# Report from the
# Delta Municipal and Industrial Water Quality Workgroup
# to
# the California State Water Resources Control Board
# for
# the Proceedings on the
# San Francisco Bay/Sacramento-San Joaquin Delta Estuary

October 17, 1989

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## I. Introduction

The Delta Municipal and Industrial Water Quality Workgroup was established as a part of the State Water Resources Control Board's San Francisco Bay/Sacramento-San Joaquin Delta Estuary Proceedings. Its purpose is to examine issues related to Delta water quality from the point of view of municipal and industrial (M&I) users. The workgroup has met on a number of occasions, including a full day meeting devoted to a workshop on Disinfection By-Products (DBPs). At the workshop a number of researchers, consultants and members of regulatory agencies presented recent information and the results of some of the latest research on this subject.

The discussions in the meetings often centered on issues of water quality as they relate to meeting drinking water standards, as well as the need to provide high quality water for aesthetic reasons. These issues are of importance for a variety of reasons, including the public perception of drinking water quality. The concern in the general public over the health effects and the taste and odor of drinking water results in a large annual expenditure in the State of California on bottled water and home treatment devices (estimated at more than one billion dollars in one study for the California Urban Water Agencies).

This report is the product of those meetings. The main body of the report summarizes the findings of the members of the workgroup and relates the issues on which there was a general consensus.

The report also includes three Appendices. The first provides summaries of the presentations made at the August 14, 1989 workshop. The second contains individual statements by members of the workgroup, most of which were or will be transmitted independently to the State Board. These statements include additional comments on issues raised by the State Board Staff and comments that expand upon the general findings of the workgroup. The third is the mailing list for the workgroup.

It should be emphasized that each of those involved in this matter has particular needs and points of view. This report is an attempt to consolidate those points on which there is a general consensus. However, each of the statements in Appendix B should be considered carefully along with this report in order to fully understand the breadth of the problems facing municipal and industrial users of Delta water.

The sections in this report can be classified broadly as follows, although it is recognized that many aspects are interrelated. Section II deals with water quality problems related to disinfection by-products (including trihalomethanes). Section

III discusses water quality problems related to salinity and chloride ion concentrations. Section IV deals with other contaminants found in Delta waters and the problems related to those contaminants. Appendix A contains summaries of the presentations made at the August 14, 1989 workshop on disinfection by-products. Appendix B contains individual statements on this document and related M&I issues by members of the workgroup. Appendix C contains the list of those who either attended meetings or asked to be included on the mailing list.

## II. Issues Related to Disinfection By-Products

The Delta M&I Workgroup examined the problem of disinfection by-products (DBPs), including trihalomethanes (THMs), in some detail. A one-day workshop was devoted to the subject and there was considerable discussion on the topic in other sessions. The main points brought out, and discussed in more detail below, are the following:

1. The presence of bromide ion in significant concentrations results in the formation of a number of brominated DBPs. This can occur in all known treatment processes, including chlorination, chloramination and ozonation.

2. Bromide is present in Delta water largely because of seawater intrusion, and there is a relationship between chloride ion concentration and bromide ion concentration.

3. THM standards will be more stringent in the near future. Other DBP standards will be promulgated and will be costly and technically difficult to meet. The U.S. Environmental Protection Agency (USEPA) is expected to set the maximum contaminant level goal for THMs at zero; precursors (including bromide) in source water must be reduced if this goal is to be approached.

4. Total organic carbon in water supplies contributes to THM and other DBP formation in water treatment systems.

5. All current treatment processes result in the production of DBPs, and there are many technical and economic uncertainties in new and advanced treatment techniques that make compliance with new standards uncertain.

### II.1 Bromides and the Formation of Disinfection By-Products

In this section, the effect of bromide on the formation of DBPs in treatment systems is discussed. Later sections will consider other DBP problems, including those which arise with new treatment technologies. The bromide problem is separated because it arose as a distinct problem in the discussion of DBPs.

Data were presented by a number of researchers which demonstrate that the presence of bromide exacerbates the problem of DBP formation in treatment processes (See Appendix A, especially James, Daniel, McGuire and Krasner; also Krasner et al. Journal of AWWA, vol 81, no. 8, 1989). As bromide concentrations increase, brominated forms of THMs generally increase (depending on the treatment process) and can easily dominate the total THM concentration.

The difficulties with bromide arise for two reasons. One is simply a molecular weight problem, the other has to do with the chemical kinetics involving bromide. Since the atomic weight of bromine is approximately twice that of chlorine, the substitution of bromine for chlorine in a molecule increases the molecular weight. Drinking water standards are set on a weight basis. Thus, a 100 µg/l THM standard that is met when no bromide is present may not be met if a sufficient amount of bromine is substituted for chlorine in the molecules (without changing anything else).

As shown by a number of researchers, other disinfectants (such as chlorine, chloramine and ozone) also react in the presence of bromide and organics to form brominated THMs and other brominated DBPs. Ozone in particular reacts with bromide to form bromate and hypobromous acid, which in turn reacts with dissolved organics to form bromoform (Daniel, Appendix A; see also McGuire and Krasner).

Data presented by several researchers (Appendix A, especially McGuire and Krasner; see also Krasner et al., Journal of the AWWA, vol 81, no. 8, 1989) show that elevated levels of bromide result in THM concentrations that are close to present standards. Even if lower levels of bromide are provided to M&I users, resulting brominated THM concentrations may exceed a possible 25 µg/l THM standard. The brominated-THMs alone will prevent utilities from meeting likely future THM standards if bromide is present in high enough concentrations.

Several agencies have also submitted data (see Appendix A) that show increasing THM formation with increasing bromide concentration for a variety of treatment processes. Included are data from the Metropolitan Water District of Southern California, the Los Angeles Department of Water and Power, the Santa Clara Valley Water District and the Contra Costa Water District. These data are for a number of treatment processes now in use and represent a wide variety of conditions. In general, there is a clear trend of increasing THMs with increasing bromide (or chloride) levels. Note that in some cases, the treatment process must be altered when chlorides are high, with disinfection reduced in order to reduce THMs.

## II.2 Bromides and Chlorides in Delta Water

Bromide is present in seawater, typically at concentrations about three one-thousandths (0.003) times the concentration of chloride. Measurements by agencies using Delta water show a relationship of this same type during periods when the Delta is subject to seawater intrusion. For the most part, the bromide/chloride ratio is about 0.003, although there is some variation. Data provided by agencies are presented in Appendix A.

The ocean is the major source of chloride and bromide in the Delta, and chloride concentration can be used as an indicator of bromide concentration. Chloride is a useful indicator because of the relationship between chloride and bromide in seawater and because of the long historical record of chloride measurements in the Bay-Delta and the ease of making accurate chloride measurements.

II.3 Future DBP, THM and Other Drinking Water Standards

Presentations by Clark and Orme of the USEPA (Appendix A) discussed health aspects of DBPs and future regulations. A number of DBPs (in addition to THMs) of concern were discussed. The EPA recognizes the need for high levels of disinfection to protect against microbial agents of disease, but also recognizes that by-products must be reduced where possible. A high level of disinfection for Giardia and virus inactivation for surface waters will be required by EPA in 1993.

The EPA is also examining the effects of disinfectants themselves. Orme (Appendix A) indicated that there may be health effects associated with chlorine, chloramine and chlorine dioxide.

Among the DBPs of concern are THMs, cyanogen chloride (formed especially during chloramination), bromate (formed during ozonation), haloacetic acids, aldehydes and MX. Aldehydes are especially associated with ozonation, but are apparently formed by all oxidants. Some or all of these DBPs are likely to fall under EPA regulations in the near future.

THMs will continue to be regulated. Although it appears that the risks associated with chloroform may be less than previously calculated, those associated with brominated THMs may be greater. The new THM standard will likely be set in the range of 25 µg/l to 50 µg/l. The standard will be proposed in September, 1991 and finalized in September, 1992 (See Clark, Appendix A, Ref. 14).

It is likely that many DBPs (including THMs) will be regulated on a class basis (rather than on an individual species basis). The standards will remain on a weight basis. This means that brominated forms of DBPs are of serious concern with respect to meeting the standards since the molecular weight of bromine is approximately twice that of chlorine. The substitution of bromoform for chloroform, for example, will double the concentration. However, EPA's goal for carcinogens is zero; USEPA staff has indicated that because of this, there will not be an adjustment in the standards to account for bromine in THMs.

Also of concern is the fact that there are, at present, insufficient data on the health effects of a number of known DBPs and that there are likely to be a number of DBPs that are not yet

identified (Appendix A, especially Harris, Clark and Orme). The latter concern is particularly true for disinfection methods that are not widely used, or that have been only recently implemented on a large scale. Nonetheless, USEPA has indicated that several classes of DBPs will be regulated.

## II.4 DBPs and Total Organic Carbon

A number of researchers presented data on total organic carbon (TOC), sources of TOC and THM formation potential in the Delta (Appendix A, especially Jung and Gaston). The data indicate that THM formation potential varies in the Delta with particularly high levels found in agricultural drains and in channels near Chipps Island.

Sources of TOC in the Delta include organics in tributary rivers, decaying organic material in the channels and adjacent bays, and discharges from agricultural drains. One analysis (Gaston, Appendix A) indicates that the agricultural drains are a significant source of TOC, in addition to other significant sources such as tributary rivers, and contribute to THM formation potential. The Interagency Delta Health Aspects Monitoring Program data (Jung, Appendix A) show THM formation potential levels in Delta agricultural discharges are commonly ten times higher than the levels found in Delta channels.

The evidence is clear that in addition to bromide, TOC is an important factor in the production of THMs and other DBPs in water treatment processes. Furthermore, it is difficult to remove TOC in treatment plants. A test-scale ozone-granular activated carbon (GAC) plant study (James, Appendix A) found that THM formation potential was reduced only by about 50% in this advanced treatment method.

Other work (McGuire, Appendix A, and McGuire, M., Journal of the AWWA, vol 81, no. 8, 1989) indicates that the use of GAC to remove a large enough fraction of organic precursors to meet standards is very expensive and probably not practical. Large quantities of GAC would be involved and it is not clear how or where the GAC could be regenerated (certainly not in any urban air basin in California). Air stripping creates similar problems in urban air basins and is not amenable for non-volatile DBP compounds. It will not appreciably remove TOC precursors.

## II.5 DBPs and Treatment Processes

Data from a number of studies using Delta water (see Appendix A) show that a variety of treatment methods, including advanced treatment methods such as those using ozone and granular activated carbon (GAC), may not allow compliance with potential standards. Using free chlorine poses significant problems with respect to

compliance with present standards for THMs. Other treatment methods have their own set of problems, as described below.

Ozonation will form bromoform, bromate ion and other brominated DBPs in the presence of bromide. Bromoform is in the trihalomethane group, and may present significant health risks of its own (Appendix A, Orme). Bromate may be toxic at low levels and may fall under future EPA regulations. In addition, ozonation results in significantly increased levels of aldehydes. Aldehydes are likely to be regulated in the future.

A number of researchers presented data on pilot and test-scale plants using ozone alone and in combination with other disinfectants (Appendix A, James and Daniel). When bromide was present, brominated THMs were produced. Cases were noted when very low levels of THM were measured if the treatment process was modified (Daniel, James; studies are being conducted on ammonia addition before ozonation, which may be promising for DBP control: Daniel). In one particular case, THMs were not detected, but only at disinfection levels deemed inadequate.

Chloramination (which generally reduces DBPs compared to free chlorine) results in a number of DBPs including THMs and cyanogen chloride. While THMs are reduced when chloramine is substituted for chlorine, cyanogen chloride increases. Because of its relatively low microbicidal characteristics compared to free chlorine, chloramination alone will not meet EPA disinfection requirements for surface water, scheduled to go into effect in 1993.

In general, it has been found that total DBPs, and particularly brominated forms of DBPs, increase as bromide concentrations increase (Appendix A), especially when chlorine is used as a disinfectant. It was agreed that much is still unknown in the area of DBPs both for commonly used processes as well as advanced processes. Several technologies seem promising, such as the use of PEROXONE (a combination of ozone and hydrogen peroxide), but there have been no large scale tests. New treatment processes are likely to produce their own set of DBPs, as yet unknown.

There are many combinations of source water quality and treatment processes that must be considered to understand the options posed by the Delta water resource system and increasingly stringent drinking water standards. These combinations can result in wide ranges of cost, technology and operational requirements. A recent study (Appendix A, California Urban Water Agencies) includes one analysis of source quality, treatment processes and costs. Much additional work is needed on this issue to attain an adequate understanding of possible alternatives and all their impacts.

## II.6 Summary and Recommendations

The findings of the workgroup on which there is general consensus are summarized below.

1) Bromide and chloride concentrations are related in Delta waters, so that a chloride objective can be set for the purpose of maintaining sufficiently low levels of bromide. Bromide is the constituent of concern and must be maintained at low levels. Based on the data submitted, additional studies for certain M&I users of Delta water may need to be conducted to confirm the bromide-chloride relationship.

2) Experience has demonstrated that bromide in source water increases the difficulty of meeting current THM standards, regardless of treatment process. The presence of bromide can result in other unwanted disinfection by-products, depending on treatment process. The maximum contaminant level goal for THMs is expected to be zero (consistent with USEPA strategy for carcinogens). Reduction of bromide levels will help agencies to approach this goal.

3) Future THM standards reportedly will be more stringent, and will be more difficult to meet unless bromide levels are less than 0.15 mg/l (corresponding to chloride levels below 50 mg/l). The brominated forms of THM alone can exceed the expected standards when bromide is present in sufficient quantities. It will be technically difficult and costly to meet standards unless bromide levels are low.

4) Total organic carbon (TOC) in water supplies contributes to THM production as well as other disinfection by-products. A reduction in TOC will aid in meeting DBP standards.

5) Agricultural drains, Delta channels and tributary streams are sources of TOC and THM formation potential. THM formation potential in agricultural drains often exceeds that of adjacent channels by factors of ten or more.

6) The data presented in the Appendices show definite relationships between bromide and DBP formation. On the basis of these data, the workgroup recommends a 50 mg/l chloride objective be set, when feasible, for M&I intakes for the purpose of maintaining bromide below 0.15 mg/l.

7) The workgroup recognizes that meeting a 50 mg/l chloride objective throughout the Delta is not feasible under all

water supply conditions with the present physical configuration. Various facilities, such as the proposed Buckhorn, Los Vaqueros and Los Baños Grandes offstream storage reservoirs, can help in producing a municipal water supply of 50 mg/l chloride. However, not all users of Delta water have access to offstream storage facilities to receive such benefits. Other facilities and solutions should be studied and evaluated to help determine a strategy for achieving this level. The salinity levels to be provided before the recommended objective is implemented are discussed by individual entities in Appendix B.

8) The workgroup recognizes that additional information will be required to completely assess the impact of agricultural drains affecting the Delta. The workgroup recommends that waste discharge requirements or other appropriate measures be employed by the Regional Water Quality Control Board as necessary to ensure that adequate monitoring is performed. The monitoring should include the volume of the applied water and of the agricultural discharges, along with water quality parameters including electrical conductivity, chloride, bromide, nutrients, total organic carbon, trihalomethane formation potential and pesticides such as carbamates, organophosphates, triazines, pyrethrums and chlorinated hydrocarbons.

9) The workgroup recognizes that future technology may allow treatment that could economically achieve standards. However, there are many unknowns at the present, including the full spectrum of disinfection by-products from current technology (especially those involving ozone). The workgroup recommends that research on pilot and demonstration scale treatment processes be encouraged.

## III. Issues Related to Salinity and Chloride Concentration

The Delta M&I Workgroup also considered salinity and chloride objectives in the Delta as they relate to municipal and industrial beneficial uses. Appendix B contains individual statements by participants on salinity objectives. This section summarizes the areas of general consensus.

The workgroup strongly believes that water quality objectives should be based upon the best achievable goals, rather than the worst allowable. It recognizes that the best achievable goal is dependent upon water availability and other factors. The consensus of the workgroup can be summarized as follows.

1) The State Board should adopt objectives that promote the best achievable water quality goals. This is consistent with U.S. Environmental Protection Agency and California Department of Health Services policy and with the State Water Resources Control Board's 1988 Report of Referee to the Superior Court (Environmental Defense Fund et al. vs. East Bay Municipal Utility District) recognizing the importance of minimizing treatment uncertainties by seeking source water of high quality.

2) The workgroup recognizes that water supply limitations make the highest water quality objective impossible to meet at all times.

3) Delta water quality objectives should reflect the inability of different entities to blend water in order to achieve water quality objectives.

4) In order to meet present and likely future drinking water standards, especially with respect to disinfection by-products, there is a need for high quality water for extended periods of time. With present treatment facilities and standards, some agencies are unable to meet THM standards when chloride levels approach 100 mg/l. Even with major changes in treatment, it will be technically difficult and costly to meet future DBP standards at bromide levels above 0.15 mg/l (corresponding to chloride levels above 50 mg/l). Some proposed standards may require chloride levels below 50 mg/l.

5) The State Board should recognize that any emergency relaxation of the standards below those recommended may increase the level of disinfection by-products. There should be monitoring for DBPs in the systems of affected agencies during any relaxations forced by an emergency so that the effects can be assessed.

6) There are a number of proposed offstream storage facilities that could enable agencies to store high quality water that could be used later. High quality water in the Delta is required for a sufficiently long period of time to enable these projects to achieve necessary water quality. However, not all users of Delta water have access to offstream storage facilities to receive such benefits.

7) Use of water with high salinity concentrations increases urban costs (due to corrosion, the use of bottled water, etc.) and reduces the aesthetic properties of water. Particular levels needed for beneficial uses of each entity are described in more detail in individual statements in Appendix B.

## IV. Other Issues Related to Water Quality

The workgroup discussed a number of other issues related to water quality. These included discharges in the Delta, taste and odor problems associated with treated Delta water, and the concerns of consumers about their drinking water supplies. The latter is a serious concern because, according to one study, purchases of bottled water and home treatment devices cost California consumers more than a billion dollars per year (Appendix A, Urban Water Agencies).

Many of the taste and odor problems in water supplies are caused by microorganisms that produce organic compounds in µg/l or ng/l concentrations. The production of taste and odor compounds by microorganisms is a complex process that depends on the levels of nutrients, sunlight and other factors.

In addition to taste and odor problems, organic classes of pesticides that may be present are of concern. In one presentation (Harris, Appendix A), data were shown that indicate that some pesticides may pose health risks at levels below analytical detection limits.

As discussed previously, agricultural drains are sources of organic carbon, and in some cases, pesticides. However, it is extremely difficult to know the extent to which agricultural drains contribute to these problems because they are not routinely monitored. In particular, the Department of Water Resources has been unable to monitor a large number of agricultural drains in the Delta because some landowners have either denied permission or not responded to requests. As mentioned previously, the workgroup recommends routine monitoring of agricultural drains affecting the Delta.

Table of Contents of Appendix A:
Supplementary Material and References

Note: Appendix A is bound separately

Summaries of Presentations to the Workgroup



Supplemental Data on DBPs Submitted to the Workgroup

Other References:

14. Science Advisory Board Drinking Water Committee Meeting of October 11, 1989 Discussion of Strawman Rule for Disinfectants and Disinfection By-Products by Stephen W. Clark, USEPA, dated September 22, 1989.

15. Krasner, S.W., M.J. McGuire, J.G. Jacangelo, N.L. Patania, K.M. Reagan and E.M. Aieta, "The Occurrence of Disinfection By-products in US Drinking Water", Journal of the AWWA vol. 81, no. 8, August 1989.

16. McGuire, M.J., M.K Davis, C.H. Tate, E.M. Aieta, I.E Wallace, J.C. Crittenden, "Evaluation of Granular Activated Carbon for Trihalomethane Control" Presented at the AWWA Research Foundation/U.S. EPA Conference, May 9-10, 1989, Cincinnati, Ohio.

17. Brown and Caldwell, Delta Drinking Water Quality Study, May, 1989 prepared for the California Urban Water Agencies

Appendix B: Individual statements on Delta Municipal and Industrial Water Quality Issues as follows:

United States Environmental Protection Agency

Environmental Defense Fund

Department of Water Resources

Metropolitan Water District of Southern California

Contra Costa Water District

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

October 16, 1989

Mr. Gregory Gartrell
Chair, Delta M & I Workgroup
Contra Costa Water District
1331 Concord Ave.
P.O. Box H20
Concord, CA. 94524

Dear Greg:

Attached please find our comments to be included in Appendix B of the Delta M & I Workgroup Report to the State Water Resources Control Board for the Bay/Delta Proceedings.

If you have any further questions, please contact Heidi Hall, Water Quality Standards, at (415) 974-8250 or 744-1729 after November 10.

Sincerely,

Robin M. Unger for

Wendy Wiltse
Chief
Water Quality Standards Section
Water Quality Branch
Water Management Division

Enclosure

United States
Environmental Protection Agency
Region 9
Appendix B Statement
Delta M & I Workgroup Report to the
SWRCB for the Bay/Delta Proceedings

EPA strongly supports the State's process in its efforts to balance the needs of all uses of Delta waters through establishing water quality criteria as evidenced by the work of the Delta M & I Workgroup in drafting this summary with recommendations to the Board.

We have several concerns regarding the Delta M & I workgroup's points listed under II.6.7 and II.6 which are described below.

1. The EPA has not made a determination regarding whether meeting a 50 mg/l chloride objective throughout the Delta, or at the M & I intakes is or is not feasible. With present chloride standards, meeting current total trihalomethane (TTHM) levels is possible with drinking water treatment techniques. Source control and flow management may bring the chloride level down to within 50 mg/l under the present physical configuration. Under any configuration, treatment would still be needed to meet the TTHM maximum contaminant level (MCL).

   EPA is currently performing TTHM health risk/treatment technique cost-benefit analyses in the process of determining reasonable TTHM and other disinfectant by-products MCL's, and associated best available treatment technology (BAT) for drinking water. The ability of water suppliers to meet future TTHM and other MCL objectives will be dependent on the ambient water quality and future drinking water standards, and will be feasible and practicable with the available treatment technologies.

2. Recommendation #7 points out that various proposed offstream storage facilities - Buckhorn, Los Vaqueros, and Los Banos Grandes in particular - would help in reducing the period of time the objective of 50 mg/l chloride must be met within the Delta or at M & I intakes. The presumption is that these three facilities would capture water during peak flows, and release it to provide dilution to meet chloride criteria in the delivery systems. We have two comments regarding reliance upon flow supplementation to meet chloride objectives.

   First, important questions have been raised regarding the effects of south of Delta winter storage on the recently listed winter-run chinook salmon. These questions must be addressed prior to counting upon winter storage to meet

water quality objectives. Second, south of Delta storage facilities should be counted upon to reduce water quality problems and fisheries impacts only if there is an up front commitment by project sponsors to operate the facilities to give top priority to these needs. Historically, new facilities have led to increased diversions with attendant instream adverse impacts. A commitment to change priorities is necessary to avoid exacerbating, rather than reducing, the basin's environmental problems.

As we noted during the Workgroup sessions, storage facilities are only one of many proposals which could improve Delta water quality, and should be considered by the Board as one of a range of options to consider. Other options include the control of salinity intrusion in the Delta through greater freshwater inflows from existing structures; the control of organic precursors through regulation of Delta agricultural discharges; and smaller scale structural adjustments within the Delta or delivery systems. Solutions must be considered for their ability to meet all water quality objectives and protect all the beneficial uses of Delta water.

# ENVIRONMENTAL DEFENSE FUND

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October 20, 1989


Gregory Gartrell
Contra Costa Water District
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Concord, California 94524

RE: Final Draft Report from Municipal and Industrial Water Quality Workgroup

Dear Greg:

I have reviewed the above report and have a few comments. While EDF was not an active participant in the workgroup and was only able to attend meetings in an observer capacity, we nevertheless have considerable interest in the workgroup's conclusions. In particular, we believe the workgroup report takes the correct approach in giving priority to protection of the Delta as a source of drinking water, rather than looking to develop new sources for urban water supplies. The relationship between bromides and chlorides in Delta water is further evidence of the need to control saltwater intrusion to protect drinking water quality. This in turn underscores the benefits of increased freshwater flow to all beneficial uses of Delta water. The report also recognizes the potential for improving Delta water quality by controlling agricultural discharges.

Some additional comments follow:

* We would agree that off-stream storage could provide water quality benefits by facilitating diversions at times when raw water quality in the Delta is best. Such facilities also have the potential to provide environmental benefits if diversions are shifted away from periods most harmful to fish and wildlife. However, the specifics of any given project, including its sizing, operations, and the environmental conditions it must meet, need to be considered before a given project should be endorsed. Moreover, if the purpose of the report's conclusions is to note the potential for off-stream storage to provide high quality Delta water (eg., p., 4), then it is inappropriate to include Buckhorn Reservoir as one of the projects mentioned. While the report is correct that Buckhorn could be operated for such a

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purpose, EBMUD proposes to use Buckhorn to increase diversions from the Mokelumne River and potentially the American River, rather than to store high quality water from the Delta.

* The report in our view understates the potential for advanced treatment technologies to improve finished water quality. While such technologies could result in added costs, and there does remain some uncertainty as to associated disinfection byproducts which should continue to be aggressively researched, the recently released report by Brown and Caldwell Engineers, "Delta Drinking Water Quality Study" (May 1989), concluded that ozonation, particularly when combined with granulated activated carbon, could meet projected THM standards using Delta water. The study specifies that a treatment process of conventional filtration, ozonation, GAC adsorption, and chloramination will meet a THM standard of 20 ug/l, the most stringent likely to be proposed, with Delta water under existing conditions. (Study at p., 4-9). For a standard of 50 ug/l, GAC adsorption would not be needed. According to the study, a treatment process consisting of ozone, conventional filtration, intermittent addition of powdered activated carbon, and chloramination "would be sufficient for treating even the worst Delta water." (Id. at p., 4-14). Some water agencies may even be able to meet a 20 ug/l standard without GAC treatment. (Id.). As pointed out in the study, such advanced treatment processes can also provide other water quality benefits in addition to THM reduction. Thus, the combination of better protection of source water quality in the Delta and improved treatment could yield significant drinking water quality benefits.

* While the report focuses on disinfection byproducts, the State Water Resources Control Board and other relevant agencies should also be urged to implement aggresively other existing regulatory programs to protect drinking water sources.

* The report cites the conclusion of the State Water Resources Control Board's 1988 Report of Referee in EDF v. East Bay Municipal Utility District concerning the appropriateness of seeking a high quality source to reduce uncertainties associated with drinking water quality (p., 10). However, it should also note the subsequent preliminary court decision which would place stringent limitations on EBMUD's diversions from the American River, including the maintenance of much higher minimum flows in

the river than recommended by the Board, in order to protect the river's instream uses. These limitations underscore the importance of considering and protecting environmental values when assessing various options for protecting or improving drinking water quality. Protection of source water quality in the Delta would be consistent with this objective.

The foregoing summarizes our general comments on the workgroup's report. We, of course, may provide additional comment or evidence at the time the Board takes up the issues covered in the report in the Bay/Delta hearing process.

Sincerely yours,

John W. Krautkraemer
Senior Attorney

STATE OF CALIFORNIA—THE RESOURCES AGENCY GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF WATER RESOURCES
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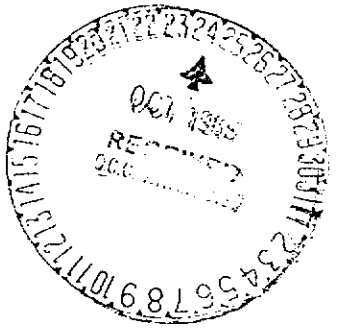
October 23, 1989



Mr. Gregory Gartrell, Chair
Delta M&I Water Quality Workgroup
Contra Costa Water District
P. O. Box H20
Concord, CA 94524

Dear Mr. Gartrell:

The Department of Water Resources has several comments for inclusion in Appendix B of the "Report from the Delta Municipal and Industrial Water Quality Workgroup to the California State Water Resources Control Board for the Proceedings on the San Francisco Bay/Sacramento-San Joaquin Delta Estuary", October 17, 1989. The points listed below, which we have previously mentioned at workgroup meetings, represent the areas in which the Department significantly disagrees with your report's findings and recommendations.

1. The report (page 5, next to last paragraph) indicates a revised THM standard will be finalized in September 1992, and the likely range of this standard will be 25 to 50 ug/L. We understand the expected range arises from the Strawman Rule EPA has issued (see "Science Advisory Board Drinking Water Committee Meeting of October 11, 1989, Discussion of Strawman Rule for Disinfectants and Disinfection By-Products"). We believe readers of the M&I Workgroup Report should be aware the Strawman Rule is a very preliminary indication of the direction of EPA's rulemaking and was proposed to encourage dialogue and debate. It is premature to use this "rule" as the basis for making Delta water supply decisions of great importance to California.

2. The Department recommends the Board adopt a 250 mg/L chloride objective until such time as new drinking water regulations are established. We do not believe a 250 mg/L chloride objective will result in municipal water supply agencies being unable to meet the current 100 ug/L maximum contaminant level for THMs using Delta waters, considering that compliance is computed as the running annual average of quarterly samples taken from representative points in the distribution system. Based on an evaluation of DWR operational data, the chloride concentrations at Harvey O. Banks Delta Pumping Plant over the period 1975 through 1988 were

below 50 mg/L 58 percent of the time. Even though these data reflect current, not future, Delta decisions, the data indicate salinity levels in Delta waters are usually low.

In prolonged dry periods, it is conceivable that elevated bromide levels could present treatment challenges to municipal users of Delta waters in regard to meeting THM standards. However, even in such an eventuality, we believe there are treatment options that could reliably meet the current THM standard.

When new drinking water criteria for THMs and other disinfection by-products are promulgated, there will be an opportunity to develop actual experience with attempting to meet the criteria using Delta water. If experience indicates the new drinking water criteria cannot be reliably or economically met, the State Board should consider amending the Delta water quality objectives.

3. The Department disagrees with the recommendation to set a chloride objective for the purpose of maintaining sufficiently low levels of bromide (page 8, recommendations 1 and 6). Although a relationship between chloride and bromide in Delta waters has been demonstrated, sufficient data have not been presented to demonstrate the relationship is sufficiently constant throughout the Delta to enable bromide concentrations to be adequately controlled through a chloride objective. Consequently, if the need for a bromide objective is demonstrated (as per 1 and 2 above), it should be specified in terms of bromide concentration. If further investigation conclusively shows bromides can be adequately assayed through electrical conductivity, chlorides, or other indirect means, the Department would not object to implementation of such means of monitoring.

4. The report should specifically characterize the longstanding problem of controlling salinity levels at the Contra Costa Canal intake, the City of Vallejo Cache Slough intake, and the North Bay Aqueduct intake at Barker Slough. Local discharges sometime create elevated salinity levels at these locations that cannot be directly controlled by regulations of other Delta diversions or outflow. Additional control points at Old River near Rock Slough and Cache Slough near

Junction Point should be established as recommended by the Department in Phase I of the Bay-Delta proceedings (see DWR Phase I closing brief, pages 21-22). The Old River and Junction Point proposed stations are controlling points for ocean salinity intrusion; any degradation at the remaining stations would be caused by land-derived salts. Without establishing these additional stations, it will be much more difficult to allocate responsibility for meeting standards in the later hearing phases.

If you have questions or need further information on these points, contact Ed Winkler at (916) 323-8884 or Rick Woodard at (916) 327-1635.

Sincerely,

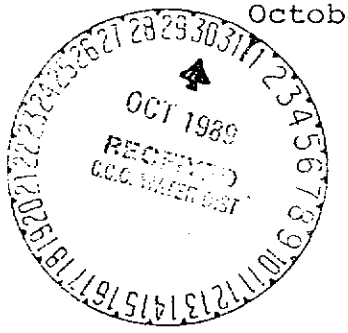
E. F. Huntley

Edward F. Huntley, Chief
Division of Planning

cc: Mr. Walt Pettit
Division of Water Rights
State Water Resources Control Board
901 P Street
Sacramento, CA 95814

**MWD**
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

October 27, 1989




Mr. Walter Pettit, SWRCB Staff
State Water Resources
Control Board
901 P Street
Sacramento, California 95814

Dear Mr. Pettit:

Municipal and Industrial Water Quality Issues

At a meeting of the "Municipal and Industrial Water Quality Work Group" held at the Contra Costa Water District on August 14, 1989, your staff distributed a list of specific questions regarding municipal and industrial (M&I) water quality issues that they have identified. The purpose of these questions was to obtain responses from those participating in the work group as to how these issues should be addressed in the next draft of the Water Quality Control Plan (Plan), Pollutant Policy Document, and also in subsequent hearing phases.

The Metropolitan Water District of Southern California (Metropolitan) has completed its responses to these questions which are enclosed with this letter. From the information presented in the work group meetings and also from the Metropolitan responses that have been developed to answer the State Water Resources Control Board (SWRCB) staff's questions, we feel that three main points must be considered when developing objectives to protect M&I water quality. First, the U.S. Environmental Protection Agency drinking water quality standards will likely become more stringent in the future, in particular with respect to trihalomethanes (THMs) and other disinfection by-products. Second, it is uncertain what future standards may be and whether advanced treatment technology alone will be enough to meet these anticipated standards. Third, the use of increased Delta outflow to control THM formation and other contaminants, instead of constructing facilities that would provide source protection, is not a reasonable use of the State's developed water supplies. The SWRCB concluded in its report (1988) as referee in the case Environmental Defense Fund et al v. East Bay Municipal Utility District, "Prudence requires that public water suppliers should minimize treatment uncertainties by seeking water from the best available source and as removed from the potential for degradation as possible".

For the above reasons, we believe that the water quality planning being conducted as part of the Bay/Delta hearing process must include consideration of facilities to improve Delta drinking water quality.

In a letter dated January 16, 1989 to Chairman Maughan, the California Urban Water Agencies (CUWA) briefly described its two-year study to develop a comprehensive report on Delta drinking water quality and the challenges that will be faced by water agencies to meet increasingly stringent drinking water standards. In the letter, the CUWA expressed its hope that this study would aid the SWRCB in the Bay/Delta hearing process. The study was completed and a report was published and sent to you in May 1989.

We continue to urge you to use this study when developing the next draft of the Water Quality Control Plan. In particular, we believe that evaluation of each of the six alternative management strategies that were included in the CUWA study is necessary for adequate analysis of the most appropriate means for protecting public drinking water supplies.

We are committed in our participation regarding this topic of the hearing process, as in others. We would be happy to meet with you and your staff to discuss this letter, our responses to the SWRCB staff questions, and the CUWA study.

Very truly yours,

Carl Boronkay
General Manager

SNA:vb

Enclosure

cc: Mr. W. Don Maughan, Chairman (SWRCB)
Ms. Darlene R. Ruiz, Vice Chairman (SWRCB)
Mr. Edwin H. Finster, Member (SWRCB)
Mr. Eliseo Samaniego, Member (SWRCB)
Mr. Danny Walsh, Member (SWRCB)
Mr. George Baumli, General Manager (SWC)
Mr. David R. Schuster, SWC Consultant
Mr. John Gaston, CH2M Hill
Mr. Art Littleworth, Best, Best and Krieger
Mr. Ed Winkler, (DWR - Central District)
Mr. Rick Woodard (DWR - Central District)
Mr. B. J. Miller, Consultant
Mr. Cliff Schulz, (Kronick, Moskovitz, Tiedeman, & Girard)
Mr. Greg Gartrell (Contra Costa Water District)

METROPOLITAN WATER DISTRICT

RESPONSE TO THE STATE WATER RESOURCES CONTROL BOARD

REQUEST FOR COMMENTS ON BAY/DELTA M&I ISSUES

These remarks are being provided in response to a request from the staff of the State Water Resources Control Board (SWRCB). At a meeting of the "Bay/Delta Municipal and Industrial (M&I) Water Quality Work Group" held at the Contra Costa Water District on August 14, 1989 the staff distributed a list of specific questions regarding issues related to the protection of water quality for municipal and industrial uses. The following material has been assembled to respond to those questions. It should be noted, however, that these questions and the answers cannot be taken out of context and do not stand alone. The responses provided are all interrelated.

## SUMMARY

The following are the main points that relate to the material developed in response to the issues. Specific answers to the questions are also provided:

- **THE FORMATION OF TRIHALOMETHANE (THM) IS THE GREATEST WATER QUALITY PROBLEM THAT IMPACTS "DELTA SOURCE" WATER UTILITIES.**

  The U.S. Environmental Protection Agency (USEPA) has indicated that the current total trihalomethane (THM) maximum contaminant level (MCL) of 100 micrograms per liter (ug/L) will likely be lowered to between 25 and 50 ug/L. It is uncertain whether future advanced treatment technology alone will be enough to meet these anticipated standards, and also what future treatment technologies will be approved.

  In addition, agricultural drains and decay of organic material in the Delta contribute to the precursor loading at M&I intakes. These issues must be addressed by requiring, at a minimum, monitoring at selected Delta sites and at all agricultural drains.

- **CHLORIDE ALONE IN DELTA WATERS DOES NOT PRESENT A THM PROBLEM; THE BROMIDE ASSOCIATED WITH SEAWATER, WHICH IS IN DIRECT RELATIONSHIP TO THE CHLORIDE, IS THE PROBLEM.**

  Data indicate that treatment plants will not be able to meet a 50 ug/L total THM MCL when free chlorine is used in treating Delta water with a chloride content greater than 50 mg/L. Further, prechlorination and postchloramination of Delta waters containing 35 to 50 mg/L of chloride produces THM levels that would, on average, exceed a 50 ug/L MCL. If chloride levels are not substantially below 50 mg/L, utilities taking water from the Delta will have to consider alternative oxidants, such as ozone. Even with ozonation, a total THM MCL of 25 ug/L would require that chloride levels be kept well below 50 mg/L in order to minimize brominated THMs formed during ozonation and subsequent chloramination. Bromide levels (and accordingly, chloride) should be reduced as much as feasible to reduce the health risk to consumers of Delta water regardless of the treatment technology used by water utilities.

- **SEAWATER INTRUSION INTO THE DELTA, AND THE IMPACT OF THE BROMIDE PRESENT IN SEAWATER, CAUSES A DRAMATIC INCREASE IN TRIHALOMETHANE PRODUCTION.**

  As a result of seawater intrusion, various chloride levels are detected in Delta waters. Seawater intrusion also increases bromide levels, and bromide ion plays a significant role in the formation of THMs. Bromide contributes to the production of significant levels of brominated disinfection by-products (DBPs), including THMs, once the water is disinfected for M&I uses. There is a direct relationship between the concentration of chloride and bromide ions in seawater, such that bromide ion levels in Delta waters can be predicted based upon measured chloride ion levels (assuming that seawater is the only source of bromide/chloride ion).

- **ADVANCED WATER TREATMENT TECHNOLOGY ALONE WILL NOT SOLVE THE TRIHALOMETHANE PROBLEM.**

  New water treatment technologies are being investigated, including ultra-filtration, ozonation/postchloramination, PEROXONE, and granular

activated carbon (GAC). Ultra-filtration has not been used at any major United States plant and is too new a technology to be relied on to meet the municipal water treatment needs of the next five to ten years. Bromide is not removed by ultra-filtration and would, therefore, still react with disinfectants to produce brominated DBPs.

Preozonation followed by postchloramination does not eliminate concerns over DBPs. When a poor quality source water (high total organic carbon or TOC level) was ozonated, numerous aldehydes were produced. In implementing ozone treatment, a utility trades off halogenated DBPs (e.g., THMs) for aldehydes and other ozonation by-products. If a water is high in bromide, ozone alone will produce brominated DBPs.

PEROXONE (the combination of ozone and hydrogen peroxide) has promise for disinfection, oxidation of taste and odor compounds and control of DBPs; however, its effectiveness and reliability have yet to be demonstrated for a full-scale operation.

GAC has been shown in a major research study to be technically capable of removing organic THM precursors down to levels that would produce 5 to 10 ug/L THMs; however only at a cost of billions of dollars statewide. GAC is well known to be incapable of removing inorganic ions such as chloride and bromide. Total organic carbon does leak through GAC no matter what size contactor units are used. Subsequent chlorination of low levels of TOC and bromide has been shown to preferentially produce brominated DBPs. In addition, there would be significant problems in siting GAC regeneration furnaces due to concerns over the emissions of toxic by-products during the GAC reactivation process.

**WATER QUALITY OBJECTIVES TO PROTECT DOMESTIC SUPPLIES CANNOT BE CONSISTENTLY AND RELIABLY MET WITH THE EXISTING PHYSICAL FACILITIES IN THE DELTA.**

The dilemma faced by the State in using the Delta for a source water includes several facets: the standards for THMs are going to be tightened; the existing water quality conditions will not allow those expected standards to be reliably met; to improve water quality by increasing Delta outflow cannot provide a

solution because existing water supplies are already insufficient to reliably meet the needs of the State Water Project and others, and using Delta outflow to solve the problem would worsen the water supply situation. Advanced treatment technology has not been shown to do the job in a proven and cost-effective fashion. There is also a lack of understanding by the public that additional physical facilities in the Delta are needed to provide better water quality.

The weight of evidence regarding bromide contamination due to seawater intrusion and agricultural drain contaminant contributions leads to the conclusion that construction of facilities is necessary to avoid the contamination occurring in the Delta. The use of additional stored water to achieve dilution of the contaminants is not a reasonable use of the State's water supplies and therefore is not the answer to the THM precursor loading problem in the Delta. Facilities that would protect water quality for M&I users of Delta water are required.

The SWRCB concluded in its report (1988) as referee in the case Environmental Defense Fund et al v. East Bay Municipal Utility District, "Prudence requires that public water suppliers should minimize treatment uncertainties by seeking water from the best available source and as removed from the potential for degradation as possible".

Additional details on these points are included in the attached material.

## RESPONSE TO SWRCB STAFF QUESTIONS REGARDING M&I WATER QUALITY

### CONTRA COSTA CANAL

1. Is 250 or 150 milligrams per liter (mg/L) chlorides at the intake to the Contra Costa Canal Pumping Plant #1 needed to protect industry? Should a lower chloride value, such as 50 mg/L, be implemented for blending purposes?

Response:

The Department of Water Resources (DWR) has been working on the problem of the chloride objective at Rock Slough

for some time. The objective of 150 mg/L chloride was established during D-1485 specifically to protect paper industries in Contra Costa County. DWR has contracted with Fibreboard to provide payment for water treatment that will eliminate the need for a 150 mg/L chloride objective. A similar contract with Crown Zellerbach (now owned by Fibreboard) will be signed in the near future. Therefore, a chloride level for industrial purposes is not required. There is no need for a blending objective for industry.

2. Should the intake to the Contra Costa Canal be relocated to Clifton Court Forebay?

Response:

Most knowledgeable water utility personnel agree that relocation of the intake of the Contra Costa Canal to Clifton Court Forebay (or that vicinity) would provide greatly improved drinking water quality for those who receive Contra Costa Canal water supplies. This is not to imply that the existing intake would be abandoned or that the Contra Costa Water District (CCWD) would never use Rock Slough as a source, but rather that the water quality in the CCWD system would be improved if they had the flexibility to use a Clifton Court intake. Evidence presented by DWR indicates that Rock Slough is subject to local drainage and other local effects that adversely impact water quality during portions of the year.

With existing facilities, an objective set for chlorides at the Contra Costa Canal controls Delta outflow for a portion of all years. In the 1920 lawsuit (Antioch v. Williams) the court found that it was unreasonable for upstream diverters to forego their water use so that the City of Antioch could continue to divert water from offshore, and the City was encouraged to move the diversion further upstream. The Contra Costa Canal was that initial movement upstream, and it was the first service from the federal Central Valley Project beginning in 1940.

The relocation of the intake is one example of the additional facilities that are essential to ensure improvements to water quality for domestic users.

BANKS AND TRACY PUMPING PLANTS

3. What chloride level (250, 100, etc.) is needed at the Banks and Tracy Pumping Plants to protect M&I in the export areas? Are total dissolved solids (TDS) objectives, similar

to the State Water Project contract criterion, needed to protect M&I in the export areas? What are the State Water Project contract criterion based on?

Response:

There is currently in place a secondary drinking water standard for chloride set at 250 milligrams per liter (mg/L). This objective has been adopted by the USEPA and the State of California Department of Health Services. It is based upon aesthetic effects on consumers (taste) and not on demonstrated health impacts. It is generally agreed that when the chloride levels approach or exceed 250 mg/L, that consumer acceptance of the water produced is lowered and complaints are registered concerning the "salty" taste.

When the State Water Project contracts were executed in the early 1960's, the contract water quality objectives were established only to keep total dissolved solids (TDS) low. The impact of ocean-derived salts (chloride and bromide) on the formation of trihalomethanes (THM) was not known. [The phenomena of the formation of THMs in drinking water was not discovered until 1974.] Clearly the M&I contractors, before and now, would prefer higher quality water than 250 mg/L chlorides. The initial reason was taste and the current reason is both taste and the formation of THMs. Further, reuse of water also becomes more limited as TDS increases. The fundamental dilemma is how to provide lower chlorides without increasing water supply shortages. Data presented by the State Water Contractors during Phase I of the Bay/Delta Hearings indicated that several water utilities had failed to meet the THM standard of 100 micrograms per liter (ug/l) in the past. This was thought to be primarily because the utilities were adjusting their treatment to meet the standard when it was first promulgated in the late 1970's. Recent occurrences of failure at two utilities are thought to be because of the increased bromide levels that have occurred in water supplies from the Delta because of the last three dry hydrologic years. With existing Delta facilities it is not possible to maintain a chloride objective of lower than 250 mg/L to deal with taste issues without sacrificing limited water supplies, and it most certainly will not be possible to maintain a lower chloride objective to protect water utilities against THM formation.

If the USEPA lowers the standards in the future so that a lower chloride objective is necessary to protect against THM formation, it will be necessary to construct additional facilities to provide water of sufficient quality without

unreasonably impacting water supply. If adequate facilities are constructed, then recent data indicates that a chloride level of 50 mg/l (bromide level of 0.15 mg/l) may be reasonable. The main issue involved is related to how lower chloride values can be provided without unreasonably impacting water supply. It does not appear possible to attain this chloride objective with the present facilities in the Delta.

4. Should a 100 mg/L (110 mg/L delivered) chloride objective be implemented at the Banks and Tracy Pumping Plants for export area blending purposes? What water quality level is needed for blending purposes? What (and how many times) is this water going to be used for?

Response:

The answer to this question is tied to the answer for No. 3 as presented above. The uses of the water were well documented in the Phase I testimony. The issue of blending is not an issue with respect to chlorides because there are numerous domestic uses directly from the aqueducts which do not have an option available to them for blending.

Blending is an issue, however, when the question of TDS is addressed. There is a secondary standard for TDS set at 500 mg/L by both the State and USEPA. The Metropolitan Water District of Southern California (MWDSC) has both the Colorado River and the State project water to use as a source, and their goal is to serve water that meets the 500 mg/L TDS standard. They still serve unblended water in portions of their system from Ventura to San Diego counties, primarily because of distribution system limitations, and that water is also used for groundwater replenishment in many areas. The Southern California basin plans were formulated on the premise that State project water would be used. Using only Colorado River water for replenishment would be in violation of the basin plan objectives.

Regarding the number of times water can be used: In the Santa Ana River basin, the water is used approximately three times before it is discharged to the ocean. Water from the Colorado River can only be used one time. If Delta facilities are constructed and a lower chloride objective is established in the future, the TDS question will be moot because the TDS will naturally be reduced as the chloride is lowered.

5. If a 150 mg/L industrial objective is set at the Contra Costa Intake, should a similar objective be set at the Banks

and Tracy Pumping Plants (or North Bay Aqueduct)? Should the same M&I objective be set at all M&I intakes?

Response:

The same M&I objective should apply at all intakes, and the industrial chloride question was answered in No. 1 for the Contra Costa Canal. If lower short-term chloride standards are desirable at specific locations because of local industrial reasons, that issue should be solved locally as is being done with the Contra Costa Canal.

6. Is it important to set a low salinity objective (for M&I and agriculture) at the pumps to reduce the salt load to the San Joaquin Valley? How much of the delivered salt load eventually returns to the Banks, Tracy and Contra Costa Canal Pumping Plants via Vernalis and/or South Delta agriculture returns? What would be the long-term effect at the various pumping plants of setting a low salinity export objective?

Response:

These questions are best answered by DWR and USBR. The issues delve into philosophical and overall balancing questions and there may not be a single answer. This is a discharge problem and should be solved via discharge controls and not by using flows for dilution. Additional study may be required to address these issues.

TRIHALOMETHANES

7. What THM levels are being delivered to the various users of Bay/Delta water?

Response:

The exhibits that all parties put into the Phase I record contain THM data for virtually every water utility. The recent problem experienced by two Southern California water utilities that failed the THM standard and had to notify the public serves as an excellent example of the vulnerability of the system and the continuing need for improvement in drinking water quality.

Examination of that data indicates that the majority of water utilities meet today's THM standard, but that none will be able to reliably meet future standards without extensive

treatment changes and improvement of source water quality.

8. How should trihalomethanes (THM's) be considered in the Water Quality Control Plan? Should a trihalomethane formation potential (THMFP) objective be set at municipal intakes? Does a sufficient relationship between drinking water THMs (or other disinfection by-products) and precursors in the Delta exist to set THM (precursor) objectives in the Bay/Delta Estuary? If not, should various water sources and/or water treatment processes be examined for combinations that would reduce THMs in the drinking water?

Response:

The trihalomethane (THM) issue is especially complex because it involves several interrelated problems. We know that THMs are formed when precursor material is chlorinated, and realize that it makes no sense to set a "THM objective" in the Delta because THM probably cannot be found in the raw water. The problem relates to the following factors:

TOTAL ORGANIC CARBON (TOC): This constituent is added to the Delta by the tributary sources, from the organic soils in the Delta, and by the discharge of agricultural waste from the Delta islands. If a TOC objective is set at the intakes and that objective is violated, there will be no way of knowing how or why the violation occurred. Also, TOC levels in Delta waters may not be flow related and increasing Delta outflow probably will not reduce the levels at the intakes. In fact, TOC levels have been higher in many instances during high-flow periods.

CHLORIDE AND BROMIDE: These two constituents are tied to sea water intrusion and impact the THM problem because of the relationship between the chloride and bromide levels and the formation of brominated THMs. Increasing Delta outflow can control the concentration of these two constituents at some points (although DWR indicates that control at Rock Slough and Cache Slough is greatly influenced by local conditions), but if low chloride levels are really necessary it will not be possible to provide the necessary carriage water on a reliable basis without unreasonably impacting the water supply.

THM FORMATION POTENTIAL: This indicator test (THMFP) can predict, to some degree, the amount of THM that will be produced when a raw water is disinfected. An objective for THMFP at the intake locations could, therefore, serve to control the problem except the THMFP analytical method is inherently

imprecise. Enforcement of a THMFP objective should wait until a better THMFP method is developed and additional data is available. In the meantime, the Delta agricultural drains should be monitored.

If we wish to set a goal for THMFP at the intakes we could choose the values currently found at the Sacramento River at Greene's Landing as representative, but the only way to insure these goals is to construct facilities to ensure the reliable supply of high quality water.

Water treatment technology may be available to treat the Delta water to help meet the levels that we anticipate in the future regulations, but that may also include both ozone for disinfection and granular activated carbon (GAC) for removal of the residual by-products at greatly increased cost. Research is not complete to allow accurate predictions as to the ultimate workability of this technology. Therefore, it is uncertain whether this treatment alone will be enough to meet the anticipated standards.

9. Should THM objectives be set for the various species of THMs? Should other disinfection by-products also be considered in the Plan?

Response:

The USEPA is considering the development of standards for the various species of THMs, and those probably will involve the brominated fraction. Another consideration is that DWR has seen an increase in the chloroform levels in the Delta that is directly related to flow and increased agricultural drainage. The implication is that this increase results from runoff from the Delta islands and discharge from the drain structures. A stringent chloroform standard could not be met by many utilities without an appropriate control strategy for the drains. Additional disinfection by-product standards are also being considered by USEPA which will further complicate the issue of taking water from the Delta with existing facilities. The level at which these standards will be set is not known at this time.

10. What is the future outlook for advanced water treatment methods, such as ultra-filtration? When will these advanced water treatment methods be practical for wide-spread use?

Response:

Data presented by the State Water Contractors in Phase I of the hearings identified approximately 60 water treatment plants that currently treat Delta water. These plants will not be replaced in the near future, and any additions to the facilities will be in the form of retrofit. The new technology that is being pilot tested in some locations may be useful in designing new water treatment plants, but may not be applicable to existing plants. An examination of the economics show that obtaining better quality source water will be the most cost effective and efficient solution in the long term. As an example, if the quality of the source water required all utilities to install GAC, it would also be necessary to address the issue of providing carbon regeneration facilities. There is little probability of siting multiple furnaces for carbon regeneration in California. This air quality issue would add to the overall cost when dealing with the water quality issue in this way.

Also, as in the answer to question 8, it is uncertain whether advanced treatment alone will be enough to meet future standards.

11. Should the objectives be tailored to water year type and/or water supply? Should "relaxations" be incorporated into water quality objectives?

Response:

The drinking water standards adopted by the USEPA and administered by the California Department of Health Services do not have provisions for water-year type. It is unlikely that such standards would be relaxed in the future, with the possible exception of secondary or aesthetic standards for taste and odor, total dissolved solids, etc. Certainly there will not be a change in the enforcement of the health-based standards for coliform bacteria, THMs, turbidity, etc. If "relaxations" are incorporated into the Water Quality Control Plan drinking water objectives, and they impact drinking water quality, the water utilities will have to bear the burden for the enforcement-related cost, additional treatment, or whatever may be included. For these reasons, no party to the Bay-Delta proceedings has recommended such relaxation for drinking water quality. This reinforces the need to devise a system for delivery of high quality drinking water which is not vulnerable to the degradation imposed by water-year type, Delta island drainage, or sea water intrusion.

12. Should the replenishment of groundwater basins be considered a beneficial use of Bay-Delta waters?

Response:

Yes. Groundwater replenishment with "Bay-Delta" waters is a practice that has been employed for many years, and if a comprehensive and balanced water management program is to be continued, this practice must also continue. Please see the answer to Question No. 4 for more detail on quality concerns relative to the Southern California basin plans.

13. Which future level of development (2010, 2000, etc.) should be considered in addition to the present 1990 (or 1995) level of development? Which upstream, Bay-Delta, and water treatment facilities should be assumed to exist at the future level of development?

Response:

During the Phase I hearing, the State Water Contractors agreed with DWR that years 1990 and 2010 were appropriate. It should be assumed that the existing water treatment facilities will also still be in service. Expansions and upgraded water treatment facilities may be present in some locations, but that is a site specific issue. New water treatment plants are being constructed and/or contemplated in some locations either to replace or supplement existing facilities. With respect to "upstream" and "Bay/Delta" facilities, it is imperative that the Water Quality Control Plan "Program of Implementation" recommend and encourage the development of facilities necessary to accommodate all uses of Bay-Delta water.

14. How will the average or overall M&I water quality benefits be analyzed? What models are needed to perform these analyses?

Response:

Improvements to water quality will be measured by continuing compliance with the drinking water standards. Most water utilities can routinely meet the existing standards, but the compliance may be difficult and costly in the near future as maximum contaminant levels (MCL's) are set and/or lowered. This will be especially true for THM and other proposed disinfection by- products.

In addition to compliance with the standards, it might also be possible to more closely examine the overall economics of the choices available to the M&I community. These might include:

a. Cost to develop the necessary upstream storage projects that would be required to maintain the water quality in the Delta without any facilities, versus

b. The cost to develop the necessary water treatment facilities for all Delta water users (including the air quality costs for carbon regeneration) and the additional operation and maintenance that will be required, versus

c. The cost for adequate facilities, and also protection for the Contra Costa Canal. A preliminary estimate of these costs is included in the California Urban Water Agencies Delta Drinking Water Report, and they will be refined in the future.

15. What are the social, economic, environmental, and institutional impacts of significant changes in water quality objectives and/or new facilities? What importance should public opinion be given in this analysis?

Response:

The complete answer to this question may be contained in the numerous volumes submitted to the SWRCB during the Phase I hearings. Therefore it would be impossible to compose a short answer to the complete question. Costs to water users and the consumers were presented by the State Water Contractors, and the institutional issues relative to some of the state agencies were presented by DWR and others.

Public opinion will certainly play a major role both in analyzing the impact of facilities and in responding to the mandatory public notification relative to the violation of the drinking water standards. An examination of the response by consumers in Southern California to the recent notification regarding THM standard violation might be an indication of the public reaction.

16. What recommendations do you have for future work/studies.

Response:

The State Water Contractors provided the Board staff with language that suggested a program for Delta drain investigation and monitoring. Added to this would be the need for an intense look at the drains at or near the water supply intakes. Specific reference is made to the drain for Veale Tract which directly impacts the Contra Costa Canal and all the water users. A similar examination of the drains in the Cache and Barker Slough areas would be required in order to examine the need to improve the water quality for the city of Vallejo and the North Bay Aqueduct users.

In addition, we urge the SWRCB to evaluate each of the six alternatives for improving Delta drinking water quality that were identified in the California Urban Water Agencies Delta Drinking Water Quality report published in May 1989.

## RECOMMENDATIONS

If the use of water for domestic supplies is the "highest use" as provided in the Water Code, then those issues relative to water quality should play an important role in the balancing process that is part of the Bay/Delta hearings. The best evidence available indicates that the existing drinking water standards will be tightened and therefore, it will become even more difficult for the water utilities to meet those standards. The SWRCB concluded in its report (1988) as referee in the case Environmental Defense Fund et al v. East Bay Municipal Utility District, "Prudence requires that public water suppliers should minimize treatment uncertainties by seeking water from the best available source and as removed from the potential for degradation as possible".

Standards which are appropriate today may not be adequate or appropriate in the future. The structuring of water quality objectives for the Bay-Delta hearings currently under way may not be reasonable to meet future needs and it is recognized that without additional facilities, it is not possible to reliably deliver high quality water. With this material as background, the following recommendations are made:

1. Until adequate facilities are in place, and capable of delivering high quality water on a reliable basis, the existing D-1485 standard of 250 mg/L chloride for municipal uses should remain in effect. However, the 150 mg/L chloride standard established for industrial uses should be eliminated because of the DWR contracts

with the industries. This short-term measure would have the goal of providing the highest water quality practicable without unreasonably impacting the 20 million people who use the Delta as a water supply. Placement of a barrier or barriers in the western Delta, possibly in Old River at Holland Tract, should also be considered in the short-term in order to reduce bromides from sea water intrusion thereby improving water quality for municipal purposes. Relocation of the Contra Costa Canal Intake along with the proposed Los Vaqueros Reservoir would provide large improvements to water quality for the people who receive Contra Costa Canal water supplies.

2. An appropriate control strategy for the agricultural drains within the Delta must be developed, especially those adjacent to the water supply intakes at Rock Slough, Cache and Barker Sloughs, the State Water Project, and the Delta Mendota Canal. The opportunity for short-term improvements in those areas should be explored and implemented.

3. The SWRCB should evaluate each of the six alternatives for improving Delta drinking water quality as identified in the California Urban Water Agencies Delta Drinking Water Quality report published in May 1989. We believe that evaluation of each of these alternatives is necessary for adequate analysis of the best means for protecting public drinking water supplies.

SNASWC2/C

Contra Costa Water District

Comments on

Bay-Delta Proceedings

Municipal and Industrial Water Quality Issues

The comments of the Contra Costa Water District on Delta Municipal and Industrial Water Quality Issues and the Delta M&I Workgroup report are outlined below. Following this outline are responses to specific questions posed by the State Water Resources Control Board's staff.

- The Contra Costa Water District (CCWD) supports the recommendation of the Delta M&I Workgroup that a 50 mg/l objective be set at Delta M&I intakes for the purpose of controlling bromides at a reduced level. CCWD believes this objective will have the added benefit of providing generally higher quality water in the Delta.

- CCWD supports the Delta M&I finding that such an objective may not be feasible all the time under all water supply conditions. However, it is noted that chloride concentrations at Rock Slough were lower than 50 mg/l almost 50% of the time since 1968. CCWD believes that operational and other studies are required to determine a strategy for meeting such an objective.

- CCWD recommends that the 150 mg/l objective of the 1978 Water Quality Control Plan be maintained for the protection of M&I use. Operational studies by the California Department of Water Resources for the Bay-Delta Proceedings indicate that this objective costs little in the way of additional outflow (on average, about 10 thousand acre-feet per year).

- CCWD recommends that a 50 mg/l objective be set at the intakes of the proposed Los Vaqueros Reservoir, to be implemented when Los Vaqueros goes into operation. In order for this reservoir to meet its operational goals of improving water quality, high quality water must be available for storage in the reservoir every year.

Response of the Contra Costa Water District
to the
Questions of the State Water Resources Control Board's Staff
on Delta M&I Issues

1. The two questions are answered separately.

Is a 150 mg/l standard needed to protect industry?

A 150 mg/l standard is needed for local industry. Some industries need low salt levels for process water. Many local industries use more water when chloride levels exceed 200 mg/l because of operational constraints in multiple pass cooling systems. Some industries have difficulties in meeting wastewater discharge requirements when there are high salt levels in source water. There are, in addition, costs associated with corrosion caused by water of high salt content, for municipal as well as industrial users.

There is a separate issue involved with a single 250 mg/l standard. Contra Costa Water District is the only M&I user that is directly affected by such a water quality standard. Most other M&I users who would presumably be affected enjoy incidental protection and are able to blend the higher quality water they receive in reservoirs.

The M&I standard should promote the best achievable water quality. The 250 ppm limit should be applied only in years of extreme water shortage. Much higher standards can and should be applied in other periods.

CCWD believes, based upon Department of Water Resources studies, that the 150 mg/l standard does not require excessive amounts of water to implement. The Impact Analysis Workgroup examined the effect of the 150 mg/l standard and found that while the required outflow was reduced by an average amount of 40 TAF when the standard was removed, surplus flow increased by an average of 30 TAF. **In other words, the net Delta outflow changed very little.** Exports increased by only 10 TAF on average (with a maximum of 40 TAF in any one year). Summaries of these results developed by DWR staff are included at the end of these comments.

Is a 50 mg/l standard needed for blending purposes?

A 50 mg/l standard is needed to reduce bromides in the water supply so that water suppliers can meet drinking water standards and try to minimize the level of disinfection by-products. One way to help meet those standards and goals is by blending to achieve a 50 mg/l or better chloride content. In order to blend to this

level, 50 mg/l or better water is required to fill reservoirs.

A 50 mg/l standard will have the additional benefits of providing high quality water, low in total dissolved solids, hardness and sodium. This will help reduce corrosion problems and improve the taste of the water.

The Contra Costa Water District is proceeding with its plans to build the Los Vaqueros Reservoir (at a cost of $350,000,000) for the purpose of improving the quality of the water it delivers to its customers. The Project is intended to store high quality water when it is available and then blend it when Delta water quality is poor. The Project will not work if high quality water is not available for storage. It also will not work if high quality water is infrequently available or if Delta water quality is frequently at or near the 250 mg/l limit.

Therefore, there should be a 50 mg/l standard at the CCWD intakes during the months when water can be diverted to the reservoir. Since the reservoir will be used to blend with Delta water, the size and ultimate success of the reservoir depend not only on filling with high quality water, but also on the availability of relatively good quality water the rest of the year. If water quality is poor, the reservoir will be drained quickly and will not meet its objectives. There should therefore be much higher standards than the 250 mg/l standard throughout those periods that it is feasible.

The Contra Costa Water District recognizes that such a standard may require substantial operational changes in some years. However, such a standard is already met about 50% of the time at Rock Slough (see Figure 1 attached; data from Phase 1, CCWD Exhibit 8 and from measurements made after April, 1987). The data shown are for a period that includes a greater proportion of critically dry years and wet years than the long term average. Furthermore, the State and Federal Projects have changed their operational procedures as a result of the 1976-77 drought and the 1978 Water Quality Plan. The District encourages further operational studies and water quality modeling to explore the means by which such a standard can be met.

2. Should the Contra Costa Canal be relocated to Clifton Court Forebay?

The Contra Costa Water District is studying Clifton Court Forebay as a second intake, along with a number of other locations in the Delta. Other sites may be preferable in terms of water quality, cost of facilities, reliability and maintenance of the project schedule.

The District has not decided to forego the significant investment represented by the Rock Slough intake nor the economic benefit of its continued use. A second intake will be considered in terms of water quality objectives and the financial and contractual obligations that may be necessary.

The District is evaluating several options at this time. Selection of possible second intakes will not be made before the end of 1989, when the District will begin formal EIR preparation and Water Rights applications.

Note that the Los Vaqueros Project may not, without approval of District voters, be used in conjunction with a Peripheral Canal or be used to increase exports from Northern California.

3. What chloride level is needed at the Banks and Tracy Pumping Plants to protect M&I in the export area?

It should be recognized that the Banks Pump Plant enjoys protection due to the Rock Slough Intake Standard. However, any beneficial use should be protected in its own right and not have to rely on incidental protection. The levels of protection should be consistent with maintaining the best achievable water quality. Higher levels of protection than the 250 mg/l chloride standard should be provided. The levels of protection provided should take into account the uses of the water such as municipal, industrial, reclamation and the levels needed for blending when water quality in the Delta is poor.

5. If a 150 mg/l industrial objective is set at the Contra Costa Canal Intake, should a similar objective be set at the Banks and Tracy Pumping Plants?

Again, a Rock Slough objective protects the Banks and Tracy Pumping Plants. However, any beneficial use should be protected in its own right. The objectives at M&I intakes should reflect the beneficial uses to be protected.

7. What THM levels are being delivered to the various users of Bay-Delta water?

The Contra Costa Water District has provided THM data from its treatment plant in the Delta M&I Workgroup Report. THM levels depend upon chloride levels in the Delta and the treatment applied. In particular, the treatment at our Bollman Treatment Plant is adjusted to reduce chlorine contact time when chloride levels are high.

These data indicate that when chloride levels are above

50 mg/l, it will be nearly impossible to meet an expected THM standard of 50 µg/l without costly changes in treatment facilities. The data also clearly show that brominated forms of THM's increase with chloride levels. They show that chloroform levels decrease slightly with chloride level, but overall are low. There is a clear need to reduce bromide in the source water.

It should also be noted that the Maximum Contaminant Level Goal for THM's will probably be set at zero. Reductions in bromide levels, regardless of treatment process, will aid in approaching that goal.

8. How should THM's be considered in the Water Quality Control Plan?

First, THM's are only one class of many disinfection by-products. Other classes (as well as some disinfectants themselves) are likely to fall under regulations in the near future.

Standards should be set to limit the THM formation potential at intakes. It is not clear that a sufficiently well established relationship between THMFP and THM production in a water treatment plant is available. It is clear that regardless of treatment process, bromide presents a problem, and if present in sufficient quantities makes the present THM standard difficult and costly to meet. Its presence will certainly make the likely future standard of 50 µg/l or 25 µg/l more difficult and costly to meet.

An objective for bromide should be established at 0.15 mg/l. A relaxation may be applied in years of water shortage, but only to the extent that one may blend to meet the objective. A window of time with the highest objective must be allotted in all years so that water can be stored for blending later in the season.

The Contra Costa Water District is considering other treatment processes to help us meet drinking water standards. However, it must be recognized that there are disinfection by-products formed in all treatment processes. Several new classes of DBP's may be regulated in the near future. These regulations may impose constraints on advanced treatment processes that may limit their flexibility or usefulness.

9. Should THM objectives be set for the various species of THM's?

A bromide objective will help reduce brominated THM's and brominated forms of other DBP's. Such an objective will help both in removing one class of THM's as well as in reducing the overall THM level. It will also help in meeting Maximum Contaminant Level Goals.

Although, EPA staff have indicated that there will probably not be separate standards for all species, several species were identified as being considered for separate standards, including bromoform and bromate. If there are separate standards for a particular specie, the State objective should take any such separation into account.

10. What is the future outlook for advanced water treatment methods?

Membrane filtration and other advanced treatment techniques are under study by the Contra Costa Water District and others. There are, as yet, no full scale tests available for this type of treatment.

A new joint treatment facility (to serve the eastern part of the District and the Oakley Water District) using ozone-GAC-chloramination is under design. The test scale facility was able to achieve very low THM levels for a variety of conditions. The actual success of the full scale plant will, of course, not be known until constructed and tested. However, the plant is being designed with a great deal of flexibility to maximize its ability to meet design criteria and achieve low THM levels. Nonetheless, potential EPA regulations on DBP's and disinfectants may reduce some of that flexibility (particularly if aldehydes, chloropicrin or chloramines are regulated, or the new THM standard is set below 25 µg/l), so there remain uncertainties.

11. Should the objectives be tailored to water year type and/or water supply?

To some extent the objectives should be tailored to water availability. By the same token, the maximum acceptable levels should in no case be considered optimal or desireable, but levels that are tolerable only because water is in short supply. Higher standards should apply so that the beneficial uses are fully protected when water is not in short supply.

Contra Costa Water District

Histogram of Chloride Levels

Measured at Rock Slough

1968-1988

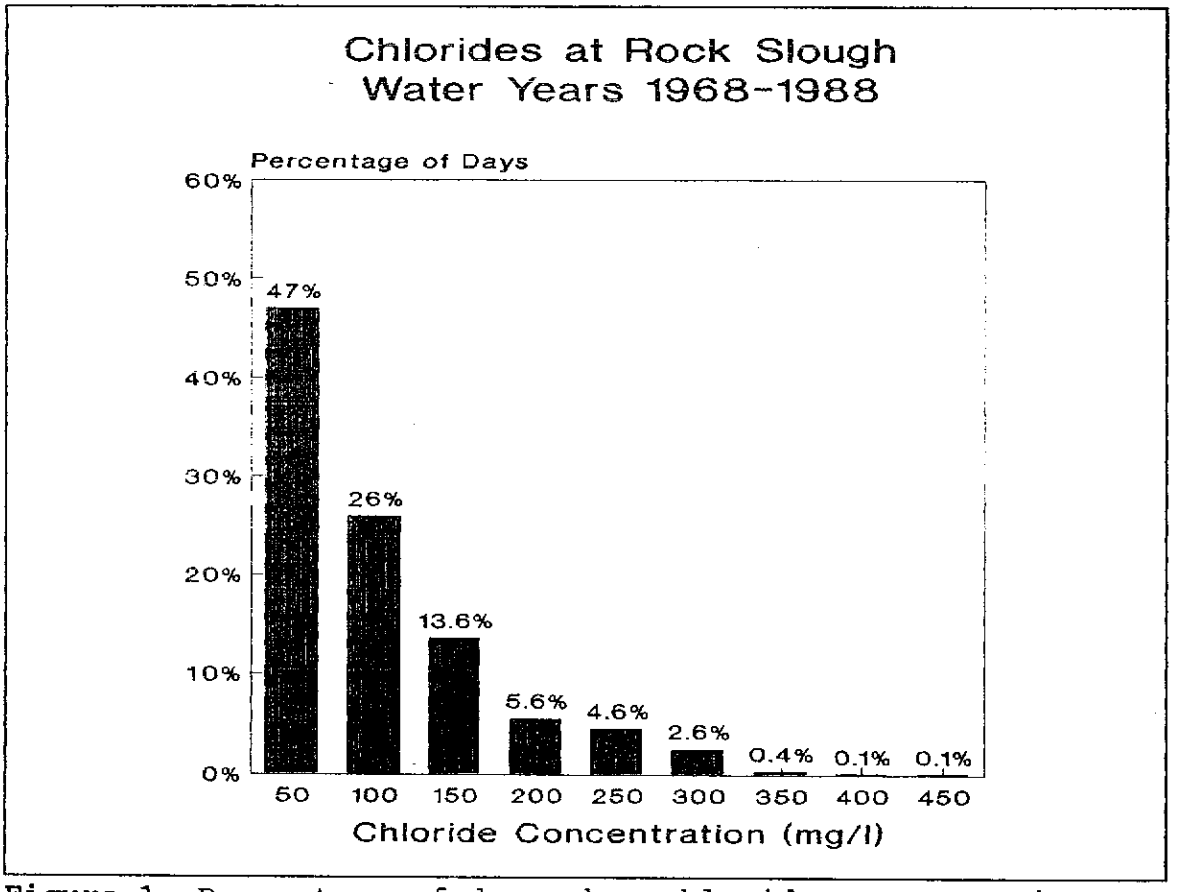



**Figure 1** Percentage of days when chloride concentrations at Rock Slough were at or below the indicated level. Period of record: Water Years 1968 through 1988.

Effect of 150 mg/l Standard
According to DWRSIM

Source: SWRCB Bay-Delta Impacts Analysis Workgroup

Base Case: Study A, D1485 standards

Compared to: Study D, D1485 standards with the elimination of the 150 mg/l chloride standard at Rock Slough/Antioch

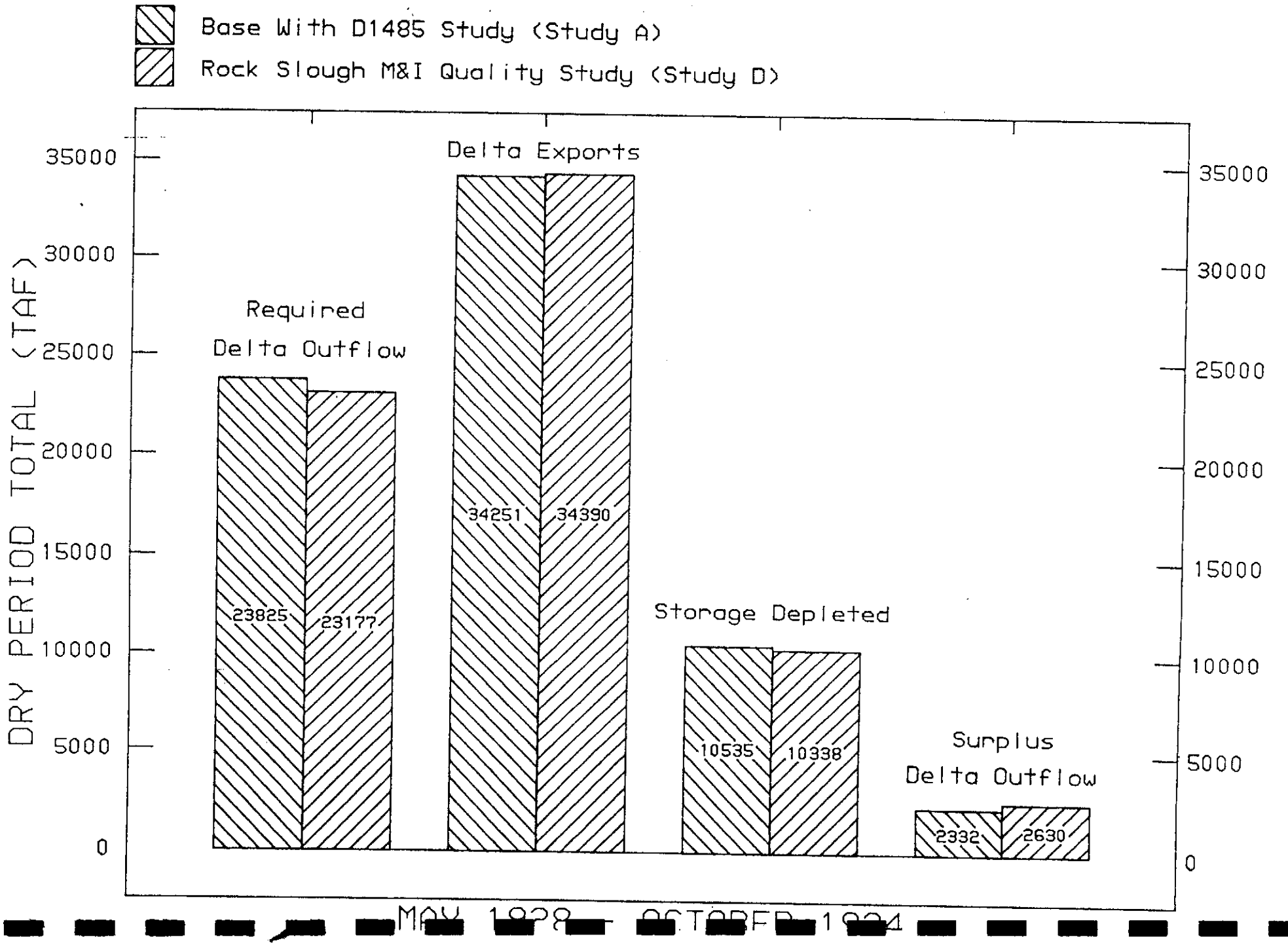
# MATRIX OF OPERATION STUDIES TO EVALUATE IMPACT OF DELTA WATER QUALITY AND FLOW OBJECTIVES

HYDROLOGY AND OPERATIONS SECTION
MODELING SUPPORT BRANCH
CALIFORNIA DEPARTMENT OF WATER RESOURCES
APRIL 18, 1989

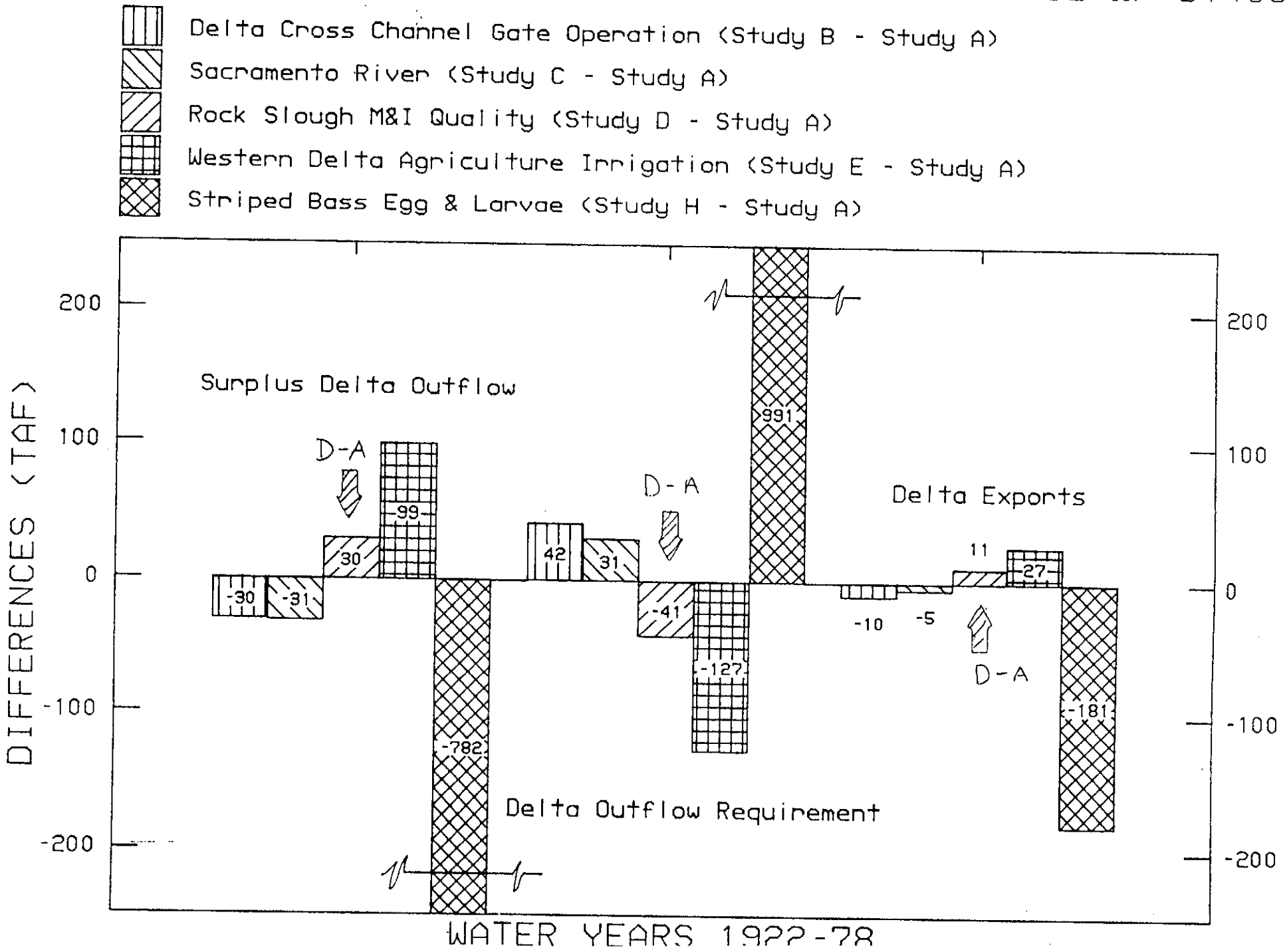
| | NEW OBJECTIVE | REQUIREMENT | BASE W/ D1485 A | B | C | D | E | F | G | H | I | J | K | L | Y | DRAFT PLAN Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) | Sacramento River | Water Year Type April-July | 0* | 0 | 1* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2) | Rock Slough M&I Quality | 250 mg/l Cl All Year | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 3) | West Delta Agric Irrig | 1.5 to 3.0 EC Emmaton & Jersey Pt 4/1 to 8/15 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4) | West Delta Agric Leach | 1.7 EC Emmaton & Jersey Pt Dec-Feb | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 5) | South Delta Agric Irrig | 0.7 EC Apr-Aug 1.0 EC Sep-Mar Vernalis | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 6) | Striped Bass Egg & Larvae | 2900 to 30000 cfs Chipps Island May-Jul | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 7) | Sacramento River Salmon | 2500 to 22500 cfs Rio Vista Apr-Jun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 8) | San Joaquin River Salmon** | 500 to 14000 cfs Vernalis Apr-Jun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 9) | Export Pumping Limits** | 2000 to 9200 cfs Apr-Jul | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 10) | Delta Cross Channel Gate Operation | Per Draft Plan | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |

* 0 means the corresponding standard is turned off (back to D-1485 Standard, if exists in D-1485), while 1 means the standard is on.
** Activation of these standards requires San Joaquin River Index.
NOTE: Draft Plan standards specified for internal South Delta and Suisun Marsh will be analyzed separately.

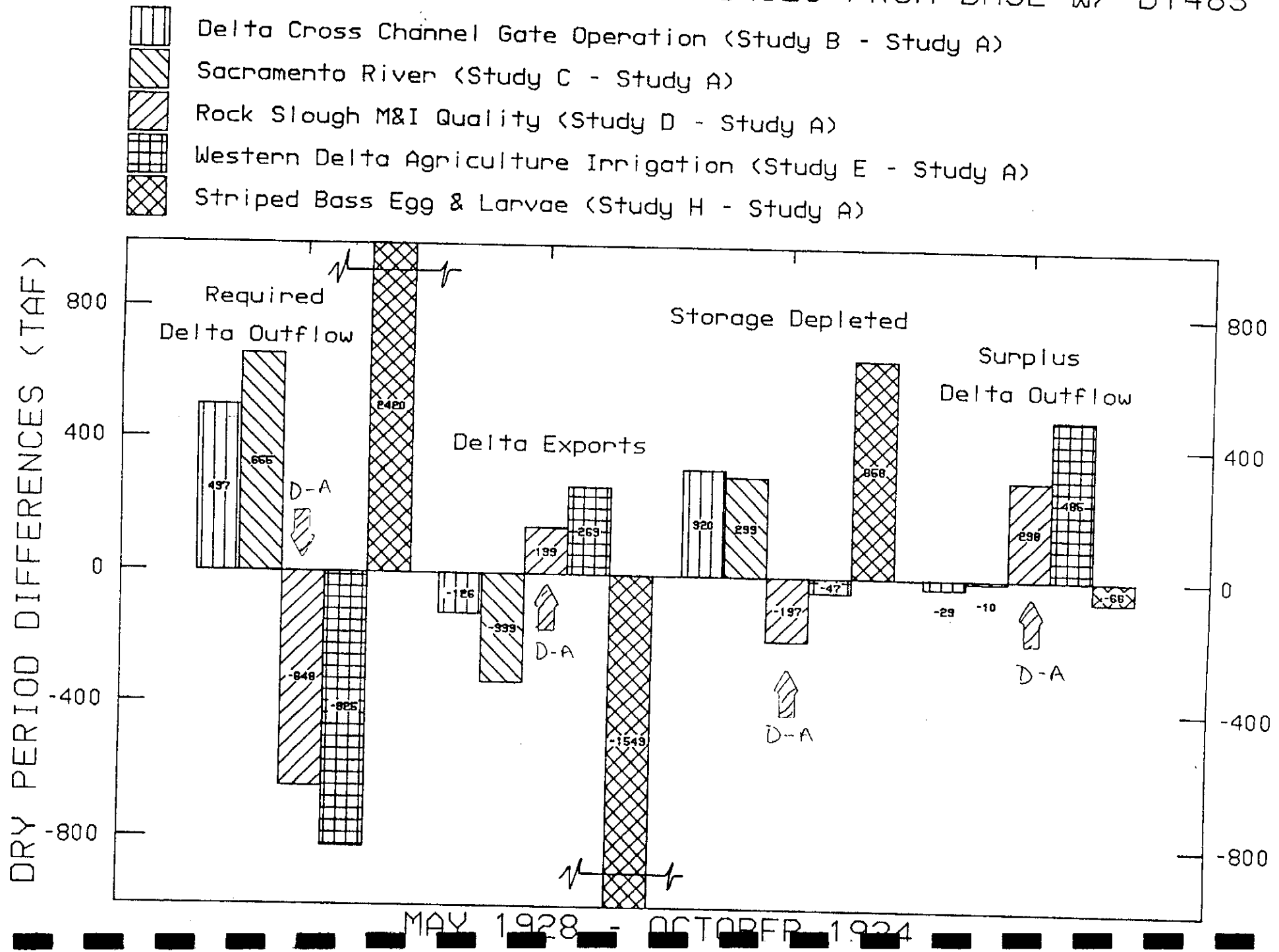
# FIGURE 7 DELTA WATER OPERATIONS



# FIGURE 8 ANNUAL AVERAGE DIFFERENCES FROM BASE W/ D1485



# FIGURE 9 DRY PERIOD DIFFERENCES FROM BASE W/ D1485



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