DWR Attachment I
(7-13-94)

Revised Water Supply Impact Analysis of ESA Requirements

Operation studies presented at the June 14, 1994 State Water Resources Control Board Workshop to estimate water supply impacts to protect winter-run salmon and Delta smelt have been revised. Attached are revised Table 1 and Figure 5, similar to those previously submitted which summarize the updated estimate of water supply impacts. In the new studies, all the modeling assumptions are identical except that a recently introduced error in the model code to simulate Delta cross channel gates closures has been corrected.

TABLE 1

SUMMARY OF COMPARATIVE WATER SUPPLY IMPACTS RELATIVE TO D-1485
(1000'S AF/Year)

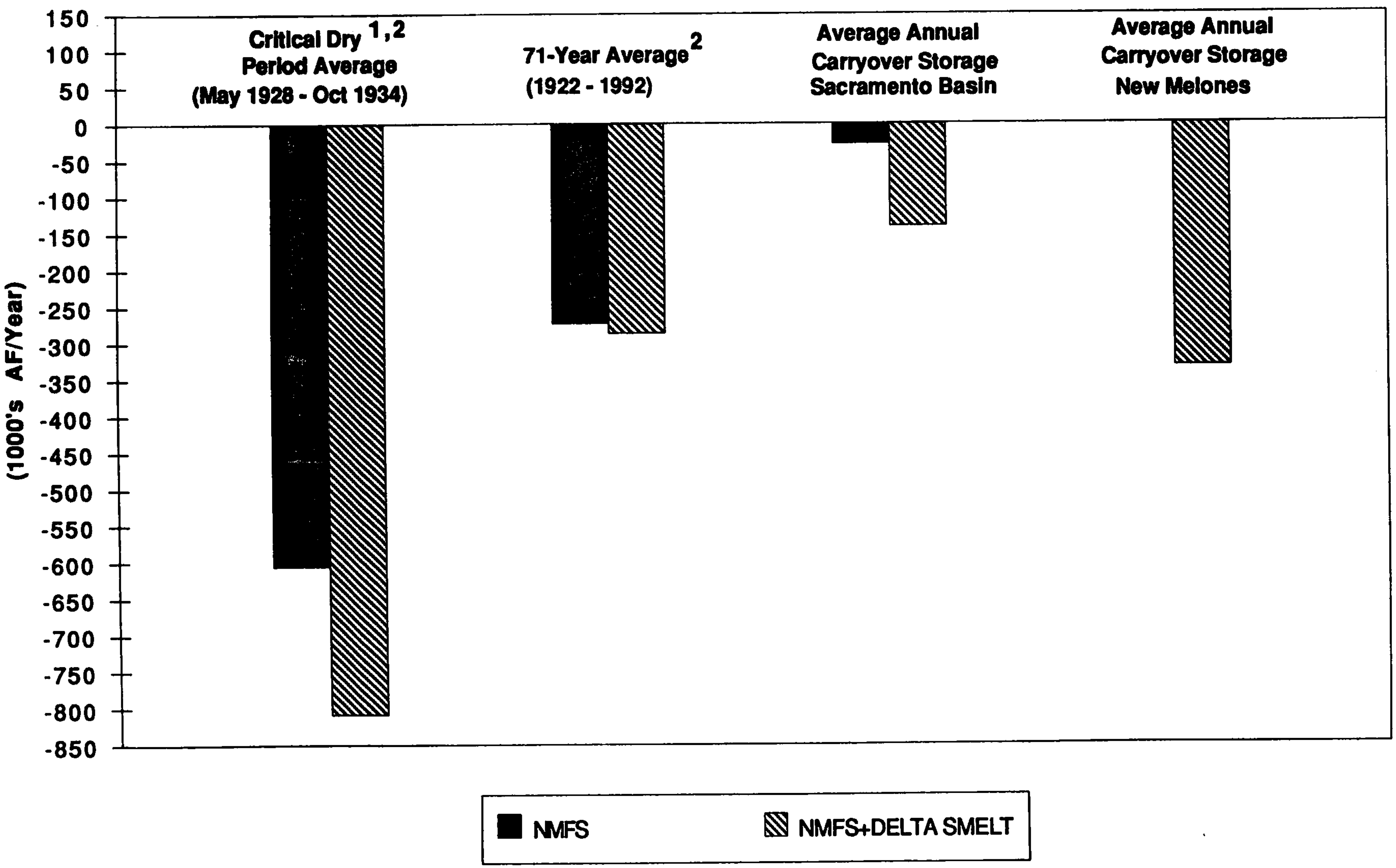
PRELIMINARY
Revised 6/30/1994

STUDY	Critical Dry Period Average (May 1928 - October 1934)	71-Year Average (1922 - 1992)	Average Annual Carryover Storage Sacramento Basin	Average Annual Carryover Storage New Melones
NMFS	-606 [1,2]	-274 [2]	-28	0
NMFS+DELTA SMELT	-809 [1.2]	-287 [2]	-141	-333

1. Includes adjustments due to upstream net storage used.
2. Does not include potential water supply impacts for "Take Limits."

FIGURE 5

COMPARATIVE WATER SUPPLY IMPACTS RELATIVE TO D-1485



1. Includes adjustments due to upstream net storage used.
2. Does not include potential water supply impacts for "Take Limits."

DWR ATTACHMENT # II

FOR THE FOURTH PUBLIC WORKSHOP FOR THE REVIEW OF STANDARDS FOR THE SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN ESTUARY

Prepared by Ray Hoagland, DWR

The following information is being submitted in accordance with the SWRCB's request for recommendations from participants on methods to be used in the analysis of economic and social effects of proposed standards.

Clearly, the preponderance of the quantifiable economic impacts will fall on agricultural and urban water users. Because of this, the focus of these comments is on the framework for analysis and analysis methods for estimating economic impacts to urban and agricultural water users potentially affected by a Bay-Delta decision. It is important to be aware of the sector- and region-specific nature of these impacts. In some affected regions, for example, the impacts may be small relative to the overall economy, allowing adverse economic impacts to be easily mitigated. At the other extreme, a small rural community may be economically dependent upon supplying services to farms and upon the hauling, storing, and processing of farm outputs. In this case, the impacts may be severe, crippling community and local governmental services and causing substantial unemployment.

Other important economic impacts will stem from reservoir operation changes associated with a SWRCB decision. These include recreation and energy generation impacts. With regard to recreation-related economic impacts, we recommend the use of a method developed by Bill Wade of Foster Associates: the Multisite Facilities-Augmented Gravity Travel Cost Model (MFAGTCM). After updating the data in the model in a cooperative effort with the USBR, we used the MFAGTCM approach for assessing the benefits of our proposed Los Banos Grandes Reservoir and feel that it is the best available tool. Energy generation impacts can be best assessed by using an avoided cost approach (i.e., the net impact of having the hydro power available on overall California energy costs).

Another important class of economic impacts are associated with fish abundance. The valuation of these is highly problematic because of the uncertainty of the relationships between Delta conditions, ocean and Bay-Delta commercial and recreational take, and fish populations. The economic value of an expected change in the number of commercially caught fish must be estimated as a net value. To try to minimize adverse economic impacts, commercial boats can, to a limited extent, shift species caught in response to changing success rates. In a similar vein, some fish processing business may be able to change their sources of supply or mix of species processed. Wholesalers and retailers, including restaurants, can also substitute products which use other species or other sources of supply. If customers switch to beef products, for example, in response to higher fish and fish product prices, the overall economic impact on retailers and wholesalers may be less than would be otherwise expected.

The economic valuation of changes in recreational fishing success rates using Contingent Valuation has been fairly well developed by academic researchers in the Pacific-Northwest. NMFS has also done work in this area of research. The weakest link using this method is probably tying a Delta management decision to a specific change in expected success rates.

Another problematic area of economic valuation is endangered species recovery. The only analysis tool with any credibility in this area is again Contingent Valuation. The application of this method is susceptible to many biases stemming from, but not limited to, survey technique, survey instrument design, payment vehicle, and presentation of choices. Further, using this technique to value ecosystems or endangered species is extremely controversial. Values generated with this approach should be used with extreme caution, aside from the fact that they (like any values generated by a market simulation technique) are not observed market values and are therefore not directly comparable to other economic values actually obtained from the market.

The successful use of the foregoing methods for estimating economic impacts is dependent upon using the proper analysis framework. This framework requires establishing a base case with which each Bay-Delta decision alternative can be compared. This base case, which covers the time period to be studied, should be as realistic as possible. In other words, it is not a "no action" case in the sense that other water managers and users of Bay-Delta supplies will do nothing to respond to the water supply and demand conditions during the time period that this case covers. Options available to water managers include, among other measures, changes to water project operations, the construction of additional storage facilities and/or water reclamation facilities, the development of conjunctive use programs, making agreements for long-term or shortage contingency water transfers, and implementation of additional demand management programs.

Commercial water users, in some cases, have the option, for example, to change their water use technologies, install on-site recycling, develop their own ground water sources, or change their levels of production. In response to water supply retailer actions, residential users may be able to modify their landscaping and install appliances that use less water, for example. In accordance with the actions taken by affected water managers and users, water shortages will be likely to occur with a specific frequency, severity, and duration. The economic consequences of these shortages will also be a function of the anticipated actions by managers and users. Actions to increase water service reliability can increase the risk of economic damage (i.e., increased costs and losses) when shortages do occur (demand hardening).

It is critical to the economic impact analysis to forecast which actions are most likely to be taken in response to the base case scenario. This implies a detailed understanding of water management and use at all levels and in all areas affected by a Bay-Delta decision. Once the base case is well understood, in terms of likely actions by managers and users, this same analysis should be applied to scenarios which include alternative Bay-Delta decisions. Only by comparing the results of these analyses with those obtained from the base case analysis can the true impact of these decisions be understood.

Different water manager and user responses to alternative decisions will result in incremental changes to operations costs, investments in water supply facilities (including reclamation), water transfer costs, and demand management program costs. Incremental long-term changes in water-related production may be seen in response to changes in the perception by businesses of economic risk due to water shortage. Incremental changes in the economic costs and losses resulting from shortages may also occur.

The Department has had a great deal of experience in coupling the output of hydrologic simulation models (i.e., DWRSIM) to economic impact models to do the kind of studies which meet the criteria outlined above. For agricultural impacts, we are currently using our Central Valley Production Model (CVPM) to predict both shortage-contingency and long-run impacts. For urban impacts, we have been using our Economic Risk Model (ERM) for the same purpose. Both models are designed to use Bulletin 160 supply and demand information along with DWRSIM input. Both models and assistance in applying them can be made available to the Board.

The Department, along with other participants, has been working productively with the USEPA on the appropriate methods, assumptions, and analytical framework to produce the EPA's Regulatory Impact Assessment for their proposed Clean Water Act rule. The Department has also been working closely with the USBR on developing agricultural impact analyses for their Programmatic Environmental Impact Statement for the Central Valley Project Improvement Act. Many of the issues described above have been addressed during these two processes and others are expected to be resolved. It is our recommendation that he SWRCB take advantage of what has been and will be learned in these venues which will be applicable to its own work.

The following is an outline of a suggested analysis framework for estimating the economic impacts of a proposed Bay-Delta decision on urban and agricultural users. The same basic method of systematically developing base case scenario and alternative scenarios which are economically justified and financially, environmentally, and politically feasible, and then comparing those alternatives to the base case is also applicable to impacts on other sectors of the economy.

Economic Analysis Framework

0. Fundamental Principles
   a. Analysis Framework for Alternative Delta Management Decisions
      i. Establish Time Horizon (e.g., 1995 - 2020)
      ii. Establish Study Years (e.g., 1995, 2000, 2010, 2020)
      iii. Establish Base Case Supply/Demand Conditions (e.g., D-1485 with ESA)
      iv. Determine Supply/Demand Conditions for Alternatives
      v. Compare Supply/Demand Conditions with Alternatives to Base Economic Conditions
   b. Primary Considerations for Projecting Study Period Supply/Demand Conditions
      i. Assumed Hydrology (e.g., 1924-1993 historical conditions)
      ii. Delta Depletions
      iii. Demands
         (1) Urban Use
            (a) Population Size
            (b) Population Distribution by Climate Zone
            (c) Adoption of BMPs
         (2) Agricultural Production
            (a) Crop Type
            (b) Acreage Planted
            (c) Basin Efficiency
      iv. Availability of Non-Delta Supplies
   c. Types of Economic Impacts to Be Considered
      i. Direct
         (1) Long-Term Costs (e.g., Additional Local Supply Development) and Risk-Related Loss of Economic Activity or Consumers' Surplus
            (a) Gross Output
            (b) Value Added Income (Gross State Product)
            (c) Employment
         (2) Shortage Contingency Costs (e.g., Drought-Related Water Transfers) and Shortage-Related Losses of Income or Consumers' Surplus
            (a) Gross Output
            (b) Value Added Income (Gross State Product)
            (c) Employment
      ii. Indirect
         (1) Economic Costs/Losses to Businesses Serving or Relying On the Output of Shortage-Affected Businesses (Input-Output Analysis)

(2) Governmental Income Impacts Due to Loss of Property Tax Revenues from Real Property Devaluation Related to Increased Water Service Risk and Loss of Sales/Income Tax Revenues From Shortage-Affected Businesses

iii. Scope of Economic Impact Analysis

(1) Local

(2) Regional

(3) Statewide

1. Supply Availability/Impact Framework

a. Purveyor/User Water Management Options

i. (If Applicable) Effect of Pro-Rata Sharing of Delta Supply Availability on Non-SWP/CVP Water System Operations (EBMUD, SFWD, etc.)

ii. State and Bureau Project Operations (Including COA)

iii. Project Wholesaler Options

(1) Reclamation

(2) Water Transfers

(a) Shortage Contingency

(b) Permanent

(3) Conjunctive Use

iv. Retailer Options

(1) Supply Management

(a) Reclamation

(b) Water Transfers

(i) Long-term

(ii) Shortage Contingency

(c) Conjunctive Use

(2) Demand Management

(a) Additional Conservation Programs

(i) Long-term

(ii) Shortage Contingency

(b) Shortage Contingency Rationing

v. User Options

(1) Long-term

(a) Alternative Supplies

(i) Ground Water (Self-Service)

(ii) On-Site Recycling

(b) Water-Use Technology/Management Shifts

(c) Forgone Uses/Economic Production

(2) Shortage Contingency

(a) Water-Use Technology/Management Shifts

(b) Forgone Uses/Economic Production

b. Determination of Likely Use of Options

i. Economic Optimization (Costs of Increasing Water

Service Reliability Versus Benefits of Reducing Shortage-Related Costs/Losses)

(1) Simulation Studies With Economic Cost/Loss Minimization Objective (e.g., DWR Economic Risk Model)

(2) Frequency Analysis (Expected Values) Using Static Mathematical Programming Models (e.g., DWR Central Valley Production Model)

ii. Reconnaissance-Level Feasibility Studies

(1) Financial

(2) Environmental

(3) Health

(4) Social

2. Assessment of Economic Costs and Losses

a. Base Case

i. Capital Investment Costs

ii. Operations Costs

iii. Shortage Contingency-Related Costs and Losses

iv. Risk-Related Long Term Costs and Losses

b. Alternatives

i. Capital Investment Costs

ii. Operations Costs

iii. Shortage Contingency-Related Costs and Losses

iv. Risk-Related Long Term Costs and Losses

c. Incremental Economic Impacts of Alternatives

i. Change in Capital Investment Costs

ii. Change in Operations Costs

iii. Change in Shortage Contingency-Related Costs and Losses

iv. Change in Risk-Related Long Term Costs and Losses

For the SWRCB's consideration, we have also attached a slightly edited version of a paper developed by the Department for the Bay-Delta Oversight Council (BDOC) process. This paper was intended to provide a comprehensive integrated resources planning framework with the breadth of scope the Department feels is appropriate for a Bay-Delta decision. The comments provided above are consistent with the broader and more comprehensive framework presented in the BDOC paper as Strategic Reliability Planning.

DEPARTMENT OF WATER RESOURCES
BRIEFING PAPER

PREPARED BY RAY HOAGLAND, DWR

LONG RANGE PLANNING CONCEPTS FOR MANAGING FUTURE WATER SUPPLY

INTRODUCTION

This paper is presented to facilitate an understanding of how economic considerations can best be used in a long-range planning framework along with environmental and social impact accounting techniques to provide a systems perspective from which to evaluate alternative Delta decisions. Briefly stated, a systems perspective imposes an obligation to look at all local and statewide economic, environmental, and social consequences of a proposed action, either direct or indirect, and to look at all alternatives to that action (structural, operational, market-oriented, institutional, etc.) in terms of their respective consequences. This paper first presents a planning approach, integrated resources planning, which incorporates systems concepts relevant to planning decisions at the local agency and water project management levels and to a Delta decision. Also presented is an example of the possible results of taking that approach for determining the management options within the scope of a Delta decision. These results are presented as a table of the resource management options potentially within the scope of the study and therefore legitimate components of alternative plans.

This paper then provides information on how specific water management options to increase or maintain reliability can affect the economic well-being of users. The remainder of this paper will discuss how this knowledge can be used at the local level and at the State and regional water project level for long-range water management planning which best achieves a balance between the economic, social, and environmental benefits of maintaining or enhancing water service reliability and the economic, social, and environmental costs of doing so. A framework is presented for using these local and State and regional water project level analyses to assist in the Delta decision process.

This paper is primarily addressed to those water uses for which the environment is not the primary beneficiary (i.e., urban and agricultural use) but for which the environment can be significantly affected as a consequence of water use. Many of the same concepts apply to analyzing options which can provide water for environmental uses but the application of these planning techniques to those uses remains highly theoretical in nature. As knowledge is gained on how to quantify the value of environmental resources in terms compatible with traditional economic analysis these techniques will become more practical. This is also true with respect to increasing our understanding of the physical/biological linkage between water available to the environment and environmental quality.

RELIABILITY PLANNING IN A SYSTEMS FRAMEWORK

In any planning process, a critical question that must be answered is the appropriate scope to use. If the scope (what types of alternative actions are evaluated, what types of costs and benefits are measured, which affected parties are considered, what time frame is used, and which geographic areas are included) is too broad, time and effort will be wasted making irrelevant analyses or dealing with matters of little significance. If the scope is too limited then the opportunity to produce the best outcome in terms of benefits and costs will also be limited. The appropriate scope is particularly important when consideration is given to the economic, environmental, and social welfare of all parties affected, directly or indirectly, by a Delta decision. A consideration of this magnitude goes well beyond the scope of traditional water management planning. This section introduces planning concepts designed to accommodate the scope needed for a Delta decision.

Traditional Water Management Planning Framework

Until recently, planning decisions in water resources have been made from a relatively narrow perspective, particularly with regard to the types of actions evaluated and affected parties considered. Generally, the institution having responsibility for the decision, either a local or regional agency, or a State or Federal water project, has had limited scope in terms of available actions. Decisions were traditionally limited to the configuration, sizing, and timing of additional water supply facilities. Parties considered were generally those directly responsible for repayment of the cost of facilities.

Now, as a consequence of the increasing financial and environmental costs of traditional supply facilities, as well as the length and uncertainty connected with the environmental review process for such facilities, other non-traditional options are either being implemented or seriously explored. These include demand management, conjunctive use, and water transfer options. Non-traditional water supply facilities such as waste water reclamation and sea water desalting are also being considered as increasingly viable planning options.

In spite of the additional credibility being given to these types of non-traditional options for water management, the scope of the analysis is usually limited to the water service reliability objective. This is entirely compatible with the mission of the water agencies. In this context, the effects of water management plans on environmental quality or social welfare, influence the planning process as statutory constraints or as mitigation costs.

Within this traditional framework, newer planning strategies--such as least-cost planning--can do a good job of finding the management plans which provide the best trade-off between the costs to the planning agency of adding or maintaining reliability and the costs of the consequences of unreliability to the agency and the users supplied by that agency. "Least-cost" does not refer to the comparative cost of implementing alternative management plans, as might be assumed (i.e., find the cheapest plan), but to the total cost of managing the resource in question (or not managing it, as the case may be). A management plan which is comparatively expensive to implement may be "least-cost" if it is effective in preventing undesireable (i.e., costly) results. (The least-cost planning strategy for water management is described in detail in the Strategic Reliability Planning section of this paper.) If applied using the traditional water agency planning scope, however, least-cost planning shows its limitations if the required perspective is resource management within a systems framework.

Systems Framework

The term "systems framework" is a generalized, shorthand way of acknowledging that limiting the planning scope by using political, statutory, or jurisdictional boundaries and assessing only those impacts that affect the planning entity directly is unlikely to produce plans which are least-cost from a statewide or regional perspective. Plans developed on the basis of this limited scope are likely to be constrained from considering all potential management options and assessing all important economic, environmental, and social costs and benefits.

Within this broader framework, the benefits of water service reliability become a consideration because they represent one consequence of managing California's resources. Like managing any resource (e.g., fossil fuels, wildlife habitat, forrest land) to maintain or enhance economic, environmental, or social well-being, water resource management represents one way of affecting these values not only directly but also indirectly because of its impact on opportunities for managing other resources.

Integrated Resources Planning

Integrated resource planning (IRP) is an implementation of least-cost planning that requires the explicit recognition of the environmental quality consequences of planning decisions beyond those that impact the planning agency directly (i.e., planning and operational constraints and mitigation costs), reflecting this broader perspective. In water management planning, as in other types of planning, these external environmental costs may affect which plan is identified as the preferred alternative from a least-cost perspective. The way these environmental costs are included is important, however. In some cases, environmental management options may exist which are outside the legal authority or financial capability of the planners, causing them to be excluded from consideration. Just as external environmental impacts are important to consider when using IRP, external environmental management options may be of major importance because of their potential effect on environmental costs.

IRP can fall short of a true systems perspective if it is applied in such a way that all alternative environmental management options are not considered prior to the assessment of environmental consequence of alternative plans. In this case, there is the assumption that existing environmental management practices will continue, precluding a true systems perspective. For this reason, an IRP approach which is constrained from consideration of all feasible environmental management options makes it less likely that a water management plan alternative which is least-cost, in terms of overall economic, environmental, and social benefits produced and costs incurred, will be identified as preferred.

IRP, to be applied in a way that represents a true systems approach, therefore, would require a planning entity capable of developing a comprehensive strategy and overseeing the management of all appropriate resources in order to insure that the selected plan was truly least-cost in terms of overall economic, environmental, and social effects. In this context, water service reliability plans would not exist independently of environmental management plans.

In a true systems process, outcomes such as income, employment, fish and waterfowl populations, water quality, species diversity, or any other measure of economic, environmental, or social welfare can be appropriately used to evaluate alternative plans. In developing these integrated resource plans, all feasible water and environmental management options for affecting these outcomes would have to be considered to increase the likelihood that a least-cost plan would be selected.

Applying IRP to a Delta Decision

Obviously, the statutory authority and planning resources needed to accomplish this task readily and to everyone's satisfaction are unlikely to ever become available to a single planning entity, particularly at the local decision-making level. With this understanding, it is reasonable to ask if this approach likely to have sufficient advantages to justify the extra effort required for its use when compared to the constrained IRP approach discussed above or even traditional planning techniques, in light of the authority and planning resources currently available or likely to be made available. Answering this question requires that the water management "problem", whether it be at the local or statewide level, be examined from a comprehensive resource management perspective.

The first step in this process is to identify the outcomes that are important to the affected parties. The list of such outcomes for a Delta decision is likely to be substantially broader than one developed at the local level, not only because of the range of potential effects but also because of the geographic scope of those effects. For a Delta decision, among the important outcomes in the areas receiving diverted water are income, employment, business and living costs, convenience, aesthetic amenities, community well-being, and health protection. These are concerns encompassed by water service reliability. From the viewpoint of environmental quality, among the relevant outcomes from a Delta decision perspective are: species diversity, fish and wildlife population numbers, maintenance or enhancement of wildlife habitat.

The second step is identifying the resource management "levers" (i.e., resource management options) which can affect these outcomes that are presently available or that can be made available to the resource managers that will be affected by a Delta decision. Making some important options available to those resource managers may require institutional or statutory changes. If this is the case, the costs associated with making those options available should be taken into account in any least-cost analysis. Clearly, such institutional or statutory changes are likely to be more feasible for agencies with statewide authority. In any case, many of the economic, physical, and biological relationships between the resource management options and the outcomes are presently not well understood. And, even if the primary relationships are well understood, the interrelationships between the outcomes and between the factors that influence them may not be.

Because economic, physical, and biological linkages and cross-linkages are present in any system for which water management planning decisions are being made and because the agents within that system, both human and non-human, are capable, within limits, of using adaptive strategies (i.e., responding in ways designed to protect their well-being) which may not be clearly foreseen, identifying the appropriate resource management options and their probable influence is problematic at best. This problem is particularly acute for a Delta decision. This has implications for which options are identified as appropriate to include in the planning process and how they should be incorporated into plans in terms of the incentives or regulations which may be needed to implement them.

Because of the uncertainties connected with the effectiveness or the feasibility of implementing some options, plans consisting of options which are "robust" with respect to desirable outcomes under a range of conditions and which are flexible enough to be modified without high cost to avoid unexpected negative results or to take advantage of unexpected opportunities have value for those reasons alone.

The third step would be to use whatever knowledge presently exists about the consequences of exercising each of the identified options to rule out the use of those options which would be highly likely to produce "unacceptable" outcomes. These might be outcomes that would be identified by a consensus process involving the affected parties. A consensus process would also have to be used to establish the "state of the art" with regard to the effect on the outcomes of exercising each option. (For this purpose, different levels of use of specific resource management actions are considered options.)

These steps are a way to limit the planning scope in a manner consistent with the systems framework. In this process, the scope is narrowed by ruling out analyzing irrelevant outcomes and use of infeasible options. This is preferable to starting with the traditionally narrow water management planning scope and trying to "patch" it by adding pieces. The latter strategy is much more likely to produce a deficient plan, especially from a statewide resource management perspective.

Scope for Delta Planning

Table 1, shown below, is an example of a possible result of applying the first two steps of the three-step process outlined above for determining the management options within the scope of study for a Delta decision:

Table 1. Example Determination of Management Options Within Delta Planning Scope

Management Options	**Outcomes**				
	Diversion and Export Area Water Service Reliability	Delta Water Quality		Aquatic Species Populations and Diversity	Terrestrial Species Populations and Diversity
		Export Area Urban Health Aspects and Farm Salt Management	Delta Farm and Industrial Use Salt Management		
Delta Facilities	✓	✓		✓	
Water Project/Local Transfers	✓				
Water Project/Local Conjunctive Use	✓				
Water Project/Local Reservoir Storage	✓				
Water Project/Local Reclamation	✓				
Local Demand Management	✓				
Delta Non-Point Source Toxics Control		✓		✓	
Local Water Treatment Facilities		✓	✓		
Delta Water Quality Standards	✓	✓	✓	✓	
Delta Flow Standards	✓	✓	✓	✓	
Poacher Control				✓	
Commercial Fishing Quotas				✓	
Exotic Species Management				✓	
Ballast Discharge Management				✓	
Acoustic Screens				✓	
Spawning Habitat Management				✓	

Table 1. Example Determination of Management Options Within Delta Planning Scope (Continued)

Management Options	**Outcomes**				
	Diversion and Export Area Water Service Reliability	Delta Water Quality		Aquatic Species Populations and Diversity	Terrestrial Species Populations and Diversity
		Export Area Urban Health Aspects and Farm Salt Management	Delta Farm and Industrial Use Salt Management		
Relocation of Diversions			✓	✓	
Diversion Screens				✓	
Predation Management				✓	
Dredging Management				✓	
Wetlands Management				✓	✓
Flood Bypass System Management				✓	
Delta Island Land Management			✓		✓
Levee Stability Management	✓	✓	✓		

LOCAL OPTIONS TO MANAGE RELIABILITY

As indicated by the example table shown above, water service reliability in Delta diversion and Delta export areas can be affected by management options available to local agency or water project planners. This section of the paper identifies specific options which may be available to managers at the local or water project level and discusses their potential consequences. Water service reliability can be increased or maintained either by the use of long-term options or by the use of contingency options. Long-term options reduce the expected frequency and severity of shortages and contingency options reduce the impacts of shortage events when they happen. The following discussion is primarily directed toward decisions made by local water agencies in the case of water for urban and agricultural uses. These local decisions must be taken into account when reliability planning is done by regional or statewide water management entities, such as a regional wholesale agency or the SWP. These broader based plans must account for the net impacts of reliability decisions made by local agencies; for example, water transfers to enhance reliability for one agency may reduce reliability for another agency or for instream uses.

Long-Term Management Options

Long-term options available to local agencies may include both supply management and demand management options. Long-term options available to wholesale water agencies are mostly limited to supply management options. Long-term options available to water project operators and wholesale agencies, while primarily supply related, can include demand management options in terms of options to manage environmental water needs.

For urban and agricultural users, available supply management options may include additional reservoir storage, reclamation projects, and brackish or sea water desalting facilities. Conjunctive use or water transfers may also be options. Long-term water transfer options include both permanent transfers and long-term agreements to make water available during shortages. Long-term agreements for water transfers for wetland habitat or other environmental needs are also options, as are storage facilities dedicated to those purposes.

Available demand management options may include water conservation and reuse such as improved agricultural irrigation management and technology. Urban water audit programs and appliance replacement programs also affect long-term demand. Water pricing programs also provide incentives for water conservation options. For example, some local agencies have instituted seasonal water rates to encourage a reduction in summer urban outdoor use. Even though increased water use efficiency can reduce the frequency and severity of shortages, the economic consequences of those shortages can be made more severe when they do occur because efficiency is often gained at the expense of taking the "slack" (shortage management flexibility) out of the system. As an example, a toilet retrofit program will reduce the savings which can be expected from an emergency toilet device distribution program in the future. Such efficiency actions further increase the value of reliability as it reduces the availability of some of the lower cost options for shortage management.

Demand management measures are not limited to urban or agricultural uses. Changes in operating criteria for releases and diversions, changes in points of diversion, temperature control structures, and streambed improvement projects can reduce environmental water use in certain instances, for example.

Chapter 11 in Volume I of DWR Bulletin 160-93 describes a number of possible long-term supply and demand management options which should be considered as options in the planning framework presented in this paper. Also described are a number of potential shortage contingency management options to which this framework applies. These latter types of options are discussed next.

Contingency Management Options

There are several ways to reduce or avoid impacts when shortages happen. One way is to reduce demand through intensified water conservation; other ways include augmenting supply or reallocating available supplies among users served by the local agency. The following discussion focuses on options which are available or generally acceptable under emergency conditions.

In urban areas, contingency conservation actions usually focus on outdoor water use. These actions might consist of any one or a combination of the following programs: drought awareness programs, "water waster" patrols, and alternate day watering programs. Contingency supply options which may be available to both urban and agricultural agencies include increased ground water pumping which is not associated with a conjunctive use program. Water transfers resulting from spot-market or drought water bank purchases may also be available as contingency options. Spot-market transfers for environmental needs during times of shortage can be an effective means of avoiding severe environmental impacts. These transfers may be for maintaining wetland habitat or for increasing instream flows needed for protecting fisheries. Temporary environmental protection structures can also be effective for maintaining water supplies for non-environmental uses during shortages. The temporary flow control barriers placed in the Delta are an example of this concept.

Contingency allocations, also known as rationing programs, can reduce impacts by avoiding or reducing shortages to critical uses. Such uses in urban areas include fire fighting, health related industries, factories, and industries where many jobs and large incomes are associated with low water use (e.g., high-technology industries). Because critical uses are a small part of total urban use, local water agencies normally have substantial flexibility to avoid affecting these uses. In agriculture, allocations to keep trees alive or prevent the loss of row crops can avoid much larger losses than would otherwise be the case. The desired allocations might result from either mandatory or incentive-based options. One type of mandatory rationing is the use of hook-up moratoriums in urban areas. This is usually considered an extreme measure. As another example of an extreme measure to mitigate the worst impacts of shortages, fishing moratoriums are a possible means of relieving shortage-induced stress on fish populations.

Rationing programs can include those which call for either uniform cutbacks or those which differ by user class. Exemption programs can provide an effective means of "reallocating" supplies to critical uses, such as businesses which are highly dependent on process water, even if the stated policy is a uniform cutback for all user classes. In either case, successful programs are likely to be based on cutbacks from calculated, rather than previous use, rates to avoid "punishing" users who have conserved in previous years. These programs include procedures for granting exemptions based on hardship. As further long-term conservation options are adopted, raising the efficiency of water use, the ability of water agencies to use rationing to limit shortage-related impacts in the future will be reduced.

Incentive programs can also result in desired allocation patterns. Incentives include using emergency water price schedules that penalize high rates of water use and permitting banking of any unused allocations for future use. However, pricing as an allocation method raises equity issues. Another type of incentive program which protects higher-valued uses includes interruptible programs. Interruptible programs allow users to agree to a water service cutoff under specified shortage conditions in exchange for lower water prices.

STRATEGIC RELIABILITY PLANNING

Strategic reliability planning (SRP) is defined in this paper as water service reliability planning which is compatible with an integrated resource management framework. Its focus is on water management planning by local agencies and water project managers. Theoretically, a Delta decision based on SRP should be made subsequent to a study made on the basis of planning for all water agencies and water projects which would be affected by a Delta decision and on the basis of assuming the planners are given widest possible legal authority. The economic, environmental, and social consequences of alternative Delta decisions could then be evaluated in a systems context, insuring that all available resource management options at the local agency and water project levels were appropriately incorporated into each alternative Decision to be evaluated. The practicality of accomplishing this within a reasonable time, even assuming that most of the needed information was made available to the planners, is highly questionable at best.

In light of this, a reasonable alternative approach is make use of whatever studies have been done by local agencies or water project managers and augment them to the extent possible to be useful in an integrated resource planning framework. To this end, SRP concepts are presented in this section are addressed to local agency and water project planners in terms of how, given their narrower perspective, they should be expected to prepare and evaluate alternative water management plans to facilitate a systems analysis at the statewide level for a Delta decision.

SRP, like any type of reliability planning, is a water management planning process which relies heavily on understanding and managing risk. Much of the discussion which follows involves concepts which have been familiar to water managers for many years. The only aspect that may be new is the planning framework for applying these concepts. For example, the strategic reliability planning approach goes beyond the traditional firm yield approach which is primarily concerned with avoiding risk rather than managing it. Although firm yield embodies some of the attributes of reliability, it doesn't provide sufficient information for a comprehensive water shortage management analysis. A comprehensive water shortage management analysis not only integrates demand management options with supply augmentation options but also integrates long-term options with contingency options, looking for the best trade-offs in all cases.

Obviously, a long-term strategy which relies on managing risk can only be successful to the degree that the risk is understood. Traditionally, reservoir yield determinations were based on relatively simple hydrologic techniques which model reservoir operations with respect to water demands set at specified values for specific years over the study period. Reliability planning carries this much further, attempting to bring into the equation available demand management options and shortage management strategies, and the cost of failing to meet those demands. This part of the equation provides valuable insight into the tradeoffs that can be used to "tune" the system.

The strategic reliability planning framework presented here is adapted from analyses conducted during the past twenty years for the energy industry. The energy crisis during the early 1970s convinced utilities to move to reliability-based planning strategies and to incorporate the least-cost principle of planning. The energy industry analogy can't be carried too far, however, because of fundamental differences in the nature of shortages, their consequences, and the alternatives available to avoid or mitigate them. For example, where it would be reasonable and necessary for an electrical utility to plan for an overall 99+ percent level of reliability for public health and safety reasons, it would rarely be considered acceptable from a financial standpoint for a water utility to do so because of the large investment in facilities needed and the relative availability of shortage management options.

From a water service reliability perspective, the following planning principles are important: (1) the costs of and losses associated with shortages, both economic and environmental, tend to escalate as shortages increase in duration and severity (e.g., some business are financially able to avoid drought-related layoffs for one year only, environmental stress is often cumulative--a may reach a point of no return for some species); (2) emergency water management actions can effectively mitigate some costs and losses during shortages, particularly if they are developed ahead of time as a part of long-term planning; (3) reliability can be enhanced by decreasing demand through reuse and conservation but usually at an increasing economic cost and, in some cases, environmental cost; (4) reliability can also be enhanced by constructing desalting, reclamation, and surface or ground water storage facilities to increase supply but at also an increasing economic and environmental cost.

Understanding the implications of these principles provides an important opportunity for developing more effective water management plans. Such plans are more likely to achieve the best balance between the costs of increasing reliability and the benefits of reducing the frequency and severity of shortages.

Major Considerations for Strategic Reliability Planning

The successful application of SRP depends upon understanding water service reliability from both the supply-side and demand-side perspectives. It also depends upon the best possible estimate of expected costs and losses associated with future shortage events. Also critical is an appropriate criterion for deciding what the "best" reliability is. For Delta planning, the criterion adopted by the energy industry--the least-cost criterion--appears to be appropriate. As discussed later, "cost", as used in this criterion, is a very broad concept not limited to economic considerations. Finally, an analytical approach incorporates these considerations in a manner consistent with integrated resources planning is needed.

Supply Reliability. Surface and ground water reservoirs provide for water supply reliability through carryover storage (the ability of facilities to make water captured but unused in previous years available for use in the current or future year). The success of these facilities in ensuring water availability depends on a number of factors, including storage capacity and precipitation and use in previous years. Use in previous years, in turn, is a function of demand by users (itself dependent on climate, among other factors, see below) and decisions made by operators of surface and conjunctive-use ground water reservoir facilities.

Operators may choose to restrict reservoir releases or ground water pumping because of the need to reduce the risk of shortages in the future. In this way, the cost of imposing a shortage in the current year is traded against the expected cost of future shortages. This strategy uses a record of historical hydrologic conditions as a surrogate for future conditions, and decisions about the amounts and timing of releases are based on these predictions.

In addition to climate, other factors which can cause water supply shortages include earthquakes, chemical spills, and energy outages at treatment and pumping facilities. Planners also need to consider the probability of catastrophic outages in reliability planning.

Demand Variability. While the water supply in any one year is influenced by runoff and reservoir operators' past and present decisions, demand is primarily a function of current year climate, including the monthly precipitation pattern.

Most of the variation in demand arises from evapotranspiration of applied water (ETAW) in relation to effective (i.e., usable) rainfall. Air temperature, solar radiation, and wind can increase ETAW, thereby increasing water use. Urban landscaping and agricultural irrigation uses are those predominantly affected by evapotranspiration variations.

Likelihood of Coincidence of Shortage-Related Factors. The likelihood and severity of shortage events can depend on factors which link the variation in demand and supply and the variation in supply among different basins. To account for the coincidence of drought events among basins, water planners considering alternative water supply sources should take into account the advantages of sources that have diverse climatic influences. For instance, supplementing a source in a coastal climate zone with a source in an inland climate zone may enhance the overall supply reliability.

Although reclamation and reuse are important for water management, both rely on the amount of local waste water available for recycling. The amount of waste water available for recycling is diminished during droughts. In most regions, however, the current amount of water recycling is quite small in comparison to the waste water available because costs and health regulations have generally precluded widespread water recycling.

Determining the Costs and Losses Due to Shortages. Evaluating the costs and losses associated with shortages requires work on three fronts: (1) the costs and effectiveness of contingency measures that would be available to water agencies during shortages, (2) how shortages would be allocated among users, and (3) the economic value of any shortage-related losses to users (including the economic value of social welfare and environmental quality losses to ecological resources and). A technique to include social welfare and environmental quality losses not quantifiable in standard economic terms is discussed later in this paper.

Some information on contingency measures was gained during the current drought, such as the cost of substituting ground water for imported or local surface water and the cost of water from the 1991 and 1992 State Drought Water Banks. In addition, both urban and agricultural agencies and individual agricultural users, in particular, had to invest in increasing ground water pumping capacity. Costs of measures to protect the environment like temporary barriers in the Delta, reservoir releases (representing foregone energy and water sales) to maintain stream temperatures, and water purchases to maintain fish flows are also part of the record.

Experience also was gained on how water is allocated during shortages. Urban water agencies were sensitive to the needs of residential users who can show extreme hardship and businesses that can show significant economic hardship, including employment impacts. Agricultural water agencies recognized the importance of keeping tree and vine crops alive because of the large investment value they embody. Most water agencies provided exemptions as part of their rationing programs even if they didn't explicitly allocate water based on use.

Because of these exemptions, even though some businesses, like nurseries and gardening services, can be hard hit, residential users absorb most of the economic impact of urban supply cutbacks, in terms of overall magnitude. Therefore, realistically measuring the economic impacts of shortages depends largely on understanding the consequences for residential users. These consequences include inconvenience; the cost of replacing lawns, shrubs, and trees; and the loss of the aesthetic and environmental benefits of urban landscaping.

Expressing this valuation in a way that can be used in a reliability model is often problematic. While some of the losses can be quantified—the cost of lawn replacement, for example—others, such as the loss of aesthetics and inconvenience, are difficult to measure. It appears that the most promising way to get useable residential shortage loss valuation estimates is through surveys of residential users. Contingent Valuation (CV) is generally accepted as a survey technique that has been used to assess the willingness of residential users to pay to avoid shortages as well as to determine the willingness of citizens to pay to preserve or enhance environmental quality. A CV survey asks respondents to say yes or no to specific hypothetical increases in water bills, user fees, or taxes, for example, to obtain the water service reliability or environmental quality objectives in question. Carefully controlled survey designs and sophisticated statistical techniques are needed to obtain valid results.

In agricultural areas, economic losses resulting from shortage can be valued by using gross crop income minus all unexpended cultural and harvest costs for land fallowed due to lack of water. Gross crop income minus harvesting costs is the appropriate value for crop failures due to a water shortage. If perennial crops are affected, the cost of stand replacement (i.e., replacing dead plants) and long-term effects on crop yield or quality have to be taken into account. Other costs and losses include the cost of on-farm pumping to substitute ground water for unavailable surface supplies and lower crop prices due to the crop quality effects of stress. Ranchers, probably already hurt by the loss of rain-fed rangeland forage, can be hurt further by the need to buy additional feed to replace pasture or feed crops lost due to water shortage.

Assessing losses arising from reductions in the availability of water to the environment are problematic for two reasons: placing an economic value on those losses and relating ecological resources to hydrology. Some losses, like loss of income to the commercial fishery industry and to recreators who fish, hunt, or view wildlife are relatively easy to value economically if the biological relationships between hydrologic conditions and wildlife populations are understood. Rates relating animal populations to commercial fishing harvest, recreational fishing and hunting success, and participation in non-extractive recreation (e.g., wildlife viewing) can used to estimate lost economic value. The weakest link in this case is the biological science for relating populations to hydrology.

Losses arising from placing stress on populations of species such that their continued existence is imperiled are more difficult to establish. Not only is the biological science still being developed, but the current methods of placing a economic value on the existence of species remain highly controversial.

Least-Cost Planning Criterion. As mentioned above, strategic reliability planning should incorporate the least-cost planning (LCP) criterion. This criterion is designed to give all available options an equal chance in the plan selection process. If any options, either demand management *or* supply augmentation, are arbitrarily excluded, it becomes more unlikely that the selected plan will be truly least-cost. The plan will probably not provide the greatest "bang for the buck", where the "bang" is meeting the needs of water users and the "buck" includes social and environmental, as well as economic, costs.

Use of the LCP criterion does not mean that planning decisions must be limited to evaluations that translate all costs into dollar amounts. The LCP concept can be incorporated into evaluations that rank plans according to their relative social and environmental impacts. However, whenever social and environmental consequences of alternatives can be reasonably expressed in dollars, identifying the preferred plan will be less subjective. The appropriate evaluation method might include a mix of economically quantifiable and non-quantifiable environmental and social impacts based on the relative confidence that can be placed in the specific approach to measuring those impacts. Thus, a plan which is not least-cost in quantifiable economic terms may be judged to be least-cost from a total welfare perspective when non-quantifiable social and environmental impacts are considered.

With LCP, the water manager's objective becomes one of meeting all water-related needs of customers, not one restricted to looking for ways of providing additional supply. If a growing service area's need for sanitation can be met with ultra-low-flush toilets rather than additional water supplies, then this option should be considered on its merits and compared with all other options when putting together a water management plan. Making such comparisons is entirely consistent with the objective of enhancing reliability. With the LCP criterion, how the service area enhances reliability relates only to the relative costs of the alternatives.

This viewpoint has its origin in the energy industry where it is called "value-based" planning. In the energy industry context, providing new customers with warm houses becomes the goal, for example. Whether this is done by adding generation capacity (supply management) or by "freeing up" existing capacity by insulating houses (demand management) is a concern only with respect to the relative costs of these options.

In addition to its focus on considering all feasible options for meeting customers' needs, the LCP process requires systematic and comprehensive evaluation of all costs associated with each option when devising alternative plans. This includes evaluating the costs of not fully meeting the customers' needs at all times (planning for some probability of shortages); this option must be as carefully evaluated as any other. (Plans which would result in extreme shortages jeopardizing life or health would be unreasonable.)

When considering water management options for environmental planning, the problems discussed above associated with placing values on environmental losses makes the process of identifying a least-cost plan more difficult than when planning only for urban or agricultural uses. For example, a species whose existence is threatened can have a value beyond that obtained from hunting, fishing, viewing, or commercially harvesting its members (i.e., existence value). This difficulty might be overcome by identifying a minimum required level of environmental quality or establishing an environmental quality goal (acres of high-quality habitat, animal populations, etc.) and then finding that plan which at least meets that criteria and has the lowest total water management cost. Another method would be to identify selected levels of environmental quality and identify, for each of those levels, the plan which has the lowest total water management cost and provides at least that level of quality necessary for ecological sustainability. Comparing these costs against levels of environmental quality can help establish a "reasonable" cost point--i.e., beyond this point costs rise rapidly but gains in environmental quality are minimal.

Social values, like those derived from preserving a viable rural lifestyle found in farm communities, for example, are also hard to quantify for the purposes of a least-cost analysis. Approaches similar to the ones suggested for dealing with environmental values might be appropriate where social impacts would be significant.

Analytical Approach. The strategic reliability planning process for a Delta decision first requires identifying local areas affected by potential decisions. Second, existing studies for those areas should be reviewed for applicability to a least-cost water service reliability analysis and for information which can be used to augment theses studies to make them useful from an integrated resource planning perspective. Identification of the economically preferred (i.e., least-cost) water management plan can be done once sufficient information is collected from existing studies or new research on the following: all costs and losses expected with the local water management options available to manage unreliability, including supply augmentation and demand management costs; shortage-related costs and losses; and any quantifiable social or environmental costs and losses. The preferred plan will be that combination of water management option which is likely to produce the lowest total of these costs and losses. The most useful way of identifying this plan is with a water system simulation model which uses either historical or synthetic (computer generated) hydrology. In this way, shortage events can be given their relative probabilities and their associated costs and losses weighted accordingly.

Figure 1 depicts the primary planning relationships important for evaluating, from a least-cost perspective, the cost of alternative plans to increase the reliability of a hypothetical water service system. The link between the investment in long-term water management options and the size and frequency of shortages is shown, as is the link between expenditures to make contingency options available on the costs and losses associated with those shortages. As indicated, simulation studies (hydrologic and shortage impact) are required to best approximate the actual nature of these links. In general, the larger the investment in long-term water management the less frequent and less severe will be the shortages experienced. Similarly, the greater the investment in making contingency measures available for future shortage events, the less economic, environmental, or social costs these shortages will cause when they occur.

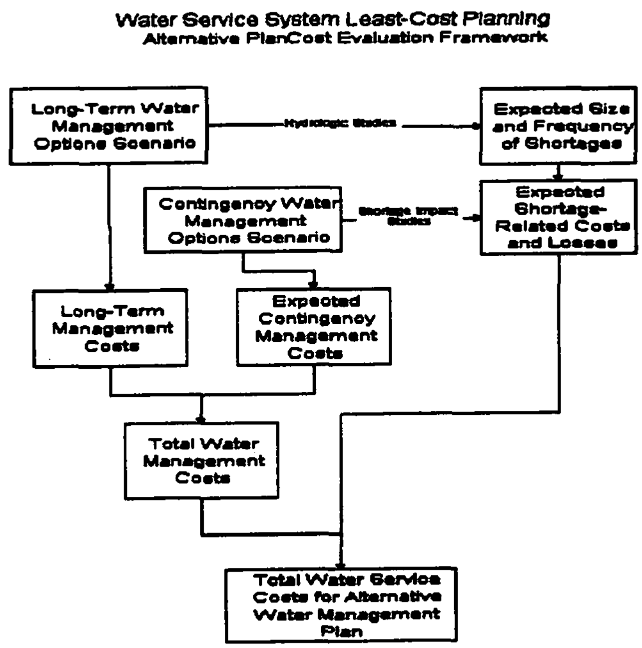


Figure 1 - Reliability Planning Relationships

The capital and operations and maintenance costs of both the long-term and contingency water management scenarios are shown as components of the total water service system costs, the remaining component being the expected costs and losses associated with shortages under those scenarios. Use of different long-term and contingency water management options affects water service costs not only directly but also indirectly through their influence on the size and frequency of shortages as well as the costs and losses associated with those shortages. They can also affect costs because of their influence on the quality of water provided to users and/or water agency treatment processes. Some options, for example, may require substantial capital investment to convert existing treatment processes to those which will be required to meet existing or expected standards if those options are to be used.

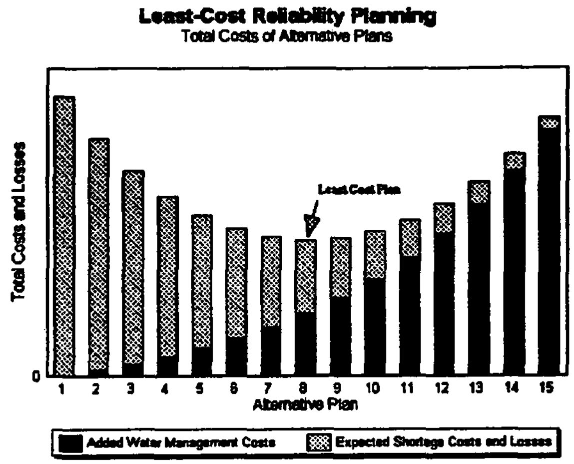


Figure 2 - Identifying an Economically Optimal Plan

Figure 2 depicts an analysis to identify an economically optimal plan for increasing water service reliability. The process involves looking at the additional water management expenditures called for by alternative water management plans (each alternative water management plan is made up of both long-term and contingency water management options) vis-a-vis the shortage-related costs and losses associated with those plans. (Plans which impose water quality-related costs on water agencies or directly on users should have these cost included in their cost of implementation.) In Figure 2, the plans are arrayed in terms of increasing water management expenditures. Plan number one represents existing conditions (no additional water management actions.) In this example, the least-cost plan in terms of total costs and losses is alternative eight. Water management expenditures lower than those represented by this plan (plans one through seven) expose the local area to higher shortage-related costs and losses than necessary. Water management expenditures higher than those associated with this plan (plans nine through fifteen) do not "pay for themselves" in terms of additional reductions shortage-related costs and losses.

Incorporating Non-Quantifiable Values. Because factors which can be quantified in economic terms and incorporated directly into the procedure outlined above are unlikely to be the only important determinants of a preferred plan, systematic techniques to incorporate non-quantifiable social and environmental impacts are also necessary. One technique used to incorporate non-quantifiable factors is the use of impact accounting matrices.

An array of all possible significant social and environmental impact categories, both direct and indirect, is presented in matrix form. Each plan can then be assessed in terms of the relative severity of the impacts it produces in each of the categories. Categories could include such items as compatibility with maintenance of species diversity or compatibility with the maintenance of a viable farm community lifestyle. Relative economic cost would then appear as one of the impact categories. Weights can then be assigned to each of the categories. A preferred plan can then be identified on the basis of its overall weighted "score". In the following table illustrating this process, the Economic Cost impact category represents all costs,including environmental and social costs which are quantifiable in economic terms. The other impact categories, which can be divided into as many subcategories as deemed appropriate, represent alternative measures of impacts not captured in the "Economic Cost" category. Such alternative measures might include relative size of expected population of animals or relative ranking of expected negative impacts on rural community lifestyle, for example. A schematic representation of applying this technique might look like the following:

Impact Categories

Alternative	Econ. Cost	Environment	Social
1			
2			
3			
4			
5			

x

Weights
Econ. Cost
Environ.
Social

=

Scores
Alt. 1
Alt. 2
Alt. 3
Alt. 4
Alt. 5

Usefulness of Results. The process outlined above can be used to calculate a single "score" for each alternative plan with respect to its overall results in each of the impact categories, permitting it to be ranked with respect to alternative plans. It is important to note that this process, if not applied carefully, may be meaningless or misleading at best. For example, the assumptions used to formulate the economic studies may be "off the mark" with regard to future conditions; the physical/biological relationships used, such as those estimated for stream flows and spawning success may be incorrect; or the environmental/social impact weighting scheme may be inappropriate for maximizing the overall welfare of Californians. As with all measures relying on uncertain future conditions or underlying relationships that are not well specified, there is no guarantee that policy choices based on them will ultimately maximize overall welfare.

In view of this, it is important that sensitivity analyses be a major part of this effort. The relative rankings of the alternative water management plans should be looked at in terms of how they change under different plausible study assumptions and alternative impact weighting schemes. For example, the future cost of energy is likely to significantly affect the value of hydropower as well as the cost of structural water management options as compared to non-structural options. For this reason, it is important to look at the effect of different energy cost assumptions on the study results. Similarly, if the political feasibility of some management options is in question, different assumptions about their future availability should reflect this uncertainty. In any case, alternative weighting schemes should be developed to reflect the diversity of opinion held by stakeholders regarding the relative importance of different impact categories.

The sensitivity analysis process will help identify those plans whose relative rankings are most susceptible to changes in study assumptions and/or weighting schemes. Plans which are most robust in terms of receiving a high ranking under a number of different combinations of study assumptions and weighting schemes will also be identified, if they exist. Similarly, those plans which fair badly under a majority of combinations will also be identified. In general, a plan which is ranked relatively high in a number of cases is to be preferred to a plan which is ranked highest in only one case (or in just a few cases) and inferior in the other cases. Even though there is the chance that opportunity to achieve the greatest amount of benefits may be foregone, it is more likely that an alternative plan will produce a better outcome. If, on the other hand, under one case out of a number of plausible combinations of assumptions and weighting schemes, one particular plan produces spectacularly dismal results, the risk of that outcome may make it desirable to avoid that plan even though it is satisfactory in majority of the other cases.

The problem of costs and/or consequences of alternative plans because of uncertainty about future conditions illustrates a benefit which some plans may have which may not be immediately obvious. Because things are almost never as expected, the ability of a plan to be modified after it is adopted without incurring large costs or experiencing a significant loss of effectiveness is very important. To take this attribute into account, a category assessing relative flexibility should be added to the impact accounting matrix described above.

Strategic Reliability Planning and Selecting a Preferred Delta Alternative

The importance of SRP for a Delta decision arises from the fact that correctly evaluating the economic and environmental consequences of alternative decisions requires that the water service reliability effects of each alternative be understood in terms of its impacts on local water management plans. By assessing the SRP effects of proposed alternative Delta decisions on each sector of the water community, a relatively stable, consistent, and comprehensive impact measure is made available. Consistent with integrated resource planning principles, these decision alternatives should, where appropriate, include resource management options that are now beyond the legal authority or financial capability of local water agency or water project planners.

To the extent that this process can be made successful, it will help insure that all the affected parties are "doing the best with what they have" prior to the calculation of impacts. This will help avoid biases which might reduce the likelihood of identifying the best Delta alternative. SRP will help assure policy makers at the statewide level that all reasonable local management options to mitigate or eliminate local adverse impacts of shortages have been considered and the costs of those actions are understood to the extent possible. Without a reasonable assurance of this, decisions concerning the Delta may be based on costs and benefits which do not adequately represent the management options available (or unavailable) at the local level. In this case, it is less likely that the most beneficial decision, from a statewide perspective, will be made.

This process, which is the minimum needed to take advantage of the benefits of integrated resource planning principles, will require close cooperation between local agencies, water project managers, and staff responsible for evaluating Delta decision alternatives. New studies may be required or existing studies may need to be modified to assess resource management options which may have been considered legally or financially unavailable by local agency or water project planners which may mitigate or eliminate the adverse impacts potentially associated with some Delta decision alternatives. These options should be incorporated into the planning process to help insure that the least-cost criterion can be applied in a manner consistent with IRP principles.

Although a comprehensive application of the strategic reliability planning approach, which this process calls for, can require large amounts of data, sophisticated hydrologic modeling, and extensive data processing capability, it can also be used at the conceptual level as a means of establishing priorities. Greater investment in the capability to do this type of planning will increase understanding of the types and magnitudes of trade-offs that can be made to achieve the best compromise between costs and benefits--both in terms of how much and to whom they accrue.

While SRP for water projects and local water agencies has been used only on a limited scale in water resource planning to date, the Department of Water Resources, the California Urban Water Agencies (CUWA) organization, and a number of local water agencies are currently working to develop data, improve techniques, and/or implement plans for urban water service reliability. Mathematical models unique to specific regions of California have been developed as part of this process. Strategic reliability planning is a viable means of long-term planning in a climate where the options for enhancing or, in some cases, maintaining reliability are usually costly and are often subject to an uncertain and lengthy regulatory process.

CONCLUSION

The use of strategic reliability planning to the extent feasible is a means to help insure that all available water management options are adequately considered in a systematic way in a decision-making process. Specifically: (1) all feasible supply augmentation and demand management options are identified, (2) the costs and benefits of the options are well understood at the State and local level in terms of plans which integrate both demand management and supply management options, (3) plans which are least-cost can be identified, and (4) the process reduces bias, helping to insure that an equal burden of "proof of need" is placed on all affected parties. In turn, placing SRP within an integrated resource planning framework is a means to help insure that all resource management options are adequately considered in a systematic way in the decision-making process.

All other things being equal, analyses based on strategic reliability planning contribute more certainty, and thus credibility, to decisions with statewide implications than less comprehensive analyses are able to provide.