OFFICE OF WATER RECYCLING
State Water Resources Control Board
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Mr. Peter MacLaggan
San Diego County Water Authority
3211 Fifth Avenue
San Diego, California 92103-5718

Dear Peter:

COST-EFFECTIVENESS ANALYSIS REVIEW

In preparation for the forthcoming meeting on economic analysis procedures, several items are being transmitted herewith:

1. "Economic Analysis Workbook," draft, 9/29/95 (Enclosure 1): One of the alternatives developed by the review committee involves adjusting the freshwater alternative cost to reflect how freshwater alternatives are expected to evolve over the planning period as based on water supply needs, new technology, and other conditions. In addition, the committee suggested providing a workbook for the economic analyses that would provide more detailed and clear explanation of procedures, similar to the economic analysis section of the DWR funding application forms. Such a workbook has been drafted incorporating procedures to compute the economic cost of water reclamation projects and of freshwater alternatives. The workbook includes a table (Table 11) that provides a procedure incorporating the new concept of using long-term freshwater supply alternatives as a benchmark.

2. Tables 10A, 10B, and 10C (Enclosure 2), Economic Cost of Freshwater Alternatives, 9/29/95; and "Table 11: Water Supply Benefit," 9/29/95 (Enclosure 3): These tables are an example of how the long-term freshwater supply alternatives concept would adjust the freshwater cost. A hypothetical project located within the service area of San Diego County Water Authority was used for this analysis. Freshwater alternatives likely for the period 1997-2016 were selected based on studies related to the revision of DWR Bulletin No. 160; "San Diego County Water Authority Water Resources Plan", November 1993; and other background information. These alternatives and the assumed timing would be revised from time to time as new information became available. The primary purpose of these tables is to demonstrate the concept of using long-term freshwater supply alternatives as the basis for the freshwater alternative economic cost.

3. "Economic Cost of Alternative Freshwater Supply under Current Procedure" (Enclosure 4): This summarizes the cost components of the current procedure for the Orange-Los Angeles County area and the San Diego County Water Authority area.

4. "Comparison of Freshwater Alternative Economic Costs Using Two Different Analysis Procedures for Southern California Projects" (Enclosure 5): This table provides a comparison of the existing analytical procedure and the long-term freshwater supply alternatives procedure. By fixing certain freshwater alternatives to time spans, the long-term procedure provides a different result depending on the beginning of reclamation project operation.

If you have any questions, please call me at (916) 227-4578.

Sincerely,

Richard A. Mills

Richard A. Mills

Enclosures (5)

cc Adrian Griffin, Executive Office (w/enclosures)

File name: C-E-REVW.39

Enclosure 1

California State Water Resources Control Board
Office of Water Recycling

WATER RECLAMATION LOAN PROGRAM

ECONOMIC ANALYSIS WORKBOOK

DRAFT: 9/29/95

Introduction

An important component of project planning is the economic analysis to determine whether a water reclamation project is economically justified when compared with alternative sources of new water supply. The basis of determining whether a water reclamation project is economically justified is establishing that the cost of the proposed reclamation project does not exceed the cost of the least-cost freshwater alternative for additonal water. In benefit/cost terminology, the economic benefit of a water reclamation project is the avoided costs of developing a new freshwater supply. Background information on economic analyses and their role in the Water Reclamation Loan Program is provided in Appendix I.

A set of tables is included in Appendix II to be used to determine the costs of reclaimed water and alternative freshwater supplies. They also provide a format for determining the net new water yield of the water reclamation project, which is needed to complete the economic analysis. The tables are available in spreadsheet form (using Lotus 1-2-3) for use with most IBM-compatible computers. You may obtain a copy of the tables by contacting the Office of Water Recycling. The tables that are provided in the appendix are expected to fit most situations. Applicants should add or modify columns to the tables if this would be necessary to present the data clearly or correctly calculate the economic costs for a particular project.

Background Assumptions

Applicants must use the following assumptions in determining the benefits and costs for the proposed project:

Period of analysis. Economic evaluation of a water reclamation project will be based on a 20-year planning period. In general, the economic evaluation of alternative freshwater projects will also be based on a 20-year period. The remaining value of facilities having useful lives longer than 20 years is accounted for by incorporating a salvage value or by converting capital costs to equivalent annual costs using the discount rate and the appropriate useful life. Because many large-scale freshwater supply projects have long useful lives and long periods of build-up of water deliveries, often the period of economic analyses is 50

years or more. For water supply projects that will be used as a basis of comparison with water reclamation, it is acceptable to use a planning period longer than 20 years.

Inflation and escalation. All costs in economic analyses are to be presented in constant dollars.

Value of the dollar. Costs of all water reclamation and other water supply alternatives will be presented in equivalent dollars in order to ensure comparability. The applicant can use published cost indexes to bring historic cost data to current values. It is permissible to present costs in future dollars projected up to the expect period of construction, but all costs, including future operation and maintenance costs, must be projected to the same dollar basis, eliminating any inflation differential between various costs. The assumed cost escalation factor between current costs and the assumed date must be stated.

Discount Rate. Because benefits and costs are evaluated over a 20-year planning period, they must be discounted to reflect the value of money over time. (A dollar received today is worth more than one received in the future.) Discounting is accomplished by multiplying the monetary value of benefits and costs that occur during the planning period by a present value factor that decreases annually. The State Water Resources Control Board (SWRCB) uses a six-percent per annum discount rate.

Multiple-funded projects. The economic analysis will be made of the entire water reclamation or freshwater alternative being analyzed, regardless of funding sources. The applicant must include all project costs in the economic analysis, even if the requested loan would fund only part of the water reclamation project or of the freshwater alternatives being analyzed would receive state or federal grants or loans or other subsidies. These costs include replacement and operating costs, purchase of water, and the portion of construction costs funded from other sources.

Numbering years. "Year" in this application refers to a calendar year. The last year of construction is Year 0, so that Year 1 is the first year of project operation. If the design and construction period exceeds one year, design and construction years are identified as Year 0 (last year of construction), -1, -2, etc. This allows the use of computerized tables on the spreadsheet with the correct discount rates applied.

Net New Water Yield

In order to compare reclaimed water with fresh water on an equivalent basis, it is necessary to determine the amount of "new" water that is yielded by the water reclamation project and to determine whether the reclaimed water supply would offset new freshwater development. The amount of reclaimed water demand associated with a water reclamation project can differ from net new water yield in several ways. In addition, new water yield from a project

may not offset any new freshwater development. Examples of situations are described below.

Existing reclaimed water use. Deliveries of reclaimed water from a new project to users already taking reclaimed water from existing facilities do not result in a new water yield. An exception would be if regulations or problems would prevent the use of reclaimed water from the existing facilities to continue without the construction of a new reclamation project. For example, new regulations might prevent the continued use of secondary effluent for a particular use. Addition of tertiary treatment in a new project then would result in what would be considered a new water yield.

Water quality. The water quality of reclaimed water is usually poorer than of fresh water. For some uses, the use of reclaimed water may require more water than the same use of fresh water. For example, due to higher salts in reclaimed water, additional reclaimed water might be needed by agricultural users to leach added salt accumulation from the soil. Only the amount of freshwater use that is replaced by reclaimed water would be considered new water yield. The additional amounts of reclaimed water deliveries necessary for additional leaching would not count as new yield.

The quality of reclaimed water may be enhanced by blending reclaimed water with fresh water. In this case the freshwater portion of deliveries would not constitute new water yield.

Displaced fresh water that does not offset new development. Reclaimed water may displace fresh water from a source that is under-utilized and there is no anticipation that within the 20-year planning period a new water supply would be needed. Thus, the use of reclaimed water would not offset a new freshwater development. For example, a freshwater source might be a groundwater basin that with expanding use will still be within its safe yield during the 20-year planning period. In such a situation, reclaimed water deliveries would not be considered to offset new freshwater development.

Reclaimed water system limitations. Due to design limitations, the planned reclaimed water system may not be capable of meeting all system water demands with reclaimed water during part or all of the year or during future years of higher demand. In order to provide costs savings in trying to design a system that will meet peak demands, the system may be designed to accept supplemental water from another source during peaks. Due to concerns over certain water quality characteristics, the system may be designed to deliver a blend of fresh water and reclaimed water. The amount of supplemental water added to the reclaimed water system to meet all demands must be accounted for to determine the amount of water offsetting new freshwater development. The supplemental water would not offset new freshwater development.

Calculation of replacement of fresh water. Tables 1-4 in Appendix II are used to calculate the amount of replacement of fresh water that would offset new freshwater development and to determine the timing of the reclaimed water demand.

Table 1. The first step is to identify all reclaimed water users to be connected to the reclaimed water system and to record pertinent data in Table 1.

Column A: Applicants may assign numbers or codes to users to assist in correlating users in various parts of planning documents or on maps.

Column B: Enter the name of the user or use site.

Column C: Enter the name of the owner or operator of the use site, such as the name of a city or school district.

Column D: The source of fresh water that would be displaced by reclaimed water is shown in Column D. Either enter the current source of water or, in the case of future potential water users, enter the source of water that would be taken if reclaimed water were not available. If fresh water is or would be purchased from a water purveyor, enter the name of the purveyor. The planning documents with the loan application should describe the sources of water for each water purveyor and describe the relationship of each source of water with the need for new freshwater facilities within the project planning period.

Column E: Enter the amount of potential reclaimed water demand. If a particular water user is expected to increase its reclaimed water use during the planning period, this increase in demand along with the timing should be noted on this table.

Column F: Each type of use should be coded and the code entered in Column F. A list of recommended codes are shown in Table I.

Column G: The amount of replacement of fresh water that would offset new freshwater development is entered in Column G. The considerations discussed above should be a guide for entries in this column. Generally, the entries will be either 0 or the same amount as the reclaimed water demand. However, in some instances, the amount of reclaimed water and replaced fresh water will differ, as in the case of the need for more reclaimed water for leaching of soils.

Columns H and I: Each type of water use entails a characteristic variation in demand over time. Irrigation and industrial demands, for example, may represent different seasonal water demands patterns. The hourly water demands for landscape irrigation, for example, can differ depending on whether a user can accept reclaimed water during the day or night. These water use patterns should be described in the planning documents. Generally, most users will fall into a few standard patterns, which should be coded for notation in Columns H and I of Table 1.

Columns J and K: To establish the year when a user will begin using reclaimed water, the years when the user will exist or when on-site water facilities will be

modified to take reclaimed water should be entered in Columns J and K. If there any special comments regarding any site, a notation should be made in Column L and the full comment provided in Table 12. The sources of data for each column should be cited in Table 12, including chapter or page numbers of sources.

Table I: Suggested Reclaimed Water Use Codes

Type of Use	Code
Irrigation of other agricultural crops	A
Landscape irrigation	L
Landscape impoundment	LI
Industrial use	I
Use on site of wastewater treatment plant for washdown, landscaping, etc.	P
Recreational impoundment	EI
Wildlife habitat enhancement, live stream discharge, wetlands	EW
Miscellaneous environmental enhancement	E
Aquaculture	H
Groundwater recharge	G
Building interior uses (toilet flushing, etc.)	B

Table 2. The monthly water demand of all users to be connected to the proposed reclaimed water system is summarized in Table 2. All users having the same seasonal pattern of water demand can be combined on a single row according to the categories shown Column H in Table 1. If any demands are expected to increase during the planning period, it may be necessary to repeat Table 2 for several years sufficient to determine the amount of fresh water displaced by the project each year. As a minimum, this table should be completed for the year of highest water demand, the year of least available reclaimed water supply, or year of most critical condition of being able to meet system demands with reclaimed water. The applicable year should be entered in the table title.

Table 3. The purpose of Table 3 is to determine the amount of supplemental water that is to be added to the reclaimed water system to meet all water demands connected to the system and to determine the net water demand offsetting new freshwater supply development. The basis of this determination is if there is insufficient reclaimed water to meet all reclaimed

water demands connected to the system, the available reclaimed water would be allocated 1) first to existing reclaimed water users, 2) second to water users that displace fresh water offsetting new water development, and 3) last to water users that do not displace fresh water offsetting new water development. If it was determined from Table 3 for the most critical year that all reclaimed water system demands offset new freshwater development, then it will not be necessary to repeat Table 3 for other years. If changes in reclaimed water supply or demand are uniform over the planning period, it may be possible to repeat Table 3 for only a few years and use interpolation to compute results for the intervening years.

Rows 1: These data are taken from the totals in Table 2.

Rows 2 and 4: These data are derived from Row 1 and the responses in Column G in Table 1.

Row 3: The sum of Rows 1 and 2.

Row 5: The sum of Rows 3 and 4.

Row 6: The maximum amount of reclaimed water available for each month based on limitations in supply of wastewater or capacities of treatment or distribution facilities.

Row 7: If Row 6 is less than Row 5, Row 7 = Row 5 - Row 6
otherwise, Row 7 = 0

Row 8: If Row 6 is less than Row 1, Row 8 = Row 2
If Row 6 is less than Row 3, then Row 8 = Row 3 - Row 6
otherwise, Row 8 = 0

Row 9: Row 2 - Row 8.

The source for the data in Row 6 should be cited in Table 12.

Table 4. The water supply and demand data needed for the economic analysis are summarized in Table 4. Data are shown for each year. The data are derived from Table 3 or interpolations between the years for which Table 3 was calculated. Any special assumptions or procedures used to calculate entries for Table 4 should be explained.

Economic Cost of Water Reclamation Projects

The economic cost of water reclamation projects is derived using Tables 5, 6, and 7.

Table 5. Capital costs of a water reclamation project are summarized in Table 5. Construction costs should be itemized at least by major project component. The number of rows in Table 5 can be expanded as necessary to characterize a project.

Column A: Rows are numbered for ease of reference, such as in documenting where data were obtained from.

Column B: Describe the cost elements in Column B. Note that all elements necessary for a complete project should be identified, including project features that will be constructed or paid for by entities other than the loan applicant. The most common of these features is the on-site retrofit costs incurred by users to be able to use reclaimed water. Costs should also include reclaimed water distribution systems that will be constructed by other water purveyors or that will be constructed in future phases to reach the reclaimed water users claimed to be a part of the project.

Column C: Enter the time span when each cost element is expected to be incurred.

Column D: The costs as estimated in the source documents are entered in Column D. These may not have been adjusted to a common time basis.

Column E: If the source costs are on a different time basis than the assumed time basis for the economic analysis, the costs are adjusted in Column E. The notes at the bottom of the table provide blanks to enter the time basis of the costs.

Column F: The useful life of each cost element is entered in Column F. A recommended schedule of useful lives is shown in Table II.

Column G: The salvage value of each cost component at the end of the planning period is calculated and entered in Column G. Assume straight-line depreciation. Thus,

$$\text{Salvage value} = (\text{Capital cost}) \times \frac{(\text{Useful life} - 20 \text{ years})}{(\text{Useful life})}$$

The salvage value for components that have useful lives less than 20 years will depend on the remaining life of the component after its last replacement before the end of the planning period.

The sources of all cost data should be cited in Table 12.

Table II: Recommended Schedule of Useful Lives

Item	Useful life, years

Wastewater treatment facilities	30
Pipelines	50
Water storage tanks	50
Pump stations	30
Design, services during construction	0
Land, rights-of-way	Unlimited
Construction contingencies	Same as primary construction components

Table 6. Operation and maintenance costs are identified and calculated in Table 6. Generally, costs can be separated into two categories: fixed and variable. Fixed costs will not vary significantly with project water deliveries. Variable costs will be significantly affected by project water deliveries.

Column A: Rows are numbered for ease of reference, such as in documenting where data were obtained from.

Column B: Describe the cost elements in Column B.

Column C: Enter the fixed cost portion of the cost element in Column C.

Column D: Often, the variable costs are proportional to water production or deliveries and can be expressed in unit costs. Enter the unit cost in this column. If supplemental water is introduced into the reclaimed water system, some costs may related only to the reclaimed water portion or the supplemental water portion. If the cost proportional to units of water other than total water delivered through the reclaimed water system, then it should be noted what the relevant measure is.

Column E: Enter the total annual cost of the cost element in the last year of analysis in Column E. Because water production or deliveries may vary over time, this cost will be only an example. Each year's costs are entered in Table 7. The sources of all cost data should be cited in Table 12. The time basis for the dollars used in this table should correspond with Table 5 and should be shown at the bottom of Table 6.

Table 7. The unit cost of the water reclamation project is determined in Table 7.

Column A: Rows are numbered for ease of reference, such as in documenting where data were obtained from.

Columns B and C: The calendar years are entered in Column C, assuming that year 0 is the final year of construction and year 1 is the first year of operation.

Column D: Total deliveries to users are equivalent to total reclaimed water system demand, obtained from Column C in Table 4.

Column E: Enter the reclaimed water component of the deliveries from the reclaimed water system, obtained from Column D in Table 4.

Column F: Enter the new freshwater supply demand replaced in Column F, obtained from Column F in Table 4.

Column G: Enter costs of design, land, and rights-of-way in Column G, obtained from Parts III and V, Column E in Table 5. The years of occurrence of capital costs should correspond with Column C in Table 5. Costs spanning more than one year should be allocated to specific years.

Column H: Enter costs of construction, construction contingencies, and services during construction in Column H, obtained from Parts I, II, and IV, Column E in Table 5. The years of occurrence of capital costs should correspond with Column C in Table 5. Costs spanning more than one year should be allocated to specific years. If there are major replacements during the planning period not accounted for in the operation and maintenance costs, such as pump replacement, those can be entered as construction costs or a new column can be added.

Columns I and J: Enter fixed operation and maintenance costs in Column I, obtained from Column C in Table 6. Enter variable costs in Column J, using the unit costs in Column D in Table 6, multiplied by the appropriate quantity, such as Column D or E. The amount in year 20 should correspond with the total in Column E in Table 6.

Column K: Reclaimed water that has not been treated in a process that would remove plant nutrients can have the beneficial effect of reducing the fertilizer needs of reclaimed water users. A credit can be shown in the economic analysis for this effect in Column K. The value of fertilizer credit is assumed to be $15 per acre-foot multiplied by the quantity of reclaimed water delivered to landscape irrigation users. A different value can be used if supported by calculations. If some of the reclaimed water users are industrial or commercial users, it may be appropriate to add another column to show the portion of Column E that is delivered to irrigation users.

Column L: The salvage value is entered in year 20, obtained from Column G in Table 5.

Column M = Column G + Column H + Column I + Column J - Column K - Column L

Column O = Column M x Column N

Column P = Column F x Column N

$$\text{Water reclamation project unit cost} = \frac{\text{(Total Column O)}}{\text{(Total Column P)}}$$

Economic Cost of Freshwater Supply Development Projects

It must be documented in the loan application that the sources of fresh water serving or that would serve the potential reclaimed water users of the proposed water reclamation project will be fully used to capacity during the planning period. Thus, at least some component of the freshwater supply system will need expansion or upgrading. The types of facilities and alternatives needed to augment the water supplies are often identified in water resources planning documents of local, regional, or state water supply agencies.

Because the scale, timing, and implementation of freshwater supplies and water reclamation projects are generally independent of each other, it is generally necessary to determine the unit costs of the alternative freshwater supplies to use as a basis of comparison with reclaimed water. Tables 8 through 10 can be used to calculate the economic unit cost of a freshwater supply development project. These tables may not be entirely suitable in particular circumstances, such as for multiple objective projects requiring cost allocation. Other formats are acceptable as long as the general approach is equivalent. All costs for freshwater projects should be adjusted to equivalent dollars comparable to the reclamation project costs.

During a 20-year planning period water supplies may have to be augmented in two or more stages. If documentation can be provided identifying the stages and planned projects over time, Table 11 can be used to integrate the unit costs of various freshwater projects planned over time into a single economic cost. Tables 8 through 10 would be prepared for each project as a basis for the data in Table 11.

Because local water retailers may depend on water supplies from regional or state agencies, the local retailers may not be familiar with the future water supply projects and their costs to use in the economic analysis. The Office of Water Recycling will assist a loan applicant to obtain the appropriate information. In some cases, certain regional and state water cost data will already be available for use.

Table 8. Capital costs of a freshwater project are summarized in Table 8. The instructions for Table 5 apply to Table 8.

Table 9. Operation and maintenance costs are identified and calculated in Table 9. The instructions for Table 6 apply to Table 9.

Table 10. The unit cost of the freshwater project is determined in Table 10. The instructions for Table 7 generally apply to Table 10.

Table 11. Table 11 is a format to compute a single unit cost of alternative freshwater supplies when it is assumed that over the planning period reclaimed water use would offset more than one new freshwater supply development.

Columns A and B: The calendar years are entered in Column B, assuming that year year 1 is the first year of operation of the water reclamation project.

Column C: Enter the name of the freshwater alternative that would be offset by the water reclamation project in Column C. If more than one alternative supply will be needed over the planning period, list each alternative during the period that it would be expected to be implemented.

Column D: Enter the unit cost of the freshwater project named in Column C in Column D. Table 10 for the appropriate project would be the source of this cost.

Column E: Enter the new freshwater supply demand that is replaced or offset by the water reclamation project in Column E, obtained from Column F in Table 4.

Column F = Column D x Column E

Column H = Column F x Column G

Column I = Column E x Column G

The final freshwater unit cost is calculated:

$$\text{Freshwater unit cost} = \frac{\text{(Total Column H)}}{\text{(Total Column I)}}$$

Documentation

Table 12. All sources of data in the tables must be documented in Table 12 by citing the sources in the planning documents and other loan application attachments. The citations should be as specific as possible, referring to chapters, tables, or pages in documents. Any special notes about any column or row or specific entry in any of the tables can also be made here.

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Appendix I

BACKGROUND INFORMATION ON ECONOMIC ANALYSES OF RECLAMATION PROJECTS

As part of the cost-effectiveness analysis of water reclamation projects, it is necessary to perform an economic analysis to determine whether a project is economically justified. It is common for a project proponent to consider a project monetarily justified if the proponent's revenues from a project exceed its expenses. While this approach may be prudent from the standpoint of ensuring that an agency remain financially whole, it may not lead to support of the most cost-effective project to meet an objective. The purpose of this paper is to explain what is intended by an economic analysis and to relate the analysis to projects proposed in the Water Reclamation Loan Program.

There are two general categories of monetary analyses: economic analysis and financial analysis. The purpose of the economic analysis is to determine all monetary costs and benefits regardless of who pays the costs or receives the benefits with the intent of determining the alternative of least cost and whether a project is justified in monetary terms. The economic analysis does not have the viewpoint of any particular public agency or private entity. On the other hand, a financial analysis is intended to determine who pays the costs and receives the benefits and to determine financial feasibility. Economic justification and financial feasibility do not always follow hand-in-hand, especially when subsidies are present or when water pricing structures represent average costs of existing facilities rather than marginal costs of new water developments, common situations in the California water industry.

The objective of the Water Reclamation Loan Program is to improve the financial feasibility of projects that are economically justified by providing capital funds at a subsidized interest rate. The basis of the economic criterion is found in the bond laws establishing the loan program. "Eligible water reclamation project" is defined as the "water reclamation project which is cost-effective when compared to the development of other new sources of water ..." in the Clean Water Bond Law of 1984 and "eligible reclamation project" means "a water reclamation project which is cost-effective when compared with the cost of alternative new freshwater supplies ..." in the Clean Water and Water Reclamation Bond Law of 1988. By policy of the State Water Resources Control Board (State Water Board) a cost-effectiveness analysis includes an economic analysis, which considers all monetary costs associated with each alternative and which will be given primary consideration unless other factors are overriding. Within this program, projects are justified in monetary terms by performing economic analyses comparing reclamation project alternatives with each other as well as with freshwater alternatives, which are the bench mark specified in the law.

In an economic analysis, project alternatives are usually compared on the basis of total net present worth of costs or net equivalent annual costs. Such a basis presumes that all

alternatives meet the same objectives or provide the same output. To provide a common basis in which to compare costs of water reclamation projects of various sizes and to compare costs of water reclamation with alternative freshwater projects, economic costs are to be reduced to unit costs of dollars per acre-foot. The data base and many of the procedures of economic analyses are common with financial analyses, which are usually performed by local agencies.

While the basic procedures of performing an economic analysis are common, certain rules apply to economic analyses that do not apply to financial feasibility analyses usually performed by local agencies. The most important rules are explained on our "Water Reclamation Loan Program Guidelines" and the "Loan Application Instructions". Additional information is found in the State Water Board's Interim Guidelines for Economic and Financial Analyses of Water Reclamation Projects and in a paper by Mills and Asano, "The Economic Benefits of Using Reclaimed Water" (Journal of Freshwater, 1986/87).

The data needed to determine the economic cost of water reclamation alternatives consist of the capital costs, operation and maintenance costs, and reclaimed water deliveries of the projects. One aspect of this analysis that can be confusing is that reclaimed water deliveries do not always translate into freshwater savings. In some cases, such as cooling towers, potable water must be replaced with a greater quantity of reclaimed water because of the poorer quality of the reclaimed water. Also, the replacement of fresh water in one location may merely shift the demand for fresh water to another location. The objective of the bond laws is to replace fresh water and augment water supplies. Therefore, in addition to determining the amount of reclaimed water deliveries for a proposed water reclamation project, it is necessary to estimate the amount of potential freshwater deliveries displaced. To provide a common basis of cost comparison with freshwater projects, the economic analysis is used to determine the cost per unit of fresh water replaced by the reclamation project.

Some water reclamation projects are proposed to serve water users that are not and would not be served with fresh water due to the minimal benefit of the use of the water, the general inaccessibility of fresh water, or the extremely high cost of fresh water. The advisory committee to the State Water Board that helped draft the 1984 bond law had a clear consensus that the loan program should not be used to subsidize projects that 1) create new uses of water or 2) are not cost-effective. The definition of "eligible water reclamation project" was worded to meet these two concerns by using alternative sources of fresh water as a benchmark.

The freshwater analysis for comparison with the reclamation alternatives can be more difficult for an applicant. The freshwater alternative must be a realistic, feasible alternative that is seriously being considered to accommodate increasing water demands in the project area. The reclaimed water produced by the project must offset the same water demands as the freshwater alternative being used for comparison. Water supply studies are available for many areas of the state where reclamation projects are being proposed. If such studies are

available, the economic analysis of the freshwater alternative is greatly facilitated. In a few areas, recent studies may not be available or water planning may be in a state of flux and an appropriate alternative is unclear. Nevertheless, the applicant must demonstrate that there is a future unmet water demand and that water projects are seriously being proposed to meet this demand and to provide the costs of such projects.

In an attempt to justify some expensive water reclamation projects, seawater desalination has been proposed as the alternative water supply for cost comparison, because desalination is very expensive. It must be shown, however, that desalination is being pursued seriously and on more than an experimental basis, as evidenced by water supply planning reports.

Assistance is available from the Office of Water Recycling of the State Water Board is developing economic analyses for water reclamation projects and their appropriate freshwater alternatives. With the assistance of the California Department of Water Resources and regional water wholesale agencies, data have been developed for much of the service area of the State Water Project for use in the freshwater cost analyses.

Appendix II

Economic tables

To evaluate the economic justification of the local water supply project, Tables 1, through 11 are provided. The tables are available as Lotus 1-2-3 files on floppy disks from the Office of Water Recycling.

PROJECT:
AGENCY:
DATE:

TABLE 1: LIST OF PLANNED RECLAIMED WATER USERS

SITE CODE OR NO.	SITE NAME	SITE OWNER OR OPERATOR	WATER PURVEYOR OR SOURCE OF FRESH WATER	ANNUAL RECLAIMED WATER DEMAND, AF/year	TYPE OF USE	AMOUNT OF OFFSET NEW WATER DEVEL-OPMENT, AF/year	MONTHLY WATER DEMAND VARIA-TION	HOURLY WATER DEMAND VARIA-TION	STATUS OF DEVELOP-MENT: EXISTING OR DATE SITE WILL EXIST	STATUS OF ON-SITE RETROFIT	NOTE CODE
A	B	C	D	E	F	G	H	I	J	K	L

File name: TABLE1.WK1

PROJECT:
AGENCY:
DATE:

TABLE 2: CALCULATION OF PROJECT MONTHLY RECLAIMED WATER SYSTEM DEMAND -- YEAR _____

MONTHLY DEMAND CATEGORY A	WATER DEMAND, ACRE-FEET												
	JAN B	FEB C	MAR D	APR E	MAY F	JUN G	JUL H	AUG I	SEP J	OCT K	NOV L	DEC M	TOTAL N
TOTAL SYSTEM													

File name: TABLE2.WK1

PROJECT:
AGENCY:
DATE:

TABLE 3: DETERMINATION OF FRESH WATER REPLACED -- YEAR _____

ROW	FACTOR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1	EXISTING RECLAIMED WATER DEMAND													
2	NEW RECLAIMED WATER DEMAND--OFFSETS NEW WATER DEVELOPMENT													
3	SUBTOTAL OF DEMAND													
4	NEW RECLAIMED WATER DEMAND--DOES NOT OFFSET NEW WATER DEVELOPMENT													
5	TOTAL SYSTEM DEMAND													
6	AVAILABLE RECLAIMED WATER SUPPLY													
7	TOTAL SUPPLEMENTAL WATER SUPPLY													
8	SUPPLEMENTAL WATER SUPPLY NEEDED TO SERVE ROW 2 DEMAND													
9	NET NEW FRESHWATER SUPPLY DEMAND REPLACED													

File name: TABLE3.WK1

PROJECT: _____
AGENCY: _____
DATE: _____

TABLE 4: SUMMARY OF WATER DEMANDS

YEAR		TOTAL RECLAIMED WATER SYSTEM DEMAND, AF	RECLAIMED WATER SUPPLIED, AF	SUPPLEMENTAL WATER SUPPLIED, AF	NEW FRESHWATER SUPPLY DEMAND REPLACED, AF
RELATIVE	ACTUAL				
A	B	C	D	E	F
0		0	0	0	0
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Calculation procedures for any data not derived directly from Table 3:

PROJECT: _____

AGENCY: _____

DATE: _____

TABLE 5: CAPITAL COSTS, SALVAGE VALUES, YEARS OF COSTS WATER RECLAMATION PROJECT

ROW	ITEM	YEAR OF COST EXPENDITURE	CAPITAL COST, $	ADJUSTED CAPITAL COST, $	USEFUL LIFE, Years	SALVAGE VALUE AT END OF PLANNING PERIOD, $
A	B	C	D	E	F	G
1	I. CONSTRUCTION					
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19	Total Construction Costs					
20						
21	II. CONSTRUCTION CONTINGENCIES					
22						
23						
24						
25	III. DESIGN					
26						
27						
28						
29						
30	IV. SERVICES DURING CONSTRUCTION					
31						
32						
33	V. LAND AND RIGHTS-OF-WAY					
34						
35						
36	VI. OTHER					
37						
38						
39						
40	VII. TOTAL PROJECT COSTS					
41						

DATE OR COST INDEX REFERENCE FOR DOLLARS OF UNADJUSTED CAPITAL COST:

Date: _____ Cost index: _____ Name of index: _____

DATE OR COST INDEX REFERENCE FOR DOLLARS OF ADJUSTED CAPITAL COST AND SALVAGE VALUE:

Date: _____ Cost index: _____ Name of index: _____

File name: TABLE5.WK1

PROJECT: _____

AGENCY: _____

DATE: _____

TABLE 6: OPERATION AND MAINTENANCE COSTS
WATER RECLAMATION PROJECT

ROW	ITEM	FIXED COSTS, $/year	VARIABLE COSTS	
			UNIT COST, $/AF	ANNUAL COST IN LAST YEAR, $
A	B	C	D	E
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22	TOTAL PROJECT OPERATION AND MAINTENANCE COSTS			

DATE OR COST INDEX REFERENCE FOR DOLLARS:

Date: _____ Cost index: _____ Name of index: _____

File name: TABLE6.WK1

PROJECT: _____
AGENCY: _____
DATE: _____

TABLE 7: ECONOMIC COST OF WATER RECLAMATION PROJECT

ROW	YEAR		TOTAL DELIVERIES TO USERS, AF	RECLAIMED WATER COMPONENT OF DELIVERIES, AF	NEW FRESHWATER SUPPLY DEMAND REPLACED, AF	DESIGN, LAND, RIGHTS-OF-WAY, $	CONSTRUCTION, SERVICES DURING CONSTRUCTION, OTHER, $	OPERATION & MAINTENANCE, $		FERTILIZER CREDIT, $	SALVAGE VALUE, $	TOTAL COSTS, $	PRESENT WORTH FACTOR, 6 %	PRESENT WORTH OF COSTS, $	PRESENT WORTH OF YIELD, AF
	RELA-TIVE	ACTUAL						FIXED	VARIABLE						
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	-5												1.3382		
2	-4												1.2625		
3	-3												1.1910		
4	-2												1.1236		
5	-1												1.0600		
6	0												1.0000		
7	1												0.9434		
8	2												0.8900		
9	3												0.8396		
10	4												0.7921		
11	5												0.7473		
12	6												0.7050		
13	7												0.6651		
14	8												0.6274		
15	9												0.5919		
16	10												0.5584		
17	11												0.5268		
18	12												0.4970		
19	13												0.4688		
20	14												0.4423		
21	15												0.4173		
22	16												0.3936		
23	17												0.3714		
24	18												0.3503		
25	19												0.3305		
26	20												0.3118		
27	TOTAL														

WATER RECLAMATION PROJECT UNIT COST = (TOTAL COLUMN O)/(TOTAL COLUMN P) = _____ / _____ = _____ $/AF.

File name: TABLE7.WK1

PROJECT: _____

AGENCY: _____

DATE: _____

TABLE 8: CAPITAL COSTS, SALVAGE VALUES, YEARS OF COSTS
FRESHWATER PROJECT _____

ROW	ITEM	YEAR OF COST EXPENDITURE	CAPITAL COST, $	ADJUSTED CAPITAL COST, $	USEFUL LIFE, Years	SALVAGE VALUE AT END OF PLANNING PERIOD, $
A	B	C	D	E	F	G
1	I. CONSTRUCTION					
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19	Total Construction Costs					
20						
21	II. CONSTRUCTION CONTINGENCIES					
22						
23						
24						
25	III. DESIGN					
26						
27						
28						
29						
30	IV. SERVICES DURING CONSTRUCTION					
31						
32						
33	V. LAND AND RIGHTS-OF-WAY					
34						
35						
36	VI. OTHER					
37						
38						
39						
40	VII. TOTAL PROJECT COSTS					
41						

DATE OR COST INDEX REFERENCE FOR DOLLARS OF UNADJUSTED CAPITAL COST:

Date: _____ Cost index: _____ Name of index: _____

DATE OR COST INDEX REFERENCE FOR DOLLARS OF ADJUSTED CAPITAL COST AND SALVAGE VALUE:

Date: _____ Cost index: _____ Name of index: _____

File name: TABLE8.WK1

PROJECT: _____
AGENCY: _____
DATE: _____

TABLE 9: OPERATION AND MAINTENANCE COSTS
FRESHWATER PROJECT _____

ROW	ITEM	FIXED COSTS, $/year	VARIABLE COSTS	
			UNIT COST, $/AF	ANNUAL COST IN LAST YEAR, $
A	B	C	D	E
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22	TOTAL PROJECT OPERATION AND MAINTENANCE COSTS			

DATE OR COST INDEX REFERENCE FOR DOLLARS:
Date: _____ Cost index: _____ Name of index: _____

File name: TABLE9.WK1

PROJECT: _____
AGENCY: _____
DATE: _____

TABLE 10: ECONOMIC COST OF FRESHWATER ALTERNATIVE
FRESHWATER PROJECT _____

ROW	YEAR		FRESHWATER PROJECT YIELD, AF	DESIGN, LAND, RIGHTS-OF-WAY, $	CONSTRUCTION, SERVICES DURING CONSTRUCTION, OTHER COSTS, $	OPERATION & MAINTENANCE		SALVAGE VALUE, $	TOTAL COSTS, $	PRESENT WORTH FACTOR, 6 %	PRESENT WORTH OF COSTS, $	PRESENT WORTH OF YIELD, AF
	RELATIVE	ACTUAL				FIXED	VARIABLE					
A	B	C	D	E	F	G	H	I	J	K	L	M
1	-5									1.3382		
2	-4									1.2625		
3	-3									1.1910		
4	-2									1.1236		
5	-1									1.0600		
6	0									1.0000		
7	1									0.9434		
8	2									0.8900		
9	3									0.8396		
10	4									0.7921		
11	5									0.7473		
12	6									0.7050		
13	7									0.6651		
14	8									0.6274		
15	9									0.5919		
16	10									0.5584		
17	11									0.5268		
18	12									0.4970		
19	13									0.4688		
20	14									0.4423		
21	15									0.4173		
22	16									0.3936		
23	17									0.3714		
24	18									0.3503		
25	19									0.3305		
26	20									0.3118		
27	TOTAL											

FRESHWATER PROJECT UNIT COST = (TOTAL COLUMN L)/(TOTAL COLUMN M) = _____ / _____ = _____ $/AF.

File name: TABLE10.WK1

PROJECT:
AGENCY:
DATE:

TABLE 11: WATER SUPPLY BENEFIT

YEAR		NAME OF FRESHWATER ALTERNATIVE	BENEFIT (ALTERNATIVE COST), $/AF	NEW FRESHWATER SUPPLY DEMAND REPLACED, AF	TOTAL BENEFITS, $	PRESENT WORTH FACTOR, 6 %	PRESENT WORTH	
RELA-TIVE	ACTUAL						BENEFITS, $	FRESHWATER DEMAND REPLACED, AF
A	B	C	D	E	F	G	H	I
1						0.9434		
2						0.8900		
3						0.8396		
4						0.7921		
5						0.7473		
6						0.7050		
7						0.6651		
8						0.6274		
9						0.5919		
10						0.5584		
11						0.5268		
12						0.4970		
13						0.4688		
14						0.4423		
15						0.4173		
16						0.3936		
17						0.3714		
18						0.3503		
19						0.3305		
20						0.3118		
TOTAL								

File name: TABLE11.WK1

PROJECT: ______________________________
AGENCY: ______________________________
DATE: ______________________________

TABLE 12: DOCUMENTATION AND NOTES

TABLE NO.	COLUMN OR ROW NO.	SOURCES, ABBREVIATIONS, NOTES

Enclosure 2

PROJECT: HYPOTHETICAL SAN DIEGO COUNTY PROJECT
AGENCY:
DATE: 9/29/95

TABLE 10A: ECONOMIC COST OF FRESHWATER ALTERNATIVE
FRESHWATER PROJECT: BRACKISH GROUNDWATER RECOVERY

COMPONENT	YEARS OF APPLICABILITY	UNADJUSTED UNIT COST, $/AF	ADJUSTED UNIT COST, $/AF
Groundwater recovery facilities, capital and O&M	1995-2000	500	500
Metropolitan Water District distribution system expansion, capital and O&M (1990 $)	1995-2020	190	214
San Diego County Water Authority distribution system expansion, capital cost (1990 $)	1995-2010	202	228
Total			942

TABLE 10B: ECONOMIC COST OF FRESHWATER ALTERNATIVE
FRESHWATER PROJECT: DOMENIGONI RESERVOIR

COMPONENT	YEARS OF APPLICABILITY	UNADJUSTED UNIT COST, $/AF	ADJUSTED UNIT COST, $/AF
Domenigoni Reservoir, capital and O&M (1992 $)	2001-2010	410	424
State Water Project/Colorado River transportation, O&M cost (1992 $)	1995-2020	80	83
Metropolitan Water District treatment and distribution system expansion, capital and O&M (1990 $)	1995-2020	279	315
San Diego County Water Authority distribution system expansion, capital cost (1990 $)	1995-2010	202	228
Total			1049

TABLE 10C: ECONOMIC COST OF FRESHWATER ALTERNATIVE
FRESHWATER PROJECT: SEAWATER DESALINATION

COMPONENT	YEARS OF APPLICABILITY	UNADJUSTED UNIT COST, $/AF	ADJUSTED UNIT COST, $/AF
Seawater desalination, capital and O&M	2011-2020	1500	1500
Metropolitan Water District distribution system expansion, capital and O&M (1990 $)	1995-2020	190	214
San Diego County Water Authority distribution system expansion, capital cost (1990 $)	1995-2010	202	228
Total			1942

[a] Costs adjusted to July 1995 using ENRCCI: 1990, 5795.21 (Los Angeles); July 1992, 6321.30 (Los Angeles); July 1995, 6533 (Los Angeles).

File name: CETEST10.WK1

Enclosure 3

PROJECT: HYPOTHETICAL SAN DIEGO COUNTY PROJECT
AGENCY:
DATE: 9/29/95

TABLE 11: WATER SUPPLY BENEFIT

YEAR		NAME OF FRESHWATER ALTERNATIVE	BENEFIT (ALTERNATIVE COST), $/AF	NEW FRESHWATER SUPPLY DEMAND REPLACED, AF	TOTAL BENEFITS, $	PRESENT WORTH FACTOR, 6 %	PRESENT WORTH	
RELA-TIVE	ACTUAL						BENEFITS, $	FRESHWATER DEMAND REPLACED, AF
A	B	C	D	E	F	G	H	I
1	1997	Brackish groundwater	942	500	471,000	0.9434	444,340	472
2	1998	"	942	625	588,750	0.8900	523,985	556
3	1999	"	942	750	706,500	0.8396	593,191	630
4	2000	"	942	875	824,250	0.7921	652,883	693
5	2001	Domenigoni Reservoir	1049	1000	1,049,000	0.7473	783,874	747
6	2002	"	1049	1000	1,049,000	0.7050	739,504	705
7	2003	"	1049	1000	1,049,000	0.6651	697,645	665
8	2004	"	1049	1000	1,049,000	0.6274	658,156	627
9	2005	"	1049	1000	1,049,000	0.5919	620,901	592
10	2006	"	1049	1000	1,049,000	0.5584	585,756	558
11	2007	"	1049	1000	1,049,000	0.5268	552,600	527
12	2008	"	1049	1000	1,049,000	0.4970	521,321	497
13	2009	"	1049	1000	1,049,000	0.4688	491,812	469
14	2010	"	1049	1000	1,049,000	0.4423	463,974	442
15	2011	Seawater desalination	1942	1000	1,942,000	0.4173	810,329	417
16	2012	"	1942	1000	1,942,000	0.3936	764,461	394
17	2013	"	1942	1000	1,942,000	0.3714	721,190	371
18	2014	"	1942	1000	1,942,000	0.3503	680,368	350
19	2015	"	1942	1000	1,942,000	0.3305	641,856	331
20	2016	"	1942	1000	1,942,000	0.3118	605,525	312
TOTAL							12,553,670	10,356

Freshwater unit cost = Column H/Column I = 1,212 $/AF

File name: CETEST11.WK1

Enclosure 4

ECONOMIC COST OF ALTERNATIVE FRESHWATER SUPPLY
UNDER CURRENT PROCEDURE

PROJECT: HYPOTHETICAL ORANGE-LOS ANGELES COUNTY PROJECT

Component	Unadjusted Unit Cost (July 1991 $) $/AF	Adjusted Unit Cost, (July 1995 $) $/AF
State Water Project Los Banos Grandes Reservoir, capital cost	271	306
State Water Project transportation, O&M cost	111	125
MWD treatment and distribution system expansion, capital and O&M cost	293	314
Total	675	746

PROJECT: HYPOTHETICAL SAN DIEGO COUNTY PROJECT

Component	Unadjusted Unit Cost (July 1991 $), $/AF	Adjusted Unit Cost (July 1995 $) [a], $/AF
State Water Project Los Banos Grandes Reservoir, capital cost	271	306
State Water Project transportation, O&M cost	111	125
MWD treatment and distribution system expansion, capital and O&M cost	293	314
San Diego County Water Authority distribution system expansion, capital cost	223	239
Total	898	985

[a] Costs adjusted using the following ENRCCI: July 1991, 4853.89 (20 city), 6089.06 (Los Angeles); July 1995, 5484.44 (20 city), 6533 (LA).

File name: CE-LBG.WK1 9/29/95

Enclosure 5

COMPARISON OF FRESHWATER ALTERNATIVE ECONOMIC COSTS USING TWO DIFFERENT ANALYSIS PROCEDURES FOR SOUTHERN CALIFORNIA PROJECTS

Economic Analysis Procedure	Start of Project Operation	Freshwater Alternative Cost [a], $/AF	
		Orange-Los Angeles Counties	San Diego County
Existing Procedure: Los Banos Grandes Project		746	985
Long-term Freshwater Alternatives	1997	984	1212
	1998	1030	1258
	1999	1077	1305
	2000	1125	1353

[a] Costs adjusted to July 1995 dollars.

File name: C-E-REVW.39