asked to review our previous conclusions based upon recent ozone treatability data included in a newly-released research report entitled "Bromate Formation and Control During Ozonation of Low Bromide Waters."

For your convenience, we have divided this letter into the following categories:

- Basis of the Original Expert Panel Report
- Basis for Review of the Original Expert Panel Report
- Scope of the Re-Convened Expert Panel
- Impact of the AWWARF Results on Source Water Quality Recommendations

In summary, the expert panel did not find sufficient information in the AWWARF report to warrant modification of the projected source water TOC and bromide concentrations in water diverted from the Delta to allow users to implement defined treatment technologies (e.g. coagulation, ozone, granular activated carbon, membranes). The reasons for this are discussed in the remainder of this letter.

### **Basis of the Original Expert Panel Report**

In 1996, CUWA retained the assistance of three water quality and treatment specialists who had specific expertise in disinfection and the formation of disinfection by-products (DBPs). These three individuals - the expert panel - evaluated specific source water quality characteristics that would be necessary to permit diverted water from the San Francisco Bay/Sacramento-San Joaquin River Delta (Delta) to be used for meeting potential public health related water quality standards under defined treatment conditions. Specifically, the expert panel was charged with 1) developing potential future regulatory scenarios, 2) defining appropriate process criteria for coagulation, ozonation, granular

activated carbon and membrane treatment processes, and 3) estimating source water quality diverted from the Delta which would allow users implementing the defined treatment technologies to comply with the regulatory scenario. The source water quality characteristics were framed in the context of total organic carbon (TOC) and bromide concentrations, both constituents that have the potential to be controlled by different management strategies for the Delta.

The final report entitled "Bay-Delta Water Quality Evaluation" was submitted to CUWA in June 1998. In that report, the expert panel concluded that source water containing < 3 mg/L of TOC and < 50 ug/L of bromide would allow users the flexibility to incorporate all of the defined treatment processes to meet the potential regulatory scenarios outlined in their evaluation. The TOC criterion was limited by the use of enhanced coagulation and the bromide criterion was limited by the use of ozone. CUWA has used this document to provide input into the CALFED process regarding source water quality needs under various Delta management strategies.

### **Basis for Review of the Original Expert Panel Report**

Several events in the water profession have been ongoing since the submission of the 1998 expert panel report, among them:

1. Additional research has been conducted regarding the efficacy of various treatment processes to provide microbial disinfection while controlling DBPs.
2. The second stage of the Microbial/Disinfection By-Product (M/DBP) regulations have been developed through the Federal Advisory Committee Act (FACA) and have been drafted by USEPA.
3. CUWA has continued to be active in the CALFED process as various Delta management alternatives have been evaluated.

Of specific interest, a report entitled "Bromate Formation and Control During Ozonation of Low Bromide Waters" has been released by the American Water Works Association Research Foundation (AWWARF). This report provides additional information regarding bromate formation under various treatment conditions for a relatively broad range of source waters. As such, it may include data that can help confirm or advance the information on ozone disinfection and bromate formation that was available to the expert panel when the source water quality recommendations in the original report were crafted.

### **Scope of the Re-Convened Expert Panel**

The expert panel reviewed the AWWARF report and reconvened on December 3 and 18, 2001 by conference call to discuss the overall implications of the new data. Specifically, the expert panel was responsible for:

1. Reviewing the results and recommendations of the original water quality evaluation submitted to CUWA in June 1998.
2. Reviewing and evaluating the results presented in the AWWARF report on bromate formation in low bromide waters.
3. Determining whether the source water quality recommendations in the 1998 expert panel report should be modified based upon the results in the AWWARF report.

The expert panel was directed to perform the above tasks under the conditions that the following assumptions would remain unchanged from the 1998 expert panel report:

1. The disinfection and DBP requirements projected in the long-term regulatory scenario.
2. The design criteria for the ozone process.

The expert panel is aware that the members negotiating the Stage 2 D/DBP Rule and Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) through the FACA process have signed an Agreement in Principle. These values differ to some degree from the long-term regulatory scenario projected in 1998. Nonetheless, it is understood that additional regulatory action may take place within this decade to take effect after 2010. Therefore, the expert panel was not requested to modify the regulatory scenario at this time.

The expert panel also understands that EPA has drafted disinfection requirements for ozone to provide various levels of inactivation for *Cryptosporidium* under the LT2ESWTR. Again, the panel was not requested to reevaluate the process criteria they used in 1998 to predict 1 log *Cryptosporidium* inactivation by ozone. Nevertheless, the panel did review their 1998 ozone criteria and determined that they were relatively consistent with the CT values provided in the LT2ESWTR pre-proposal draft released by EPA for stakeholder review on November 27, 2001.

### **Impact of AWWARF Results on Source Water Quality Recommendations**

The AWWARF report evaluated bromate formation for 14 different water sources. Bromate formation was evaluated under various water quality and temperature conditions. Treatment conditions were also varied including reducing pH and adding

ammonia to reduce bromate formation. Finally, the impact of hydraulic regime (e.g., true batch, semi-batch, continuous flow and full-scale operation) on bromate formation was conducted.

As indicated by the testing plan described above, there are a multiplicity of factors that affect bromate formation which make it difficult to identify controlling variables and simple, direct “cause and effect” relationships. Several factors contribute to this:

1. Low level bromide/bromate analysis and detection is still difficult as evidenced from the results presented in the AWWARF report. Round robin analyses at various laboratories used in the study highlighted the difficulty in obtaining consistent low-level analysis (< 10 ug/L) for bromate. This variability in evaluating water quality and treatment impacts on measured bromate formation was an important consideration for the expert panel.
2. A wide range of bromide conversion to bromate that could not be completely explained based upon the variables considered further complicated the data evaluation.
3. Relatively few bromate observations were made at concentrations of 5 ug/L or less, the value used in the long-term regulatory scenario in 1998. Many observations were at concentrations between 10 ug/L and 40 ug/L or higher, allowing for an understanding of the impact of treatment conditions on bromate formation, but posing significant limitations for extrapolating to the region of greatest interest. This limited the usefulness of the information for refining the limiting source water bromide concentration of 50 ug/L recommended in the expert panel’s 1998 report.

Given this background, the expert panel arrived at the following conclusions regarding the impact of the AWWARF results on the conclusions in the 1998 expert panel report:

1. In terms TOC and bromide in source water, the data in the AWWARF report suggest that TOC alone will not be a controlling variable for bromate formation. The panel understands that higher TOC will result in higher ozone dosages to meet a fixed microbial inactivation target, but TOC alone will not control bromate formation. The TOC limit of < 3 mg/L was based upon using enhanced coagulation together with a chlorine/chloramine disinfection strategy to meet the total trihalomethane (TTHM) and haloacetic acid (HAA) limits for 2 log *Giardia* inactivation. It was not related to ozone treatment. The panel therefore focused on bromide concentration in its evaluation of potential changes to source water quality diverted from the Delta.
2. The 1998 expert panel report only evaluated lowering pH as a treatment technique to reduce bromate. The AWWARF report also evaluated the addition of ammonia at concentrations of 0.5 or 1.0 mg/L to form bromamines and thereby reduce bromide availability to participate in bromate-forming pathways upon ozonation. The

3. AWWARF report indicated favorable results demonstrating a reduction in bromate formation with the addition of ammonia for some waters. The data provided, however, indicated that the positive effect of ammonia addition primarily influenced bromate reduction to levels higher than the panel's 5 ug/L regulatory estimate. In addition, there are secondary consequences of ammonia addition at treatment facilities including 1) a need to potentially provide breakpoint chlorination to allow for some short period of free chlorine contact after biologically active filters, and 2) the promotion of nitrification within biologically active filters. Therefore, the panel did not consider these data sufficient to justify modifying the 50 ug/L allowable source water bromide concentration using this treatment technique. Utilities could consider this treatment technique on a case-by-case basis.
4. The AWWARF report confirmed the positive impact of lowering pH in reducing bromate formation upon ozonation. Lowering pH to a value of 6.0 to 6.5 reduced bromate formation within the range of 5 ug/L in a few waters tested. The results confirmed previous evaluations made by the expert panel in 1998 and did not suggest that the 50 ug/L bromide limit previously recommended should be modified.
5. The AWWARF report provided interesting results implying that bench-scale reactors could provide reasonable simulations of pilot-scale and full-scale bromate formation trends provided an accurate estimate of the amount of ozone contact could be determined. More data with low ozone exposures (e.g. low products of concentration and contact time) in batch experiments will help understand this more fully. Regardless, this does not affect the expert panel's conclusions contained in the 1998 report.

In summary, the expert panel was charged with evaluating whether the source water quality recommendations in the 1998 expert panel report should be modified based upon the results in the AWWARF report. The expert panel performed the above tasks under the conditions that the disinfection and DBP requirements projected in the long-term regulatory scenario, and the design criteria for the ozone process, would remain unchanged from the 1998 expert panel report. The expert panel did not find sufficient information in the AWWARF report to warrant modification of the projected source water TOC and bromide concentrations in water diverted from the Delta to allow users to implement the defined treatment technologies (e.g. coagulation, ozone, granular activated carbon, membranes).

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We appreciate the opportunity to provide assistance to CUWA in your important participation in the CALFED process. We remain available to provide additional assistance, as you consider appropriate. If you have any questions or desire additional information, please do not hesitate to contact Doug Owen at (914) 641-2700.

Very truly yours,

MALCOLM PIRNIE, INC.

Three handwritten signatures in black ink. The first signature is 'Douglas M. Owen', the second is 'Phillippe A. Daniel', and the third is 'R. Scott Summers'.

Douglas M. Owen, P.E.  
Vice President  
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