II.D.DWR

PHASE I

SACRAMENTO-SAN JOAQUIN DELTA/SAN FRANCISCO BAY

ESTUARY HEARING

Closing Brief

Department of Water Resources

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INTRODUCTION

In its notice of October 30, 1987, the Board invited the submittal of closing briefs after the end of evidentiary hearings in Phase I of the Sacramento–San Joaquin Delta/San Francisco Bay Estuary Hearing. The notice stated that the closing briefs may cover any point or points or set forth any argument related to the evidentiary hearings as to the use of this evidence in Phase II.

The purpose of this brief is to set forth the recommendations of the Department of Water Resources regarding the identification of beneficial uses in the Bay–Delta Estuary, the establishment of water quality objectives to afford reasonable protection to those beneficial uses, and measures or actions required to implement those objectives. This brief will also attempt to address any significant factual issues, raised by the Department or by any other participant, in need of clarification or special attention. It is not the purpose of this brief to present a detailed recapitulation of the evidence set forth in the Department's testimony and exhibits. Nor is it the intention of this brief to address and dispose of all of the myriad assertions of fact or law made in the course of over fifty days of hearings which may be expressly or implicitly at variance with the Department's evidence or recommendations.

In addition to our conclusions and recommendations pertaining to the factual record, we will also set forth the legal and policy principles that we believe govern how that record should be used to prepare a water quality control plan focusing on flow and salinity impacts and a pollutant policy document for the Bay–Delta Estuary. Specific recommendations regarding the use of the Phase I record in Phase III proceedings to implement Bay–Delta water quality objectives will not be included in this brief, although such issues may be touched upon, especially in discussing the program of implementation portion of the water quality control plan.

Citations to exhibits admitted into the record will use the organizational acronym and exhibit number used on the exhibit. Volume numbers (in capital roman numerals) and page numbers will refer to testimony in the published hearing transcript. Transcript errata will not be noted but will be submitted under separate cover along with this brief. Thus, transcript volumes will also be identified by their original numbering.

SECTION 1

LAW AND POLICY

There are three primary authorities which govern the preparation and content of a water quality control plan. The first is Article 10, Section 2 of the California Constitution, which sets forth the single overriding principle applicable to the use of California's waters: that water shall be used reasonably and not wasted, and that its method of use and method of diversion shall also be reasonable. The second is the Porter-Cologne Water Quality Control Act, Section 13000 et seq. of the California Water Code and, specifically, Sections 13170, 13241 and 13242. This is the organic law under which the Board is empowered to develop water quality control plans, and the Regional Water Quality Control Boards are authorized to adopt individual basin plans. The third authority is the Court of Appeal decision in United States v. State Water Resources Control Board, 182 Cal. App. 3d 82 (1986), delivered by Presiding Justice Racanelli and commonly referred to as the "Racanelli decision". This decision is the most recent and most authoritative judicial interpretation of the Porter-Cologne Act and the responsibilities of the State Water Resources Control Board under that act regarding the formulation of water quality control plans. It is also authority on several points relating to the role of other laws in the water quality planning process.

In addition to these three direct authorities, there are many other laws which are relevant to the Board's planning processes). It is also clear that the plan must be forward looking, to anticipate as well as possible future needs and changing circumstances.

Although broad and far-reaching in these respects, a water quality control plan is not simply a "wish list" under which any asserted use is automatically beneficial and entitled to maximum protection. The plan must operate within the bounds of reasonableness, as directed by statute and by the Constitution.

Water Code Section 13241 states that the water quality objectives are to "ensure reasonable protection of beneficial uses." Section 13000 declares that the purpose of the Porter-Cologne Act is "to attain the highest water quality which is reasonable, considering all demands being made and to be made". In quoting these two sections, the Court of Appeal stated, "We think this statutory charge grants the Board broad discretion to establish reasonable standards consistent with overall statewide interest." (Racanelli, pp. 116, 122) Clearly, water quality objectives in the water quality control plan must be reasonable, in light of all demands being made and to be made. And as in water rights adjudications involving the principle of reasonable use, water quality planning objectives necessarily involve the balancing of the needs of competing uses.

Whether the protection afforded by a proposed objective is reasonable should be determined in reference to the following points:

1. The relationship between the water quality parameter (flow, salinity, etc.) and the beneficial use should not be speculative. There must be adequate and reasoned support in the evidentiary record.

2. The protection to be afforded a beneficial use must not be wasteful. For example, in speaking of the Board's elimination of the former Antioch standard as unreasonable, the Court of Appeal noted:

> "Under such circumstances, the Board was fully authorized to eliminate the burdensome Antioch standard from the Plan...In light of the constitutional mandate proscribing unreasonable or wasteful use of water [citation], the Board had little choice but to exempt the projects from the Antioch standards." (Racanelli, p. 144)

3. The objectives must be reasonably capable of achievement. For example, a set of objectives which requires more than the available water supply would be incapable of implementation and hence unreasonable. This criterion reflects both the principle that the plan should be useful, and the observation that "reasonable protection" can only be afforded if objectives are realistic. Of course, the Board may identify implementation measures which are outside its own power to enforce, or "requiring significant time intervals" (Racanelli, p. 122).

In addition to the role of reasonableness in setting the planning objectives, the implementation of the plan must also be reasonable, i.e., it must not result in an unreasonable use of water under Article 10, Section 2. Although this determination cannot embrace the precision and detail (nor many of the individual circumstances and equities) involved in an actual adjudication and allocation of water among water users, the Board is nonetheless bound to consider the general manner and character of uses which will emerge from the plan, if implemented. Much of the testimony on upstream uses and export M & I and agricultural uses was relevant to this point: management techniques, conservation, reclamation and reuse programs, alternative supplies, conjunctive use, etc. all pertain to the question of how efficiently water is being used and what are the reasonable demands for Delta water supplies. Similarly, testimony on source control of pollutants and dredging regulation, non–flow or non–Delta alternatives for salmon enhancement, the availability of substitute supplies and physical solutions in the Delta, farm management practices, etc. helps to define what demands for water are reasonable.

The program of implementation should reflect a weighing of the importance and efficiency of competing beneficial uses to assure that the plan produces a reasonable use of limited water supplies, as well as can be determined based upon the broad picture of water use contained in the record.

II

THE ROLE OF THE PUBLIC TRUST

The Public Trust is the name given to a special relationship between government and the public with respect to the use of certain important resources. Specifically, these resources are tidelands and the navigable waters of the state and the lands underlying them to the ordinary high water mark.

Originally, the Public Trust Doctrine protected the public's right to use the navigable waters of the state for purposes of navigation and commerce, and also included the right to make incidental uses of the resource while engaged in those activities, such as fishing, hunting and swimming. Over time, as needs expanded, the definition of proper public trust uses has also expanded, to include such things as flood control and even highway commerce. The case of Marks v. Whitney, 6 Cal. 3d 251 (1971) recognized the propriety of expanding the doctrine to reflect current values and needs. That case specifically recognized the use of tidal waters for recreation, scientific study and scenic and aesthetic enjoyment as additional proper and protectable trust purposes. Notably, neither this case, nor any case which has followed it, has suggested that environmental or preservation values have or should have replaced the original purposes of navigation, commerce, flood control, etc., but rather have been added to those as alternative, legitimate trust uses. Obviously, potential public trust uses of the same resource may thus be in conflict with each other.

In the course of the hearings, a certain shorthand was adopted. It is a shorthand which tends to equate environmental values with public trust values. This shorthand is incomplete and erroneous, for while the public trust has been seen and used from time to time as a tool for environmental protection, it is not simply that. It also protects uses which may well impair or destroy environmental values, such as channel dredging, or channelization to improve navigation, notwithstanding the impacts on natural riparian or riverine values; flood control; tidelands oil drilling; and the construction of freeway bridges over natural navigable channels. In the 1960s and 1970s, with the growth in environmental consciousness, environmental values came to be included as appropriate uses of public trust resources; but they were never intended to be the exclusive trust use, only an additional one. Thus, as the Board considers the public trust resources, it must consider the full array of socially valuable uses, including aesthetic enjoyment, navigation, fishing, flood control, commerce, scientific study and recreation.

Until recently, water law and public trust law had developed independently in parallel fashion. In the Mono Lake case, National Audubon Society v. State Water Resources Control Board, 33 Cal. 3d 419 (1983), the California Supreme Court was called upon to reconcile these two bodies of law. The court found that their equal doctrinal dignity requires (1), that water rights and allocation decisions be made with express attention to and consideration of public trust resource uses and values, and (2), that such allocations remain subject to review for their impacts on public trust uses.

The court then prescribed a balancing test, under which the water rights administrator must weigh the competing public interest in the use of water under the water rights system against the use of water for public trust purposes. The court expressly pointed out that public trust values may be impaired or destroyed where preservation would be impractical in light of the competing needs for water. The Racanelli decision pointed out

SECTION 2

HYDROLOGY AND UPSTREAM AND EXPORT USE

I

BAY-DELTA WATER SUPPLY

The Department of Water Resources submitted several sets of hydrology to quantify the Bay-Delta water supply under various scenarios. The historical hydrology (DWR-27) presents the actual flows over time (1921 to 1983) and is used as the basis for estimating the other hydrologic scenarios. The historical hydrology has very limited direct usefulness for quantifying water supply or identifying water development effects because it mixes variations in natural hydrology with changing levels of water development over time.

The unimpaired hydrology (DWR-26) adjusts the historical flows to eliminate the effects of regulation and use upstream of the Delta and in the export areas, but assumes present channel configurations. The unimpaired inflow to the Delta (DWR-26, p.35; DWR-26d) is a good estimate of the total Bay-Delta water supply available for all uses. The Department of Water Resources estimate of unimpaired Delta outflow (DWR-26, p. 37) differed from the State Water Resources Control Board estimate (SWRCB–3, p. M-2) primarily because of different estimates of Delta use under unimpaired conditions. Use of Delta inflow to estimate total supply more properly considers Delta use (channel depletion) as a demand on supply and avoids the problem of defining an "unimpaired Delta".

Since unimpaired flow estimates assume present channel configurations and levee and flood bypass systems, they are not the same as natural flows (i.e., flows that occurred in a state of nature, before development). Natural flows through the Delta would probably be far smaller than unimpaired flows due to consumptive use by extensive natural marshes and riparian areas that were later leveed and reclaimed. Monthly distribution of flows would also be different. (SWC-262; SWC-276).

Use of unimpaired flow estimates as a base condition for measuring the impacts of alternative objectives on flow and quality is not appropriate because they do not represent a real situation (Huntley, Vol. III, Pg. 160). The proper base condition for measuring impacts of alternative objectives and the reasonableness of those impacts is the conditions and circumstances of today. These conditions and circumstances are described by hydrology for the 1990 level of development (DWR-30). This hydrology was developed by superimposing today's regulation and use upstream and in the export areas on the unimpaired Bay-Delta supply.

An historical perspective on the use of Bay-Delta water supply is afforded by the estimated hydrology at the 1920 (DWR-28) and 1940 (DWR-29) levels of development. These two estimates indicate that before the advent of large multipurpose water projects with carryover storage, early water development had major effects on water supply in dry seasons.

There was considerable confusion during the hearing regarding the nomenclature and use of certain hydrologic scenarios; particularly "natural", "unimpaired", and "historical". In some cases, the confusion led to misuse of hydrology estimates. The most common misuse was the use of unimpaired flows as natural flows (Rosengurt, Vol. IV-A, pg. 186; Williams, Vol. V-B, pg. 5). In another instance, the Central Delta Water Agency cited historical flows as "natural flows" (CDWA-4, Orlob, Vol. XII, p. 112).

The Environmental Defense Fund (EDF) purported to illustrate the impacts of water diversions by comparing pre-CVP historical Delta outflows with recent historical Delta outflows (EDF-4, Figs. 1-4). However, EDF compared years with different runoff (unimpaired hydrology) which were consistently wetter in the pre-CVP period, thereby exaggerating the impacts of water development (DWR-102; Huntley, Vol. V-B, pgs. 60-62).

As another example, the Romberg Tiburon Center misunderstood the Four-Basin Index, believing that the index is used somehow to quantify the availability of water (RTCES-21, pgs. 7-9). The index is only used to determine the relative wetness of the water year for setting standards, and the four basins are a good index of the total supply (USBR-122).

Further evaluations of the various water supply scenarios indicate that variations in hydrology, caused by both nature and water development, affect Bay-Delta water quality (DWR-70). The relationship between Delta outflow and salinity intrusion is not linear, so changes in outflow during low flow periods have greater effects on salinity than similar changes during high flow periods (DWR-58). Consequently, a diversion of water during high flow periods causes minor increases in salinity while the release from storage of the same quantity of water during low flow periods greatly reduces salinity.

Today, Delta outflow is frequently at controlled levels (i.e., under balanced conditions), particularly from spring through the fall, to meet D-1485 standards (DWR-30). "Balanced water conditions" are periods when releases from upstream reservoirs plus unregulated flow approximately equal the water supply needed to meet the in-basin uses, exports, and water needed to meet Board standards, and, thus when there is no surplus water available (Mierke, Vol. XXVIII, pg. 167; Cowan, Vol. XXVIII, pg. 30). Therefore, any change in Bay-Delta flow and quality objectives during these controlled periods will have a direct effect on the availability of supplies for diversion to beneficial uses of Delta water supplies throughout California. The distribution and use of the Bay-Delta water supply is limited by various physical and operational constraints, particularly flood control considerations (DWR-15; DWR-708).

II

UPSTREAM AND EXPORT USE

The Bay-Delta water supply is used throughout the State (DWR-20). Most of the supply is used in-basin for needs in the Sacramento and San Joaquin Valleys, the Delta, and for mandatory and unregulated Delta outflow (DWR-4; DWR-5). There is a continuing and increasing need for supplemental water from the Bay-Delta supply in upstream and export areas as shown in DWR Bulletin 160-83 and Bulletin 160-87 (DWR-401, Chapt. V; DWR-707, Chapt. 5). This increasing need is primarily to meet urban growth requirements and to correct ground water overdraft (DWR-707, Chapt. 2).

Urban water conservation programs are being implemented statewide (DWR-422; DWR-423). Agricultural water conservation is widely practiced for local cost savings, although potential net water savings in the Central Valley are limited because most excess water returns to usable ground water or surface water supplies (CVAWU-64a). There are several existing water conservation laws and regulations related to fixtures (showers, toilets, etc.) and water conservation planning that have proven to be practical and effective. However, mandatory performance standards such as conservation goals are not practical because of problems with establishing base conditions and measurement methods. Government-encouraged and assisted voluntary programs based on economic considerations are more practical (Huntley, Butterfield, Vol. XXI, pgs. 248-252).

Water conservation, wastewater reclamation, and other alternative supplies will not overcome the increasing need for supplemental water from the Bay-Delta supply (DWR-707, Chapt. 5). For the State Water Project, even with water conservation, alternative supplies, and several new facilities to make use of surplus water from the Bay-Delta supply, future needs cannot always be met under D-1485 (DWR-703a). More stringent Bay-Delta flow and water quality objectives would increase current and future shortages in SWP service areas. The statewide benefits of upstream and export use of the Bay-Delta supply are large and reducing that use could cause severe adverse impacts (DWR-402, DWR-474, DWR-480, DWR-483, SWC-51, SWC-450).

SECTION 3

MUNICIPAL AND INDUSTRIAL USES

Organizations presenting direct testimony on Delta municipal and industrial use included the Department of Water Resources, City of Antioch, City of Tracy, Shell Oil Company, Contra Costa Water District, Oakley Water District, and the Sacramento Environmental Health Coalition. Although evidence in much greater depth on export municipal industrial uses was presented later in Irvine, statewide use figures for municipal and industrial use of Delta waters were given at this session. Water quality objectives and proposed methods of implementation will, therefore, be discussed for both local and export M & I uses.

I

BENEFICIAL USES

DWR-207 describes the history and development of municipal and industrial water uses of Delta water supplies. DWR-204 is a chart which shows the actual quantities and population served by water diverted from the Delta itself. These exhibits point out that approximately ninety-three percent (93%) of California's current population of 27.3 million people depend on water supplies in or tributary to the Delta for municipal and industrial needs. They also show that more than 16.5 million people receive at least a part of their municipal and industrial supply directly from the Delta. As shown on DWR-204, this amounted to almost 1.2 million acre feet of water use in 1986.

Testimony showed that M & I water is diverted from the Delta at the following locations:

1. The Contra Costa Canal (CCC) intake at Rock Slough for Contra Costa Water District;
2. Clifton Court Forebay for the State Water Project, California and South Bay Aqueducts;
3. Barker Slough for the State Water Project, North Bay Aqueduct;
4. Tracy Pumping Plant for the Central Valley Project, Delta Mendota Canal;
5. Mallard Slough for Contra Costa Water District;
6. Antioch Water Works for the City of Antioch; and
7. Cache Slough for the City of Vallejo.

Testimony and exhibits from DWR indicated that the City of Vallejo will shift from its point of diversion at Cache Slough to taking water from the North Bay Aqueduct. It also showed that the City of Antioch receives a water supply through the Contra Costa Canal when water from the river channel is worse than 250 ppm chlorides. The City of Antioch and the Department of Water Resources have a contract to compensate for increased costs to Antioch for CCC water resulting from offshore quality impairment due to SWP operation. A similar situation and agreement exist for the Contra Costa Water District's diversion at Mallard Slough.

The service areas for M & I diversions were depicted on DWR-202 and DWR-203. These exhibits were explained and supplemented by the testimony of George Deatherage. (Vol. VI, pp. 17-26) Contra Costa Water District testified that it has been considering the relocation of its canal intake from Rock Slough to a location less susceptible to water quality degradation, such as Clifton Court Forebay. (Vol. VII, pp. 32, 43)

The evidence also indicated that in addition to these municipal and industrial diversions, there were two active diversions for industrial process water in the western Delta: Louisiana Pacific-Fibreboard and Gaylord Container, Inc. (formerly Crown Zellerbach). These two companies produce paper products, and both receive water from the Contra Costa Canal in addition to direct offshore diversion at their plants in the vicinity of Antioch.

II

WATER QUALITY REQUIREMENTS

A. Municipal Uses

DWR-223, a December 1982 report on public health aspects of Sacramento-San Joaquin Delta water supplies, identified sodium, asbestos, and trihalomethane-forming materials as water quality parameters of human health concern in Delta water supplies (exclusive of any episodic pollution problems). DWR exhibits and testimony described how the Interagency Delta Health Aspects Monitoring Program (IDHAMP) was initiated in July 1983, in response to this report. The testimony of DWR witness Richard Woodard, along with DWR-222, DWR-224, and DWR-225 set forth the most recent findings and conclusions of the IDHAMP. For sodium, there has been no maximum contaminant level established by the EPA. The National Academy of Sciences has recommended a guideline that persons on moderately restricted sodium diets should limit their intake of water to 270 mg/l sodium.

As for asbestos, there is continuing doubt whether asbestos in drinking water (as opposed to inhalation of asbestos) presents a public health threat. There is no established Maximum Contaminant Level for asbestos.

Drinking water supplies of Delta origin generally do not meet the EPA's trihalomethane (THM) Maximum Contaminant Level of 100 ug/l without specialized treatment. As Mr. Woodard's testimony indicated, THMs essentially do not occur in the Delta water but are formed upon the chlorination of Delta waters (for disinfection) in which THM precursors are found. The organic THM precursors come from decayed vegetation, although what the relative contributions of the different sources of the organic precursors (i.e., natural vegetation, agricultural drainage, phytoplankton, etc.) are remains a question. As Department testimony and exhibits indicated, agricultural drains in the Delta are being investigated to determine their contribution to the THM formation potential and the possibility of control (DWR–229). Treatment for THM prevention, THM control, or isolation of M&I supply are the other feasible methods of handling the problem. It should also be noted that bromide derived predominantly from sea water is an inorganic precursor to THM formation in water taken from the Delta, and it has been suggested but not yet established that brominated THMs may be more carcinogenic than chlorinated THMs.

B. Industrial Uses

The only industries for which direct testimony was given regarding water quality requirements were Fibreboard and Shell Oil. For both, the single water quality concern was salinity. The problem for Fibreboard was the rusting of metal containers encased in interior liner board fabricated with water exceeding 150 ppm of chloride. The concern of Shell Oil was for corrosion resulting from the use of water for cooling and for steam generation.

Shell testified that it gets the water it needs of suitable quality from the Contra Costa Canal and is prepared to accept reclaimed water from the Contra Costa Water District's reclaimed water plant when available (Vol. IX, pp. 44, 47, 49, 50). Fibreboard, as discussed previously, is also a customer of the Contra Costa Canal. The presentation of Department witnesses George Deatherage and Richard Lerseth, supplemented by the testimony of Robert Hall for the Contra Costa Water District, disclosed that the company is currently capable of treating water of up to 240 ppm chlorides before it would suffer production losses of interior liner board but that the mill at Antioch also makes a corrugated medium that does not require such high quality water as that for liner board. (Vol. IX, pp. 80, 82) Finally, the testimony of Department of Water Resources indicated that Fibreboard and the Department are close to an agreement whereunder the Department would pay for water quality impairment caused by operation of the State Water Project.

III

WATER QUALITY OBJECTIVES FOR MUNICIPAL AND INDUSTRIAL NEEDS

A. Municipal

The Department recommends that an objective of 250 mg/l chlorides should be established for all municipal uses. This does not represent a general health criterion, but one only for taste. From a health standpoint, even users on moderate sodium restricted diets would be protected under the NAS recommended guideline for sodium. Persons on severely restricted diets, limited to no more than 20 mg/l sodium, have reasonable recourse to bottled water and other such sources for necessary drinking water. There was no testimony or evidence that municipal needs required better than 250 mg/l chlorides.

B. Industrial

The testimony did not indicate any need for a special industry objective. Both the paper companies and Shell Oil meet or supplement their needs with CCC water, which is of suitable quality for Shell and treatable for Fibreboard. Although Fibreboard needs to treat water to 150 ppm for one of its products (interior liner), it did not request such an objective either at Antioch or at the CCC. Fibreboard's ability and practice of blending and treating water and of producing other than salt-sensitive liner board remove the need for an industry standard different from the municipal water quality objective. The Board should note the current negotiations between Fibreboard and DWR for reimbursement of costs attributable to SWP quality impairments. Given these points, any objective at Antioch would be unreasonable. Similarly, the testimony of DWR witnesses John Michael Ford and Richard Lerseth and, specifically, DWR-261 and DWR-272 demonstrate the high cost in additional outflow required to increase the objective from 250 mg/l to 150 mg/l chloride at Old River near Rock Slough.

IV

IMPLEMENTATION

A. Water Quality Standards

1. Location of Standards

The location of standards of 250 mg/l chlorides should reflect the fact that salinity degradation in the Delta is a result of both ocean salinity intrusion and land-derived salts. It should consequently reflect that ocean salinity is controllable through outflow (and hence, through control of depletions), and that land-derived salts are the products of point and non-point local discharges in the vicinity or upstream of M & I diversion points. The testimony of Edward Winkler and, specifically, DWR-242, DWR-244, DWR-245, and DWR-246 demonstrated one, the impacts of local degradation, and two, the ineffectiveness of outflow to correct or overcome problems caused by local discharges. (Vol. VI, pp. 51-58) Testimony on this subject was also given by Harvey Banks, (Vol. VII, pp. 32, 50).

With this understanding, the specific locations for meeting the M & I objective as a maximum daily salinity standard should be the following:

a. Contra Costa Canal intake and Pumping Plant No. 1 (until CCC moved);

b. Old River near Rock Slough (until CCC moved);

c. North Bay Aqueduct intake at Barker Slough;

d. Cache Slough near Junction Point;

e. Clifton Court Forebay intake at West Canal; and

f. Delta Mendota Canal at Tracy Pumping Plant.

The Old River and Cache Slough stations are the controlling points for ocean salinity intrusion and should be maintained by fresh water flows assured by upstream, local, and export users. Any degradation at the remaining stations would be caused by land-derived salts that should be controlled by controlling local and upstream discharges.

2. <u>Enforcement of Standards</u>

Means of enforcement follows from the previous discussion. Depleters having an impact on Delta outflow and, hence, sea water intrusion, should be responsible for meeting the standards under their control. The Board has the necessary and adequate water rights authorities to enforce these standards against riparians, statutory and pre-1914 appropriators. Enforcement of the standards at locations applicable to dischargers is available under both the Board's water quality and water rights authorities.

B. <u>Measures Other than Standards</u>

Actions other than the setting of objectives and/or the enforcing of water quality standards against water users and dischargers were proposed in the course of the hearings on this topic. Treatment of raw water to a quality suitable for intended use is an example. In fact, in the preceding discussion of Delta industrial needs, the Department recognized industrial treatment to be practical and reasonable and a superior method of achieving desired water quality to the establishment of wasteful objectives or standards for ocean salinity control. Similarly, treatment processes to arrest THM formation or to remove THMs are in place at municipal water works which use water diverted from the Delta.

Other measures have been recommended regarding the THM problem for several reasons, including potential action by the EPA to reduce substantially the Maximum Contaminant Level for THMs. One is the possibility of some reasonable form of control of agricultural drainage, depending on the results of the drainage investigation, the magnitude of the island's contribution, and the cost of drainage treatment or disposal.

Another measure is the isolation of M & I supplies from Delta contributions to THM formation potential. Another would address the contribution of bromides to THM formation by eliminating reverse flows that bring bromides from sea water to the M & I diversion points. Both of these would involve measures and facilities to improve water transfer across the Delta. In the sessions on program of implementation, DWR submitted exhibit DWR-710 which described the Department's current efforts toward Delta water management planning through a planning and environmental documentation process. This is a process which will investigate many of these measures and their environmental impacts and which may result in specific recommendations and actions having salutary affects on Delta water quality concerns.

SECTION 4

DELTA AGRICULTURAL USES

I

BENEFICIAL USES

The Department of Water Resources presented a significant body of direct testimony concerning agricultural uses of water in the Delta. That testimony began with an update of our historical land use surveys for the Delta area, as set forth in DWR-304. DWR-312 and DWR-313 provided additional information on long-term trends in Delta cropping patterns. DWR-308 through DWR-311 described the distribution of Delta crops, and indicated that the predominant crop was corn, which represented some 26 percent of Delta crop acreage in the most recent crop distribution survey, followed by grain and hay. For the very salt-sensitive crops, those exhibits indicated that beans are grown predominantly in the south Delta, and tree crops are generally grown in the mineral soils along the edges of the Delta. Corn is grown throughout the Delta, but especially in the central and western Delta.

DWR's testimony and accompanying exhibits DWR-316 through 325 described Delta agricultural practices for both surface irrigated mineral soils and sub-irrigated peat soils. There are significant differences in irrigation practices for surface and sub-irrigation, and the resulting differences in soil salt buildup require different soil salinity management practices (leaching). While leaching under surface irrigation practices is a function of additional water applied during irrigation ("leaching fraction") as well as adequate drainage, leaching for sub-irrigated lands requires separate leaching activities such as fall sub-irrigation and winter ponding.

DWR also presented substantial information on the economic value of Delta agricultural production in exhibits DWR-338 through 343. They showed that corn is the leading Delta crop from the standpoint of gross farm income and that Delta irrigated farming is a significant component of the regional and State economy.

II

WATER QUALITY REQUIREMENTS

A. Salt Sensitivity of Delta Crops

DWR-326 through 328 and accompanying testimony, together with crop survey data previously presented, provided evidence of the significant salt-sensitive crops in the Delta. They showed that corn is the most extensively grown single crop of the Delta lowlands and is moderately sensitive to salinity. This is a continuing confirmation of the Board's earlier findings in Decision 1485.

As a follow-up to the exhibits and testimony of the Board staff witnesses regarding conduct and results of the Delta Corn Study, DWR provided testimony on selected results of the Corn Study. The Corn Study, begun soon after the conclusion of the D-1485 hearings, solicited participation from interested parties, and was eventually co-sponsored by the Board, the

University of California, the U.S. Salinity Lab and the Department of Water Resources. A key finding of the Corn Study was that corn yield depends on the average soil salinity rather than the quality of applied irrigation water at any given time. This average is the electric conductivity of the soil water, weighted for both time (irrigation season) and root zone depth.

B. Salt Management Practices

DWR-329 set forth the relationships between the salinity of applied irrigation water and resulting soil salinity for both surface irrigated mineral soils and sub-irrigated peat soils, using the results of the Corn Study for the equations for organic soils. DWR-332 depicted graphically the salt tolerance of corn at various growth stages, and was compiled from information in Board staff exhibits. That exhibit shows that corn requires relatively low salinity water during the early growth stages, but can tolerate relatively high salinity water after tasseling and maintain full yield.

DWR-334 and DWR-335 describe DELCORN, a mathematical model which was developed directly from results of the Corn Study as set forth by Board staff witnesses. DELCORN was used to estimate the differences in corn yield for two types of leaching practices, under the five different sets of hydrology presented in the Department's hydrology testimony. Results were reported for two different Delta locations. They indicated that practices such as post-harvest sub-irrigation and winter pond leaching are effective in reducing soil salinity and increasing corn yields, as compared to no leaching practices. In addition, results indicated that pond leaching would be needed less often than post-harvest sub-irrigation to maintain crop yield.

III

WATER QUALITY OBJECTIVES FOR DELTA AGRICULTURAL USES

Water quality objectives for the western and central Delta should be based upon the results and information derived from the Corn Study. Corn continues to be the most significant, salt-sensitive crop grown in the Delta, and should continue to be used as the basis for development of water quality objectives. There is no new evidence to suggest any change away from corn as the basis for Delta agricultural water quality objectives. No evidence was submitted by any party which controverts results of the Corn Study. Water quality objectives should also reflect the availability of reasonable and practical on-farm salt management practices to control average soil salinity through means beyond just the control of the quality of applied irrigation water. It is reasonable to expect Delta agricultural water users to employ some sort of leaching practice to reduce soil salinity, in order to make the most effective use of Delta water supplies.

DWR presented an economic analysis of the impact of leaching practices on corn production revenues and income, using the DELCORN model scenarios for hydrology, leaching frequencies, rainfall, and corn yield. These results are set forth in DWR-344 and DWR-345. They showed that the maintenance of high yields (and, hence, revenues) through leaching more than offset the costs of leaching. DWR's analysis addressed both fall post-harvest subirrigation and pond leaching, but not the two in combination which could be even more economical.

The Central Delta Water Agency (CDWA) was the only other party to address leaching practices, but their testimony was limited to very expensive practices used to protect production of very high value crops, which are grown in very limited acreage in the Delta. CDWA's testimony greatly overstated the costs of pond leaching as generally practiced in the Delta. CDWA's witness indicated that the testimony and exhibits presented by CDWA were not representative of a typical Delta operation (Vol. XII, p. 112).

In developing water quality objectives, the Board should make use of DWR's mathematical model, DELCORN, to evaluate potential objectives. The only party which submitted any sort of separate analysis of the Corn Study was the Central Delta Water Agency. CDWA's simplified model was much the same as the DWR's model "DELCORN", with key differences being a lesser degree of sophistication and a different set of assumptions. DWR made its model assumptions clear during direct testimony, and indicated that a variety of assumptions could be used with the model. Part of DWR's recommendations was to make DELCORN available for Board staff review of potential draft water quality objectives, using whatever assumptions were considered appropriate.

DWR recommends that a post-harvest subirrigation leaching objective in the form of average EC should be provided for a 10-day period between November 1 and December 20 at the Emmaton and Jersey Point stations when upstream October 1 storage conditions are at or above normal operating levels (11 million acre-feet for major Sacramento River system reservoirs); and that a winter ponding objective in the form of maximum monthly EC should be provided at the Junction Point and San Andreas Landing stations for December through February.

DWR's testimony discussed its activities concerning development of a solution to water level, water quality and circulation problems in the South Delta. In the interim agreement with SDWA, DWR has mitigated for SWP impacts on water levels for most of the South Delta. DWR also testified that SWP operations have no adverse impact on, but in fact may improve, circulation and water quality in the South Delta. DWR also described how negotiations should lead to a solution to protect agriculture in the South Delta. These negotiations include DWR, SDWA, and the USBR, and they cover all issues relative to flow and salinity in the South Delta.

IV

IMPLEMENTATION OF OBJECTIVES

A. Salinity Standards

DWR recommends that specific Delta agricultural objectives for the irrigation season should be adopted for the following locations: (1) Sacramento River at Emmaton, (2) San Joaquin River at Jersey Point, (3) Mokelumne River at Terminous, (4) San Joaquin River at San Andreas Landing, and (5) Cache

Slough near Junction Point. The Emmaton and Jersey Point stations are the controlling points for ocean salinity intrusion and should be maintained by freshwater flows assured by upstream, local and export users. Degradation at the remaining stations would be caused by land-derived salts that should be controlled by local and upstream dischargers. Leaching standards should be maintained by freshwater flows assured by upstream, local and export users.

B. Form of Standards

1. EC-Days

The Board should utilize the concept of "EC-days", which recognizes a key result of the Corn Study, in developing water quality objectives. That result was that yield for corn (and presumably other Delta crops) is a function of average soil water salinity over the irrigation season, and not of a specific irrigation water quality at a specific point in the irrigation season. While this concept may also be appropriate for other beneficial uses, it is particularly appropriate to Delta agricultural uses which respond to average soil salinity rather than a time-specific irrigation water quality.

2. April-July Flow

The Board should utilize April-July Four Basin Index forecasted runoff rather than year-round runoff as the basis for water quality standards for individual years. DWR's testimony established that an April-July forecast would be a better indicator of spring-summer available water supply than the full year forecast. The Board should also use continuous "sliding scale" standards rather than the existing discontinuous "stair step" approach, to avoid big jumps in the assessment of water availability and to give greater operational flexibility to those charged with meeting the standards.

C. Relocation of Standards

The Board should provide for relocation of water quality standards at Emmaton when overland facilities or an alternative are provided for Sherman Island.

D. South Delta

The Board should rely on completion of negotiations among the Department, U.S. Bureau of Reclamation, and the South Delta Water Agency to provide permanent solutions to local water level, quality and circulation problems in the southern Delta.

SECTION 5

STRIPED BASS

I

BENEFICIAL USES

The major evidence on striped bass as a beneficial use of Bay-Delta waters was contained in the Interagency Ecological Studies Program report (DFG-25) and agency testimony on that report. The sport fishery value of striped bass is undoubtedly its predominant beneficial use.

A. Status of the Stocks

Exhibit 25 submitted by the California Department of Fish and Game describes the status of the resource and is the basis for the following summary. Peterson population estimates (SWRCB-500) also were used to characterize recent trends in adult striped bass.

The first striped bass life stage where reasonably long-term estimates of abundance are available is when the average size is 38.5 mm (1-1/2 inches). The exact time each year when this juvenile stage occurs in the Bay/Delta varies somewhat, but is generally toward the end of July to early August, or about 3 months after the eggs were fertilized. The index of the abundance at this life stage has been used by DFG as an estimate of year class strength (i.e., the Striped Bass Index, or SBI). It should be emphasized that this is an index of abundance and not an absolute measure of abundance -- a distinction that places some limits on the use of the data. An analysis of the 38 mm index data demonstrates that since 1976, with the exception of

1986, the index has been much lower than expected using the SBI/Delta outflow correlation developed for D-1485. From 1959 through 1976 the average index was about 67, whereas from 1977 through 1986 the average had decreased to about 26. With the exception of 1982 and 1986, the post-1976 indices were all lower than any measured between 1959 and 1976.

Annual estimates of adult striped bass abundance are obtained by a mark-recapture technique called the modified Peterson method. Results of the Peterson estimates, tabulated in SWRCB-500, show that the estimated numbers of adult bass were also considerably lower after 1976. The average annual total number of adult striped bass (3 years and older) was 1.7 million during 1969 through 1976 and 1 million from 1977 through 1985. After 1976 the fraction of adults in the 6-year and older age class was less than would be expected from a proportional decrease in the total population.

The 38 mm index data and the adult estimates indicate that a fundamental environmental change may have occurred in the estuary during and after (though not necessarily because of) the drought. High flow years occurring after the drought failed to produce the expected numbers of juvenile bass. The fact that adult numbers decreased the same year as the juveniles (not lagged by several years as would be expected) indicates that conditions during the drought may have been stressful to all life stages. Post-drought conditions appeared to be more favorable to adult survival than for young bass in that the adult population has remained relatively stable, whereas the juvenile population reached historical low levels.

The Department of Fish and Game examined mortality of adult bass during the 1969 through 1985 period and concluded that although total adult mortality had increased, the increase could not be ascribed solely to fishing or natural mortality. In this case, natural mortality consists of everything other than legal fishing causing an adult bass to die, including poaching, toxicity, disease, spawning stress, migration from the system, and old age.

As pointed out in DWR-605, San Francisco Bay striped bass populations are not the only ones that have been depressed in recent years. A spawning population in Coos Bay, Oregon has apparently not spawned successfully in several years, and on the East Coast there has not been a strong year in the dominant Chesapeake Bay stocks since 1972. The exception to the generally low levels of striped bass is the Hudson River fishery, which is doing well in spite of high body burdens of the potentially toxic PCB. It is not known if there are common factors causing low stock sizes in the various populations.

B. <u>Possible Causes of the Decline</u>

DFG-25 contains examinations of the possible causes of the decline in adult striped bass abundance in the Sacramento-San Joaquin estuary. Following is a summary of these results, supplemented with information from other testimony.

1. <u>Adult Mortality</u>

As pointed out earlier, total adult mortality appears to have increased since 1969, but there was no trend in the two components of total mortality -- fishing and natural. The evidence on growth rate of adult stripers before and after the drought did not show a trend; thus, it did not appear that there had been a change in food supply that would limit growth and survival. This conclusion should be qualified by the observation that there were significantly fewer adult bass in the post-drought period, so that, theoretically, the population could maintain itself on a much smaller food base.

The potential effects of toxics on survival of adult bass were presented in DFG-25, with the general conclusion that not enough information was available to determine if toxics were having an impact. In DFG-45, however, concern was expressed that pollutant loading to the Bay may be part of the cause for the striped bass decline. In DWR-605, reference was made to studies by the National Marine Fisheries Service and the Cooperative Striped Bass studies, which showed that in many ways San Francisco Bay adult bass, particularly females, were apparently in worse shape than adults from other systems, including Coos Bay (Oregon), Lake Mead, and the East Coast. Pollutant body burden, egg resorption, and parasite infestation (and reactions to infestation) were used to characterize their relative condition.

2. <u>Juveniles</u>

Much of the effort to determine causes of the decline was devoted to analysis of factors causing the low abundance of juvenile striped bass (the 38 mm index). The reason for this effort was the observed statistically significant positive relationship between the abundance of striped bass at 38 mm and an index of abundance (catch per unit effort of 4-year-old bass) of adults. There was also a positive, and statistically significant, relationship between an index of abundance at 8 mm and abundance at 38 mm.

There have been four general hypotheses advanced to explain the relatively low numbers of young striped bass observed after the drought: decreased food supply, toxics, insufficient eggs, and entrainment. Each of these hypotheses is discussed below.

a. Decreased Food Supply

As shown in USBR-111, there has been a general decrease in chlorophyll *a* concentrations in the Delta-Suisun Bay area since the drought. In the Delta, recent blooms have consisted of *Melosira granulata*, a long chain diatom. *Melosira* has probably always been in the Delta, but only recently has it consistently dominated blooms. There is considerable, but undocumented, concern that *Melosira* may not be readily used as a food supply for zooplankton because of its large size (DFG-28).

DFG-28 shows that there is a general and positive statistical relationship between zooplankton abundance and chlorophyll *a* concentration. Because chlorophyll has declined since the drought, one would expect to see declines in zooplankton abundance. Such a decline took place with almost all native zooplankton, including the opossum shrimp (*Neomysis* mercedis), showing lower abundance after the drought. The only exceptions were zooplankton of the marine genus Acartia, which occurs in Suisun Bay during periods of low flow. Some introduced zooplankton, especially Sinocalanus, may have displaced native species such as Diaptomus and Eurytemora. The abundance of Eurytemora, a native calanoid copepod, has been linked to post-larval striped bass abundance during 1984, 1985, and 1986 (DFG-25), but it is not clear that its abundance actually limits striped bass abundance. Neomysis, an important food for juvenile striped bass, has been about half as abundant since the drought, with only 1980 and 1982 being years of high abundance.

DFG-25 contained a brief evaluation of the possible impact of competition for food by the young of other species (such as yellowfin gobies and inland silversides) on striped bass abundance. The data did not appear to support competition as a valid explanation for the observed striped bass decline.

The "sewage hypothesis" is another food-related issue that has been suggested as an explanation for low striped bass populations since the drought (SWC-203). This hypothesis is that changes in sewage treatment imposed by EPA in the mid-1970s reduced the amount of organic materials reaching striped bass nursery areas and may have adversely affected their food supply. Changes from primary to secondary treatment substantially lowered particulate organic matter -- organic matter that may have been important as a detrital food supply for some zooplankton. There is some evidence for such an effect in the San Joaquin River below Stockton (USBR-111 and DFG-28) where phytoplankton and the exhibit did contain data to support the following conclusions:

(1) The magnitude of loading of potential toxics to the estuary and lower rivers is great enough to warrant concern (see also AHI-302).

(2) There has been considerable work on rice field herbicides (Ordram and Bolero, in particular), which indicates that they should not cause direct mortality to young bass in either the lower Sacramento River or the Bay-Delta, but could be harmful to Neomysis, cladocerons, or other food organisms in the lower Sacramento River and upper Delta (DFG-65).

(3) Some trace elements, chlorinated hydrocarbons, and cyclic aromatic hydrocarbons were found at elevated levels in striped bass, as compared to other areas of the Nation, but their presence could not clearly be shown to have caused detrimental impacts.

(4) The most likely adverse impact of toxics on striped bass young was through the female, which would result in decreased effective fecundity and the production of gametes and zygotes with reduced viability.

(5) On the East Coast, a much more intensive study of the effects of toxics has thus far not clearly

defined their role in the decline of striped bass in Chesapeake Bay populations.

c. Reduced Egg Supply

The population of adult stripers has clearly declined over the last 10 years, with the decline in the older bass (6+ years) even more dramatic (SWRCB-500). Such a reduction is accompanied by a reduction in the number of eggs available for fertilization. The reduction is greater than total number of adults alone indicates, because fecundity of older females is much higher than that of 4- and 5-year-olds.

Reduction in fecundity and in subsequent egg deposition has certainly occurred. There is doubt, however, as to whether the reduced egg supply is keeping the population from rebounding. Although the evidence is not unequivocal, it seems unlikely that egg supply is limiting. Information supporting this conclusion is:

(1) A strong year class was produced in 1986 without any apparent changes in the adult population. Thus, it appears that the present egg supply is adequate when conditions (as yet undefined) are right.

(2) The Bay-Delta striped bass population resulted from a plant of only a few hundred fish.

(3) Striped bass have evolved with a reproductive strategy calling for releases of large numbers of eggs and requiring relatively poor survival to maintain a constant population size. Thus, even the present

comparatively small population releases billions of eggs during spawning. Although in many species with such reproductive strategies density-dependent mortality often comes into play to stabilize the numbers of older juveniles and adults resulting from variable spawning successes, such mechanisms have not been shown to be present in Bay-Delta populations.

d. Entrainment

Striped bass eggs, larvae, and juveniles are entrained into various diversions throughout the lower rivers, Delta, and Suisun Bay. These diversions include the State and Federal pumps in the southern Delta, about 2000 small agricultural diversions throughout the Delta, and PG&E powerplants at Antioch and Pittsburg. Collectively the diversions annually entrain hundreds of millions of striped bass (DFG-25). (Entrainment losses have been estimated for the State pumps and PG&E powerplants. Less reliable information is available for the Federal pumps, and there are few data for entrainment in local Delta agricultural diversions).

The impact of entrainment losses on older juvenile and adult striped bass is difficult to assess. Since there was no dramatic increase in Delta diversions between 1976 and 1978, the period when the decline in both adults and 38 mm bass apparently occurred, it appears unlikely that entrainment is directly responsible for the decline. DFG-25 contains an analysis using entrainment and egg and larval abundance data to estimate the impact of entrainment on year class strength as measured by the

38 mm index. There are some technical questions associated with these analyses, mainly dealing with the use of abundance index data as if they were actual abundances, but there are a couple of interesting results. First, the percentage of total instantaneous larval mortality due to entrainment at the State and Federal pumps is apparently low, usually on the order of a few percent. Second, total mortality between size intervals -- 6 to 7 mm, for example -- is quite high, often exceeding 80 percent. The cumulative impact of entrainment losses of eggs and larvae to the pumping plants will act to reduce the striped bass index if no density-dependent survival is assumed. However, the index would still be much lower than predicted, even if there had been no entrainment. Thus, something other than entrainment is acting to hold down striped bass populations.

There are some conflicts within the evidence offered by DFG regarding entrainment, especially at the State pumps, which need to be resolved before its effects can be readily assessed. In DFG-25, the results of calculations and mathematical modeling lead to the conclusion that the losses of larval bass due to entrainment are particularly important when projecting subsequent numbers of striped bass caught by anglers. The entrainment of young bass larger than 20 mm has substantially smaller impacts. On the other hand, in DWR-609 (a report prepared by DFG on 1985 and 1986 entrainment losses at the State pumping plant), losses of all size classes have been converted to yearling equivalent losses. Using these procedures, the losses of bass less than 20 mm appear to be relatively minor in terms of total equivalent losses. The apparent contradiction is probably due to the poor quality of data used to make practically all of the calculations, plus the many assumptions required to calculate survival in those cases where there are no data.

Although entrainment is not likely to be the cause of the striped bass decline, the numbers of fish entrained are large enough to warrant concern. The Department of Water Resources and PG&E have signed agreements with DFG aimed at reducing entrainment and mitigating for unavoidable losses (see discussion of 2-Agency Fish Agreement in Section 6). In the case of DWR, the losses are actually more than entrainment, and include all losses after the bass enter Clifton Court Forebay. Mitigation measures now being implemented include releases of hatchery-reared fish and construction of grow-out facilities to rear striped bass salvaged at the John E. Skinner Delta Fish Protective Facility, and screening diversions in Suisun Marsh.

There was another issue raised in the hearings that involves entrainment, although not in the classic technical sense of the word. Eggs, larvae, and small juvenile bass are pulled (entrained) into the interior Delta and lower San Joaquin River by way of the Delta Cross Channel and Georgiana Slough and by reverse flows in the San Joaquin River. The movement of these juvenile stages into the central Delta is cause for concern because data in DFG-25 indicates that there apparently has been poor survival in this area during recent years. During testimony by DFG and others, there was considerable discussion of methods of keeping the young bass out of the central Delta. These methods included closing the cross channel when pulses of eggs and larvae were coming down the Sacramento, reducing the frequency and duration of flow reversals in the San Joaquin River, and flow pulses to move the organisms into Suisun Bay.

After analyzing the four hypotheses proposed to explain the striped bass decline, it does not appear that any one of them provides the complete explanation. Figures 8 and 13 from DFG-25 provide some support for the food theory, or some other fundamental change in the estuary, by showing that the numbers of 38 mm striped bass calculated to result from a given outflow has been significantly decreased after the drought. From Figure 13, the post-drought flow-index equation, it is apparent that outflow alone is not effective for increasing the striped bass index. It is likely that a combination of factors, both cultural and natural, has acted to reduce the ability of striped bass to survive in this and other estuaries. It is not clear that we know enough about, or can even control, the factors that might improve survival to pre-1977 levels.

II

RECOMMENDATIONS FOR OBJECTIVES

DWR's basic recommendation is to retain the striped bass protective measures and standards provided in Decision 1485 as appropriate objectives. Without agreement among technical experts as to the cause of the decline nor as to measures that can reasonably be expected to restore the population, new objectives are not warranted. DWR does support continued studies of factors controlling the abundance of striped bass and specifically the design and execution of tests that will help in the development of practical measures to provide protection for the species. The flexibility to perform these tests without formal Board action needs to be added to the objectives.

The Department of Fish and Game and other fishery agencies have advocated a goal of a 38 mm abundance index of 106. This goal is based on the 1959-1976 flow-striped bass relationship (Figure 8, DFG-25) and 1922-1967 pre-SWP flows. While using the 1959-1976 flow-SBI relationship to develop a desired level of abundance, DFG has also recommended as an interim measure a flow objective that would yield an index of abundance predicted by a 1976-1986 (post-drought) flow correlation. The procedure used by DFG in making this correlation is a simple linear regression on the data points depicted in Figure 13, p. 38 of DFG Exhibit 25. As with all statistical analyses of this type, the procedure provides a "best estimate" of the actual underlying relationship. Because of the paucity of these data points and their "scatter", a careful confidence interval examination is critical before decisions using the estimated relationship are made.

At a confidence level of 95 percent, the range of possible "true" relationships or "best estimates" which could have produced the same depicted data points includes, for example, a line relating an abundance index of about 26 to an outflow of 40,000 cfs. The relation used by DFG would show an abundance of approximately 43 for this outflow. <u>If the 1982 data point is not included in the analysis (it is far beyond the range</u>

of flows in the DFG recommendation), then it becomes possible that the "true" relationship could be that abundance is inversely related to outflow, that more flow would yield lower survival. The DFG "correlation" (or, actually, absence of correlation) cannot reasonably support the proposed objective.

Even if the flow-SBI were assumed to be accurate, the interim objective proposed by DFG would require unreasonable amounts of water. DFG estimated that their proposal would only increase the average SBI from 22 to 28 (far short of the 106 goal) at a cost of 650,000 AF per year (DFG-64, p. 10). Put in perspective, this amount of water is slightly more than DWR hopes to gain in yield from all of the new SWP facilities and measures planned for the next two decades, including four additional pumps at the Delta Pumping Plant, Delta Transfer Facilities, Los Banos Grandes Reservoir, Kern Water Bank, and 250,000 AF of CVP interim water (DWR-703b-c).

DFG's recommended goal of a 106 SBI was based on a desire to restore striped bass to an "historical level". "Historical levels" is an objective which should be approached with caution, and the following questions should be asked: Which historical period, and why? What is the biological significance of that period? Are there any actual historical measurements? If the eco-system has been greatly modified by land use changes, development, urbanization, deforestation, reclamation, levee building and channelization, the introduction of new species, etc., what is the soundness of reverting one ecological parameter (flow) and not the rest? How are the natural changes (climate, etc.) which have occurred since the "historical period" to be considered? DFG-30 describes how the 1922-1967 period ("historical level") was selected. Apart from yielding a higher average SBI than under more recent May-July flows (assuming of course the validity of using and extrapolating from the 1959-1967 flow-bass relationship, which has, in fact, fallen apart), the "historical level" has no apparent intrinsic significance in terms of the needs or demands of striped bass as a beneficial use. It appears to mean, simply, "increased abundance". While DWR has no argument with the concept of an increased abundance goal for a fishery agency, it does not seem reasonable as a basis for fishery protection objectives when there is no practicable or ostensible means of achieving the goal.

III

IMPLEMENTATION

A. Standard Format

DWR recommends that the striped bass flow standards in Decision 1485 be converted to sliding scales based on an April-July Four Basin Index, as described previously for Delta agriculture standards. Care must be exercised in this conversion to avoid changing the existing balance.

B. Enforcement

The flow standards should be maintained by upstream, local and export users who deplete Delta outflow. The Antioch water quality station is a controlling point for ocean salinity intrusion and should be maintained by freshwater flows assured by upstream, local, and export users. Any degradation at the

Prisoner's Point water quality station would be caused by land-derived salts and should be controlled by local and upstream dischargers.

C. Relaxation of Pumping Curtailment

The Decision 1485 standards include curtailment of export pumping (regardless of hydrology) during May-July when striped bass eggs and larvae are abundant to reduce entrainment. Since the standards also allow for closing the Delta Cross Channel to reduce entrainment from the upper Sacramento River, the pumping curtailment is primarily to reduce entrainment from the western Delta and lower San Joaquin River nursery area caused by reverse flows in the lower San Joaquin. Consequently, DWR recommends that the standards be modified to eliminate the pumping curtailment when net flows in the lower San Joaquin River at Antioch are positive.

D. Other Measures

DWR will be pursuing the implementation of physical measures in the Delta to lessen any adverse impacts caused by moving Sacramento River water to project pumps. One of the primary goals of the current planning effort described in DWR-710 is the reduction or elimination of reverse flows in the lower San Joaquin.

SECTION 6

CHINOOK SALMON

I

BENEFICIAL USES

The major evidence on chinook salmon as a beneficial use of Bay-Delta waters was given in the report of the Interagency Ecological Study Group (USFWS-31), in agency testimony on the report, and in the supplemental reports and testimony of Donald Kelly (DWR-56). The value of chinook salmon as a beneficial use of Bay-Delta waters has three aspects: its value as a commercial (ocean) fishery; as a sport (ocean and inland) fishery; and as natural spawning populations. Having noted the stability in commercial catch and escapement over the past 30 years (the first and a large part of the second aspects of value), the Department witnesses testified that in-Delta survival is one of several factors in the basin that contribute to the sustenance of natural spawners, the third aspect of beneficial use. The dimension and significance of this factor, however, was the subject of much testimony and few conclusions.

A. Status of the Stocks

The information on salmon stocks came from USFWS-29, DFG-15, and DWR-561. Chinook salmon are native to California's Central Valley, which is at the southern end of their range on the west coast of North America. There are four races of this species in California -- fall, late fall, winter, and spring. The races are distinguished by the time of year adults move upstream from the ocean to spawn in the Sacramento and San

Joaquin Rivers and their tributaries. Whereas the Sacramento system at one time probably supported all four races, the San Joaquin probably had major runs of only the fall and spring races.

Numerically the fall race is now dominant in both the Sacramento and San Joaquin rivers and supports the majority of the recreational and commercial fisheries relying on Central Valley chinook salmon stocks. The late fall and spring runs have decreased to low, but fairly stable, levels of a few thousand adult spawners. The winter run, which showed a dramatic increase after Shasta Dam was built, has declined during recent years and may be danger of disappearing. The National Marine Fisheries Service has been instrumental in developing a 10-point program to prevent the disappearance of the winter run.

Although the factors controlling the abundance of salmon stocks vary with the races and river system, a few general observations can be made. First, there has been a loss of upstream spawning and rearing habitat. This loss has occurred because of mining, logging and agricultural and urban activities in the watershed; blockage of upstream areas by dams; and water quality degradation due to waste discharges and thermal inputs. The San Joaquin system, in particular, also suffers from low flows in the mainstream and tributaries that restrict its suitability as salmon habitat. In the Delta, local diversions and export pumps tend to entrain young salmon. The export pumps have changed flow patterns in the Delta by bringing more Sacramento River water to the interior Delta and the San Joaquin

River. The new flow patterns complicate both upstream and downstream migration. Finally, there is an intense commercial and recreational fishery in the ocean, which harvests between 70 and 80 percent of the adult salmon that were destined to spawn in Central Valley streams (DWR-570).

Habitat degradation and the ocean fishery have severely changed the Central Valley spawning runs. Instead of four races that supported genetically distinct populations, there has been a shift to a reliance on the fall run to provide for a fishery and spawning escapement. Unfortunately, many of the factors that resulted in the decline of the other races, the spring run in particular, are such that it is unlikely that the runs could recover. For example, Shasta, Oroville, and Friant dams blocked the upstream access to spawning grounds necessary to maintain the spring run (although a small run persists in the Sacramento River). The ocean fishery, and perhaps hatchery practices, have acted to restrict the age composition of spawners to mostly between 2 and 4 years of age (mostly 3-year-olds) instead of the 2- to 6-year-old spawners found in the 1940s.

That the ocean catch has remained relatively stable since the late 1950s (Fig. 111-3, DWR-561), in spite of major changes in riverine habitat quality and a reliance on fall run fish, can be attributed to an increasing contribution by hatcheries. During recent years, hatcheries on the Feather and American Rivers have contributed about half of the ocean catch. Other hatchery operations, such as Coleman on the upper Sacramento and facilities on the Merced and Mokelumne rivers, have been less effective. Hatchery operations have contributed significantly to catch and escapement, and strays from the hatcheries have helped provide instream spawners to tributaries other than the ones on which the hatcheries are located. From a salmon management perspective, hatchery stocks can sustain a higher fishing pressure than can naturally spawning stocks. This is due to much lower early mortality in hatchery-reared juveniles when compared to those found in stream-reared fish. Since natural and hatchery stocks occur together in the ocean, commercial and sports fishing regulations on mixed stocks tend to result in natural stocks being over-harvested. In the Central Valley, hatcheries and habitat changes have acted to reduce the genetic diversity; thus even the four existing races have lost much of their genetic distinctiveness (USFWS-29).

In summary, the relatively stable adult spawning populations over the past 30 years, especially in the Sacramento system, and stable ocean catch is probably due largely to hatchery production of fall run salmon. Recent relatively large runs to San Joaquin tributaries do indicate that, when conditions are right, these tributaries can make significant contributions to the fishery and escapement.

B. The Sacramento-San Joaquin Delta and Chinook Salmon

Salmon pass through the Bay/Delta system as adults on spawning runs to the rivers and as juveniles moving downstream to the ocean. Some juveniles (fry) also rear in the Delta until late spring, when they undergo a physiological transformation (smolting) which prepares them for the ocean stage of their life cycle. The following is a summary of the importance of the Bay and Delta to survival of the three life stages (fry, smolts, and adults). This information is taken mainly from USFWS-31.

1. Fry

Salmon fry are found in the Delta, Suisun Bay, Montezuma Slough, and other downstream locations during wet years. Increased downstream abundance is related to freshets occurring during the winter and may be the result of physical displacement of the recently emerged fish by flow pulses. Based on our analysis of survival rates developed from releases of marked fish (data in USFWS-31), it does not appear that fry make significant contributions to the adult populations. Large numbers of fry only appear during the winter months of wet years, periods when flows are largely unregulated. In addition, there are relatively few data to help determine conditions necessary to maximize the suitability of downstream habitat for fry rearing.

2. Smolts

For purposes of this summary, the transformation to smolts is assumed to have occurred upstream, and the young fish are moving through the Delta and Bay to the ocean. During this migration the smolts undergo considerable mortality due to predation, disease, toxics, entrainment in diversions, adverse water quality conditions and perhaps lack of food. The U.S. Fish and Wildlife Service, as part of the Interagency Ecological Studies Program, has attempted to measure this mortality in lower portions of the Sacramento and San Joaquin Rivers through the Delta to Rio Vista and through the Bay to the Golden Gate. The studies were done by marking hatchery-reared fall run smolts and releasing them at various locations in the San Joaquin and Sacramento Rivers, the Delta, and Suisun Bay. Some of the tagged fish were subsequently recovered by netting at Chipps Island (downstream of the Delta) or at the Golden Gate, or as adults in the ocean catch. Survival rates were developed by comparing recovery rates of fish released at various locations. For example, fewer fish recovered from a Sacramento release than from a lower Delta release would indicate a source of in-Delta mortality.

USFWS-31 developed a relationship between April-May-June Rio Vista flows and smolt survival through the Delta based on ocean catch. The regression equation for this relationship was smolt survival = (0.000056) average April-May-June Rio Vista flow (cfs) - 0.258. This equation indicates that no smolts survive at flows of 4,600 cfs or less and that survival is 100 percent at flows exceeding 22,000 cfs. The equation was used as a basis of recommended levels of protection by the fisheries agencies (USFWS, DFG, NMFS), by taking the average flow of a selected "historical" period and applying it to the smolt survival equation. The agencies did differ in the period on which the recommended survival levels were based. USFWS (and NMFS) selected the "1940 level of development" hydrologic scenario from DWR-28 through 30, and took the average April-May-June flow over the 1922-1978 hydrological period. DFG took the average actual historical April-May-June flow from the 1922-1967 period. Both agencies called the associated survival rates the "historical" survival through the Delta.

In studies leading to USFWS-31, an attempt was made to determine the underlying causes of the flow-survival relationship. Flows and temperatures were directly related, with observed temperatures often in the range that would be detrimental to smolt survival either by direct lethal effects or indirectly by increasing metabolism and the accompanying need for additional food. Two factors may have made the temperature effects of particular importance in the flow-survival relationship. First, most of the fish releases used to develop the relationship were made in late May through early June (to represent the whole April-May-June migration period) -- a time when temperatures are highest and adverse temperature effects would be most likely. Second, DWR-562 shows there has been an apparent (and unexplained) 2-3°C increase in temperature in the Sacramento River at any given flow. The combination of relatively late smolt releases and higher than normal temperatures may have made temperature an important variable in causing the observed relationship. Since flow and temperature are directly related, it is statistically impossible to determine which is the controlling variable; that is, the previous equation would explain about the same amount of variability in smolt survival if April-May-June water temperatures at Rio Vista were used instead of flows.

The other major factor thought to be important in the flow-survival relationship is entrainment of smolts into the interior Delta through the Delta Cross Channel and Georgiana Slough. A comparison of estimated survival of smolts released in the Sacramento River above and below the Cross Channel demonstrated significantly higher survival in the below-Cross-Channel releases. A possible explanation for these results is that fish leaving the main channel may take longer to get out of the Delta, thus increasing their exposure to predators, Delta agricultural diversions, and poor water quality and higher temperature in the lower San Joaquin River. An important point about these results is that it may be possible to achieve higher through-Delta survival by physical measures (closing the gates or temporary screens at the Cross Channel, for example) that keep the smolts in the Sacramento River. Flows through the Cross Channel and Georgiana Slough are mainly a function of the balance between flows in the Sacramento and Mokelumne Rivers; thus, curtailment of pumping in the southern Delta would have essentially no effect on entrainment of salmon smolts through the Cross Channel (DWR-50, DWR-51C, DWR-51D).

Although the salmon-flow relationship is statistically significant and is the best information currently available in this area, there are some technical concerns that limit its usefulness as a basis for Delta objectives or standards. Among these concerns are:

a. The data were developed by measuring the relative survival of hatchery fish planted mostly in late May and early June at various locations in the lower rivers and the Bay/Delta system. It is not certain if results using hatchery fish accurately reflect what happens to wild fish. It is unlikely that survival of wild fish passing through the Delta is zero at flows less than 4,600 cfs and 100 percent at flows greater than 22,000 cfs. This concern is heightened by the data in Figure 3-6 (USFWS-31) relating catch of smolts at Chipps Island with April-May-June Rio Vista flows. The data show no relationship between smolt catch and flow when flows are in the range of about 5,000 and 20,000 cfs. (The inclusion of data for 1982 and 1983, extremely high flow years, does result in a statistically significant relationship.) Based on the equation, one would have expected fewer smolts to be captured at the lower flows.

b. There is no reasonable certainty that improving through-Delta survival will result in increased spawning populations. DWR-572 is an analysis of the relationship between Delta survival (as calculated using the equation in USFWS-31) and spawning escapement in the upper Sacramento River lagged by 2-1/2 years. (The upper Sacramento River was chosen because relatively good escapement information is available and essentially all of its downstream migrants pass through the Delta to the ocean.) As was shown, there was no relationship between flows during downstream migration and subsequent return of adult salmon 2-1/2 years later.

c. The apparent precision of the regression equation may cause an unrealistically high expectation that its use as a basis for survival standards will result in dramatic changes in adult stocks. The situation is somewhat analogous to the Decision 1485 hearings, in which a similar striped bass/flow relationship was adopted to provide protection for the striped bass fishery. A major assumption in the use of such relationships developed over relatively short time intervals is that average environmental conditions before and after the test period would be so similar that the same relationship holds for all periods. As it turned out, such an assumption certainly was not valid for striped bass, and it is unlikely that it is true for salmon. In reality, actual historical smolt survival through the Delta is not known, nor, given continuous natural and human-induced changes in the system, can we predict what it will be in the future. The apparent change in the temperature-flow relationships in the Sacramento River, even in the lower river areas where reservoir releases do not directly influence temperatures, is an indication that basic environmental conditions are changing.

The smolt survival data were developed for fall run chinook salmon on the Sacramento River system. Similar data are not available for late fall, winter, and spring runs. In fact, there are relatively few good data that show the exact period when young from these runs migrate downstream. On the San Joaquin side, there is now only a fall run, and the data on smolt survival are not adequate to establish a flow-survival relationship. Analysis of mark-recapture data does indicate that diversion of downstream migrants into Old River at its head can be the cause of significant mortality. It does appear, however, that once the smolts pass the head of Old River, survival can be good to Chipps Island in spite of low flows and high temperatures. Although much more information is needed to define the flow requirements of chinook salmon on the lower San Joaquin River, it is likely that some sort of physical or hydraulic barrier at the head of Old River during the period of downstream migration could significantly improve smolt survival, especially in combination with pulses of water from the tributaries.

3. Adults

As summarized in USFWS-31 (pp. 93-95), there has been no recent work since the late 1960s to quantify the needs of upstream migrating adult chinook salmon and even the earlier work was only with fall run fish. It appears that although positive downstream flows prevent excessive delays in the Delta, adult salmon have continued to find their ways to home streams under present hydrologic conditions. On the San Joaquin River, dissolved oxygen concentrations less than 5 mg/l can block upstream migration in the fall. In the past, DWR has placed temporary barriers to increase flows past the problem area near Stockton. It appears that improved sewage treatment at Stockton and water quality releases from New Melones have decreased the need for the barriers. DFG can still request DWR to construct a barrier should dissolved oxygen problems reoccur.

C. Four Pumps Fish Mitigation Agreement

The Departments of Water Resources and Fish and Game provided testimony on an agreement designed to provide mitigation for direct losses of chinook salmon, striped bass, and steelhead trout at the intake to the California Aqueduct (also called the "2-Agency Fish Agreement", submitted as DWR-560). The testimony emphasized that the agreement was the result of a long series of discussions among the two agencies and representatives of the State Water Contractors and fish and environmental organizations. The agreement provides a means of funding various measures that should result in increased abundance of the three species. Although hatchery production is an alternative included for consideration, the agreement specifies that selection of measures that improve the survival of in-river spawners and their progeny are preferred. Personnel from the two departments are now working on a list of salmon mitigation projects to be submitted through an advisory committee to the Directors of Fish and Game and Water Resources for funding. These projects can include measures in the upper watersheds of the Sacramento and San Joaquin Rivers, as well as the lower reaches and the Delta. Projects resulting in protection to any of the four races are being considered. The agencies expect to initiate the first projects in 1988.

II

RECOMMENDATION FOR OBJECTIVES/IMPLEMENTATION

The Department of Water Resources joined with the Department of Fish and Game, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the U.S. Bureau of Reclamation in a proposal to defer setting specific flow and salinity objectives for chinook salmon until Phase III of these hearings. As described in DFG-65, staff from these five agencies, along with other interested individuals, will evaluate measures, projects, and standards that should result in increased protection to chinook salmon resources. Such a deferral in setting objectives is needed because of the complex nature of the task of analyzing the relative effectiveness and costs of a variety of measures that could result in achieving the overall goal of increased in-river spawning populations -- measures both in and above the Delta. Analysis of ocean fishery impacts will be included in this effort, possibly through the use of mathematical models to determine what impact the fishery has on the ability of any action to increase spawning stocks.

Earlier, at the hearing on salmon, DWR recommended that appropriate objectives for salmon should be based on maintaining the current stable population of adult salmon and escapement, and increasing, where feasible, the natural spawning population. As of today, flow objectives exceeding the D-1485 standards for salmon or striped bass (the latter of which serves as a salmon protective standard) would be unreasonable. As previously noted, DFG and USFWS recommended goals or objectives for increasing the rate of salmon smolt survival through the Delta to "historical levels", based on the statistical correlation in USFWS-31 (whose weaknesses and bias are discussed above). The discussion in Section 5 on the questionable significance of "historical levels" for striped bass is perhaps even more pertinent here, where DFG and USFWS have selected different historical periods. In addition, using only flow to meet the salmon survival goals proposed by DFG and USFWS (DFG-64, USFWS-47) would require excessive amounts of water. The proposal could require in excess of 1,000,000 AF per year over and above that available under current operations (DWR-567, Huntley, Vol. XXXVII, pp. 186-188). Finally, and most importantly, there has been little or no consideration during Phase I of the effectiveness of non-flow or non-Delta measures to improve the salmon resource, which would serve as alternatives to the dedication of greater spring flows to Delta outflow. USFWS-47 listed several such measures, which included screening agricultural diversions, decreasing water temperatures through agricultural drainage controls, and preserving or increasing streamside vegetation; and which could have included investigations to improve smolt "imprinting" by means such as mid-migration capture (at fish screens) and release past the Delta. Just as beneficial uses in the export areas have a burden of showing the consideration of reasonable alternatives to "more diversions" (conservation, transfers, reclamation, etc.), so must alternatives to "more flow" be considered.

The five-agency study may well serve to illuminate what objective is or is not reasonably capable of implementation, or whether the setting of a flow standard in lieu of non-flow alternatives is reasonable or unreasonable. DWR agrees to defer the establishment of objectives. But if the Board believes it must set an objective now, it should adopt the flow standards in D-1485 (salmon and bass) as reasonable flow objectives[1]. The results of the five agency study would be useful then for the adoption of means of implementation of the non-flow objective to increase, where feasible, natural spawning.

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1. The January-March Delta Cross Channel closure standard in D-1485 seems unwarranted with the USFWS data on fry survival. In a high flow year, the Cross Channel is closed for scour reasons, and during low flow years the fry are not moved to the Delta. However, the closure of the Delta Cross Channel during certain years does increase the amount of ocean water (and, hence, bromides) in the drinking water of Delta water users thus increasing brominated THMs.

SECTION 7

RESIDENT FISH AND OTHER MIGRATING FISH (AMERICAN SHAD)

The Department of Fish and Game testified before the Board regarding the results of their studies to determine if flow and salinity standards are needed to protect resident fish and American shad. The U.S. Fish and Wildlife Service also presented testimony relating to two fish species that are found in the Delta during all or portions of their life cycles, namely, the Delta smelt and the Sacramento Splittail. In the following brief summary of this testimony, Delta smelt and Sacramento splittail are included with the resident fish.

I

RESIDENT FISH

In DFG-24, the California Department of Fish and Game described the results of a 3-year study of resident fish populations in the Sacramento-San Joaquin Delta. Forty-two species of fish were collected by electrofishing surveys from May 1980 to April 1983. The most common fish collected were from the bass and sunfish, minnow, and catfish families. Although the results indicated that there were some consistent species groups that were characteristic of Delta regions with specific habitat and water quality variables, the data did not support the need for flow or salinity objectives or standards.

As summarized in USFWS-35, the U.S. Fish and Wildlife Service presented information to show that populations of Delta smelt and Sacramento splittail are currently experiencing population declines. Although the USFWS did not propose any specific flow or salinity objectives for these two fish, it is examining the available data to determine whether either of these species qualifies for addition to the List of Endangered and Threatened Wildlife.

II

AMERICAN SHAD

DFG-23 is a summary of the American shad in the Sacramento-San Joaquin River system. The American shad was introduced to the Bay/Delta in the late 1800s and has been the object of commercial and recreational fisheries. At this time there is only a recreational fishery with a 25 fish per day bag limit. Most shad fishermen apparently release the fish after capture, probably because the flesh contains numerous small bones.

The American shad life cycle is somewhat similar to that of striped bass in that mature adults spawn in lower reaches of rivers tributary to the Delta and the Delta itself. The young shad spend considerable time in the Delta nursery area. Unlike striped bass juveniles, however, young shad migrate to the open ocean where they remain until returning to spawn. Little is known of the shad's marine residence in the Pacific Ocean.

The Department of Fish and Game has conducted some studies to determine the status of American shad stocks and to investigate factors controlling their abundance. As stated in DFG-23, there are indications that adult stocks are depressed from those that were present in the early 1900s.

There has been relatively little data collected which can be used to assess the environmental requirements of American shad or even to determine population trends. Although there is a positive correlation between Delta inflow and juvenile abundance (Figure 3, DFG-23), it is not clear if the relation is due to flows in the Delta or in the upstream spawning and nursery area.

III

RECOMMENDATIONS

DWR recommends that flow and salinity objectives for resident fish and American shad not be established at this time. There are no data showing that flow or salinity in the Delta is resulting in impairment of beneficial uses. Existing striped bass standards will provide any necessary protection for these fish.

SECTION 8

WILDLIFE USES

I

BENEFICIAL USES

A. Bay-Delta Wildlife

In addition to the significant wildlife habitat in the Suisun Marsh, discussed below, the Bay and Delta support a range of wildlife plant and animal species. The Delta area provides habitat to several species of birds, diverse mammals (especially small rodents), and several rare plant species. For the Bay (apart from the Marsh), important bird species include scoter, scaup, and canvasback duck, and several species of shorebirds. Bay-Delta wildlife and their habitat needs were identified in DFG-6 and DFG-7.

B. Suisun Marsh Wildlife

The Suisun Marsh is a unique and irreplaceable resource of the State and the Nation--recognized as such by the State Legislature and U. S. Congress. The primary wildlife benefit of the Marsh is the waterfowl habitat it provides.

In D-1485, the Board ordered the USBR and DWR to develop a plan to protect the Marsh and its waterfowl habitat. A plan was subsequently developed by DWR through an interagency committee, and the Initial Facilities were completed as required by D-1485.

To define and provide for implementation of the Suisun Marsh Plan of Protection, agreements have been negotiated among

DWR, USBR, DFG, and Suisun Resources Conservation District (SRCD). Three agreements were developed: the Preservation Agreement, Mitigation Agreement and the Monitoring Agreement. The Preservation Agreement (DWR-506b) defines the Plan of Protection for the Marsh, a schedule for its implementation, and water quality standards to be met.

The Mitigation Agreement (DWR-507b) provides for purchase and development of wetlands to replace those lost through direct construction impacts of the facilities of the Marsh Plan of Protection and due to the impacts of upstream diversions on the Channel Islands--Ryer, Rowe, Freeman, and Snag. The Monitoring Agreement (DWR-508b) defines the extent and the methodology of the comprehensive monitoring program of the Plan of Protection. The monitoring program is described in DWR-509 and shown on DWR-510.

The Preservation Agreement provides for three water quality standards: the Initial Standards, the Normal Standards and the Deficiency Standards. The details of the various standards are contained in DWR-506. The Initial and Normal Standards are very similar to the Interim and Post-1984 Standards of D-1485.

The Deficiency Standards only apply when an extended (more than one year) dry period occurs. The Deficiency Standards are virtually the same as the Normal Standards during October through December, but a relaxation is provided in January through May. When the Deficiency Standards are in effect, two-thirds of the Marsh will achieve normal production of waterfowl food, and one-third will exhibit reduced production (Vol. XXIX, p. 130). According to operation studies, the Deficiency Standards would be in effect some part of 10-14 percent of all years, and in effect for the entire year in only two years over a 57 year historical record.

The facilities of the Plan of Protection are shown and described in exhibits DWR-511, DWR-512, DWR-513, DWR-514, DWR-516 and DWR-520. A staged sequence of construction was incorporated into the Plan of Protection so that the effectiveness of facilities in meeting prescribed water quality could be assessed. The need for further facilities could then be verified and the design of those further facilities made appropriate. If all facilities are needed, it will take approximately 13 years to complete the remaining facilities, at a total estimated capital cost of $105 million. The cost is to be shared among USBR, DWR and other State funding sources on a 40-40-20 basis (DWR-507).

II

RECOMMENDED WATER QUALITY OBJECTIVES FOR WILDLIFE

A. Suisun Marsh

DWR recommends that the Board endorse the Water Quality Standards and other provisions of the Suisun Marsh Preservation Agreement for the protection of Suisun Marsh wildlife. The Preservation Agreement, and the Plan of Protection it defines, were developed through negotiations among the major water users and the representative of the wildlife values. The Agreement is endorsed by the parties as an appropriate balancing of the needs of beneficial uses of the Marsh with the limitations of available water supplies (Vol. XXIX, pp. 155 and 197; Vol. XXX, pp. 247 and 19). The Plan of Protection is endorsed by DFG as providing a reasonable and satisfactory degree of mitigation (Vol. XXIX, p. 152).

No one testified at the hearings in opposition to the agreements. Some who testified requested that the Board consider objectives for wildlife in addition to those provided by the Preservation Agreement. None of these, however, had made any attempt to consider the limitation of available water supplies or balance the benefits of their requests against the water costs.

Dr. Williams for San Francisco Bay Conservation and Development Commission (BCDC) requested that Control Station S-36, in the mouth of Suisun Slough, be reinstated. Meeting the Preservation Agreement's water quality standards at S-36 would have an incremental water cost of at least one million acre-feet of water per year (Vol. XXIX, pp. 101 and 103). Dr. Williams assessed the impact of eliminating S-36 as "4,000 acres of managed wetlands and around 1,000 acres of tidal wetlands would be lost" (Vol. XXIX, p. 259). DWR does not agree with this assessment.

The elimination of S-36 does not have any significant impact on water quality served to managed wetlands in the area. Some of these managed wetlands now have a water supply via the Morrow Island Distribution System, an overland supply constructed by DWR. Other managed wetlands in the area have supply intakes within the Marsh, remote from S-36, and are not expected to be adversely affected by the elimination of S-36.

Some of the remnant tidal wetlands in the area may become more brackish. DFG testified that the positive aspects of this, primarily as habitat for the Suisun Marsh harvest mouse (an endangered species), outweigh the negative aspects. In making this evaluation, DFG considered that extensive emergent habitat exists in Suisun Marsh, both in tidal and managed wetlands (Vol. XXIX, p. 157).

BCDC's major request to the Board was that a new objective be established to protect remnant tidal marsh. They desire to protect the emergent vegetation habitat, which consists primarily of cattails and tules. Dr. Williams, the witness for BCDC, predicted extensive conversion of brackish to salt marsh without a standard to protect the tidal areas. His prediction is unrealistic and was based on misapplication and misuse of hypothetical operation studies. Appropriate predictions were presented by DWR in testimony in the hearings on hydrologic conditions. Of the 58,000 acres of wetlands within Suisun Marsh, there are approximately 5,000 acres of tidal wetlands. Approximately 4,000 will receive the full water quality benefits provided to the managed wetlands. Only the remaining 1,000 acres will not (Vol. XXIX, pp. 133 and 134). Areas not receiving the full water quality benefits are expected to become more saline and support more salt tolerant plants. The change in the habitat is expected to be fairly subtle. The periodic aerial flights of Suisun Marsh have shown no reduction in emergent habitat on tidal wetlands from 1973 through 1981 (Vol. XXIX, p. 158). The change will have adverse impact on some species, but will benefit others, including the two endangered species in the Marsh: the salt marsh harvest mouse and the clapper rail.

The negotiators of the Preservation Agreement considered this evidence and concluded that the benefits of the change in habitat would outweigh the risk of modification. It was judged to be an acceptable impact of the Plan of Protection.

Dr. Williams testified that achieving BCDC's requested objective would require approximately 30,000 cubic feet per second for four months (Vol. XXIX, p. 236). This quantity of water is equivalent to 1.8 million acre-feet per month for the four months for a total of 7.2 million acre-feet of water (Vol. XXIX, p. 239). The question of protecting the Marsh with outflow alone was considered during the D-1485 Hearings. At that time, it was estimated that it would require an additional 2 million acre-feet per year of freshwater outflow to protect the Marsh, considerably less than what Dr. Williams estimates is needed to meet his proposed objective. During the D-1485 Hearings, the State Board considered the reasonableness of this use of water and chose to order DWR and USBR to protect the Marsh through facilities of a Plan of Protection, rather than outflow (Vol. XXX, pp. 246, 247, 197 and 198; and Water Rights Decision 1485, p. 14).

BCDC's requested objective would constitute substantial freshening compared to the quality existing in the Suisun Marsh today. This would have significant adverse impacts upon the habitat of a rare and endangered species of the Suisun Marsh--the salt marsh harvest mouse. We do not believe that it has been demonstrated that a significant beneficial use would be served by establishing the objective requested by BCDC.

As previously discussed, BCDC recommended an objective to protect Suisun Marsh tidal marshes. That objective was also intended to protect tidal marshes along the north Contra Costa shore. We do not believe their requested objective is reasonable or needed to protect the tidal marshes along the Contra Costa shore. There is no evidence the salinity increases projected by BCDC will occur, and the water cost of meeting the objective is far beyond reason.

Dr. Steven Granholm, testifying for the Bay Area Audubon Council (BAAC), discussed impacts on various wildlife species. He assumed that BCDC's salinity predictions were correct (Vol. XXX, p. 92 and 95). Dr. Bruce Pavlik, testifying for the California Nature Plant Society (CNPS), made similar assumptions (Vol. XXX, p. 142 and 143)92). Their predictions of impacts on various wildlife and plant species cannot be accurate if the underlying salinity predictions are not. DWR believes BCDC's predictions are inaccurate and unreasonable, being based on misused operation studies.

Frank Wernette of DFG testified that most of the Marsh will receive water quality similar to that now existing (Vol. XXIX, p. 137). Accordingly, no significant impacts on wildlife and plant species are projected by DFG. He also testified that the tidal wetlands as far west as Pittsburg would not receive water quality under the Suisun Marsh Preservation Agreement Standards significantly different than that they now receive (Vol. XXIX, p. 147).

Mr. Wernette also testified that from Pittsburg to Martinez the tidal wetlands may become less of an emergent brackish marsh and will tend more toward the salt tolerant species. Mr. Wernette did not regard this as a significant adverse impact. In fact, he noted that DFG owns 700 acres of the wetlands impacted, the Point Edith Wildlife Area. He testified the projected increase in salinity would fit in with DFG's desires to improve conditions on this wildlife area for the salt marsh harvest mouse (Vol. XXIX, p. 148).

While there has been significant reduction in tidal wetlands along the north Contra Costa County shore, the cause of this reduction has not been upstream diversion. Dr. Joselyn testified for BCDC that the primary cause of the reduction in tidal wetlands in this area is from diking and development (Vol. XXIX, p. 274).

B. <u>San Francisco Bay</u>

DFG provided evidence on the Bay's importance to wildlife. They do not recommend adoption of any specific objectives to protect wildlife in the Bay (DFG-7, p. 14). DWR concurs that no specific objectives are needed to protect wildlife in the Bay.

C. The Delta

DFG presented evidence that meeting the current agricultural water standards in the Delta "will essentially meet the needs for wildlife in the Delta" (DFG-6, p. 8; Vol. XXX, p. 223). Accordingly, DFG does not recommend a specific objective in the Delta to protect wildlife. DWR concurs and adds that water quality objectives that reasonably protect agricultural crop needs will also protect wildlife and wildlife habitat needs, and therefore the agricultural objectives that are adopted will be sufficient for wildlife.

SECTION 9

FRESHWATER FLOW TO THE BAY

This section discusses testimony and exhibits presented to the Board regarding salinity and flow impacts on beneficial uses of San Francisco Bay. Although San Francisco Bay is generally defined as that portion of the estuary west of the Carquinez Strait, some testimony regarding Suisun Bay was also presented. The analysis and determination of freshwater impacts on San Francisco Bay is a complicated process. It was lacking in previous water rights hearings such as those leading to Decisions 1379 and 1485 because of insufficient data. D-1485 required DWR and USBR to initiate studies to help determine the flow needs of the Bay. The resulting studies, especially those conducted by DFG as part of the Interagency Ecological Studies Program and discussed later in this section, afford a relatively short data base for the Bay inflow program, in comparison to those for striped bass and salmon, for example.

The very question of how freshwater outflow to the Bay is used beneficially or provides benefit is qualitatively different from freshwater diversions or riverine instream uses and is not easily answered. If freshwater outflow provides benefit, it must do so via complex interactions of fresh and sea water, of tides, winds, and currents. These are difficult in themselves to measure or characterize; but then their complex interaction with Bay biota must also be understood, as well as the interactions among different trophic levels of that biota.

Freshwater flowing through the Carquinez Strait causes a variety of physical, chemical, and biological effects. The following is a summary of some of the major potential interactions or effects.

I

PHYSICAL INTERACTIONS

A. General

San Francisco Bay consists of three embayments (San Pablo, Central and South Bays) which vary considerably in their physical, chemical, and biological resources. Much of this variability is due to bathymetry and the ways in which ocean water and freshwater mix to create salinity gradients and circulation patterns (USGS-3). San Pablo Bay is shallow with the major freshwater input to the entire Bay coming through the Carquinez Strait at the Bay's easterly end. South Bay, also shallow, receives much smaller freshwater inputs and during most of the year is a tidal lagoon with salinities approaching those of the coastal ocean. Central Bay receives large inputs of ocean water (approximately 2,100,000 cfs during flood tide) about one-fourth of which on a half tidal cycle is ocean water new to the Bay (DWR-660 through 662). Central Bay sometimes receives significant freshwater inputs, especially during periods of high inflow from the Sacramento and San Joaquin Rivers.

B. Salinity

Put simply, the ocean is salty and water from the San Joaquin and Sacramento Rivers contains little salt and about any intermediate level can be found in San Francisco Bay. The exact salinity level at a given location and depth varies according to inflow levels (current and antecedent), tidal amplitude, tidal exchange, tidal currents, depth, and wind speed, direction, and duration. Since outflow is, and always has been, seasonal (DWR-665), salinity variability between seasons and years is the rule. Organisms inhabiting the Bay also vary with time, from those tolerant of ocean salinities (stenohaline), to those only tolerating freshwater (oligohaline), to those estuarine organisms that have developed a tolerance to wide varying salinities (euryhaline).

C. Circulation and Mixing

Density differences between tidally driven ocean waters and gravity driven freshwater flows act to produce stratified flows and so-called gravitational circulation. USGS-3 contains a description of these processes. For purposes of this discussion the important points are:

1. Freshwater flow can create salinity conditions where the water column is stratified, i.e., the more saline bottom water is partially isolated from the fresher surface waters. This stability is enhanced during periods of weak tides and calm winds and is broken down, especially in the shallows, when tides and winds are strong.

2. The interaction of freshwater flow and more saline waters can result in outflowing currents at the surface and landward flowing currents at the bottom. These currents can serve as transport mechanisms for planktonic organisms such as larval fish that have hatched in the ocean and passively enter

the Bay via the bottom current. Organisms can also be transferred to the ocean by way of surface currents.

3. A special case of the two-layer flow phenomenon occurs in the upper estuary, most often in Suisun Bay, where the two-layer flows and the density of suspended materials act to concentrate such particles as phytoplankton cells and zooplankton. This zone has been referred to as the area of entrapment and is characterized by often having higher concentrations of suspended materials than those areas immediately upstream or downstream.

4. The evidence does not currently present a clear understanding of the effects of fresh water flow on circulation and mixing in the Bay, especially the South Bay.

D. Productivity

Freshwater flow contributes plant nutrients (nitrogen, phosphorus, and silica) to the estuary and thus may enhance productivity at the base of the food web. Other nutrient sources include waste discharge, regeneration from bottom sediments, the ocean, and direct input from the atmosphere from precipitation or particulates.

E. Sediment

Most of the new sediment reaching an estuary comes from inflowing streams. Sediment is important in that it contributes to turbidity in the water column (and thus affects plant growth), adsorbs such possible pollutants as trace elements and organic pesticides, and contributes to shoaling in depositional areas.

Adsorbed pollutants (as well as dissolved) from upstream areas also can contribute to toxic loading to the bay.

II

BIOLOGICAL IMPACTS

As can be seen, freshwater flow affects San Francisco Bay in a variety of ways. From DWR-665 it can be concluded that variability in flows is the norm. The issue then becomes one of determining if evidence regarding the present, past, or future changes in freshwater flow due to water development result in conditions that will have adverse impact on beneficial uses. The evidence pertaining to the use of the Bay as fish and wildlife habitat (including that pertaining to lower trophic levels) is the focus of the following discussion. The assumption is that protection of fish and wildlife habitat will result in protection of other uses. (In fact most of the testimony presented dealt with direct or indirect fish and wildlife impacts of freshwater flow.)

A. Primary (Plant) Production

Perhaps the major issue facing the Board regarding San Francisco Bay concerns the possible impact of water development on the ability of San Francisco Bay to produce enough food at the base of the food web to support a diverse assemblage of higher animals including fish. Unfortunately this area of study has been almost completely overlooked by those agencies and organizations studying the Bay. We do not know if the apparent reduction in algal biomass in Suisun Bay and the Delta from 1977 on (see striped bass section) occurred in the Bay as well. There are little or no data describing what levels of primary production (or biomass) are necessary to support fish populations.

The Environmental Defense Fund and the Contra Costa Water Agency presented testimony relating to their recommended salinity objectives in South, San Pablo, and Suisun Bays to provide conditions deemed conducive to the growth and/or accumulation of algal cells (EDF/CCWA-1 through 4).

In the EDF/CCWA exhibits the link between primary production and higher trophic levels was made through the use of a figure from the open literature (e.g., Figure 3 in EDF/CCWA-1). In this figure a generalized relation between primary production and fisheries yield was shown. In DWR rebuttal testimony regarding proposed South Bay standards, it was pointed out that general relationships such as these may not be applicable to specific areas. The main concerns were:

1. There is considerable scatter in the relationship even when plotted on a log-log scale. This means that fisheries yield varies widely at any given level of plant production.

2. The data on production are derived from a variety of plant groups including phytoplankton, benthic microflora, macroalgae, and even emergent vegetation. The importance of each plant group varies by area. In San Francisco Bay there are insufficient data to characterize the total primary production from all the plant communities in the system, thus a Bay production estimate cannot be placed on the fisheries yield/plant

production curve (i.e., the productivity of the Bay/Delta or its relationship to other systems is not known).

The following comments relate to the specific objectives proposed by EDF/CCWA and their consultants.

1. South San Francisco Bay. As pointed out in DWR rebuttal testimony, EDF/CCWA-4 incorrectly characterized South Bay as a generally unproductive environment. In reality South Bay is well supplied with plant nutrients and is quite productive. South Bay also supports a diverse benthos which acts to help keep algal biomass below nuisance levels. High spring outflows do cause salinity stratification in the channels and this stratification can result in algal blooms at the surface. It does not appear, however, that the stratification effect explains algal blooms in shallow areas which form the majority of South Bay (DWR-675). As the USGS pointed out in response to cross-examination (testimony record) and in DWR-677 and DWR-678, spring algal blooms also occur in South Bay during low outflow years. Finally the data used in the EDF/CCWA-4 relating growth in the clam Macoma balthica were from a two-year study of sites high in the intertidal area. More years of data are needed to determine if salinity and flow might have impacts on broader assemblage of plants and animals in that portion of San Francisco Bay south of the Bay Bridge.

2. San Pablo Bay. In EDF/CCWA-3 a flow objective to maximize phytoplankton abundance in San Pablo Bay was recommended. According to the exhibit the proposed flow would create an entrapment zone which would act to concentrate algae

and other particulates. The USBR presented rebuttal testimony regarding this exhibit (Vol. LXII, pp. 75-87). In essence the rebuttal stated that the EDF/CCWA-3 incorrectly interpreted the data in trying to show the presence of an entrapment zone in San Pablo Bay and that mechanisms controlling the abundance of phytoplankton abundance in this area are too poorly understood to form the basis for flow on salinity objectives.

3. Suisun Bay (Marine benthos control). In EDF/CCWA-2, a salinity objective was proposed which would maximize phytoplankton abundance by limiting the intrusion of marine benthic organisms in Suisun Bay. The idea for such an objective came from a paper by Dr. Fred Nichols of the USGS (EDF/CCWA-7) in which he hypothesized that low phytoplankton levels observed in Suisun Bay during the second year of the 1976-77 drought were caused by benthic grazers. Dr. Nichols observed that the marine benthos entered Suisun Bay due to its relatively high salinities through late 1976 to late 1977 and their grazing pressure alone could have reduced algal biomass. The USBR presented rebuttal testimony regarding the proposed marine benthos objective (Vol. LXII, pp. 66-72). Basically, the evidence does not show that enough is known about the role of either freshwater or marine benthos in controlling phytoplankton abundance in Suisun Bay to establish a salinity objective at this time.

4. Suisun Bay (entrapment zone). In EDF/CCWA-1 a salinity objective was proposed to maximize phytoplankton abundance in Suisun Bay by positioning the entrapment zone off

the shallow areas. The USBR (Vol. LXII, pp. 33-66 and USBR-103) and the Bay Institute (BI-49) presented extensive testimony describing estuarine hydraulics which result in a null zone and an area of entrapment downstream of the null zone. It was fairly clearly demonstrated that location of the null zone affects chlorophyll (phytoplankton) concentrations in the entrapment zone. When the entrapment zone is located off the shallow areas of Grizzly and Honker Bays, the phytoplankton standing crop is maximized. The observed increase is apparently due to accumulation caused by the interaction of particle settling and the two-layer flow system, not increased growth of algal cells.

Although the mechanics of the entrapping process are generally agreed upon, agreement has not been reached regarding flows necessary to position the zone to maximize chlorophyll levels nor the ecological significance to higher trophic levels of increased chlorophyll. In addition, since the 1976-77 drought it appears that although the entrapment zone has been in the proper location during critical periods for the development of young striped bass, the striped bass year class remained much below predrought levels (DFG-25, Table 25; Fig. 301a, USBR-103). Thus, the data to date are not adequate to justify an entrapment zone-based objective to reasonably protect beneficial uses in the estuary.

The EDF/CCWA proposal for primary production would require huge amounts of water. When combined with their other proposals, the total water required in addition to that available under current operations would be between 5 million and 8 million

AF per year (USBR-121). These proposals are clearly unreasonable since they would require drastic reductions in existing beneficial uses (total current exports from the Delta are less than 5 million AF, DWR-27f), and in some months the required outflow would be greater than the total available supply (EDF/CCWA-30 and EDF/CCWA-31).

The concern about low algal levels of Suisun Bay phytoplankton is relatively recent. In hearings leading to Decisions 1379 and 1485, the major concern with regard to phytoplankton was that water diversions (and San Joaquin Valley drainage) would result in massive algal blooms in the Suisun Bay area, blooms which cause adverse environmental conditions in the estuary. The drought and succeeding years have demonstrated that excessive algal growth has not occurred in Suisun Bay during low flows and increased water clarity.

B. Zooplankton

Relatively little information was presented regarding zooplankton abundance and distribution in San Francisco Bay. In DWR rebuttal testimony regarding South Bay phytoplankton objective (Vol. LVI, pp. 318-333) it was pointed out that in about 3-1/2 years of studying South San Francisco Bay, USGS scientists did not find a relation between Delta outflow and zooplankton abundance. In DFG-60 data were included regarding the distribution and abundance of such marine zooplankton as euphausids (krill) and arrow worms (Sagitta) and the Bay shrimp (Crangon franciscorum) in San Francisco Bay. There were no clear flow-related benefits to marine zooplankton populations determined from these data.

The Bay shrimp can be characterized as a macrozooplankton which at the same stages has enough motility to affect its location in the water column. Although its main adult population may be offshore, it was by far the most numerous of the 14 shrimp species captured by DFG in their 6-year study. In Figure 41b (submitted as part of DFG-60) a relationship between average monthly Delta outflow (March through May) and annual abundance of all sizes of Bay shrimp was shown. Although the relationship had an apparent high correlation, the following potential problems were identified by DWR (Vol. LIII, pp. 189-198).

1. The abundance of the numerous individual life stages does not always show the same relation to outflow.

2. Although the March-May period was used in the correlation, high autocorrelation between months would tend to obscure the actual period, if any, when flow is having an impact.

3. The small fishery for Bay Shrimp now in place is probably not limited by current population levels (see also DFG-60, p. 41).

4. The Bay shrimp is an important component of the estuarine food web; however optimum levels of shrimp abundance have not been determined.

5. During the late 1920s and early 1930s, the period with the longest sustained drought, commercial fishermen were

harvesting 2 to 3 million pounds of shrimp annually from the Bay (see also Figure 27, DFG-60).

In summary the existing data do not demonstrate that flow and salinity objectives are needed to maintain reasonable levels of zooplankton abundance in the Bay.

C. Fish

Most of DFG-60 was devoted to an analysis of the effects to Delta outflow on the distribution and abundance of numerous fish in San Francisco Bay. In their 6-year study DFG, using various types of gear, collected over 120 species of fish. These fish represented marine and freshwater species, as well as those truly estuarine species that have adapted to the variable salinity conditions in these areas.

Of the 120+ species of fish captured, detailed analyses were made of 69 species according to their response to water year types (wet, limited wet, no preference, limited dry, and dry). Basically, a wet response species was most abundant in wet years. In their summary analysis, DFG showed that 42 of the selected species had no apparent preference regarding flow, 20 had either a wet or limited wet response, and 7 had a dry or limited dry response (DFG-59). In their testimony, DFG pointed out that the relationship between flow and abundance was particularly good for two species, the longfin smelt and the recently introduced yellowfin goby.

In DWR testimony regarding DFG-59 and DFG-60 (Vol. LIII, pp. 189-198), DWR made the following observations regarding the present usefulness of such data for developing flow and salinity standards for the Bay.

1. Although the data base used to develop DFG-59 and 60 is by far the best we have to date, it is based solely on an attempt to develop statistical relationships between observed flows and abundances. Data are not available to show what flow related phenomenon might have caused the relationship, or whether the relationship was spurious.

2. The data base is relatively short (6 years of data were used in the analysis) and limited in type. This limitation is especially apparent when compared to that for striped bass; a species still not well understood in spite of the long (29 years) period during which a large number of potential controlling factors were studied. DFG estimated that a minimum of 10 years of such studies would be needed to provide the necessary data.

3. In many of the fish species studied a major portion of the life cycle is spent in the ocean. The study does not provide data which could be used to determine if variations in the abundance of life stages in San Francisco Bay have any effect on adult stocks.

4. There is no adequate record of the historical levels of most of the species of fish and invertebrates collected in the Bay studies. Certain species that do inhabit the Bay during portions of their life cycles, for example striped bass, naturally spawning populations of chinook salmon, and an invertebrate, dungeness crab, have shown declines in recent

years. As of yet the causes of the declines have not been linked to conditions in the Bay.

5. As for striped bass and salmon, DFG proposed attainment of "historical levels" (see DFG-30) for all Bay species (Vol. LII, p. 22). DFG's recognition, however, that different species might respond in opposite ways to flow changes, that the estuary is highly modified with many introduced species, and that, ultimately, goals would have to be set on a species-by-species basis, underscores the point that "historical levels" does not have intrinsic significance but rather expresses the resource manager's goal of greater abundance.

III

RECOMMENDATIONS

DWR recommends that no flow and salinity objectives be adopted at this time for San Francisco Bay. The data are not adequate to determine if there has been a flow-related change in the ability of San Francisco Bay to support reasonable levels of beneficial uses. The data bases for all trophic levels, phytoplankton, zooplankton, and fish cannot be used to establish cause and effect relationships between flow related parameters and desirable levels of a particular species.

Present and future changes in freshwater flow on the estuarine system should nonetheless be carefully examined. There is a de facto moratorium, as described in Edward Huntley's testimony (Vol. LIII, pp. 218-219), on significant changes during which additional data needed to establish flow and salinity objectives can be obtained. Requests for any changes will be subject to extensive public and agency review during environmental impact analysis and permit application processes.

It also became quite clear during testimony that much of the needed data is not being collected. DWR recommends that the Board be an active participant in helping establish a research and monitoring program that can provide answers. Part of this program can be a revised Interagency Study Program, but more is needed. Since more is involved than water project effects, there is a possible need for sources of funding in addition to those from the water project as well as for close coordination of all research and monitoring activities in the Bay.

SECTION 10

POLLUTANTS

I

EFFECT ON BENEFICIAL USES

The discharge of pollutants, including both point sources and such dispersed sources as urban runoff and agricultural drainage has the potential to affect many of the estuary's beneficial uses. Human domestic and recreational water needs depend on clean unpolluted water. The major human health concerns are with THMs, which are discussed in Section 3. Waste products can kill organisms in a short time (acute toxicity) or over the long period (chronic toxicity). Some pollutants act to make fish and shellfish inedible because of tainting or excessive concentrations of particular contaminants such as bacteria and trace elements. Pollutant loading can also destroy the aesthetic quality of the estuary by causing scums and unsightly plant blooms.

II

SUMMARY OF ISSUES

Since DWR is not involved in most pollution studies of the Bay direct testimony was not presented on most pollutant-related issues. (As noted above, the exception was trihalomethanes, which is discussed in Section 3). Considerable testimony, especially that by the Aquatic Habitat Institute (AHI-302 and 303), the Bay Area Dischargers Association (BADA-1 through 10) and the U.S. Bureau of Reclamation (USBR-105, 106a, 107), described pollutant loading and the environmental effects of such loading on the Bay/Delta. In general, this testimony and supporting exhibits demonstrated that:

1. Although large amounts of pollutants are still discharged to the Bay/Delta there has been a reduction in loading of many compounds and elements.
2. Certain areas of the system have shown significant improvement in environmental quality as a result of better waste treatment and outfall design and location. Improved dissolved oxygen and ammonia-nitrogen levels in South San Francisco Bay are a particularly good example of such changes.
3. There are still areas in the Bay where concentrations of some elements are elevated. The contaminants of concern are generally trace elements or organic compounds which may be associated with the bottom sediments.
4. Although tissue concentrations in some organisms may be elevated, data are generally not available to show that such concentrations are adversely affecting the health of those organisms.
5. Much of the present pollution loading is derived from dispersed sources such as local storm runoff and Delta outflow.

III

RECOMMENDATION

The Department of Water Resources' position is that any policy or standard which would dedicate Delta water supplies to the dilution or flushing of pollutants, in the Bay or elsewhere, would be wasteful and unreasonable. The appropriate way to control pollution is at the source. If discharges are the source, they should be controlled; if dredge spoil deposition is a source, it should be regulated; if toxics-bearing sediments are of concern, they should either not be disturbed or cleaned up. DFG has expressed a like view in DFG-45, in which it urges that "the Board policy for control of pollutants should provide for elimination of all potential adverse impacts on fish and wildlife prior to discharge to the Bay/Delta". DWR recommends that efforts be continued to identify and control sources of pollutants that adversely affect the beneficial uses of the Bay-Delta estuary.

As noted in the discussion of the Bay, it became evident during the testimony that there is not a clear understanding of the effects of freshwater flow (and the effects of water project operations on these flows) on Bay circulation and mixing. This lack of understanding was particularly apparent for South San Francisco Bay. To help clarify the picture, DWR recommends that the State Board and its staff continue to play an active role in the hydrodynamic element of the Interagency Ecological Studies Program.