INTERIM GUIDELINES

for Economic and Financial Analyses of Water Reclamation Projects

February 1979

OFFICE OF WATER RECYCLING

State Water Resources Control Board

INTERIM GUIDELINES FOR ECONOMIC AND FINANCIAL ANALYSES OF WATER RECLAMATION PROJECTS

Prepared for

OFFICE OF WATER RECYCLING

STATE WATER RESOURCES CONTROL BOARD

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I. INTRODUCTION

A. Purpose of the Guidelines

The State Water Resources Control Board has adopted a plan to emphasize the reclamation and reuse of treated wastewater. This plan recognizes the existing water shortage in certain areas of California and the higher levels of treatment now required by environmental regulations. The opportunity now exists to construct financially feasible and economically justifiable reclamation projects which will qualify for state and federal grants.

These Guidelines present procedures, forms and examples for performing economic and financial analyses of proposed water reclamation projects being studied under the State and Federal Clean Water Construction Grant Program.(1) The reason for developing these Guidelines is first, to elaborate on the U.S. Environmental Protection Agency (EPA) regulations and make them specific to reclamation projects and second, to assist the engineers and financial advisors in performing appropriate economic and financial evaluation.

These Guidelines should assist grant applicants in determining the most cost-effective reclamation alternative in a manner consistent with the "Cost-Effectiveness Analysis Guidelines"(2) issued by the EPA to implement the Federal Water Pollution Control Act and consistent with SWRCB's Grants Management Memorandum No. 9.01, Wastewater Reclamation. A detailed Glossary of terms appears at the end of the Guidelines.

Accordingly, the Guidelines will:

- Present a methodology for quantifying the costs and values to be considered in evaluating reclamation as a source of water supply.

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(1) Authorized under California Clean Water Bond Laws of 1970 and 1974 and Clean Water and Water Conservation Bond Law of 1978 and under Federal Water Pollution Control Act, Section 201.

(2) 40 CFR Part 35, Subpart E, Appendix A.

- o Demonstrate techniques useful in comparing alternative water resource management projects and procedures for "cost-effectiveness analysis."

- o Describe the methods of evaluating wastewater reclamation projects under conditions of:

  - Scarcity: the impending need of additional water supply to serve existing markets.

  - Novel Application: the use of reclaimed water in a new market not currently filled by an alternative water source.

  - Abundance: the use of reclaimed water in the presence of an adequate supply of water from existing sources.

- o Demonstrate the techniques of financial analysis appropriate to public sector project analysis.

- o Discuss procedures for allocating costs of multipurpose projects between water pollution control and water supply objectives.

- o Establish a technique for dealing with the uncertainties of energy supply and inflation in the context of project planning.

Each major topic will be presented in a progression: basic theory and application with relevant examples, then generalized procedures coupled with appropriate data forms. The State is the general frame of reference for presenting these procedures, although, this context does not omit local or national economic consequences.

A reclamation water project is economically viable when the benefits associated with the project exceed the costs. Optimal investment criteria dictate that scarce funds should be allocated among the set of "economically viable" projects in descending order of net present value, which is the appropriately discounted flow of the benefits minus the opportunity costs of the resources required to produce the reclaimed water. The "opportunity cost" concept is the real cost to society of a resource, that is, the maximum value which would be earned by the resource in an alternative use.

Given these general investment directives, a careful distinction must be made between economic analysis and financial analysis.

Economic analysis focuses on the basic opportunity costs of goods and services computed in the present value calculation. Financial analysis, on the other hand, is based on the market monetary value of goods and services at the time of sale, incorporating any particular subsidies or transfers which may exist. Whereas economic analysis evaluates projects in the context of impacts on society, financial analysis focuses instead on local ability to raise money from project revenues, government grants, loans, and bonds to pay for the project. Both orientations, therefore, are necessary. However, only projects which are viable in the economic context should be given further consideration and have financial analysis performed for them.

B. Economic Analysis: An Overview

The objective of economic analysis is the determination of optimal use of resources; that is, which particular available alternative provides the very best use of resources in the sense of maximizing the net gain to society (benefits minus costs discounted over time). Economic analysis considers only the future flow of costs and benefits for decision making and disregards previous expenditures (except any salvage value of the facilities) as sunk costs which do not directly affect the allocation of resources in the future. The idea here is that expenditures made in the past are history and cannot be changed by decisions made today. The best allocation of scarce funds today is determined by the opportunity cost of the investment.

The challenge is to find where the next dollar(s) spent will bring forth the greatest benefits for the public in the future. For economic purposes costs are defined in terms of "opportunity costs" or "alternative costs"; the real cost to society is the maximum value which that resource can earn in any alternative use. It should be noted that this economic definition of costs is quite distinct from accounting costs or engineering costs. Accountants often measure costs on a historical basis or other prearranged systems such as Generally Accepted Accounting Principles. Engineers tend to use market measures of cost without regard to alternative uses of the resources.

A critical issue confronting any evaluation of wastewater treatment facilities is weighing the benefits to society of reclamation projects in comparison with projects to deliver more fresh water. To perform this kind of economic analysis, the costs of fresh water must be valued by making a calculation which identifies the real resources (physical units) necessary to deliver the fresh water. These resources must then be valued at their (opportunity) market cost over the time span relevant to the analysis, that is, as they would appear without subsidies. It is only in this way that one can look at the actual resources which society foregoes by delivering different kinds of water, and then evaluate the benefits and costs obtained from those resources when they are allocated towards delivering fresh water versus delivering reclaimed water.

C. Financial Analysis: An Overview

An examination of the sources and uses of funds for each time period is required to determine whether or not a reclamation project is financially feasible. Financial solvency exists when there is sufficient working capital to fund the cost of construction, operation, maintenance and debt service. Financial feasibility analysis compares the monetary cost of building and operating a project with the funds generated from user charges and fees from loans, bonds and government grants.

The actual amount of revenue funds generated from users of reclaimed water depends on the actual level and structure of fees charged for pollution control and reclaimed water and on the total demand of each of these services. The actual structure and level of the rates which are charged have an important impact on revenue. However, it is not the purpose of these Guidelines to dictate rate policy or methodology.

D. The Uses of Reclaimed Water: Potential Markets

For many years, wastewater was considered a liability which had to be collected, treated, and returned (disposed) to the environment. Now, however, municipal wastewater is being recognized as a valuable resource. The reclamation and reuse of municipal wastewater offers many communities potential benefits rather than disposal liabilities. Reclamation reduces the overall volume of municipal wastes requiring disposal to the local environment and augments the existing water supplies. Reclaimed water is being utilized for many nonpotable purposes once served by fresh water sources. Irrigation of agricultural and landscaping areas is the major use of reclaimed water, followed by groundwater recharge and industrial and recreational uses. The reclamation and reuse of wastewater is due in part to:

- Regulatory agencies, supported by an environmentally-concerned citizenry, are imposing increasingly stringent standards on sewage treatment plant effluent. Thus, the quality of treated municipal wastewater is being upgraded and is often suitable for industrial and irrigation applications.

- "Population increases in many urban centers are placing an added burden on traditional fresh water supplies. In some parts of the U.S., augmentation of existing fresh water supplies by expanding supply sources, by importation, and/or by groundwater overdrafts is necessary to satisfy water requirement. Such water supply projects are very costly, and local governmental agencies are faced with large expenditures to supply citizens with accustomed volumes of fresh water. In addition, major water augmentation projects may cause significant environmental problems. As an alternative in many locations, reclaimed municipal wastewater is a readily available source of water for nonpotable uses to satisfy a portion of the area's demands, thereby delaying other supply projects that may involve greater environmental and economic risks."(3)

E. The Cursory Evaluation of Wastewater Reclamation Potential in an Area

Several site specific characteristics define the potential for wastewater reclamation in an area. The simple checklist in Table I-1 can help evaluate this potential.

If one or more reclamation factors exist, then a more detailed economic and technical analysis should be performed and a "facility plan" prepared.

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(3) This section was taken from "Cost-Effectiveness Analysis of Municipal Wastewater Reuse," by C. J. Schmidt and D. E. Ross, Water Planning Division, U.S. EPA, April 1976.

Table I-1

CHECKLIST FOR DETERMINING THE POTENTIAL PRACTICALITY OF WASTEWATER REUSE(4)

Wastewater reuse is potentially practical if one or more of the following factors are true for an area. Once established to be so, a more complete analysis should then be performed.

1. Existing or future fresh water supply is limited relative to demand.
2. Existing or future fresh water supply is expensive.
3. The area presently includes or will include individual users of large volumes of water.
4. Municipal wastewater that meets high-quality standards is presently discharged for disposal.
5. Requirements for improved wastewater effluent are impending or anticipated.
6. Wastewater disposal is expensive, e.g., a long outfall line is required.

(4) Ibid.

F. The Sequence of Analysis

A sequence of four steps are followed in the monetary evaluation to help select the optimum alternative wastewater management and reclamation project. First, the costs of constructing and operating each alternative are determined. Second, the project related economic benefits and costs of each alternative are determined. Third, project costs and net benefits of all alternatives are compared in an economic analysis to determine the total monetary benefit to society of each alternative. Finally, the monetary costs of building and operating the project are matched with potential sources of cash to determine if the project is financially solvent.

In the Clean Water Construction Grant Program the economic analysis is performed within the context of cost-effectiveness analysis, which is defined as an analysis to determine which waste treatment management system or component part will result in the minimum total resources costs over time to meet federal, state, or local requirements. The most cost-effective alternative is the system which has the lowest present monetary value or equivalent annual value unless nonmonetary costs are overriding (40 CFR Part 35, Subpart E, Appendix E). As a component of cost-effectiveness analysis, economic analysis is performed by computing the total project costs of each alternative and selecting the alternative with the lowest costs. Because different alternatives, particularly those involving water reclamation, may be different, project related benefits and costs must be subtracted from the project costs before selecting the project alternative with the minimum net cost. It must be remembered the economic analysis is only one component of the cost-effectiveness analysis and final project selection must involve consideration of nonmonetary factors.

Financial analysis establishes the monetary costs of a project and determines if the locale can raise the necessary funds to build and operate the project. Typical sources of funds are grants, loans, bonds, taxes, operating revenues, and fees. A formal (pro forma) cash flow statement is generated to determine if all costs of a period can be paid in that period with cash from working capital (financial solvency). In addition, financial analysis includes evaluation of external financial impacts, that is, financial impacts on other parties, such as fresh water purveyors whose water sales are reduced as a result of reclamation.

II. GENERAL CONSIDERATIONS IN PROJECT ANALYSIS

A. "With Project" and "Without Project" Analysis

The proper basis for determining the effects of a project is to compare the future results "with" the project and "without" the project. Benefits resulting from the project, monetary and nonmonetary, should exceed the costs. It is improper simply to determine the difference "before" and "after" implementation of the project. It is possible that some of the benefits predicted to occur in the future with the project may have occurred even without the project, and, therefore, these benefits should not be attributed to the project.

Applicants are required to define and then use as a basis for comparison the "without project" or "no project" alternative. The "without project" alternative is based on the assumption that the existing water supply facilities are the only ones utilized throughout the planning period and that no augmentation of these facilities occurs. It is then necessary to detail the economic and financial effects so that the data can be used as the basis of comparison for the "with project" alternative.

B. Time Horizons

There are three significant time horizons that are used in facilities planning that must be kept distinctly in mind. Specifically required lengths of time are based on EPA regulations (40 CFR Part 35, Subpart E, Appendix A).

1. Planning Period is the period over which a waste treatment management system is evaluated for cost-effectiveness. The planning period begins with the system's initial operation and is defined by the EPA to be 20 years. The economic analysis will involve the many monetary transactions during this planning period.

2. Useful Life is the estimated period of time during which a treatment works or a component of a waste treatment management system will be operated. This time period is usually equivalent to the time period during which a facility is capable of performing its function. However, in some cases a facility will cease being useful even though it is still functional, in which case its useful life will be shorter than its operable life. The useful life of a facility may or

may not exceed the 20-year planning period. Actually, the useful life is probably more likely to be 30 to 50 years. (Extending the analysis to 30 or 50 years would increase the economic value or benefits of the project but incur costs as well. Because it is difficult to estimate so far into the future, the analysis is to be stopped at the 20 years planning period.)

The treatment works' useful life for a cost-effectiveness analysis shall be as follows:

Land--permanent.

Wastewater conveyance structures (includes collection systems, outfall pipes, interceptors, force mains, tunnels, etc.)--50 years.

Other structures (includes plant buildings, concrete process tankage, basins, lift station structures, etc.)--30-50 years.

Process equipment (includes major process equipment such as clarifier mechanisms, vacuum filters, etc.; steel process tankage and chemical storage facilities; electrical generating facilities on standby service only)--15-20 years.

Auxiliary equipment (includes instruments and control facilities; sewage pumps and electric motors; mechanical equipment such as compressors, aeration systems, centrifuges, chlorinators, etc.; electrical generating facilities on regular service)--10-15 years.

Other useful life periods will be acceptable when sufficient justification can be provided. Where a system or a component is for interim service, the anticipated useful life shall be reduced to the period for interim service.

3. Financing Period. This is the time period for bond redemption or required paybacks. This period may be shorter or longer than the planning period. It is relevant mainly in financial analyses.

C. Interest Rates

There are three interest rates that are used in economic and financial analyses. How they are handled and specified rates are based on EPA regulations (40 CFR Part 35, Subpart E, Appendix A).

1. Inflation. The inflation rate is the rate of increase in the price of goods or services. The rate may be different for individual items. See the following section for a detailed discussion of adjustment for inflation.

2. Discount Rate. The discount rate is the interest rate used in the economic analysis comparison of project alternatives. It is a representation of the time value of money. Even in periods of no inflation, a dollar received today is worth more to the holder than a dollar expected in the future, simply because a dollar received today can be put to immediate benefit by the holder. The discount rate is used to adjust dollars received or spent at different times to dollars of a common value, usually present day dollars ("present value" or "present worth"). The value to use for this rate is the rate of return that is expected from a project investment. Under present EPA policy, an assessment of federal borrowing costs is involved in setting the discount rate for economic analysis of water reclamation projects.

   The discount rate which the United States Water Resources Council establishes annually for evaluation of water resources projects shall be used. For projects commencing planning during fiscal year 1978-79 (i.e., 1 October 1978 - 30 September 1979), the rate has been set at 6-7/8 percent.

   The discount rate is not the project's funding costs or an inflation factor. Inflation is adjusted separately as discussed below.

3. Local Financing Rate. This rate is simply the bond interest rate and is used in financial analysis only.

D. Inflation

Inflation is defined as an increase in prices. Nationwide inflation is seen as the general loss in purchasing power of the dollar which affects the prices of all goods equally. However, prices of individual goods may inflate at different rates due to changing efficiency in production (that is, changing resources expended to produce a given output), changing resource cost, and changing product demand. The treatment of inflation differs in economic and financial analyses.

The objective in performing an economic analysis is to determine the real resource cost, as measured in monetary terms, of project alternatives. Dollars of a common value should be used in pricing goods purchased at different times. Therefore, prices used in economic analysis are held constant over time, except for items that are expected to experience an inflation rate different from the general inflation rate.

To adjust a future cost of an item for differential inflation, first determine the item's present cost, P_p, then determine its future cost in present dollars, F_p, as follows:

$$F = P_p(1 + i_p)^n$$

$$F_p = \frac{F}{(1 + i_o)^n} = P_p \frac{(1 + i_p)^n}{(1 + i_o)^n} = P_p (1 + i_d)^n$$

where i_d = differential inflation rate = $(1 + i_p)/(1 + i_o) - 1$

i_o = general inflation rate

i_p = inflation rate of item

F = future cost in future dollars

F_p = future cost in present dollars

n = number of time periods to future time

P_p = present cost in present dollars.

Differential inflation rates for natural gas and land are specified below.

For the purpose of economic analysis, the grantee is required to calculate the various components of costs on the basis of market prices prevailing at the time of the analysis. The analysis cannot allow for inflation of wages and prices, except those specifically for land, as described below, and for natural gas. This stipulation is based on the implied assumption that prices, other than the exceptions, for resources involved in treatment works construction and operation, will tend to change over time by approximately the same percentage. Changes in the general level of prices will not affect the results of the economic analysis. Natural gas prices shall be escalated at a compound rate of 4 percent annually over the planning period, unless the Regional Administrator of EPA determines that the grantee has justified use of a greater or lesser percentage based upon regional differentials between historical natural gas price escalation and construction cost escalation.

Land purchased for treatment works may be assumed to have a salvage value at the end of the planning period at least equal to its prevailing market value at the time of the analysis. In calculating the salvage value of land, the land value shall be appreciated at a compound rate of 3 percent annually over the planning period, unless the Regional Administrator determines that the grantee has justified the use of a greater or lesser percentage based upon historical differences between local land cost escalation and construction cost escalation. Right-of-way easements shall be considered to have a salvage value not greater than the prevailing market value at the time of the analysis.

In financial analysis, the full rate of inflation must be considered. That is, the impact inflation has on cost and therefore the revenues which must be collected to cover the inflation must be included in the analysis.

E. Cost Indices

Cost or price indices are used to measure the relative change in cost of a commodity or category of commodities over time. The Engineering News-Record (ENR) Construction Cost Index is commonly used in the civil engineering field. Cost indices are a useful cost estimating tool to convert cost data obtained from different sources and applicable for different dates to constant dollars at a given date. Even though future inflation which affects all goods similarly is generally disregarded in economic analysis, there is still a need when developing the cost estimate to adjust costs to constant dollars at the time of the study. For the same reason they are used in financial planning also.

A cost index is usually established by first selecting the commodity or set of commodities that will be used to measure the index. Because the ENR Construction Cost Index was intended to represent heavy construction, it is composed of 200 hr. of common labor, 2,500 lb. of structural steel shapes, 1.128 tons of Portland cement, and 1,088 board feet of 2x4 lumber.(1) A base year is chosen (1913 for the ENR Construction Cost Index) and usually given an index of 100. Periodically thereafter the same goods are priced and the new index is computed by multiplying the base year index (e.g., 100) by the ratio of the new total price to the base year total price.

To convert a cost to a different time, use the following equation:

$$C_2 = \frac{C_1 I_2}{I_1}$$

where C_1 = cost at time t_1

C_2 = cost at time t_2

I_1 = cost index at time t_1

I_2 = cost index at time t_2

It should be noted that cost indices are records of past cost fluctuations and are not predictors of future cost fluctuations. Insofar as past trends can be determined from cost indices, they are useful in predicting future trends, but the user of the index data must accept the responsibility for an assumed future cost trend.

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(1) "ENR cost indexes gain about 7.6% in '77," Engineering News-Record, Vol. 200, No. 12, March 23, 1978, p. 72.

The EPA produces five cost indices related to construction costs of wastewater facilities. Its two old indices, based on 1957-59 at 100, are for sewage treatment plant construction and sewer construction.(2) Its three new construction cost indices are for large city advanced treatment, small city conventional treatment, and complete urban sewer system, based on the third quarter 1973 at 100.(3) The old indices have been computed back to 1930, the new ones to 1973. Because these indices are tailored to wastewater facilities, it is recommended that they be used to adjust costs for water reclamation projects.

F. Present Value (Present Worth) and Equivalent Annual Value

The purpose of the economic analysis component of the cost-effectiveness analysis is to compare project alternatives on a monetary basis to determine their relative net costs or benefits. As discussed previously (subsection on discount rate), money has time value. To compare alternatives with different costs, benefits, and time distribution of these costs and benefits, the costs and benefits are converted to their equivalent present value, that is, to their equivalent value if spent or received today.

To compute the present value of an amount for an economic analysis, use the appropriate interest factor for the required discount rate, not the inflation or bond rate. Tables and formulae for interest factors are in Appendix C. In some cases it may be desirable to express the costs in annual terms. To determine the equivalent annual value, determine the present value and multiply the present value by the capital recovery

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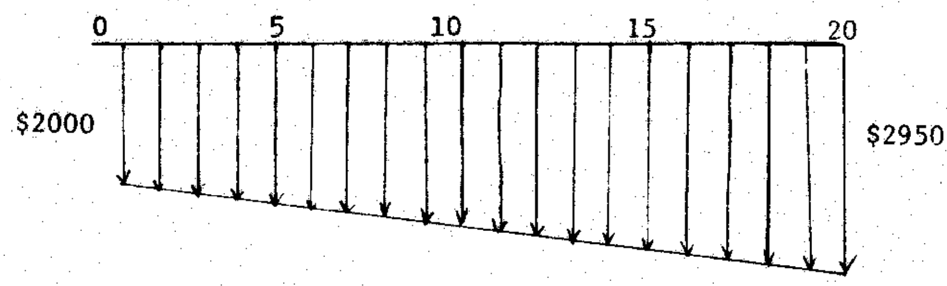
(2) Sewer and Sewage Treatment Plant Construction Cost Index, Division of Construction Grants, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C., December 1967.

(3) "EPA creates new sewer and plant indexes," Engineering News-Record, Vol. 194, June 19, 1975, pp. 73-74.

factor for the planning period, 20 years. Additional background on the purpose, derivation, and use of interest factors is available in many engineering economy references.[4]

Example: Find the present value and equivalent annual value for the operation and maintenance costs of a pump station. The costs are estimated to be $2,000 in the first year of operation and will increase in equal increments to $2,950 in the 20th year. The discount rate is 6-7/8 percent. A cash flow diagram can be used to illustrate the cash flow.



The costs are divided into two components, a uniform series of $2,000 per year, and a gradient series. The increments in the gradient are

$$\frac{\$2,950 - \$2,000}{19 \text{ years}} = \$50/\text{year}.$$

Using the interest factor table in Appendix C for 6-7/8 percent,

Present value = ($2,000)(P/A,6-7/8%,20)+$50(P/G,6-7/8%,20)
= ($2,000)(10.6977)+$50(78.6486)
= $25,328

Equivalent annual value = $25,328(A/P,6-7/8%,20)
= $25,328(0.09349)
= $2,368

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(4) DeGarmo, E. Paul, Engineering Economy, Fourth Edition, The Macmillan Company, New York, 1967.

Grant, Eugene L., and W. Grant Ireson, Principles of Engineering Economy, Fifth Edition, The Ronald Press Company, New York, 1970.

James, L. Douglas, and Robert R. Lee, Economics of Water Resources Planning, McGraw-Hill Book Company, New York, 1971.

G. General Approach of Economic Analysis

For single purpose water pollution control projects, alternative wastewater collection, treatment, and disposal projects are compared. The project costs are the capital and operation and maintenance costs for these alternatives. The benefits[5] might include, for example for a land application project involving the purchase of presently unproductive land, net income from the sale of fodder crops. If the land were already in production and reclaimed water would replace well water, the benefit would be the cost savings from using reclaimed water instead of well water. The water quality benefit, the major project output, would be essentially the same for all alternatives and would not be quantified in monetary terms in the economic analysis. Benefits would be subtracted from the project costs for each alternative and the net cost (or net benefit) would be the basis of economic comparison.

For multipurpose projects with the primary purpose of water reclamation, the alternatives that are evaluated are various reclamation schemes and fresh water supply alternatives. The project costs are, again, the capital and operation and maintenance costs of these alternatives. Benefits would be benefits or costs related specifically to each alternative. Because fresh water supplies are evaluated as separate alternatives, water supply cost savings would not be deducted from the water reclamation alternative project cost. The savings would be apparent by comparing the net costs for each alternative, but because it is difficult to quantify water quality effects monetarily, a qualitative description is generally adequate.

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(5) These benefit categories may actually be net of some categories of costs but since we are primarily discussing benefits we call them such.

III. SPECIAL CONSIDERATIONS IN PROJECT ANALYSIS

This chapter describes several concepts and techniques for dealing with uncertainty and unclear market signals in key variables which impact economic and financial analysis. Many factors, such as cost allocation and pricing, interact and therefore require a uniform method of treatment to avoid ambiguous results.

A. Sunk Costs

The purpose of economic analysis is to determine which particular available alternative provides the best use of resources. Only the future flow of costs and benefits is considered as the basis of decision. Previous expenditures, the sunk costs, do not affect choice: The expenditures of the past cannot be changed by any decision made today.

On the other hand, when a financial analysis is performed, cash flow is a basic consideration. Sunk costs that are continuing financial obligations, such as bond redemption payments for existing facilities, must be included in the financial analysis.

Even to justify continuing funding a project which is nearly completed requires that the additional benefits from the project exceed the additional costs to complete the project. If the project does not yield benefits until it is completed, the relevant costs are the costs to complete the project, the relevant benefits are the total benefits of the project. Past investments in the project are not considered.

The decision regarding where to allocate scarce funds hinges on the opportunity cost of the investment: Where will the next dollar spent bring forth the greater benefits? When the costs of a project (Chapter IV) are considered, previous investments are ignored. Only new purchases are considered as costs. For example: If an old well is going to be used as a source of make-up water to handle peak demand, only the costs of upgrading the well are considered. The original drilling and well construction costs are ignored. If an existing treatment facility is being supplemented or enhanced by a new project, the costs of the existing facility are ignored. However, if a new project replaces an existing treatment facility, any extra costs of replacement (such as transfer fees) must be considered in the project's cost. To repeat, the focus is on future cost and future benefits--not past investments. The analysis examines only those costs which are affected by the project. If debt service and contractual obligations occur either with or without the project, they are included in both the with or without project analysis and result in a zero net differential effect.

Care must be taken when utilizing cost data for economic analysis to ensure that sunk costs for existing facilities are not included. For example, water prices usually embody sunk costs and are not representative of the future economic costs to supply the water.

B. Energy Resources and Costs Analysis

The cost of water reclamation and fresh water supply is very sensitive to energy cost. In addition, an important resource impact of reclamation and water supply is energy consumption. Therefore, an analysis of the potential energy consumption of each project alternative is required as part of the environmental impact analysis and the economic and financial analyses.

To determine the total energy resources impact, the following must be determined for each alternative:

- energy consumption to manufacture and construct the project facilities,
- energy consumption to operate and maintain treatment and conveyance facilities,
- energy consumption to manufacture chemicals used in wastewater and water treatment,
- primary energy consumption required to produce the energy for the above items, taking into consideration the energy conversion efficiencies (total energy output/total energy input) of various energy forms, such as electrical power production, natural gas production, or diesel fuel production.

For an environmental impact analysis, to allow for comparison of project alternatives, energy consumption should be reported in units of total BTU per year and BTU per acre-foot of water processed. Guidelines for energy analysis are available.[1]

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(1) Roberts, E.B., and R.M. Hagen, Guidelines for the Estimation of Total Energy Requirements of Municipal Wastewater Treatment Alternatives, SWRCB, Sacramento, August 1977.

Not all of the data in the energy analysis required for environmental impact analysis is used in cost analyses. The cost of the energy consumed to manufacture and construct facilities is usually embodied in the source cost data used for construction cost estimates and need not be separated out. Energy conversion efficiencies and primary energy consumption are also not needed, because the cost of primary energy consumption is reflected in the price of energy in its secondary form, such as cents per kilowatt-hour of electricity delivered at the point of use.

To perform cost analyses it is usually necessary to know the energy consumption to operate facilities in units of delivered form, for example, kW-hr/year of electricity, BTU/year of propane or natural gas, or gallons/year of diesel fuel. This should be determined for fresh water alternatives as well as reclaimed water alternatives. It is usually not necessary to know the energy for chemical manufacturing because its cost is included in the price of the chemical. However, for energy intensive chemicals, such as chlorine, it may be desirable to separate the energy cost from other manufacturing costs to adjust the cost for inflation if differential inflation is expected.

In evaluating processing equipment, energy consumption should be determined at operating capacity and at relevant operating levels (such as half and three-quarter capacity) because of varying efficiencies of operation. For example, a pump station is designed with two 500 gpm pumps to generate a 250 foot head pressure. At full load the two 40 HP pumps draw 65 kW or 350 kW-hr/acre-foot. At three-quarter capacity the pump station will consume 60 kW or 430 Kw-hr/acre-foot.

Once the energy consumption has been estimated, a price must be assumed to determine the energy cost. Present day prevailing market prices must be used, and, if appropriate, future prices must be adjusted for differential inflation. Because of market imperfections, prices paid for energy by some users are often artificially low due to 1) price regulation or 2) historical contracts which permit energy to be supplied well below today's market values. In addition, the distribution of certain energy sources (oil and gas) are restricted resulting in a controlled market.

When water is delivered using energy supplied by historic contracts at a price lower than today's market value, substitute the current market energy price which reflects the opportunity cost or alternate value of the energy. (Current electrical energy cost is around 38 mills per kW-hr for nuclear powered generators, 40 mills for coal-fired plants and 45 mills for oil-fired plants. This is in contrast to historic contract costs as low as 3 mills per kW-hr.) Predictions of significant price changes in energy should be footnoted but only utilized consistent with federal regulations regarding differential inflation (see previous discussion on inflation).

C. Format for Reporting the Benefit-Cost Analysis

Total benefits of a project are the sum of the present value of benefits to each major user of reclaimed water. The report of benefits should reflect this concept. The report should list the present value of primary, secondary, and adverse benefits for each user by class of user as discussed in Chapter V. In addition, the present value of the project cost should be brought forward from the computations in Chapter IV. Finally, the net present value of all benefits less costs should be computed. Schedules and forms for specific user benefits could be presented in the appendix of the facilities plan.

D. Groundwater Overdraft

When the availability of reclaimed water prevents groundwater overdraft, this benefit to society from reclamation must be accounted for. Since overdrafts are often legally permitted and the "price" of the water itself (excluding pumping costs) is zero, the overdraft water must be valued at its worth, or "opportunity cost" to society. If fresh water is readily available and it is the realistic substitute for the overdraft, use the value of fresh water as the real value of the overdraft. If, on the other hand, fresh water is not readily available (for example, if the geographic area in question is far from imported water supplies) and the cost of importing the water so high as to be financially and economically unfeasible for the area, then the overdraft has to be valued in terms of its contribution to the value of the product. You must ascertain the highest price the user would pay for the water and still remain in business. (Of course this highest price need not be charged, but it is an indicator of the value of the water in production.) This area of estimation is difficult because to be conceptionally correct, you want to determine the highest price which would be paid for the water in production but as the price rises, different production processes as well as the very product themselves (usually crops) would change. Since defining and dealing with all these possibilities would overextend the estimating capabilities of the project analysts, it is essential that you carefully identify the assumptions made here.

E. Water Supply Costs or Benefits in Economic Analysis

Case 1 Abundance of Fresh Water

When there is an adequate supply of fresh water to serve the project area during the planning period without the need to construct any new water supply facilities, fresh water costs are only the operation and maintenance costs of the existing facilities. These are the marginal costs to supply water. It would not be appropriate to compare reclamation with the construction of new water supplies because such construction would not be contemplated.

If water pollution control alternatives are being evaluated, the fresh water supply operation and maintenance costs that are saved by using reclaimed water would be subtracted from the water reclamation alternative project cost to determine the net project cost. If water reclamation is the primary project objective, the fresh water supply operation and maintenance costs would be included as part of the fresh water supply alternative project cost. In reality, because no fresh water supply facilities are to be constructed; the fresh water supply alternative is part of the no-project alternative.

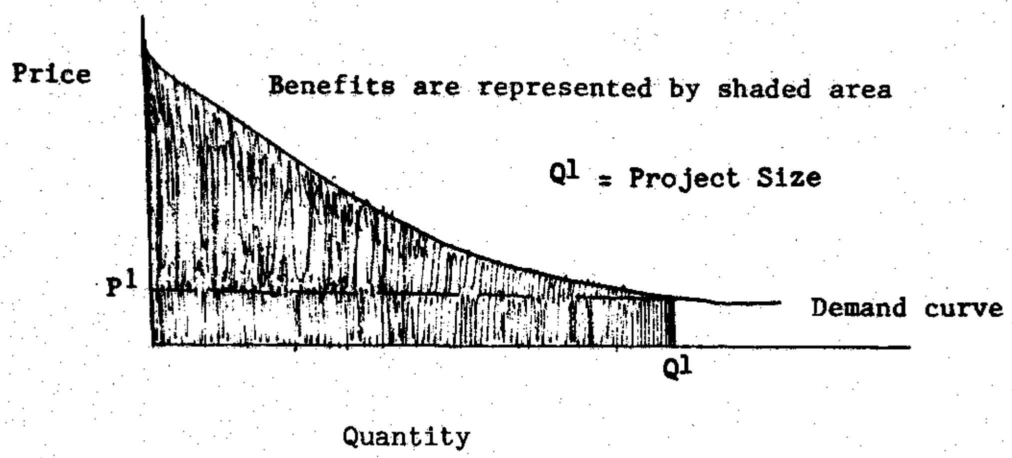
Case 2 Novel Application of Reclaimed Water

It may be proposed to apply reclaimed water to a use of water which is not presently occurring and which would not be served in the future without reclaimed water. The use is a new, unplanned use of water. This situation usually occurs when fresh water is very expensive. In fact in this case the water is so expensive that the costs of fresh water exceed the benefits derived from the proposed use. It would therefore be unjustifiable to spend more to serve the proposed use than the benefits from that use. Thus, water reclamation is not compared to fresh water supply costs, but rather to the benefits received from using the reclaimed water.

A measure of the benefits of the reclaimed water is the price that users are willing to pay. Such information is derived from a market assessment, but the true willingness to pay is not easy to obtain. Because buyers will usually understate the true price they are willing to pay, methods other than simple inquiries of the prospective buyers may be necessary.

A demand curve, as shown in Figure III-1, can be developed from a composite of the data obtained about each prospective user. For each price it can be determined how much reclaimed water could be sold by asking individual users what quantity they would take at that price. These data are aggregated into a total market demand curve for reclaimed water.

The total benefit(1) is the area underneath the curve. This benefit would then be subtracted from the



BENEFIT MEASURED BY DEMAND CURVE

Figure III-1

reclamation project cost to determine net cost. Note that this potential area of benefit (the shaded area) is independent of the actual price (or set of prices) that will be charged for the reclaimed water, as long as Q^1 is sold. If several sized project alternatives are under consideration, each generating different quantities of reclaimed water, obviously different levels of total benefits would be involved for each project. Total benefits would have to be separately calculated for each project by this method.

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(1) This Total Benefit is composed of the economic value of the sale P^1Q^1 (the rectangle below P^1) plus the "consumer surplus" area above P^1 (i.e., what demanders would have been willing to pay but did not have to at price P^1). Consumer surplus is an intangible benefit.

Case 3 Scarcity of Fresh Water

When at some time during the planning period there will be a need for new water supply facilities and reclamation would affect the need for those facilities, then reclamation is compared to fresh water supply costs. In the short term the impact on fresh water costs would be only the reduction in operation and maintenance costs of existing fresh water facilities. In the long term the construction costs of new facilities would be affected by delaying them or perhaps eliminating them.

In water pollution control studies the resultant fresh water cost savings would be subtracted from the reclamation alternative project cost in the economic analysis. Generally, to substantiate an effect on construction of new water supplies, SWRCB will require a complete fresh water supply analysis as is required for projects with the primary purpose of water reclamation. Therefore, for water pollution control projects, include only reduction in operation and maintenance costs in the economic analysis. In water reclamation studies, the fresh water supply costs without reclamation would be shown as the costs of the fresh water supply alternative.

F. Demand Analysis for Reclaimed Water

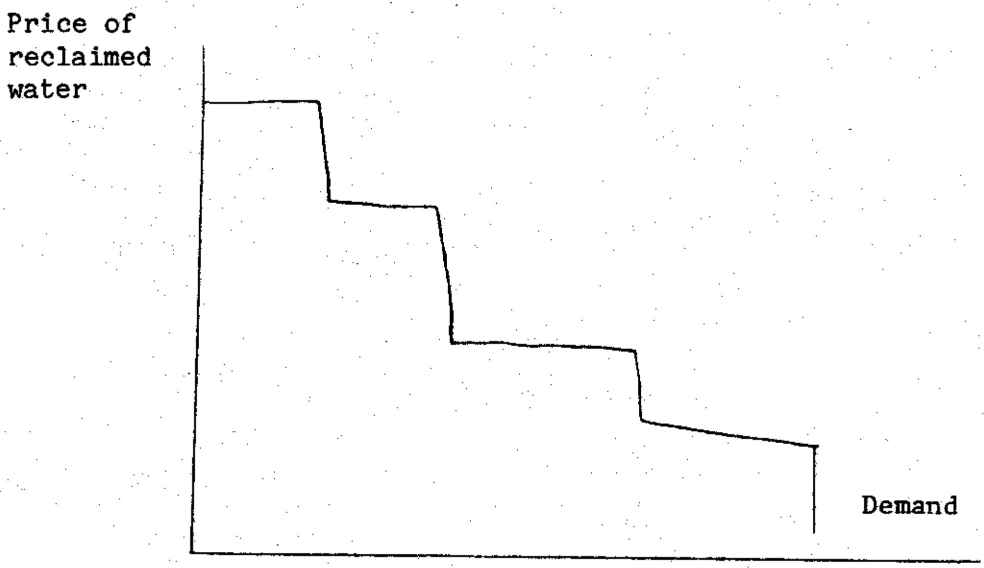
In estimating demand curves for the future, one of the basic assumptions must be the price of substitute goods, which is generally the price of fresh water. Since it is difficult to forecast the price of fresh water itself and even more difficult to forecast the types of subsidies which will be granted to agencies and by agencies (internal subsidies from one group of users to another) and thus passed down to actual prices facing users, the following approach accommodates these areas of uncertainty.

1. Assume several, perhaps four, alternative prices of fresh water in the future for the base case against which demand for reclaimed water is determined. Make sure the range of four prices includes extremes and several likely events.

2. Then for each one of those assumed prices of fresh water, ask the major users what quantity of reclaimed water would they demand over a range of prices of reclaimed water (try to get at least five points on each demand curve). That is, derive a demand curve for reclaimed water. This exercise would be repeated four

times and we would get four potential demand curves for reclaimed water, each one based on an alternative assumption about the price of fresh water. We would then have this information available to build into our analysis as required. Of course, many users will demand a single quantity of reclaimed water regardless of price up to a maximum. It is important to know this as well.

In effect then, you are gathering data to fill in Figure III-2 based on four different assumptions about the price of fresh water, each one of which may very well cause the demand for reclaimed water to change.



Cumulative demand for reclaimed water based on assumed price Number 1 of fresh water

DEMAND CURVE

Figure III-2

G. Sensitivity Analysis: Handling Uncertainty

It is often important to determine what would happen to an analysis if some of the assumptions are proven wrong, as will inevitably occur. Sensitivity analysis permits the determination of how sensitive a project's economic value or financial feasibility is to a change in some of the critical assumptions, such as, a change in the price of important resources (energy), a change in the construction period, a change in assumptions about inflation, a change in market demand, and so on. In order to perform sensitivity analysis, one merely makes alternative assumptions about any or all of these key variables and reworks the analysis under the alternative scenarios. It can then be readily determined how sensitive an individual project is to these various assumptions. When all reclamation projects in the state are comparatively evaluated, other things being equal, selection of projects can be made with the additional insight supplied from sensitivity analysis.

A sensitivity analysis is particularly important if a significant portion of the planned reclaimed water market is not yet committed to participating in the project. As a minimum the worst case should be tested, assuming that all uncommitted users do not eventually take reclaimed water as planned. With this assumption the economic and financial analyses should be performed of the proposed project to determine if it would still be economically justified and financially feasible.

IV. COSTS: PROJECT RESOURCE REQUIREMENTS

A. Defining Costs

This chapter discusses the collection of data necessary to establish project costs.[1] In essence, project costs are the monetary expenditures necessary to build, operate, and maintain the water reclamation facility. Table IV-1 shows typical elements included in project costs.

Table IV-1

TYPICAL PROJECT COST ELEMENTS

Capital Construction Costs	Annual Operations and Maintenance Costs
Contractors Cost of Construction	Salaries of Plant Staff
o Labor	Fringe Benefits
o Materials and Equipment	Overhead
o Overhead	Supplies
o Profit	Equipment Replacement and Parts
Cost of Land	Energy: Electricity, Fuel
o Purchase Price	Administrative Costs
o Relocation Cost	Staffing and Hiring Cost
o Right-of-Way	Outside Contracted Services
o Easement Acquisition	
o Water Rights	
Design Engineering	
o Field Exploration	
o Engineering Services	
Project Administration	
o Management Services	
o Legal Services	
Cost of Financing	
o Bond Sales Fees	
o Interest During Construction	
Contingency Fee Allowance	
Start-Up Costs	
o Training Cost	
o Supplies During Start-Up	
Costs of Auxiliary Facilities	
o Access Roads	
o Distribution or Collection Works	
o Storage Facilities	
o Ground Water Recharge Basins or Wells	
Cost of Users to Switch to Reclaimed Water	

(1) Some ambiguity exists among the many definitions of "costs" such as: first cost, construction cost, capital cost, initial cost, investment cost, installation cost, economic cost. Care must be exercised to reconcile the definitions to avoid confusion.

Project costs should encompass the entire planning period. This includes the sum of all goods, services, labor, and money used over the period during which the water reclamation system is evaluated for cost-effectiveness.

"Economic cost" is defined as the combination of all project costs including an evaluation of all secondary and intangible costs (e.g., environmental) resulting from the project. Economic costs encompass all costs to society which include costs borne by the user in converting his facilities to use reclaimed water. Project costs do not capture user-borne costs. To avoid confusion in notation with federal regulations, this Guideline suggests that secondary and intangible costs be considered in the evaluation of benefits. (See Chapter V: adverse effects as negative benefits.)

B. Uniform Estimation Procedures

Data on estimated construction and operations costs can be obtained from the U.S. Environmental Protection Agency (EPA), published literature, or water treatment plant records. Procedures for estimating plant construction costs can be found in many engineering texts. Costs should be calculated at prevailing market prices. Difficulties in dealing with the effects of inflation and energy costs are discussed in Chapters II and III.

Once a project cost estimate is made, the data should be transformed into present worth values. The planning period is 20 years, however, the useful life of most project facilities is 30-50 years. Therefore, salvage value (residual value) is computed by straight-line depreciation based on the schedule provided in Chapter II under Useful Life.

C. Example of Cost Estimation

For example, assume an economic analysis is being performed for a plant with a capacity of 12 MGD that was constructed in four years with the following investment pattern (in millions of dollars):

Item	Construction Costs, $\$10^6$, By Year* -4	-3	-2	-1	0	Useful Life, Years
Structures	1	1	2	1	1	48
Process Equipment	-	-	1	4	.6	20
Ancillary Equipment	-	-	-	2	1	12
Land	0.8					
Administrative	0.1	0.1	0.2	0.2	0.1	
Start-up	-	-	-	-	0.8	

*The negative value for years is to stress that the evaluation period begins with commencement of operations - NOT with construction.

The operating costs all have a fixed component of $200,000 per year and a variable component of $54.80 per million gallons processed.

The market analysis estimates the following mean flow levels:

Year	MGD
1-3	6
4	7
5	8
6	9
7-12	10
13-15	11
16-20	12

Assume a discount rate of 7 percent.

The computation proceeds by completing the forms as shown in Tables IV-2, IV-3, and IV-4. Capital construction costs are computed in the first form (Part I) shown in Table IV-2. All line items are summed by year and then multiplied by the proper

Table IV-2

PART I: PLANT INVESTMENT
(millions of dollars)

Item	Plant Investment By Year					Total
	-4	-3	-2	-1	0	
Structures	1	1	2	1	1	6
Process equipment	0	0	1	4	0.6	5.6
Auxiliary equipment	0	0	0	2	1	3
Land	0.8	0	0	0	0	0.8
Administration	0.1	0.1	0.2	0.2	0.1	0.7
Start-up	0	0	0	0	0.8	0.8
Annual Total	1.9	1.1	3.2	7.2	3.5	16.9
Future Value Factor at 7% Discount Rate	1.311	1.225	1.145	1.07	1.0	
Future Value	2.5	1.3	3.7	7.7	3.5	18.7

TABLE IV–3

PART II: REPLACEMENT COSTS AND SALVAGE VALUE (1)

Item	Total Cost, $\$10^6$ a	Useful Life, Yr b	Useful Life During Planning Period, Yr c	Salvage Life, Yr (b)-(c) (2) d	Salvage Value (a)(d)/(b), $\$10^6$ e	Salvage Value Adjusted for Inflation, $\$10^6$ f
Structures	6.0	48	20	28	3.498	3.5
Process Equipment	5.6	20	20	0	0	0
Auxiliary Equipment	3.0	12	20	-8	0.0	0
Replaced Auxiliary Equipment	3.0	12	8	4	1.0	1.0
Land	0.8	Infinite	20	Infinite	0.8	1.4(3)
Administrative	0.7	20	20	0	0	0
Start-up	0.8	20	20	0	0	0
Total Salvage Value					5.298	5.9
Salvage Present Value(4)					1.367	1.5

(1) By straight-line depreciation.

(2) If salvage life is less than zero, the equipment must be replaced before the end of the project period. Place the cost of replacement into the plant cost form, part III; the item should be replaced every period equal to the item's useful life. (For example: a pump with a useful life of 8 years would be installed in year "0" and replaced in year "8" and year "16".) A new line item should be created for each replaced item.

(3) A differential inflation rate of 3 percent is assumed per 40 CFR Part 35, Subpart E, Appendix A. The compound amount factor is 1.8061 for 20 years.

(4) Discount rate is 7 percent. Present value factor is 0.258.

Table IV-4

PART III: PLANT COSTS

Item	Project Costs, \$10^6, by Year																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1) Investment	18.7																				
2) Replacement Costs													3.0								
3) Fixed Costs		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4) Variable Rate, \$/MG		54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80	54.80
5) Annual Volume (MGD)		6	6	6	7	8	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10
6) Variable Cost		0.12	0.12	0.12	0.14	0.16	0.18	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7) Total Expense	18.7	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
8) Present Worth Factor at 7% Discount Rate	1.0	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	0.339	0.317	0.296	0.277	0.258
9) Present Value	18.7	0.28	0.26	0.24	0.23	0.29	0.27	0.25	0.23	0.22	0.20	0.19	1.51	0.17	0.16	0.14	0.14	0.13	0.12	0.11	0.10
10) Total Expense P.V.	23.9																				
11) Minus Salvage P.V.	1.5																				
12) Total P.V.	22.4																				

future value factor. While this calculation is termed "interest during construction" in the federal regulations (40 CFR Part 35, Subpart E, Appendix A), this term is not correct. Following Federal water resource project practices, interest is treated as a financing cost. The actual interest rate contracted for on a bond issue, for example, is a financing cost, not a cost to be used in the economic analysis. This calculation is a present value calculation that requires the use of the future value (compound amount) factor because the costs occur prior to the beginning of the planning period. The future value for each year is then summed and placed in line 1 of Part III (Table IV-4) as the value of plant investment. For projects with construction periods of less than two years you can simply sum the construction costs and not compute an interest effect.

Part II (Table IV-3) is used to compute the salvage or residual value of the investments at the end of twenty years of operation. Assume depreciation begins at the end of year "-1", when processing begins. Note that capital items which have a useful life shorter than the planning period need to be replaced at the end of the useful life. The replacement cost has to be entered in line 2 of the third form under the year of item replacement. Each time an item is replaced, it should appear as a new line on Part II of the form. The new line entry should contain an appropriately adjusted useful life during planning period (the time remaining between the year of replacement and the end of the original planning period).

Part III is used to determine the present value of all project costs. After the investment and replacement costs have been entered, the estimates of operating and maintenance cost should be made. The preferred procedure is to estimate separately the level of plant operation (line 5), the fixed costs (line 3), and variable rate of operation cost (line 4). The product of variable rate and plant production level yields variable cost (line 6). The total annual expense is then computed by adding the cost of investment, replacement, fixed O&M, and variable O&M (lines 1, 2, 3, and 6). These costs are then multiplied by the appropriate present worth factor and the resulting products are summed to determine their total present value at time 0.

Finally, the present worth of the project is determined by summing the present value of costs with the salvage value of the plant and equipment. The resulting present value in line 12 is used as the opportunity cost of this project.

To summarize, Cost-Effectiveness Analysis requires that you:

1. Analyze the locale's wastewater problems and water reclamation potential.

2. Set the project objectives to address the water quality and water supply problems.

3. Develop alternate project designs to meet the project objectives.

4. Determine the costs of each alternative.

5. Measure the impact of the projects on society and the environment.

6. Select the optimal project.

This chapter addresses step 4 above of the procedure. A set of forms, similar to Table IV-2, IV-3, and IV-4 should be prepared for each alternative. Among the cost estimates performed should be an analysis of scaling up current water supply sources such as increasing the amount of imported water. Staging construction over time to meet growing demand should also be analyzed.

According to Cost-Effectiveness Analysis, the optimal water reclamation project is the least expensive alternative which meets wastewater effluent standards and provides the quality and quantity of reclaimed water to meet the projected demand unless nonmonetary factors are overriding.

In later chapters, the definition of optimality is expanded; the optimal project provides the maximum net benefits. (Net benefits equal benefits less all costs.)

V. BENEFITS

A. Defining Benefits[1]

The key to economic analysis is the identification of benefits and costs for each project alternative. The primary alternative for project comparisons is "no planned activity," that is, comparing the effects of "with" and "without" a project. Note that the comparison is not "before" and "after" the project; some changes will occur with time even if no project is undertaken. A project is economically feasible if the difference in benefits between having and not having the project exceeds the costs of the project (symbolically $B-C > 0$).

This Guideline adopts the convention of defining costs as all monetary transactions to build and operate the water reclamation system, as described in Chapter III. Benefits then encompass all positive and all adverse effects resulting from the project. To help describe these broad effects, a hierarchy of benefit classes have been defined:

I. Tangible benefits are the net monetary value (evaluation in the marketplace) of both favorable and adverse effects to private parties resulting from the project.

   A. Primary benefits are those project produced goods and services, such as the value of reclaimed water or pollution abatement (technological result).

      1. Direct benefits accrue to individuals who use the goods and services of the project, such as a farmer using reclaimed water for irrigation.

      2. Indirect benefits are the result of using the project's output, such as reduction in dust storms due to irrigation or increased pipe scale due to industrial use of reclaimed water. (Remember benefits can be favorable or adverse.)

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(1) This section is based on L. Douglas James and Robert R. Lee, Economics of Water Resources Planning, McGraw-Hill Book Company, New York, 1971.

B. Secondary benefits or "spill-over benefits" are economic results which stem from or are induced by the project. They are external monetary effects such as increased income from selling farm equipment to farmers using reclaimed water or processing grain due to the increased agricultural output of farmers using reclaimed water. Within this category of benefits are:

1. Employment benefits are the increased level of income resulting from constructing, operating, or maintaining the water reclamation system.

2. Public benefits are increases in the public welfare due to reduced pollution, enchanced environmental quality, economic stabilization, regional development, and other spill-over effects. These benefits can only be evaluated in monetary terms by means of value judgments on the desirability of the social goals. Often, these public benefits are treated as intangible benefits (see II below).

II. Intangible benefits are those effects which cannot be expressed in monetary terms. Examples are the preservation of unique natural beauty, improvement in general health conditions, or saving a life. Intangible benefits are often classified as "extra" market effects.

Intangible benefits are the non-monetary consequences of a water reclamation system. These spill-over effects, by their very nature, are difficult to evaluate in a feasibility study because of the subjective criteria used to judge them. This difficulty can be exemplified by evaluating the worth of an archeological treasure, or the value of preserving Yosemite Valley for future generations. Whether subjectively perceived or objectively measured, specific criteria should be used to describe the beneficial or adverse aspects of each alternative plan. The most straightforward way of presenting intangible benefits is catalogued in a table with a description and a rating.

The data necessary for this evaluation can prove to be overwhelming unless the emphasis is placed on measuring changes among alternative projects and the "without" case. The scope of the intangible benefits analysis should be commensurate with the scale of the feasibility report. Only those factors which differentiate projects should be used for the initial screening. A complete environmental impact analysis will be necessary for the final project proposal. Data from the environmental impact analysis can be used to verify the earlier analysis.

III. Adverse benefits or "spill-over costs" are those costs which private parties incur in the use of the project's output. These adverse benefits are subtracted from favorable tangible benefits to determine the level of tangible benefits to be used in benefit-cost analysis.

   A. Associated costs are the expenditures and investments made by individuals to obtain primary or secondary benefits from the project. Examples would be the installation of a nonpotable water plumbing system in an industrial plant so reclaimed water could be utilized; or the installation of irrigation conduits so a farmer could use reclaimed water for irrigation. These costs are treated as "negative benefits" instead of costs because the user pays for them as opposed to the group financing the reclamation project itself.

   B. Induced costs are those incurred by use of the output of the water reclamation system, such as an increased detergent use when utilizing reclaimed water.

Project evaluation requires the comparison of these benefits for each alternative considered. Then the differences between the alternatives can be assessed and the net cost or benefit determined.

B. Categories of Benefits

A number of potential benefits and constraints are associated with the use of reclaimed water. Although these will vary for different projects and must be evaluated on a case-by-case basis, some of the potential benefits and constraints that have been identified are listed below. The potential benefits include:(2)

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(2) This section is taken from "Policy and Action Plan For Water Reclamation in California," California State Water Resources Control Board, January 1977.

Augmentation of local supplies and improvement of groundwater quality in many instances;

Postponement of the need for water development and conveyance project construction;

Reduction of the need for further inter-basin freshwater transfers in the State;

Reduction of energy requirements in situations where reclamation is an alternative to importation of freshwater or disposal of wastewater;

Reduction of pollution loads;

Reduction of land subsidence and groundwater overdrafting when used for groundwater recharge;

Availability of nutrients to certain crops when used for irrigation water;

Augmentation of stream flow, development of wetlands and lakes, restoration and enhancement of fish and wildlife habitat; and

Creation of scenic water bodies for recreational and esthetic enjoyment.

The potential constraints to using reclaimed water include:

The possible presence of pathogenic organisms, such as bacteria and virus; and toxic constituents, such as stable organic compounds, heavy metals, etc., which requires that the quality of reclaimed water be carefully matched to beneficial uses;

Environmental impacts, such as groundwater degradation, accumulation of toxic materials in soil, plants, animals, etc.;

A requirement that the reliability of conventional waste treatment facilities be maintained at a high level;

A requirement for the development of improved and more expensive monitoring techniques;

The possible economic disadvantage, including energy costs, when compared with the pricing structure of many other water supply sources; and

The lack of public and user understanding of reclamation and the potential uses of reclaimed water.

C. Measuring Water Pollution Control Benefits

For ease of analysis, particularly in the allocation of joint costs, the benefits from waste treatment will be classified separately from water reclamation because of the dramatically different markets involved. The primary beneficiaries of waste treatment are the individuals and corporations who have their liquid wastes processed to meet government regulations. If a project has the combined objectives of water pollution control and water reclamation, it is best to estimate the benefits of water pollution control as the alternative cost of a single purpose treatment and disposal project. The single purpose project should process the same quality and quantity of flow and produce an effluent which meets pollution requirements. The relevant costs to include are the costs for construction, operation, maintenance costs, as well as the other costs discussed in the chapter on costs, of the single purpose alternative.

D. Examples of Benefit Analysis

The benefits from water reclamation depend on the end use of the water and on alternate water sources available to the area. Potential areas of primary benefit are urban water supply, agricultural supply, and recreational use. Benefits in each of these areas result from freeing up a high quality water from a lower level use or avoiding the importation of additional supplies of water.

Urban Supply. The benefits from a new supply of water to meet urban needs can be evaluated by both vendability and alternative cost. In the case where current sources of supply are near capacity and alternate sources are expensive, vendability is appropriate. Vendability is estimated by determining the price at which each additional acre-foot of water (of appropriately matched quality and use) could be sold. The relationship of water demand to price is essential for this evaluation of benefits. Benefits are equal to the price of reclaimed water times the quantity of water purchased in excess of the next best alternative source. Where the water demand/price relationship is not known, vendability can be estimated on the basis of market prices for water in a comparable economic area.

If the current water supply has sufficient capacity to accommodate growth, then the alternative cost is the current water rate. In conditions of scarcity, alternative sources could be additional ground water sources, constructing new surface supply facilities, importation as well as water reclamation. For this analysis, alternative sources must be structured to provide a similar quality of water (or better) at the same point of distribution. Careful consideration is necessary to match the water quality needs to the proposed supply. All project costs for the alternative sources should be estimated and allocated to determine the alternative cost per acre-foot. In determining the cost of importing new water supplies include transportation cost, treatment cost, and any effect at the new source caused by withdrawing more water. Do not include government support or subsidy payments.

Adverse benefits must be subtracted from the positive benefits to obtain the net benefits of the project. These include associated costs, such as the installation of special nonpotable plumbing systems and treatment facilities by users in order to use reclaimed water. Induced costs must also be subtracted, such as increased operating costs because the service life of plumbing may be reduced due to corrosion and scale formation from the reclaimed water.

Agricultural Use. Although irrigation is currently the major use of reclaimed wastewater, measuring the benefits accrued from this use is complex. The ability-to-pay technique is often employed with varying degrees of complexity. This technique requires the determination of how many acres of each crop will be planted by each farmer, the water necessary for each planted acre, the cost of planting, maintaining, and harvesting the crop, and the market yield of the crop. Profits from agriculture, the differences between all farming costs and the market prices, becomes the upper limit of benefits. The level of benefits thus depends significantly on the end market of farm products (and other regions' farm production) rather than on the market for water.

A more direct approach is to apply the alternate supply technique to estimate benefits. Estimate the annual demand for water from each major farm which is a potential reclaimed water user. Then estimate the current cost of water and the cost of supplying additional water supplies. The cost of current or new supplies sets the upper limit of benefits. (If reclaimed wastewater will replace current supplies, then use current costs excluding sunk costs; if reclaimed water is used in addition, then use new supply costs.) Two adjustments to this benefits evaluation are made: associated benefit and associated costs. Farmers can benefit from the nitrogen and phosphorus found in reclaimed water by reducing the cost of fertilizer. However, the higher levels of solids and salts in reclaimed water can cause premature replacement of irrigation equipment and salt build-up in the soil. In essence a customer by customer analysis is required.

For example: A large corporate-owned orchard currently pumps 750 gpm from a series of wells 200-300 feet deep. The cost of this water is approximately $20/acre-foot for energy and $1,700/year for pump maintenance costs. In addition, 900 acre-feet/year are purchased from a State Water Project for $61/acre-foot. Therefore, the cost of purchased water should be adjusted by the following technique:

1) Assess the marginal energy cost of conveying the water from its point source to its point of use.

2) Add in any treatment costs and relevant O & M cost.

Power costs for the imported water are $100/acre-foot. No treatment is required. The alternative cost is then:

Source	Volume, Ac-ft/Year	Unit Cost, $/Ac-ft	Annual Cost, $/Year
Wells			
Operation	1,200	20	24,000
Maintenance			1,700
Imported water	900	100	90,000
Total	2,100		115,700

The present value of the benefits (as measured by alternative costs), assuming a discount rate of 6-7/8 percent and using the series present worth factor for 20 years, is

($115,700/Year)(10.6977) = $1,238,000.

These benefits must be compared to the project cost to determine if the project is economically justified. Note that the price of the imported water is not used as a measure of the benefit. This price incorporates sunk costs as well as possible subsidies. In addition, it is based on the present contract price for energy, which is below the prevailing market price, which must be substituted.

The cost of reclaimed water is determined as described in the costs chapter. If this corporate orchard were to use reclaimed water, it would require a booster pump and additional piping. The initial investment would be approximately $90,000 for piping and $50,000 for a pump station. Energy costs would be $12/acre-foot and maintenance would be $800/year. The present value of project costs is determined in the following tables:

Item	Booster Pump	Piping
Total cost, $	50,000	90,000
Useful life, year	20	50
Useful life during planning period, year	20	20
Salvage life, year	0	30
Salvage value, $	0	54,000
Total salvage value, $	54,000	
Salvage present value, $	14,000	

Item	Year 0	Year 1-20
Capital cost	$140,000	-
Fixed annual costs	-	$ 800
Unit variable cost, $/ac-ft	-	12
Annual volume, ac-ft	-	2,100
Variable annual costs	-	$ 25,200
Total cost	$140,000	$ 26,000
Present worth factor	1.0000	10.6977
Present value	$140,000	$278,000
Total present value	$418,000	
Salvage present value	- 14,000	
Net present value cost	$404,000	

The project is economically justified because B-C = $834,000 which is greater than zero.

Recreational Use. The value of recreational use of reclaimed water should be included in the calculation of net benefits if, as part of the project, special facilities for recreation have been provided. Such facilities would be access roads, parking, and adjacent area to the reservoir.

Some existing projects have used reclaimed water to create reservoirs suitable for fishing and boating (for example, reservoirs at Santee, Lancaster, and Indian Creek). The benefits from recreational use are difficult to quantify fully. One approach would be to value the reservoir water at the rate which the water could be sold for alternate uses. This alternate-use approach assumes society has valued the recreational use of this water above any alternate use. A second approach is to predict the number of people using the lake for recreation and assess the "admission price" someone would be willing to pay if a fee were charged for water recreation at the reservoir. To help determine the value for recreational uses of water, the California Departments of Water Resources and Parks and Recreation have adopted a "Statement of Guidelines" and a "Recreation Planning Manual, March 1976."

Recreational benefits are segregated into general and specialized recreation. General recreation has a value of $1.00 to $5.00 per person-day depending on the variety, quality, and esthetics of the area. Specialized recreation has a range of $3.50 to $10.00 based on the specific activity. (For example, an average trout catch of 1/2 pound per day is evaluated at $4.50 per person-day; whereas, striped bass angling is evaluated at $8.00/per person-day for an area with an average catch of one per day.) Specific evaluations should be discussed with the Department of Water Resources.

The annual benefit for recreational use is the sum of the products of participant day times the daily value of recreation. An analysis of the demand for water recreation is necessary to establish the number of participant days. This analysis should take into consideration population trends and other recreational substitutes for this reservoir. For example, a reservoir is located 35 miles from a population center of 4 million people. Demand analysis has shown the following pattern of use for a developed boating and fishing area.

Year	General Use	Specialized Use
	(Participant Days)	
0-1	5,000	-
2-3	60,000	500
8-12	95,000	2,500
13-15	103,000	5,000
16-20	110,000	7,000

Because of the characteristics of the facility, general use is valued at $1.50/participant day and specialized use at $4.00/ participant day. We assume no associated costs of recreational use. However, if in reality costs of boating or fishing facilities exist, including stocking fish and building parking facilities, include them.

The net recreational benefit is determined by multiplying the number of participant days of each category by the value rate then determining the net present value. These calculations are presented in Table V-1.

E. Measuring Benefits From Delaying Construction of A New Facility

Supplying reclaimed water to a service area often reduces the area's demand for fresh water. If the area's current fresh water supplies are sufficient to meet the demand, then the potential benefits of using reclaimed water is the short run marginal cost of the current fresh water as supplied, and the possible deferral of new water supply projects. Each potential benefit should be evaluated separately.

The short run marginal cost of current fresh water supplies is the operation and maintenance cost of the water treatment and supply system . If water is being imported, the costs are primarily the pumping costs (energy costs) to transport the water and the chemical costs of treatment. This short run marginal cost can be used as an assessment of the opportunity cost of water and to define the minimum benefit level. Additional benefits of reclaimed water use are possible.

Using reclaimed water has in effect increased the potential supply of water. In some instances, future demand will still exceed existing supplies of water and additional water supply

Table V-1

RECREATIONAL BENEFITS

Year	0	1	2	3	4	5	6	7	8	9	10
GENERAL USE											
Participant Days		5,000	5,000	5,000	60,000	60,000	60,000	60,000	95,000	95,000	95,000
Value (Dollars), at $1.50/participant day		7,500	7,500	7,500	90,000	90,000	90,000	90,000	142,500	142,500	142,500
SPECIALIZED USE											
Participant Days					500	500	500	500	500	2,500	2,500
Value (Dollars), at $4.00/participant day					2,000	2,000	2,000	2,000	10,000	10,000	10,000
TOTAL VALUE (Dollars)		7,500	7,500	7,500	92,000	92,000	92,000	92,000	152,500	152,500	152,500
Present Worth Factor		0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508
Present Value		7,013	6,548	6,120	70,196	65,596	61,272	57,316	88,755	82,960	77,470

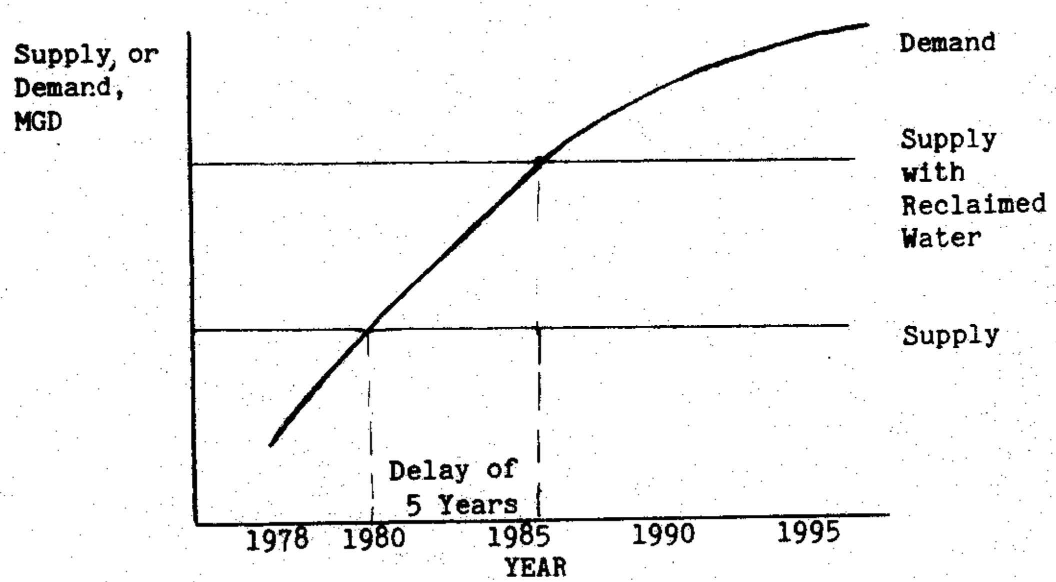
Year	11	12	13	14	15	16	17	18	19	20
GENERAL USE										
Participant Days	95,000	95,000	103,000	103,000	103,000	110,000	110,000	110,000	110,000	110,000
Value (Dollars), at $1.50/participant day	142,500	142,500	154,000	154,000	154,000	165,000	165,000	165,000	165,000	165,000
SPECIALIZED USE										
Participant Days	2,500	2,500	5,000	5,000	5,000	7,000	7,000	7,000	7,000	7,000
Value (Dollars), at $4.00/participant day	10,000	10,000	20,000	20,000	20,000	28,000	28,000	28,000	28,000	28,000
TOTAL VALUE (Dollars)	152,500	152,500	174,500	175,500	174,500	193,000	193,000	193,000	193,000	193,000
Present Worth Factor	0.475	0.444	0.415	0.388	0.362	0.339	0.317	0.296	0.277	0.258
Present Value	72,438	67,710	72,418	67,706	63,169	65,427	61,181	57,128	53,461	49,794

Total Present Value $1.15 million

capacity will be necessary. The effect of using reclaimed water delays the implementation of new water supply projects, as shown in Figure V-1.

Figure V-1

A HYPOTHETICAL WATER SUPPLY AND DEMAND CURVE



The benefits of delaying a potential water project can only be included in the analysis if the contracting agency can actually delay the project. Will using reclaimed water actually change the construction schedule of the alternative water supply project? If not, no additional benefits are accrued to the reclamation project. If yes, the additional benefit is computed in the following manner:

1. Compute the present value of costs for the water supply project assuming no schedule change.

2. Compute the present value of costs for the water supply project on the delayed schedule.

3. The net benefit of delay is the difference between present values with and without delay.

If benefits from delay are included in the analysis, the computations must be displayed separately. A letter of intent to delay from the water supply agency would be strong supporting documentation.

F. Benefit Analysis for Single Purpose Water Pollution Control Projects

To this point, the Chapter has emphasized a detailed evaluation of economic benefits from projects with the primary purpose of wastewater reclamation. An abbreviated procedure exists for benefit analysis of water reclamation from single purpose projects. Frequently, in the planning of a wastewater treatment facility, there are project alternatives which include disposing of treated effluent on land (in contrast to alternatives which dump the effluent into waterways which ultimately flow to the ocean). The differences in disposal procedures should be evaluated when judging the alternative projects. In general, land disposal of effluent can be considered water reclamation. The benefits from this reclamation through land disposal depends on where the water flows and its resulting impact.

Initially, the potential benefits for reclamation should be qualitatively listed. For example, dumping effluent on an alfalfa field adjacent to the treatment plant could result in:

- reduced fresh water use for irrigation
- reduced fertilizer use
- possible ground water recharge

Dumping into a vacant land area could result in:

- ground water recharge
- reduced top soil loss due to dust storms
- enhanced habitat for plants and animals.

These benefits can then be judged according to the opportunity cost of water used for the same purpose. The opportunity cost of the alternate water would be the short run marginal cost -- the operation and maintenance costs of the supply. For example, if well water would be used for irrigation, the benefit of land disposal is the cost savings of not pumping the water. If the ground water is being "mined," more water being removed than replenished by natural processes, then the value of effluent is the marginal value of water which would be used for recharging the ground water. Oftentimes, the benefits of land disposal are non-quantifiable and can only be listed and judged as intangible benefits.

If potential benefits exist, they should be counted in the benefits of a project whenever a conveyance facility exists such that the benefits can realistically be taken advantage of. If in fact no such conveyance facility (for either fresh water <u>or</u> reclaimed water) exists, then in order for the benefits to be included, you must include the cost of building the conveyance facilities in the cost analysis as it has become part of the project.

For example: A community is expanding its wastewater treatment facility to meet increased demand for pollution control and to upgrading the quality level of the treated effluent to meet pollution control regulations. Three alternative projects appear most technically feasible. Each alternative is based on the same treatment process, but utilize different methods of effluent disposal:

Alternative A - effluent disposal into a creek which empties into the ocean.
Alternative B - effluent disposal into a pond adjacent to farm land.
Alternative C - effluent disposal into a series of recharge ponds used currently to retard salt water intrusion into the ground water.

The list and evaluation of potential benefits are:

Alternative A results in nominal changes in the ecological habitat of the creek due to increased flow, especially during dry summer months.

Alternative B results in a potential decrease in ground water use for irrigation. The farmer can now draw more water from the pond for crop irrigation and use less well water. This results in a net savings of energy from reduced pumping cost; pumping 200 gpm less water from the 175 foot well results in a savings of approximately $5 per acre-foot.

Alternative C adds water to a current water use. The additional water can either save a portion of fresh water currently used for recharge - or increase the effectiveness of the recharge/barrier to salt water intrusion project. The benefit would be the marginal cost (not purchase price) of water currently used on the project, which is estimated at $60 per acre-foot.

In summary, if single-purpose waste treatment projects can reclaim water by any land disposal method, then potential benefits accrue to the project. If these projects yield intangible benefits, simply list them and do not attempt to quantify them. Secondly, if these projects yield substantial benefits which should be quantified, then include the benefits valued simply at the opportunity costs of the resources it takes to earn the benefits. This gives a crude approach to measuring benefits, but it is better than simply ignoring them. A more complete measure of benefits generally requires a detailed analysis of the general water supply situation and alternative new water supplies, as would be undertaken for a project with a primary purpose of water reclamation.

VI. FINANCIAL FEASIBILITY ANALYSIS

A. Overview

It has been shown how through economic analysis alternative projects can be compared and monetary benefit to society can be determined. These determinations are based on the net present value of the opportunity costs and benefits for each alternative project. However, a project which generates a great many net benefits to society may not ultimately be chosen because sufficient capital is unavailable to construct and operate the project or may cause financial hardship on other agencies, such as fresh water purveyors. The purpose of financial analysis is to plan and determine the financial solvency of the project and to determine the financial impacts on affected entities.

The financial analysis of monetary factors and capital funds of a project is conceptually different from economic analysis. It is important to recognize the differences between economic and financial analysis. For example, financial analysis is based on the market monetary value of goods or services at the time of sale; economic analysis is based on the opportunity cost of goods and services computed to the present value. The interest rates of local bonds and loans are used as the cost of capital in financial analysis. The discount rate used in economic analysis is set ideally as society's preference for investment. Although the data used for economic and financial analysis are similar, the conceptual differences should be kept in mind. Economics evaluates the project in the context of impacts on society. Financial analysis focuses on the local ability to raise money from project revenues, government grants, loans, and bonds to pay for the project.

Financial analysis examines the sources and uses of funds for each period to determine if a project is financially solvent. A wastewater reclamation project is financially solvent if sufficient working capital (cash) is available to fund the costs of construction, operations, maintenance, and debt service. Financial feasibility analysis compares the monetary costs of building and operating the project with the funds generated from user fees, standby fees, and funds from loans, bonds, government grants, and contributions from developers and new applicants for service. Another aspect of financial analysis that must not be overlooked is to determine the financial impact of the proposed project on the users of the reclaimed water and on other entities that might be affected, such as fresh water purveyors in the service area. Users must be financially prepared to make the necessary modifications to their water systems to accommodate reclaimed water. If reclaimed water significantly reduces the fresh water market, fresh water purveyors may have difficulty spreading the fixed covers over fewer users. The following sections related to financial analysis are included in this chapter: general requirements, determination of financial feasibility, cost allocation, and pricing.

B. General Requirements, User Charges and Industrial Cost Recovery

An applicant for a Clean Water Construction Grant has to demonstrate that it has the financial capability to operate and maintain the project (FWPCA, Section 204(b)(1)(C); 40 CFR 35.925-5). A financial plan and revenue program are required to document this financial capability. The financial plan contains a description of the sources of funding for the construction of the project. Sources of funds for debt service and operation and maintenance costs are described in the revenue program.

Federal law requires that each recipient of wastewater treatment services pay its proportionate share of operation and maintenance costs of wastewater treatment and that industrial users of treatment works pay for the federal share of the construction costs attributable to the industrial users' wastewater (FWPCA, Section 201(b)(1)(A) and (B); 40 CFR 35.928, 35.929). This user charge system and industrial cost recovery system is to be presented in the revenue program. For projects that have a significant component with the primary function of water reclamation rather than water pollution control, the wastewater services user charges and industrial cost recovery requirements shall apply only to the portion of the capital and annual costs allocated to water pollution control. Details on the requirements for the financial plan, revenue program, wastewater services user charges, and industrial cost recovery are contained in the SWRCB Financial Plan and Revenue Program Guidelines for Wastewater Agencies.

A basic concept to be applied in the establishment of user charges and prices is that beneficiaries of waste treatment or water reclamation services should pay their allocated share of the costs of such services. That is, charges must be fair and equitable. Such beneficiaries may be indirect beneficiaries or nonusers of the reclaimed water. For projects with the primary purpose of water reclamation, users and other beneficiaries (as can be reasonably included) of the reclaimed water shall pay the local share of capital and operation and maintenance costs. For projects with the purposes of both water reclamation and water pollution control, waste dischargers shall pay the local share of costs allocated to water pollution control, and users and other beneficiaries of the reclaimed water shall pay the local share of costs allocated to water reclamation. Refer to the following section on cost allocation for more detail.

Federal law encourages the generation of revenues in excess of costs for reclamation projects to lower the costs of wastewater management and to benefit environmental improvement programs (FWPCA, Section 201(d) and (e)). All revenues in excess of costs shall be used by the wastewater management agency to lower wastewater discharger charges (such as sewer service and user charges) and aid in financing other environmental improvement programs. Excess revenues may also be used to help pay off the unused portions of existing water supply facilities if a commitment has been made to abandon or withhold permanently from use such portions of facilities because of the use of reclaimed water. To assure such application of revenues when the wastewater management agency is a multipurpose agency such as a city, the revenues shall be deposited into accounts designated for this purpose. Applicants who are not wastewater management agencies are encouraged to use excess revenues to benefit the community through environmental improvement programs or lowering prices of all water customers in their service areas (refer to the section on pricing).

A financial analysis should not cover just the financial situation of the applicant. A successful project often requires the proposed users of the reclaimed water to make modifications to their on-site water systems. Their financial preparedness to make these modifications should be addressed in financial analysis.

A water reclamation project can have financial impact on other entities, in particular, water purveyors. Because fresh water demand may be reduced in the service area of a water service utility, the utility's revenue may be reduced and its ability to recover costs for capital investments or other fixed costs may be significantly affected. This problem is recognized in the law, and compensation to the water service utility may be required (California Public Utilities Code, Sections 1501 et seq.). The financial analysis must address the financial impacts on other entities.

C. Determination of Financial Feasibility

To appraise the financial feasibility of a project, it is necessary to determine:

- o capital construction costs,
- o annual operating and maintenance costs,
- o cost of financing,
- o revenue generated from waste treatment,
- o revenue generated from water reclamation,
- o charges to contracting agencies for service or water,
- o receipt of state and federal grants for construction.

The project costs included in financial analysis are presented in more detail in Table IV-1 and are discussed in more detail in Chapter IV. No present value calculations are performed as part of this financial analysis, rather the information is tabulated in a cash flow summary. The cost cash flow summary would appear as lines 1 through 7 in Table IV-4. The revenue cash flow summary would be similar to Table VI-1.

The revenue aspects of financial analysis combine information from the demand analysis (performed as part of the market survey), the rate structure, and the proposed service level schedule. Careful analysis of the demand for reclaimed water and pollution control services by each sector by year is required. In some instances, the market for reclaimed water will have to be broken down by water quality, prices, and the resulting demand.

Once the demand and price are established, plant production capacity should be verified (match supply with demand). Revenue will then be the product of sector demand and price for each level of service of water quality. Revenue data should be summarized in tabular form for each sector as shown in Table VI-1.

Once the revenue and expenses are tabulated, it is necessary to evaluate capital funding sources. Large amounts of capital will be necessary at the beginning of the project to construct the reclamation facility. This capital may be available from state and federal grant programs, current system revenues, bond issues, and long-term debt. Selecting sources of capital depends on the characteristics of the project and on local

Table VI-1

REVENUE CASH FLOW SUMMARY

Sector	Largest Consumers (with SIC)	Water Quality	Price $/1,000 Ft.	Revenue by Year								
				1	2	3	4	5	6	7	8	9
Urban	Municipal water supply	Surface Irrigation I										
Industrial		Irrigation I Cooling										
Agricultural		Irrigation I Irrigation II Irrigation III										
State Gov't	Recreational Lake Green belt	Surface Irrigation II										
Federal Gov't	National Parks	Irrigation II										

conditions such as existing debt, outstanding bond issues, the local tax base and legal limits on debt. Sources of grant money and additional information on funding can be obtained from the State Water Resources Control Board. It is beyond the scope of this Guidelines to prescribe the capital fund's structure. However, once the financial portfolio has been selected, a summary of sources should be presented, as in Table VI-2.

The elements of the cash flow analysis have all been discussed. The next step is to adjust the costs and revenues for inflation. Each element should be appropriately adjusted for a change in price level using past increase in the EPA Construction Cost Indices, the GNP deflator or other index as a guide. The index for each year should be clearly stated in a footnote along with any future assumptions or price level changes made to generate the pro forma cash flow statement.[1]

Finally, the elements of the sources and uses are consolidated into a pro forma cash flow statement. The top of the statement shows operating sources and uses; the bottom of the statement shows non-operating or financial sources and uses. The difference in each year between sources and uses becomes the change in working capital. Each year, the change in working capital is added to the previous year's balance to determine the balance in the working capital account. The balance in the working capital account must always be above zero to keep theproject financially solvent. For ease of presentation, the cash flow statement in Table VI-3 is broken down into ten-year periods, although the analysis should cover the twenty-year project planning period.

In summary, financial analysis examines the project's source and uses of money. Financial feasibility depends on the project's cash position at any one period to pay the costs incurred. The cash flow statements and projected balance in working capital is a clear presentation of the project's solvency.

These Guidelines do not prescribe a given pricing policy or methodology for determining rates.

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(1) A pro forma cash flow statement is a projection based on explicit assumptions. As with the result of any stepwise modeling effort, it is useful in that when any variable or assumption is changed, the financial impact can be ascertained.

Table VI-2

HYPOTHETICAL SUMMARY OF CAPITAL FUNDS PORTFOLIO

Source	Projected Date of Issuance	Projected Amount ($1,000)	Comments
Grants			
EPA: Clean Water Grant Program	1980 1981 1982	$ 400 1,850 2,400	Repay a portion of grant used for industrial waste treatment over 30 years.
State: Clean Water Grant Program	1980 1981 1982	67 308 400	
Bonds & Debt			
General Obligation	-	-	
Revenue Bond	1982	900	At 6-7/8% interest over 30 years with sinking fund and serial redemption starting in 1992.
General Funds			
Water District Funds		100	
TOTAL CAPITAL INVESTMENT		$6,500	

Table VI-3

PRO FORMA CASH FLOW STATEMENT

Description	YEAR 1	2	3	4	5	6	7	8	9	10
Operating Costs										
Capital Equipment										
Maintenance										
Replacement Equipment										
Operations of Treatment										
Operations of Distribution										
Administration										
Net Operating Cost										
Operating Revenue										
Wastewater Treatment Fees										
Reclaimed Water Sales										
Net Revenue										
Net Operating Loss or Profit										
Non-Operating Cost										
Debt Service										
Grant Repayments										
Non-Operating Revenue										
Grants										
Bonds and Loans										
Taxes										
Funds Transfers										
Net Change in Working Capital										
Beginning Balance										
Change in Working Capital										
Ending Balance										

D. Cost Allocation

Water reclamation projects are multipurpose in nature. Often, one facility will be used to collect and treat wastewater, then provide tertiary treatment and distribution of the effluent. The costs of one plant to provide both pollution control/waste treatment and water reclamation/recycling are usually less than the combined costs of separate waste treatment and fresh water supply facilities. The question becomes: Which customers receive the cost savings - those paying for pollution control or those buying reclaimed water? How can costs be distributed between the two functions in an equitable manner? And ultimately, how do these joint costs relate to prices charged to the user? Cost allocation is a segment of financial analysis which assigns costs to specific objectives, benefits, functions, or customers.

Cost allocation should not be confused with cost sharing. Cost allocation refers to an equitable division of costs among various purposes served. Cost sharing refers to the division of costs allocated to each purpose to the individual agencies involved, which may include the federal, state, and one or more local governments.

Cost allocation, however, may serve as a basis for cost sharing. For reclamation projects cost allocation is necessary to identify the costs to be included in the wastewater discharger user charge and industrial cost recovery provisions of the Clean Water Construction Grant Program. If a water reclamation project is integrated with a fresh water supply, then it may be necessary to allocate costs between reclamation and fresh water supply, with state and federal grant eligibility under the Grant Program being limited to the reclamation portion. Cost allocation may also be appropriate to set prices for different service areas or classes of customers.

Definitions and General Principles

To discuss cost allocation some definitions are needed:

1. Specific costs: costs of facilities that exclusively serve only one project purpose.

2. Joint costs: costs of facilities that serve more than one purpose.

3. Separable costs: costs which could be omitted from a project if one purpose of the project were excluded. In some cases specific costs and separable costs are identical.

4. Alternative cost: cost of the most cost-effective single purpose alternative means of providing the same benefits as provided for that purpose in the multipurpose alternative.

5. Justifiable cost: the lesser of benefits or alternative cost for a given purpose.

6. Remaining benefits: justifiable cost less separable cost for each purpose.

General principles of joint cost allocation are:

- The sum of the allocated costs should equal the total project cost.

- No purpose should be assigned costs beyond the level of the justifiable cost for that purpose.

- No purpose should be assigned less than its separable or specific costs.

- The level of prices charged for project outputs should be related to the allocation of costs.

Application

Water reclamation projects generally have two functions, water quality improvement and water reclamation, serving each in varying degrees. To reduce the effort to perform the cost allocation, simplified procedures will be followed if appropriate.

1. Projects with the Primary Purpose of Water Reclamation. For projects in this category existing wastewater treatment and disposal facilities are adequate to meet waste discharge requirements. While water quality benefits may result from the reclamation project, because there is no current requirement that action be taken to improve water quality or because the water quality benefits are derived indirectly or outside of the project area, it is usually difficult to place a monetary value on the water quality benefit. Such projects are usually

evaluated economically based on comparison with alternative water supply benefits, because the goal is to make better use of the wastewater. Therefore, generally, all of the costs will be allocated to water reclamation, and no attempt will be made to recover costs from wastewater dischargers (sources) through user charges and industrial cost recovery.

If fresh water supply components are included in the overall project, then at a minimum the specific costs will be allocated to fresh water supply. If joint costs remain, depending on their magnitude, perhaps an attempt should be made to allocate the costs using the Separable Costs-Remaining Benefits or Alternative Justifiable Expenditure method described below.

2. Projects with the Primary Purpose of Pollution Control. Projects in this category are initiated for the primary purpose of meeting a waste discharge requirement or other pollution control requirement. Three situations generally exist.

a. Reclamation may be the most cost-effective method of treating and disposing of the wastewater, even when the benefits of the use of the effluent, such as revenue from the sale of the effluent, are disregarded. Even though reclamation benefits exist, it will not be required to allocate costs to reclamation. User charges and industrial cost recovery will apply to the whole project. However, consideration should be given in setting prices for the reclaimed water or for leasing grantee-owned farm land to the benefit the user receives from the reclaimed water.

b. Reclamation is the most cost-effective alternative of treating and disposing of the wastewater only by giving weight to the benefits of the use of the treated wastewater. In this case the reclamation alternative is more costly than other pollution control alternatives, but the costs are offset by the benefits (monetary or nonmonetary) of reclamation. Depending on the magnitude of the costs and the burden on industrial wastewater sources if industrial cost recovery applies to the whole project, it may be desirable to allocate costs using the Separable Costs-Remaining Benefits or Alternative Justifiable Expenditure method.

c. Reclamation is part of the proposed project but is not an integral part of the pollution control component needed to meet the minimum waste discharge requirements. In this case reclamation is severable from the project with little or no effect on the pollution control portion. The reclamation component is then analogous to a separate project with the primary purpose of water reclamation. The specific costs related to reclamation are allocated to reclamation and wastewater discharger user changes and industrial cost recovery are not applied to this portion of the project.

If there are facilities that serve more than one project purpose, that is, if there are joint costs, and it is necessary to allocate those costs to each purpose, then it may be necessary to apply the Separable Costs-Remaining Benefits Benefits method or Alternative Justifiable Expenditure method of cost allocation. These methods are generally felt to provide the most equitable allocation of costs according to the benefits accruing to each purpose. The Alternative Justifiable Expenditure method is a simplified version of the Separable Costs-Remaining Benefits method and is recommended except where unusual circumstances warrant use of other methods.

Separable Costs-Remaining Benefits (SC-RB) Method

By the SC-RB Method each purpose is allocated its separable cost and a share of the remaining joint costs. The following steps are followed(1):

1. The benefits of each purpose are estimated.

2. The alternative costs of single purpose projects to obtain the same benefits as the proposed multipurpose project are estimated.

3. The lesser of the results of Steps 1 or 2 is designated for each purpose as the justifiable cost and is generally the maximum amount which should be allocated to each purpose.

4. The separable cost of each purpose is estimated. The project with a purpose omitted should be the least costly project capable of providing the same benefits for the remaining project purposes. That project can be at the same site or at another site as long as the service areas for the remaining purposes are the same. The cost savings by omitting a purpose is the separable cost for that purpose.

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(1) Economics Practices Manual, draft, California Department of Water Resources, 1977.

5. The separable cost of each purpose is deducted from its justifiable cost to determine its remaining justifiable cost.

6. The remaining justifiable costs of each purpose are added, and the percentage distribution among the purposes is determined.

7. The total of separable costs is deducted from the total project costs to determine the total remaining joint costs.

8. The remaining joint costs are distributed proportionately according to the remaining justifiable costs of each purpose (that is, by applying the percentages found in Step 6).

9. The allocation to each purpose is the sum of the distributed remaining joint cost and the separable cost.

Example: A 15 MGD water reclamation project has a total present value cost of 10 million dollars. The project will provide reclaimed water for industry, agriculture, and a recreational lake. It is desired to allocate the costs among the three use classes for consideration in setting prices for reclaimed water. The SC-RB method is to be used. The allocation procedure is shown in Table IV-4, with the step numbers corresponding to those given above.

Table VI-4

ALLOCATION OF COSTS OF 15 MGD RECLAMATION PROJECT
BY SC-RB METHOD
(millions [a])

Step	Item	Industry	Agriculture	Recreation Lake	Total
1	Benefits[b]	$ 6.50	$ 7.70	$0.30	$ 14.50
2	Alternative costs[b]	5.00	10.00	1.00	16.00
3	Justifiable costs[c]	5.00	7.70	0.30	13.00
4a	Project cost with specified use omitted[b]	7.00	8.50	9.75	
4b	Separable costs[d]	3.00	1.50	0.25	4.75
5	Remaining justifiable costs[e]	2.00	6.20	0.05	8.25
6	Percentage distribution[f]	24.2	75.2	0.6	100.0
7&8	Remaining joint costs[g]	1.27	3.95	0.03	5.25
9	Total allocation[h]	4.27	5.45	0.28	10.00

[a]Except for Step 6.
[b]Given.
[c]Lesser of Steps 1 or 2.
[d]$10.00 - Step 4a.
[e]Step 3 - Step 4b.
[f]Based on Step 5.
[g]Total = $10.0 - Step 4b. Distribution based on Step 6.
[h]Step 4b + Step 8.

Alternative Justifiable Expenditure (AJE) Method

The AJE method is similar to the SC-RB method except that specific costs rather than separable costs are used. The following steps are followed(2):

1. The benefits for each purpose are estimated.

2. The alternative costs of single purpose projects to obtain the same benefits as the proposed multipurpose project are estimated.

3. The lesser of the results of Steps 1 or 2 is designated for each purpose as the justifiable cost and is generally the maximum amount which should be allocated to each purpose.

4. The specific cost of each purpose is estimated.

5. The specific cost of each purpose is deducted from its justifiable cost to determine its remaining justifiable cost.

6. The remaining justifiable costs of each purpose are added, and the percentage distribution among the purposes is determined.

7. The total of specific costs is deducted from the total project cost to determine the total joint costs.

8. Joint costs are distributed proportionately according to the remaining justifiable costs of each purpose (that is, by applying the percentages found in Step 6).

9. The allocation to each purpose is the sum of the distributed joint cost and the specific cost.

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(2) Economic Practices Manual, draft, California Department of Water Resources, 1977; U.S. Environmental Protection Agency Construction Grants Program Requirements Memorandum No. PRM #77-4, Subject: Cost Allocations for Multiple Purpose Projects, From: John T. Rhett, Deputy Assistant Administrator for Water Program Operations, To: Regional Administrators, Regions I-X, December 3, 1976. Note that the steps shown differ slightly from the EPA procedure, which does not include Step 1 and uses only alternative cost as the justifiable cost.

Example: The same problem that was used for the SC-RB method example will be evaluated using the AJE method, as shown in Table VI-5 with the step numbers corresponding to the AJE steps. Note that the specific costs are less than the separable costs. In this example, specific costs included primarily branch pipelines to specific users. Separable costs also included costs of portions of jointly used facilities, the sizes of which could be reduced if a project use were omitted.

Table VI-5

ALLOCATION OF COSTS OF 15 MGD RECLAMATION PROJECT
BY AJE METHOD
(millions [a])

Step	Item	Industry	Agriculture	Recreation Lake	Total
1	Benefits[b]	$ 6.50	$ 7.70	$0.30	$ 14.50
2	Alternative costs[b]	5.00	10.00	1.00	16.00
3	Justifiable costs[c]	5.00	7.70	0.30	13.00
4	Specific costs[b]	2.90	0.95	0.25	4.10
5	Remaining justifiable costs[d]	2.10	6.75	0.05	8.90
6	Percentage distribution[e]	23.6	75.8	0.6	100.0
7&8	Joint costs[f]	1.39	4.47	0.04	5.90
9	Total allocation[g]	4.29	5.42	0.29	10.00

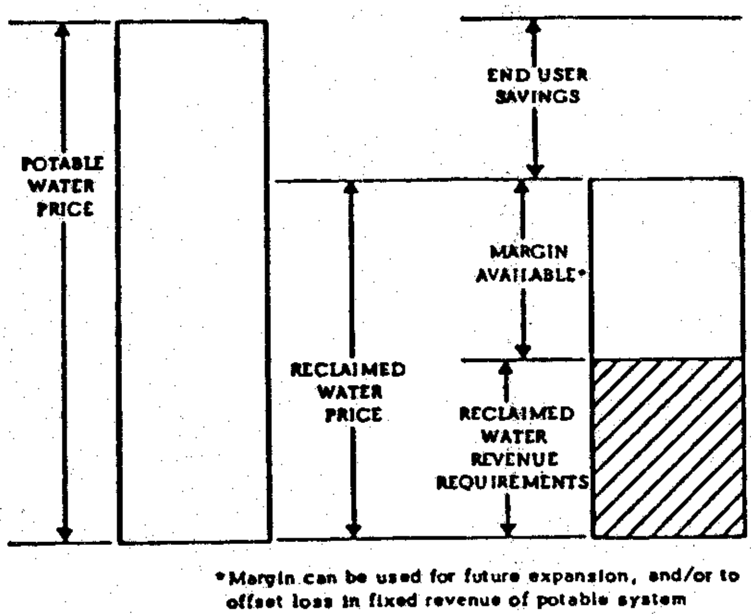
[a]Except for Step 6.
[b]Given.
[c]Lesser of Steps 1 or 2.
[d]Step 3 - Step 4.
[e]Based on Step 5.
[f]Total = $10.00 - Step 4. Distribution based on Step 6.
[g]Step 4+Step 8.

E. Pricing Policy

Prices must be set to return as a minimum the incremental (marginal) costs of providing the reclaimed water to each end user in order to ensure its efficient, non-wasteful use. Prices may be set higher, however, but then it would be expected that less reclaimed water would be demanded. In order to provide maximum incentive to use reclaimed water while maintaining economic efficiency, the pricing concept illustrated in Figure VI-1, is useful. Note that the reclaimed water price is below the potable water price yet above the level required to ensure cost recovery (coverage of the revenue requirements). Of course if the costs necessitate a price so high that the reclaimed water is not competitive with fresh water, the project is simply not financially feasible without benefit of external subsidies.

As depicted on Figure VI-1, a margin or profit exists when the costs are less than the revenue generated by selling the reclaimed water. This profit should be used as specified in the preceding general requirements section.

When ample short-term source of supply of potable water exists, the most straightforward incentive for use of reclaimed water is price. The price of potable water can be expected to increase due to inflation, to renegotiation of power supply costs for Colorado River and State Water Project water, and to increasing development costs because new sources of supply are more difficult to develop than present sources were. As potable costs continue to increase in the 1980's, the value in use of reclaimed water will increase.



RECLAIMED WATER PRICING POLICY CONCEPT

Figure VI-1

In summary, a proper pricing policy could be the pricing of reclaimed water at some price below that for potable water but above the minimum level required for the cash needs of the reclaimed water system to:

- Provide an economic incentive for the immediate and efficient use of reclaimed water by potential users.
- Provide funds as necessary for the expansion of the reclaimed water system, to expand service systematically to future reclaimed water users.
- Reimburse the potable water system for loss of revenue due to substitution of reclaimed water for fresh, should there be a significant adverse impact on the recovery of fixed costs of operation.

Even though reclaimed water development may be economically justified, the local cost to supply reclaimed water may still exceed fresh water prices. If the reclaimed water users are required to provide all of the revenue for the project, it may not be financially feasible. Consideration should be given to integrating reclaimed water costs with fresh water costs in setting prices, in a manner similar to the way the costs of new fresh water supplies are combined with the costs of existing supplies and spread over all customers, both existing and new. Fresh water users may benefit from some users relying on reclaimed water, such as by delaying the need to develop new fresh water supplies. It may be appropriate for fresh water prices to include some of the costs of the reclaimed water system such that reclaimed water prices can be lowered sufficiently to provide incentive for reclaimed water use.

"Price discrimination" occurs when different price levels for a homogeneous product have been established for different users in a manner not consistent with the variations in costs of serving different users. Under some circumstances, it is conceivable that price discrimination may be used to maximize water reuse. For example, potable water pricing for agricultural irrigation in California generally reflects value of service or ability to pay rather than cost of service. The use of reclaimed water in agricultural irrigation as a substitute for fresh water would depend upon a pricing policy which takes into consideration the lower value in use assigned to fresh water.

While a specific water reclamation project may be cost-effective and financially feasible, a short-run cash flow problem may exist in the early years of operation. Financing flexibility is limited in that general obligation bonds, which are dependent upon the ad valorem tax base, may no longer be approved within California by the voters. Mitigation efforts must be found in order to implement the project, by using the financing capability of existing agencies to provide for the local share of capital costs in the short term, before reclaimed water user charge revenue is available. Other financing alternatives may also be identified.

APPENDICES

APPENDIX A. GLOSSARY

Definitions of terms and concepts used in the Guidelines.

Capital Recovery Factor

The amount of money that can be withdrawn at the end of each year, for N years at i interest if one dollar is the initial investment. This factor is used to convert present values to equivalent annual values.

Cost Allocation

The procedure for dividing costs of a project among project functions or beneficiaries. This procedure is part of financial analysis in determining user charges.

Cost-Effectiveness Analysis

An analysis to determine which waste treatment management system or subsystem, including water reclamation, will result in the minimum total resources cost (opportunity cost) over time to meet the local, state and federal requirements.

Demand (For Water)

The total amount of water withdrawn or taken-in by all users in a particular area regardless of end use.

(The water need not be consumed, recycled water use is part of total demand for water.) The demand of a treatment plant is the total sewage output of an area.

Demand Function

Schedule showing for each possible price of water the quantity demanded. This information is based on specific assumptions on prices of related goods.

Design Capacity (System)

The maximum level of operation of a facility at which the facility operates reliably.

Disaggregation

The breaking down of state (or other geographic area) population or economic activity statistics into smaller areas for market demand analysis. This procedure is used in market analysis to forecast the demand for water and waste treatment.

Discount Rate

The expression of the time value of capital (money) used in comparing alternative projects by present value analysis; the opportunity cost of capital. This is a measure of society's choice between current consumption and future returns.

Economic Benefits

All results and effects of a project are considered economic benefits. In some cases adverse benefits (negative effects of projects) are netted out of the Benefit calculation.

Economic Costs

All resources used to build, operate, and maintain a project, and the resources necessary to benefit directly or indirectly from the project output of goods and services.

Economic Analysis

The procedure for determining a water reclamation system's net economic benefits overtime and comparing the net benefits of alternative systems with project objectives.

Equivalent Annual Value

Restates the present monetary value of a project in an equivalent uniform annual amount over the time frame of analysis. (The product of the capital recovery factor and the present value.)

Financial Analysis

The procedure to determining the cash flow of expenses and revenues for a project over time. A water reclamation system will be financially feasible if the initial investment capital can be generated and the revenues (from all sources) exceeds the expenses for any period.

Industrial Cost Recovery

The generation of revenue from nongovernmental and nonresidential users of wastewater systems to recover the federal grant amount allocable to the treatment of the users' waste.

Interest Cost (rate)

The fee charged for the use of capital (borrowed money) as determined by the capital market.

Marginal Cost

The additional cost incurred to produce one more unit of a good or service from a stated level (often the current level) of output. Marginal cost is the rate of change of total cost as a function of output.

Net Worth (See present value)

Opportunity Cost

The productivity foregone by not investing in the next optimal project. The value of the sacrificed productivity is determined by the monetary value placed on the output of the alternate project by consumers.

Optimum (project)

The production of maximum net benefits constrained by a maximum budget on costs; or the minimization of costs constrained by a minimum level of benefits.

Planning Period

The period over which a waste treatment management system is evaluated for cost-effectiveness. The planning period begins with the system's initial operations and is defined by the EPA to be 20 years.

Present Discounted Value (See present value)

Present Value (Present Worth)

The amount of money paid today which is equivalent to the future flow of costs and benefits at a given interest and time frame. (The sum of the products of benefits or costs and the present worth factor.)

Project Analysis

The evaluation of engineering, economic, environmental, financial, political and social factors which impact on the construction and operation of a water reclamation system.

Reclaimed Water

The California Water Code (Sec. 13050) defines reclaimed water as "water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur."

Replacement Cost

Expenditures for obtaining and installing equipment during the useful life of the plant to maintain the designed plant capacity and performance.

Salvage Value

The residual value of a facility or component of a facility at the end of the planning period, if the item is useful and has a market value. For planning purposes, straight-line depreciation from the first day of plant operation is used to determine the residual value.

Service Life

The period of time during which a facility will be capable of performing a function within specifications.

Useful Life

The period during which a facility will operate.

User Charge

A charge levied for waste treatment or the price charged for reclaimed water.

Water Reclamation System (Plant)

A complete water reclamation system (complete waste treatment system) consists of all the treatment works involved in transporting wastewater from homes or buildings to the treatment facility, treating wastewater to remove pollutants and contaminants, distributing the reclaimed (treated) water, and disposing of the waste and process residue. Treatment works consist of land, buildings, equipment, and sewage systems.

APPENDIX B. ABBREVIATIONS

ac-ft	acre-foot = 326,000 gallons = 1.23 million liters
AJE	Alternative Justifiable Expenditure
BOD	biological oxygen demand
BTU	British thermal unit = 1050 joules
C	costs
ccf	one hundred cubic feet = 748 gallons = 2830 liters
CFR	U.S. Code of Federal Regulations (The citation XX CFR YY.YYY refers to Title XX, Section YY.YYY of the CFR.)
ENR	Engineering News-Record
EPA	U.S. Environmental Protection Agency
FWPCA	Federal Water Pollution Control Act
gpm	gallons per minute
HP	horsepower
hr	hour
kW-hr	kilowatt hour = 3.60 million joules
lb	pound
MGD	million gallons per day = 43.8 liters/second
NPV	net present value
O&M	operation and maintenance
SC-RB	Separable Costs-Remaining Benefits
SIC	Standard Industrial Classification Code
SWRCB	California State Water Resources Control Board

APPENDIX C. INTEREST FACTORS

Formulae

i = interest rate per period

n = number of time periods

Compount amount factor (F/P) = (1 + i)n

Present worth factor (P/F) = $\dfrac{1}{(1 + i)^n}$

Sinking fund factor (A/F) = $\dfrac{i}{(1 + i)^n - 1}$

Capital recovery factor (A/P) = $\dfrac{i(1 + i)^n}{(1 + i)^n - 1}$

Series compound amount factor (F/A) = $\dfrac{(1 + i)^n - 1}{i}$

Series present worth factor (P/A) = $\dfrac{(1 + i)^n - 1}{i(1 + i)^n}$

Gradient series compound amount factor (F/G) =

$$= \frac{1}{i} \cdot \left[\frac{(1 + i)^n - 1}{i} - n \right]$$

Gradient series present worth factor (P/G) =

$$= \frac{1}{i} \cdot \left[\frac{(1 + i)^n - 1}{i(1 + i)^n} - \frac{n}{(1 + i)^n} \right]$$

Gradient series to uniform series equivalent factor (A/G) =

$$= \frac{1}{i} \cdot \left[\frac{n}{(1 + i)^n - 1} \right]$$

The gradient series formulae are based on a n-year end-of-year series 0, G, 2G, 3G, ... (n-1)G.

Tables

Below are interest tables for interest rates that are not commonly found in many references. Many engineering economy texts have tables for other interest rates. If a table cannot be found, the formulae provided above can be used.

6-5/8 PERCENT

n	F/P	P/F	A/F	A/P	F/A	P/A	P/G
1	1.0662	0.93787	1.00000	1.06625	1.0000	0.9379	0.0000
2	1.1369	0.87959	0.48397	0.55022	2.0662	1.8175	0.8796
3	1.2122	0.82494	0.31219	0.37844	3.2031	2.6424	2.5295
4	1.2925	0.77368	0.22648	0.29273	4.4153	3.4161	4.8505
5	1.3781	0.72561	0.17520	0.24145	5.7079	4.1417	7.7530
6	1.4694	0.68053	0.14112	0.20737	7.0860	4.8222	11.1556
7	1.5668	0.63824	0.11688	0.18313	8.5555	5.4605	14.9851
8	1.6706	0.59859	0.09879	0.16504	10.1223	6.0591	19.1752
9	1.7813	0.56140	0.08480	0.15105	11.7929	6.6205	23.6664
10	1.8993	0.52651	0.07367	0.13992	13.5741	7.1470	28.4050
11	2.0251	0.49380	0.06463	0.13088	15.4734	7.6408	33.3430
12	2.1593	0.46312	0.05715	0.12340	17.4985	8.1039	38.4373
13	2.3023	0.43434	0.05087	0.11712	19.6578	8.5382	43.6494
14	2.4549	0.40736	0.04554	0.11179	21.9601	8.9456	48.9450
15	2.6175	0.38204	0.04096	0.10721	24.4150	9.3276	54.2936
16	2.7909	0.35831	0.03699	0.10324	27.0325	9.6859	59.6682
17	2.9758	0.33604	0.03353	0.09978	29.8234	10.0220	65.0449
18	3.1729	0.31516	0.03049	0.09674	32.7992	10.3371	70.4027
19	3.3832	0.29558	0.02780	0.09405	35.9721	10.6327	75.7232
20	3.6073	0.27722	0.02541	0.09166	39.3553	10.9099	80.9903
25	4.9714	0.20115	0.01668	0.08293	59.9452	12.0581	106.1025
30	6.8513	0.14596	0.01132	0.07757	88.3211	12.8912	128.4898
35	9.4421	0.10591	0.00785	0.07410	127.4273	13.4957	147.7568
40	13.0125	0.07685	0.00552	0.07177	181.3212	13.9344	163.9305
45	17.9332	0.05576	0.00391	0.07016	255.5950	14.2526	177.2577
50	24.7145	0.04046	0.00279	0.06904	357.9550	14.4836	188.0829

6-7/8 PERCENT

n	F/P	P/F	A/F	A/P	F/A	P/A	P/G
1	1.0688	0.93567	1.00000	1.06875	1.0000	0.9357	0.0000
2	1.1422	0.87548	0.48338	0.55213	2.0688	1.8112	0.8755
3	1.2208	0.81917	0.31143	0.38018	3.2110	2.6303	2.5138
4	1.3047	0.76647	0.22565	0.29440	4.4317	3.3968	4.8132
5	1.3944	0.71717	0.17432	0.24307	5.7364	4.1140	7.6819
6	1.4902	0.67103	0.14024	0.20899	7.1308	4.7850	11.0370
7	1.5927	0.62787	0.11600	0.18475	8.6210	5.4129	14.8042
8	1.7022	0.58748	0.09791	0.16666	10.2137	6.0003	18.9166
9	1.8192	0.54969	0.08392	0.15267	11.9159	6.5500	23.3141
10	1.9443	0.51433	0.07281	0.14156	13.7351	7.0643	27.9430
11	2.0780	0.48124	0.06378	0.13253	15.6794	7.5456	32.7554
12	2.2208	0.45028	0.05631	0.12506	17.7574	7.9959	37.7085
13	2.3735	0.42132	0.05005	0.11880	19.9782	8.4172	42.7644
14	2.5367	0.39422	0.04474	0.11349	22.3517	8.8114	47.8892
15	2.7111	0.36886	0.04018	0.10893	24.8884	9.1803	53.0532
16	2.8975	0.34513	0.03623	0.10498	27.5995	9.5254	58.2301
17	3.0967	0.32293	0.03279	0.10154	30.4969	9.8483	63.3970
18	3.3096	0.30215	0.02977	0.09852	33.5936	10.1505	68.5336
19	3.5371	0.28272	0.02710	0.09585	36.9032	10.4332	73.6225
20	3.7803	0.26453	0.02473	0.09349	40.4403	10.6977	78.6486
25	5.2711	0.18971	0.01610	0.08485	62.1254	11.7860	102.4461
30	7.3499	0.13606	0.01083	0.07958	92.3628	12.5665	123.4153
35	10.2486	0.09757	0.00743	0.07618	134.5251	13.1262	141.2522
40	14.2904	0.06998	0.00517	0.07392	193.3153	13.5276	156.0514
45	19.9263	0.05019	0.00363	0.07238	275.2910	13.8155	168.1042
50	27.7847	0.03599	0.00257	0.07132	389.5963	14.0219	177.7804

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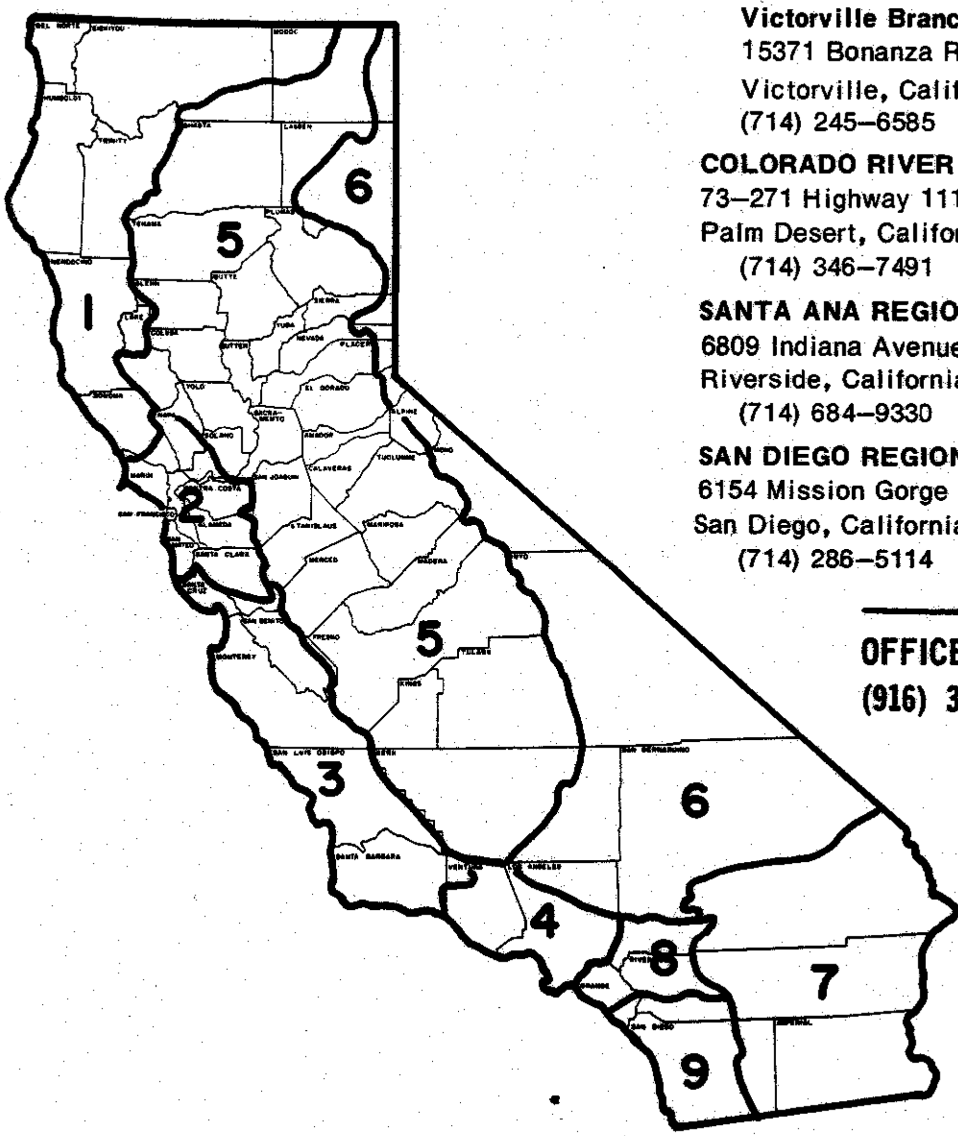

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