Appendix F. Draft Alternatives

Selecting Analytical Tools and Information for Assessment of CALFED Bay-Delta Alternatives

INTRODUCTION

Analytical tools will be used to provide quantitative information about the relative performance of CALFED alternatives for satisfying all objectives of the CALFED program and to assess the environmental effects of these alternatives. Analytical tools describe or simulate analytical relationships between variables of interest. An analytical relationship describes the response of a resource variable to potential changes in environmental conditions. These relationships will be analyzed in terms of how they are influenced by CALFED Bay-Delta alternatives. One example of an analytical relationship would be acres of suitable estuarine habitat as a function of Delta outflow. This relationship might be constructed from a hydrodynamic model that simulates salinity as a function of flows and the hydrography of the estuarine portion of the Bay-Delta.

These analytical relationships can be obtained directly from historical data about the Bay-Delta resources, as well as from results of models and other methods for estimating likely future conditions. In this document, the combination of analytical tools and the analytical relationships obtained from these tools is called "analytical information". The overall purpose of this document is to review all sources of analytical information and recommend the best possible set of analytical tools and analytical relationships that can be used to assess the potential benefits and impacts of CALFED alternatives for all categories of Bay-Delta resources. Some modification of existing analytical tools or analytical relationships may be recommended to improve the results of the CALFED alternatives assessment. Some of the analytical relationships identified for CALFED assessment will require additional evaluation to resolve uncertainty. This selection of analytical information can be described by the following steps:

- define resource categories and issues requiring analytical tools and relationships,
- identify and describe available tools for each resource category,
- identify the analytical relationships required for impact assessment,
- describe analytical relationships using analytical tools or data,
- determine connections between selected analytical information,

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- identify changes in existing analytical tools and analytical relationships needed to reduce uncertainty or provide better results, and

- recommend strategy for applying analytical information (tools and relationships) to evaluate CALFED alternatives.

DEFINE RESOURCE CATEGORIES AND ISSUES REQUIRING ANALYTICAL TOOLS AND RELATIONSHIPS

The resource categories and potential resource management issues that must be evaluated and analyzed during the impact assessment of CALFED alternatives will be defined so that analytical tools can be identified for each. The resource categories and issues are directly related to CALFED goals, objectives, and solution principles. The resource categories that were used for the CVPIA PEIS have been expanded to include the broader range of objectives that CALFED alternatives are attempting to satisfy. Available analytical tools and analytical relationships needed for impact assessment will be described and reviewed for each of these resource categories.

Table 1 provides a draft list of the resource categories that have been defined for impact assessment of CALFED alternatives. The best available information will be included for each resource category, together with a recommended strategy for integrating results from each analytical tool or relationship, to provide a comprehensive and consistent impact assessment.

IDENTIFY APPROPRIATE TOOLS

The most appropriate analytical tools and relationships for assessing each resource category must be identified. Identification will be based on an inventory of all available tools that could be used to evaluate individual resource categories, issues, or environmental conditions. The goal of the inventory is to match the CALFED objectives and expected effects of alternatives with potential analytical tools or methods of analysis.

The CVPIA PEIS assembled a comprehensive list of available tools (PEIS Team 1993) that will be used as the initial CALFED list. However, the broader range of CALFED objectives will require that additional resource categories be inventoried. Some of the assessment tools developed for CVPIA PEIS will be included in the updated PEIS inventory. Other agencies or stakeholders may have developed new tools or modified existing tools since the PEIS team listed available tools. All of these potential changes in the PEIS inventory will be made for the CALFED inventory.

Very few analytical tools are available that integrate two or more resource categories; therefore, assessment will require combining results from several models to provide multiresource analysis. Some resource categories may have more than one analytical tool, and each may provide unique information that may be useful for evaluating CALFED alternatives. Only a few of the resource categories requires a choice between more than one well-developed analytical tool. Most resource categories have several analytical tools that emphasize different analytical relationships or environmental effects. Results from each of these tools may be useful for assessing CALFED alternatives.

IDENTIFY ANALYTICAL RELATIONSHIPS NEEDED FOR IMPACT ASSESSMENT

Impact assessment will be based on several analytical relationships between environmental conditions and responses for each variable of interest. There will generally be a "chain of effects" between specific actions that are included in a CALFED alternative and the environmental conditions that benefit or impact a resource category. Each of the analytical relationships that govern the chain of effects must be identified.

Analytical information (models and data) can be used to quantify the analytical relationships that will be used for impact assessment. Some analytical tools that do not provide sufficient information about likely effects of CALFED alternatives can be eliminated. The results from different models can be compared for the same analytical relationships to determine if there are substantial differences among different tools. It is most likely that combinations of available tools will be suggested as the best approach for comprehensive assessment of CALFED alternatives.

Spatial information that is organized in Geographic Information System (GIS) databases and historical field measurements for tides, river flows, salinity, water quality, and fisheries conditions will be considered as analytical tools because these data have been used for developing and testing analytical relationships between environmental conditions and impact effects.

Figure 1 illustrates the concept of matching the expected environmental effects of CALFED alternatives with appropriate groups of analytical relationships, using Delta aquatic habitat as the example resource category. Because there is not a single integrated model of Delta aquatic habitat conditions, several relationships must be selected to cover the full range of environmental effects on this habitat that are expected to result from CALFED alternatives. Habitat restoration activities, in combination with flow and salinity management actions, will be evaluated through a series of connected analytical relationships. Suitable aquatic habitat is described as some combination of shallow-water area with appropriate salinity that also has adequate transport conditions to protect the vulnerable life stages from entrainment and effects of toxicity. Several analytical relationships will be required to evaluate the benefits and secondary impacts for each CALFED alternative. Similar diagrams for each resource category can be prepared from the list of analytical tools and analytical relationships.

DESCRIBE AVAILABLE ANALYTICAL TOOLS AND RELATIONSHIPS

An inventory of analytical tools together with 1-page descriptions of each potential tool will be prepared. A similar list of analytical relationships with 1-page descriptions of each relationship will complete the identification and description of analytical information that is appropriate for CALFED impact assessment purposes.

The general description of each appropriate analytical tool will include a short summary of its purpose and approach along with the input requirements, general methods or calculations, and results. Identifying previous applications of the tools for Bay-Delta water resources, environmental assessments, or economic evaluations is a critical part of the analytical information selection process. The calibration and validation of the tool with historical data and the sensitivity of the results to changes in the inputs are also important selection criteria that should be included in the analytical tool description. A 1-page executive summary of each analytical tool will be prepared. Two example descriptions are attached at the end of this document.

One important type of analytical relationship is the spatial distribution of habitat conditions in the Bay-Delta and tributary streams; therefore, important analytical tools will include spatial data (maps) that can be developed from GIS-based procedures. Another important type of analytical relationship is the historical sequence of measured environmental conditions or biological populations. Algebraic equations or functions (e.g., correlations or regressions) between two variables of interest can be developed from simulated or historical measurements of environmental conditions and biological populations to provide another major type of analytical relationship.

The general description of each analytical relationship will include the variables of interest and the type of information contained in the relationship (i.e., GIS map, historical data or simulated sequence, or graphical comparison of two variables of interest). A short discussion of the potential application for CALFED evaluations will be provided. The analytical relationship will be shown on the bottom of a 1-page description of each. Two example descriptions of analytical relationships are attached to this document.

CONNECT AND INTEGRATE ANALYTICAL TOOLS AND RELATIONSHIPS

Because a wide range of analytical tools and relationships will be used in the overall assessment of CALFED alternatives, the connections between these analytical tools and relationships must be carefully planned and described to provide integrated and consistent assessment results. The integration task can be described using a series of flow charts that describes the necessary links between the selected analytical tools and analytical relationships to evaluate the chain of effects between CALFED actions and expected environmental benefits and secondary impacts.

Some of the analytical tools and relationships will be used in an assessment sequence; one model or relationship will provide necessary inputs for another. This may require iterations and changes to maintain consistency among the analytical tools or relationships that are used. Sequential analytical tools and relationships will be critically evaluated during the selection process to ensure that sequential or iterative analyses can be completed within the CALFED schedule.

Other analytical tools will be used to provide general results that can be specified as inputs for another tool or relationship, but will be not require iteration or changes in the first model. Because analytical uncertainty may compound when using several analytical tools or relationships together, the confirmation of model assumptions through calibration and validation is an important consideration. Some analytical tools and relationships may be eliminated if they would not provide sufficient analytical information about the effects of CALFED alternatives on environmental resources of interest. The reliability of the assessment of CALFED alternatives obtained using selected analytical tools and analytical relationships will be described with general sensitivity and error analyses.

Figure 2 provides an example of the connections between analytical tools and analytical relationships for assessing effects from CALFED alternatives on estuarine habitat conditions. As part of the San Francisco Estuary Project (SFEP 1993) the historical electrical conductivity and outflow data were evaluated to estimate an X2-outflow relationship, and historical fish abundance indices were evaluated as a function of the seasonal X2 location. Based in part on these relationships, the California State Water Resources Control Board established the 1995 Water Quality Control Plan objectives for Delta outflow and X2 location to protect estuarine habitat conditions.

These same analytical tools and analytical relationships can be applied to identify Delta outflow and X2 objectives that would be appropriate (i.e., provide protection of all beneficial uses) for each CALFED alternative that may include modified channels and export locations. CALFED alternatives would then be evaluated with water management models that would simulate the most likely future Delta outflow conditions. The X2-outflow relationship and similar analytical relationships between X2 and available estuarine habitat would then be used to estimate fish habitat and abundance for each alternative. Similar flow charts of analytical tools and analytical relationships for other resource areas will be prepared for integrated assessment of CALFED alternatives.

MODIFY AND ENHANCE ANALYTICAL TOOLS AND RELATIONSHIPS

Several available analytical tools can be substantially enhanced for improved assessment of CALFED alternatives with relatively minor adjustments in the model structure or calculations. Some CALFED alternatives will include new facilities and operations that are not included in the evaluation capability of existing analytical tools. New reservoirs, channel barriers for salt and/or fish, relocated or isolated Delta transfer facilities, screened diversions, and habitat restoration programs are examples of actions that may not be included, but that could be added without invalidating the tools.

There will be opportunities to apply existing analytical tools with slightly changed assumptions and input specifications to allow assessment of likely conditions that better approximate CALFED alternatives. For example, conservation and reclamation actions can be represented by reduced demands in the water management models.

Changes in habitat conditions and water management facilities or operations would also cause shifts in the analytical relationships used for impact assessment. For example, the relationships between outflow and habitat area may need to be modified because CALFED alternatives will include modified Bay-Delta channels and tidal habitat that may change historical analytical relationships. These assumed shifts in the analytical relationships will govern the impact assessment of each CALFED alternative.

Modifications and enhancements to existing analytical tools and shifts in analytical relationships will be recommended if the changes will allow more accurate representation and assessment of CALFED alternatives.

SUGGEST STRATEGY FOR APPLYING SELECTED ANALYTICAL TOOLS AND RELATIONSHIPS

There are four categories of analytical tools and analytical relationships that can be used for assessment of CALFED alternatives benefits and secondary impacts. Figure 3 illustrates these four general types of analytical tools and relationships that will be recommended for assessing CALFED alternatives, which are described as follows:

- Preliminary analytical tools and relationships can be used to help define the operational criteria or boundary conditions that are necessary for accurate assessment of the CALFED alternatives; preliminary analytical results would be summarized as tabular or graphical information.

- Primary analytical tools and relationships can be used to provide comparative simulations of the likely conditions resulting from the CALFED alternatives under the wide range of hydrologic conditions experienced in California. Monthly analyses are appropriate for characterizing seasonal hydrologic and biological conditions throughout the Bay-Delta and tributary streams. These primary simulations of major variables of interest will form the backbone of the assessment of CALFED alternatives.

- Secondary analytical tools and relationships can be used to describe important additional issue-specific effects based on primary assessment tool results for each CALFED alternative. These secondary assessment variables should not influence the primary variables. The secondary assessment can then be done independently using the results of the primary assessment tools.

- Supporting analytical tools and relationships can be used to describe site-specific effects of CALFED alternatives on resource issues that are important for various stakeholders but are beyond the programmatic level of detail for CALFED assessment. The primary and secondary CALFED assessment tools should provide necessary information for these supporting assessments.

Several preliminary issue-specific or site-specific tools and relationships will be needed to provide necessary boundary conditions or input assumptions for the primary CALFED assessment tools. Examples of these preliminary tools include hydrologic water balance models used to describe the monthly river flows and diversions for specific watershed areas with assumed land use (e.g., consumptive use and depletion analyses) and simulations of individual water district facilities and demands (e.g., water district reservoir operations to meet projected demands, or SWP demands based on MWD integrated resource planning results). These preliminary tools and relationships will be identified to allow improved cooperation and coordination with stakeholder models and inputs.

Another possible use of preliminary tools would be to provide screening analysis, using a simplified version of the primary tools, to allow many simulations of possible operations criteria. For example, a spreadsheet model of Delta operations (e.g., DeltaSOS) could be used to evaluate operations rules for an in-Delta storage or an isolated transfer facility that is included in a CALFED alternative. Many iterations with the simplified model would lead to a proposed operation of the new facilities, which would be incorporated into the primary analytical tool for evaluating water supply management effects of CALFED alternatives.

Some analytical tools will be necessary and appropriate for primary assessment purposes. For example, DWRSIM, PROSIM, and SANJASM are the best-known general water supply planning models for the Bay-Delta tributaries and can be used as general assessment models for CALFED alternatives. Simulation of hydropower generation and pumping requirements can be made with a power planning model based on the water supply simulations. Many important Delta environmental conditions can be simulated as functions of outflow and channel flows (e.g., estimates of estuarine habitat area, entrainment effects, salmon mortality, and other conditions that have been shown to have strong relationships with Delta channel flows). The number of primary tools and relationships should be limited to avoid lengthy, iterative modeling sequences.

Many analytical tools and relationships have been developed for specific purposes that will provide useful information for particular CALFED issues, but cannot be used to evaluate the overall effects of the CALFED alternatives. The results of secondary analytical tools can be summarized as secondary analytical relationships. Some examples of secondary specific-purpose or single-issue models are listed below and shown in Figure 3.

- Delta hydrodynamics model can be used to determine the effects of tidal habitat restoration or levee failure on salinity intrusion that can be summarized as an analytical relationship between surface area and tidal salinity intrusion.

- Delta water quality model can be used to determine the effects of wetland restoration or agricultural drainage controls on export water quality that can be summarized as a series of analytical relationships between land use and drainage-water quality.

- Delta water tracking model can be used to determine the effects of barriers and diversion screens on entrainment effects for vulnerable life stages of fish that can be summarized as a series of analytical relationships that estimate transport and entrainment as a function of Delta flows and exports for each potential spawning location.

- Delta habitat evaluation procedures can be use to determine the relative effects of habitat restoration actions on important aquatic, wetland, and terrestrial species.

The fourth general way to use analytical tools or relationships for assessing CALFED alternatives is to support evaluations of site-specific effects that may be important to individual stakeholders but are not considered necessary for programmatic level-of-detail CALFED evaluations. These supporting analytical tools can be used by stakeholders to evaluate effects based on results from the primary and secondary CALFED analytical tools. For example, supporting analytical tools could be used to simulate disinfection by-products at specific MWD, CCWD, or SCVWD water treatment plants, based on export water quality results (e.g., chloride and dissolved organic carbon concentrations) from primary and secondary CALFED water-quality assessment tools. A second example of supporting tools would be the simulation of CCWD Los Vaqueros Reservoir operations based on simulated Delta chlorides. These supporting analytical tools will be identified so that the necessary inputs can be provided by the primary and secondary CALFED assessment tools.

The connections between the selected analytical tools and relationships will be carefully identified so that an overall integrated and comprehensive assessment of CALFED alternatives can be accomplished with the selected analytical information (tools and relationships).

Table 1. CALFED Resource Categories Requiring Analytical Tools and Relationships

Resource Category	Issues and Conditions
Water Resources	Reservoir operations Water supply demands and diversions Delta operations
Hydrology	River hydraulics Watershed hydrology and water budgets Irrigation and drainage
Groundwater	Pumping Recharge Storage and depth to water
Delta Hydrodynamics	Tidal and net channel flow Tidal mixing and salinity intrusion density stratification and gravitational circulation
Aquatic Habitat	Estuarine tidal Delta tidal freshwater River and riparian wetlands
Aquatic Habitat Conditions	Temperature Estuarine Salinity Entrainment and mortality
Fish Populations	Food web productivity Anadromous species Resident Delta and estuarine species
Agricultural Water Quality	Minerals Nutrients and dissolved organic carbon drainage toxicants
Drinking-Water Quality	Turbidity and dissolved organic carbon TDS, chloride and bromide Disinfection by-products
Power	Hydropower generation Pumping requirements

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Resource Category	**Issues and Conditions**
Regional Economics	Fishing and recreation Agricultural economics Municipal and Industrial water supply economics
Vegetation and Wildlife	Habitat evaluation procedures Species of concern Habitat management
Levee and Infrastructure	Seismic risk analysis Flood risk analysis
Systems Analysis	Geographical information systems Decision support Display and simulation

Analytical Tool Description Example 1

Tool & Category: **DeltaSOS Model** **Delta Operations**

Purpose: Evaluate Delta channel flows and operations for alternative Delta water quality and flow objectives, such as D-1485 or 1995 WQCP.

Approach: Spreadsheet calculations compare initial monthly Delta water budget with specified Delta water quality objectives (flow and export limits) to determine potential effects of objectives on Delta exports.

Inputs: Initial monthly Delta water balance (flows and exports) for 1922-1991; Delta water quality and operations objectives specified as month x year-type values for approximately 25 different operational controls.

Methods: Channel flows estimated with "flow-split" equations based on RMA hydrodynamic model results. Incremental changes in exports are calculated to satisfy specified gate, diversions, outflow, and export objectives.

Results: Monthly Delta channel flows, isolated and direct CVP/SWP exports, outflow, and in-Delta storage operations are calculated as incremental changes from initial values that are required to satisfy specified objectives. Time-series of monthly values with annual summaries; monthly and annual graphics.

Applications: Used to describe in-Delta storage operations for Delta Wetlands EIR/EIS prepared by SWRCB and Corps.

CALFED Potential: Could be used to explore Delta operations of new or modified facilities with alternative water quality objectives. Can provide iterative and interactive evaluation and display of potential Delta operations. Can be used to demonstrate and communicate differences between alternatives.

Documentation: Appendix A2 "Delta Standards and Operations Simulation Model" & Appendix A3 "DeltaSOS Simulations of Delta Wetlands Project Alternatives" in Delta Wetlands Project Draft EIR/EIS (September 1995).

Availability: Free-access, Lotus 123 Spreadsheet Model, Jones & Stokes Associates, Russ T. Brown (916) 737-3000.

Analytical Relationship Example 1

Resource Category: **Delta Hydrodynamics**
Relationship: **X2 Location vs. Delta Outflow**

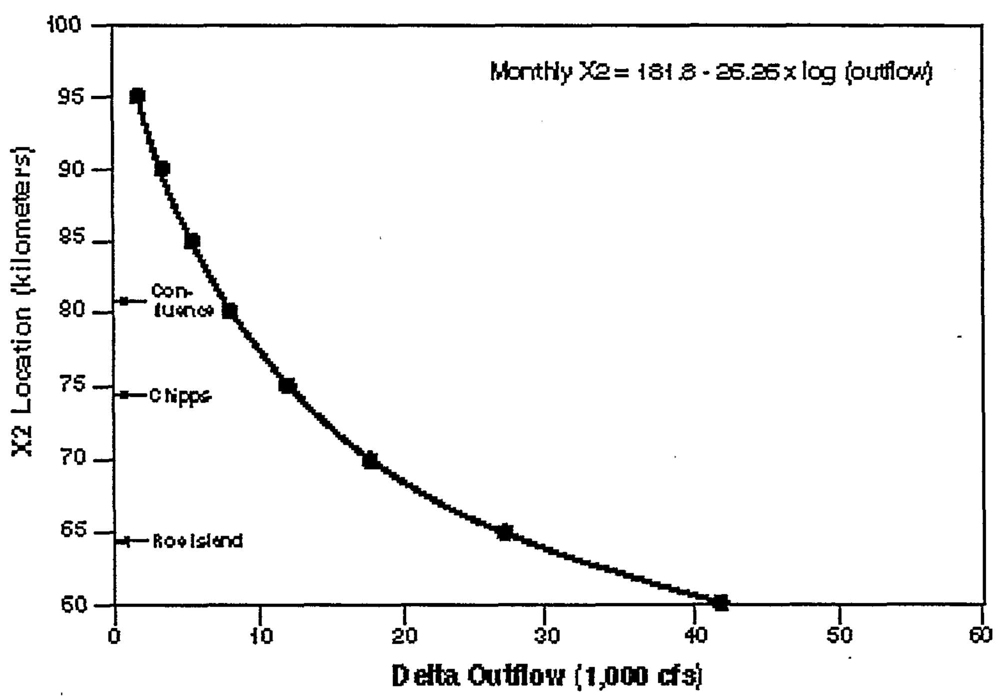
Description: General tidally-averaged location of the 2 ppt salinity gradient (X2) in kilometers upstream of Golden Gate as a function of estimated net Delta outflow in the vicinity of Chipps Island.

Assumptions: The effects of spring-neap tidal flows into and out of the Delta are ignored. X2 is considered to be a moving-average function of the antecedent X2 position and Delta outflow (autoregressive).

Basis: Daily and monthly equations have been estimated from daily average historical EC records from Benicia, Port Chicago, Pittsburg, Collinsville, Emmaton, and Rio Vista for 1968-1991.

Reference: Wim Kimmerer & Stephen Monismith (1992) An estimate of the historical position of 2 ppt salinity in the San Francisco Bay estuary.

Steady-State X2 Location vs. Delta Outflow



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Analytical Tool Description Example 2

Tool and Category:	**Chinook Salmon Population Model (CPOP-2) Fisheries**
Purpose:	Estimate the effects of changes in flow, temperature, toxins, or morality rates (from natural causes and from fishing) on the population dynamics of fall-run chinook salmon stocks in the Sacramento River system.
Approach:	
Inputs:	Streamflow information for reaches in the Sacramento basin. User can also change a number of parameters in the model including temperature, concentration of toxins, and various mortality rates.
Methods:	CPOP-2 is a large, complex deterministic model that simulates Sacramento River fall-run chinook salmon population dynamics throughout the entire life cycle. A variety of natural and human-induced mortality rates are initially set based on literature information, but a number of these may be changed by the user. The model was developed primarily to simulate the effects of changes in streamflow on Sacramento fall-run chinook salmon, but it can also be used to simulate the effects of changes in other factors (e.g., temperature, fishing mortality, diversion mortality, etc.) including several in the Delta.
Results:	The results produced by this model are the simulated population dynamics of Sacramento River fall-run chinook salmon under various user-specified conditions.
Applications:	Results from this model can be used to estimate the potential effects of changing streamflow, temperature, and other factors on Sacramento River fall-run chinook salmon.
CALFED Potential:	High potential for use in CALFED Bay-Delta programs.
Documentation:	Kimmerer, W., J. Hagar, J. Garcia, and T. Williams. 1989. Chinook salmon population model for the Sacramento River Basin. Version CPOP-2. Submitted to California Department of Fish and Game, Sacramento, California.
Availability:	California Department of Fish and Game, Sacramento, California.

Analytical Relationship Example 2

Resource Category: Primary and Secondary Production
Relationship: Chlorophyll (ug/L) as a function of total phosphorus concentration

Description: empirical relationship between mean summer chlorophyll concentration and summer mean total phosphorus concentration among temperate streams worldwide.

Assumptions: Psuedo steady state.

Basis: Literature data.

Reference: Van Nieuwenhuyse, E. E., and J. R. Jones. 1996. Phosphorus-chlorophyll relationship in temperate streams and its variation with stream catchment area.