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BENEFIT-COST EVALUATIONS AS APPLIED TO AID FINANCED WATER OR RELATED LAND USE PROJECTS

Supplement No. 1
To
Feasibility Studies
Economic and Technical Soundness Analysis
Capital Projects

May 31, 1963

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CONTENTS

Page No.

A. INTRODUCTION

1. Purpose 1
2. Benefits 2
3. Costs 2
4. Comparison with Alternatives 3

B. FACTORS TO BE USED IN ALL ANALYSES

1. Period of the Analysis 3
2. Interest Rates 4
3. Conversion of Costs to Common Currency 5
4. Taxes 5

C. APPLICATION OF COMPOUND INTEREST

1. Amortization of Installation Cost 5
   T-1 - Single Payment-Present Worth Factor ... 6
   T-2 - Uniform Series-Present Worth Factor ... 7
   T-3 - Capital Recovery Factor 8
2. Discounting of a Replacement 9
3. Discounting of Terminal Salvage Value 9
4. Lag in Accrual of Benefits 10
   T-4 - Uniformly Increasing Annual Series-Present Worth Factor 11

D. EXAMPLES OF BENEFIT-COST CALCULATION 13

E. IRRIGATION PROJECT

1. Project Description 13
2. Estimated Installation Cost 14
3. Annual Costs 15
4. Associated Costs, Paid by Landowners 15
5. Primary Benefits to Landowners 15
6. Benefit-Cost Ratio 16
7. Secondary Benefits 16

CONTENTS (contd.)

Page No.

F. WATER SUPPLY PROJECT

1. Project Description 17
2. Estimated Installation Cost..... 17
3. Annual Costs 18
4. Cost of Equivalent Supply from Best Alternate Source 18
5. Benefit-Cost Ratio 19
6. Secondary Benefits 19

G. HYDROELECTRIC POWER PROJECT

1. Project Description 19
2. Estimated Installation Cost..... 20
3. Annual Cost 21
4. Cost of Same Amount of Power from Best Alternate Source..... 21
5. Benefit-Cost Ratio 22
6. Secondary Benefits 22

H. PORT DEVELOPMENT

1. Project Description 22
2. Estimated Installation Cost..... 23
3. Annual Cost 24
4. Annual Primary Benefits..... 24
5. Benefit-Cost Ratio 25
6. Secondary Benefits 25

I. MULTIPURPOSE PROJECT

1. Definition of Terms and Their Use in Cost Allocation..... 26
   a. Alternate Cost 26
   b. Separable Cost..... 26
   c. Specific Cost..... 27
   d. Joint Cost 27
2. Description of Method 27
3. Example of Cost Allocation (Where benefit for each purpose exceeds its alternate cost) 28
4. Example of Cost Allocation (Where benefit for each purpose is less than or equal to its alternate cost) 31

BENEFIT-COST EVALUATIONS AS APPLIED TO AID FINANCED WATER OR RELATED LAND USE PROJECTS

A. INTRODUCTION

1. Purpose

Sec. 101 of the 1963 Foreign Aid Appropriations Act requires that none of the funds therein appropriated (other than funds appropriated under the authorization for "International Organizations and Programs") shall be used to finance the construction of any new flood control, reclamation, or other water or related land resource project or program which has not met the standards and criteria used in determining the feasibility of flood control, reclamation and other water and related land resource programs and projects proposed for construction within the United States of America. Senate Document No. 97, 87th Congress, sets out policies, standards and procedures for such projects.

The Manual entitled "Feasibility Studies, Economic and Technical Soundness Analysis, Capital Projects", June 1, 1962, with revisions, contains four chapters covering types of projects for which a computation of benefits and costs may be required in accordance with Senate Document No. 97, namely:

Chapter III.	Electric Power Projects (Hydroelectric Power Projects Only)
Chapter IV.	Agriculture and Irrigation Projects
Chapter VI.	Port Development Projects
Chapter XI.	Municipal Water and Sewerage Projects

This Supplement describes methods and standards to be used in computing benefits and costs and the benefit-cost ratio where Senate Document No. 97 is applicable. Numerical examples of the computations for four hypothetical projects are given for illustration. In addition, the Supplement describes the method to be used in allocating the costs of multipurpose projects to the respective purposes. Where a new project consists of additions

to an existing project or system the determination of a benefit-cost ratio is based on benefits and economic costs of the new project only.

It is the responsibility of the engineer for the borrower or grantee to prepare the economic analysis of the proposed project.

2. Benefits

Benefits are evaluated from the standpoint of the economy of the country where the project is located. In computing the benefit-cost ratio, the benefits used should be the tangible benefits, primary or secondary, which can be reliably estimated in monetary terms. If secondary benefits are included, they must be listed separately. Intangible benefits may be cited as supplementary justification. Benefits are generally expressed as an annual equivalent over the established period of the analysis.

In cases where benefits accrue at their full value immediately upon the completion of the project installation, the annual equivalent will be the same as the estimated benefit for the first year. If, on the other hand, benefits increase gradually or do not commence at all for several years, the annual equivalent benefit must be computed by the use of compound interest factors.

3. Costs

Project economic costs used in computing the benefit-cost ratio should include:

a. Installation, including cost of land and right-of-way, engineering and inspection, construction, and interest during the construction period.

b. Operation, maintenance and replacement. Maintenance and replacement must be estimated on a scale sufficient to ensure effective operating capacity and dependability to attain the level of benefits claimed for the project throughout the established period of analysis.

c. Induced costs resulting from the project installation such as resettlement of people or relocation of highways may be accounted for either by addition to project economic costs or deduction from primary benefits.

All costs are reduced to an equivalent annual amount by amortizing over the period of analysis. Costs for investigating, surveying and planning incurred prior to commitment for a project will not be included as project economic costs.

4. Comparison with Alternatives

In certain types of projects where direct evaluation of the benefits is difficult or impossible (e.g. hydro-power or water supply), the usual practice is to consider that the benefit is equal to the cost of the most economically attractive alternative project which will produce the same products or render the same service at the same place. In such cases the cost of the alternative must be estimated in the same manner as the cost of the project.

B. FACTORS TO BE USED IN ALL ANALYSES

1. Period of the Analysis

The period of analysis shall encompass that period of time over which the project will usefully serve its intended purpose In any case, this period should not exceed 50 years.

The following typical examples of useful lives (in years) may be used where appropriate:

Dams, earth or concrete	50
Pumps (large)	25
Canals and ditches	50
Wells and well pumps	15 (maximum)
Treatment plant tanks	35
Pipe, reinforced concrete	50
Water tanks, steel	30
Warehouses	50
Factory buildings	50

Diesel generators:	
high speed	10
low speed	20
Power plant structures	50
Hydraulic turbines and generators	35
Penstocks	50
Turbo-generators, steam	30
Transformers	25
Transmission towers and wires	
steel or concrete	50
treated wood	20-35

Related pieces of equipment may be assigned a group life in many cases. The limiting time of 50 years will be applied to all water and related land resource projects. In some cases, to justify this period it may be necessary to include in the project the interim replacement of certain shorter-lived elements of the project in addition to normal maintenance charges.

2. Interest Rates

The interest rate for amortizing Federal costs and for discounting benefits is established in Senate Document No. 97 as the average rate on outstanding U.S. Government interest-bearing marketable securities running for 15 years or more. The most recent determination by the Treasury Department in August 1962 has fixed this average at 2-7/8 percent. This is the basic risk-free rate established for the purpose of benefit-cost studies for projects in the United States. The same rate is not necessarily applicable to projects in foreign countries where a higher rate due to investment risk may be appropriate.

For A.I.D. benefit-cost evaluations an interest rate of 3-1/2 percent is established for amortizing U.S. dollar costs. The application of this rate will tend to depress benefit-cost ratios slightly but is still low enough to give suitable encouragement to foreign water and related land resource development projects.

The above rate is applicable only to the U.S. dollar portion of project installation costs. The local costs of project installation and the cost of future additions or replacements are

to be treated on the basis of the local interest rates. This will also apply to the benefits as they accrue only to the local economy. The appropriate rate should be established for the particular country and if possible should be based on the interest rate applicable to outstanding government interest-bearing marketable securities of 15 years or more maturity. In cases where local rates are unreasonably high or low or where an accurate rate cannot be determined, the rate of 6 per cent per annum will be used.

3. Conversion of Costs to Common Currency

The computation of a benefit-cost ratio requires that all factors be expressed in one currency and for this purpose U.S. dollars shall be used. The local component of installation costs and the maintenance and operation costs, as well as the monetary value of the benefits, shall be converted to U.S. dollars at the effective rate of exchange at which U.S. dollars are sold or offered for sale in the Applicant's country.

4. Taxes

Taxes shall be used as an item of cost only when it is necessary to compare the cost of a project with the cost of an alternate project, either operating or proposed, where taxes are applicable.

C. APPLICATION OF COMPOUND INTEREST

Tables of commonly used factors at various interest rates are shown on the following pages.

1. Amortization of Installation Cost

The total installation cost is converted to an equivalent uniform annual amount over the period of analysis by applying the Capital Recovery Factor (T-3). This computes the amount required to retire a debt at interest by a series of equal end of year payments and is referred to as amortization (of the installation cost).

T-1
Single Payment-Present Worth Factor

$$\frac{1}{(1 + i)^n}$$

This factor is the present value of a $1.00 payment which is to be made n years from now, assuming money compounds annually at the interest rate used. For example, the present value of $1.00 to be spent 10 years from now is $0.5584, if interest compounds at 6 per cent. This means that I must set aside $0.5584 today at 6 per cent interest in order to have the $1.00 I will need 10 years from now.

The use of this factor is referred to as discounting.

n year	Interest Rate-i							
	2½%	3%	3½%	4%	5%	6%	7%	8%
1	0.9756	0.9709	0.9662	0.9615	0.9524	0.9434	0.9346	0.9259
2	0.9518	0.9426	0.9335	0.9246	0.9070	0.8900	0.8734	0.8573
3	0.9286	0.9151	0.9019	0.8890	0.8638	0.8396	0.8163	0.7938
4	0.9060	0.8885	0.8714	0.8548	0.8227	0.7921	0.7629	0.7350
5	0.8839	0.8626	0.8420	0.8219	0.7835	0.7473	0.7130	0.6806
6	0.8623	0.8375	0.8135	0.7903	0.7462	0.7050	0.6663	0.6302
7	0.8413	0.8131	0.7860	0.7599	0.7107	0.6651	0.6227	0.5835
8	0.8207	0.7894	0.7594	0.7307	0.6768	0.6274	0.5820	0.5403
9	0.8007	0.7664	0.7337	0.7026	0.6446	0.5919	0.5439	0.5002
10	0.7812	0.7441	0.7089	0.6756	0.6139	0.5584	0.5083	0.4632
11	0.7621	0.7224	0.6849	0.6496	0.5847	0.5268	0.4751	0.4289
12	0.7436	0.7014	0.6618	0.6246	0.5568	0.4970	0.4440	0.3971
13	0.7254	0.6810	0.6394	0.6006	0.5303	0.4688	0.4150	0.3677
14	0.7077	0.6611	0.6178	0.5775	0.5051	0.4423	0.3878	0.3405
15	0.6905	0.6419	0.5969	0.5553	0.4810	0.4173	0.3624	0.3152
16	0.6736	0.6232	0.5767	0.5339	0.4581	0.3936	0.3387	0.2919
17	0.6572	0.6050	0.5572	0.5134	0.4363	0.3714	0.3166	0.2703
18	0.6412	0.5874	0.5384	0.4936	0.4155	0.3503	0.2959	0.2502
19	0.6255	0.5703	0.5202	0.4746	0.3957	0.3305	0.2765	0.2317
20	0.6103	0.5537	0.5026	0.4564	0.3769	0.3118	0.2584	0.2145
21	0.5954	0.5375	0.4856	0.4388	0.3589	0.2942	0.2415	0.1987
22	0.5809	0.5219	0.4692	0.4220	0.3418	0.2775	0.2257	0.1839
23	0.5667	0.5067	0.4533	0.4057	0.3256	0.2618	0.2109	0.1703
24	0.5529	0.4919	0.4380	0.3901	0.3101	0.2470	0.1971	0.1577
25	0.5394	0.4776	0.4231	0.3751	0.2953	0.2330	0.1842	0.1460
26	0.5262	0.4637	0.4088	0.3607	0.2812	0.2198	0.1722	0.1352
27	0.5134	0.4502	0.3950	0.3468	0.2678	0.2074	0.1609	0.1252
28	0.5009	0.4371	0.3817	0.3335	0.2551	0.1956	0.1504	0.1159
29	0.4887	0.4243	0.3687	0.3207	0.2429	0.1846	0.1406	0.1073
30	0.4767	0.4120	0.3563	0.3083	0.2314	0.1741	0.1314	0.0994
31	0.4651	0.4000	0.3442	0.2965	0.2204	0.1643	0.1228	0.0920
32	0.4538	0.3883	0.3326	0.2851	0.2099	0.1550	0.1147	0.0852
33	0.4427	0.3770	0.3213	0.2741	0.1999	0.1462	0.1072	0.0789
34	0.4319	0.3660	0.3105	0.2636	0.1904	0.1379	0.1002	0.0730
35	0.4214	0.3554	0.3000	0.2534	0.1813	0.1301	0.0937	0.0676
40	0.3724	0.3066	0.2526	0.2083	0.1420	0.0972	0.0668	0.0460
45	0.3292	0.2644	0.2127	0.1712	0.1113	0.0727	0.0476	0.0313
50	0.2909	0.2281	0.1791	0.1407	0.0872	0.0543	0.0339	0.0213

T-2

Uniform Series-Present Worth Factor

$$\frac{(1 + i)^n - 1}{i\ (1 + i)^n}$$

Given a uniform annual series of one dollar per year for n years, this factor is the corresponding value at the beginning of the series. For example, a benefit of $1.00 to be received each year for 50 years is worth $15.76 today, if money compounds at 6 per cent. This means that if $15.76 is invested at 6 per cent it will yield payments of $1.00 each year for 50 years.

The use of this factor is referred to as discounting also.

n year	Interest Rate-i							
	2½%	3%	3½%	4%	5%	6%	7%	8%
1	0.976	0.971	0.966	0.962	0.952	0.943	0.935	0.926
2	1.927	1.913	1.900	1.886	1.859	1.833	1.808	1.783
3	2.856	2.829	2.802	2.775	2.723	2.673	2.624	2.577
4	3.762	3.717	3.673	3.630	3.546	3.465	3.387	3.312
5	4.646	4.580	4.515	4.452	4.329	4.212	4.100	3.993
6	5.508	5.417	5.329	5.242	5.076	4.917	4.767	4.623
7	6.349	6.230	6.115	6.002	5.786	5.582	5.389	5,206
8	7.170	7.020	6.874	6.733	6.463	6.210	5.971	5.747
9	7.971	7.786	7.608	7.435	7.108	6.802	6.515	6.247
10	8.752	8.530	8.317	8.111	7.722	7.360	7.024	6.710
11	9.514	9.253	9.002	8.760	8.306	7.887	7.499	7.139
12	10.258	9.954	9.663	9.385	8.863	8.384	7.943	7.536
13	10.983	10.635	10.303	9.986	9.394	8.853	8.358	7.904
14	11.691	11.296	10.921	10.563	9.899	9.295	8.745	8.244
15	12.381	11.938	11.517	11.118	10.380	9.712	9.108	8.559
16	13.055	12.561	12.094	11.652	10.838	10.106	9.447	8.851
17	13.712	13.166	12.651	12.166	11.274	10.477	9.763	9.122
18	14.353	13.754	13.190	12.659	11.690	10.828	10.059	9.372
19	14.979	14.324	13.710	13.134	12.085	11.158	10.336	9.604
20	15.589	14.877	14.212	13.590	12.462	11.470	10.594	9.818
21	16.185	15.415	14.698	14.029	12.821	11.764	10.836	10.017
22	16.765	15.937	15.167	14.451	13.163	12.042	11.061	10.201
23	17.332	16.444	15.620	14.857	13.489	12.303	11.272	10.371
24	17.885	16.936	16.058	15.247	13.799	12.550	11.469	10.529
25	18.424	17.413	16.482	15.622	14.094	12.783	11.654	10.675
26	18.951	17.877	16.890	15.983	14.375	13.003	11.826	10.810
27	19.464	18.327	17.285	16.330	14.643	13.211	11.987	10.935
28	19.965	18.764	17.667	16.663	14.898	13.406	12.137	11.051
29	20.454	19.188	18.036	16.984	15.141	13.591	12.278	11.158
30	20.930	19.600	18.392	17.292	15.372	13.765	12.409	11.258
31	21.395	20.000	18.736	17.588	15.593	13.929	12.532	11.350
32	21.849	20.389	19.069	17.874	15.803	14.084	12.647	11.435
33	22.292	20.766	19.390	18.148	16.003	14.230	12.754	11.514
34	22.724	21.132	19.701	18.411	16.193	14.368	12.854	11.587
35	23.145	21.487	20.001	18.665	16.374	14.498	12.948	11.655
40	25.103	23.115	21.355	19.793	17.159	15.046	13.332	11.925
45	26.833	24.519	22.495	20.720	17.774	15.456	13.606	12.108
50	28.362	25.730	23.456	21.482	18.256	15.762	13.801	12.233

T-3

Capital Recovery Factor

$$\frac{i\,(1+i)^n}{(1+i)^n - 1}$$

Given a present debt of $1.00, this factor is the necessary uniform annual payment to be made each year for n years at the applicable interest rate which will retire the debt with interest. For example, to spread a present debt of $1.00 over the next 50 years with interest at 3-1/2 per cent, it would be necessary to pay $0.04263 each year. Similarly, with interest at 6 per cent, it would be necessary to pay $0.06344 each year. This process is called Amortization.

n year	Interest Rate-i							
	2½%	3%	3½%	4%	5%	6%	7%	8%
1	1.02500	1.03000	1.03500	1.04000	1.05000	1.06000	1.07000	1.08000
2	0.51883	0.52261	0.52640	0.53020	0.53780	0.54544	0.55309	0.56077
3	0.35014	0.35353	0.35693	0.36035	0.36721	0.37411	0.38105	0.38803
4	0.26582	0.26903	0.27225	0.27549	0.28201	0.28859	0.29523	0.30192
5	0.21525	0.21835	0.22148	0.22463	0.23097	0.23740	0.24389	0.25046
6	0.18155	0.18460	0.18767	0.19076	0.19702	0.20336	0.20980	0.21632
7	0.15750	0.16051	0.16354	0.16661	0.17282	0.17914	0.18555	0.19207
8	0.13947	0.14246	0.14548	0.14853	0.15472	0.16104	0.16747	0.17401
9	0.12546	0.12843	0.13145	0.13449	0.14069	0.14702	0.15349	0.16008
10	0.11426	0.11723	0.12024	0.12329	0.12950	0.13587	0.14238	0.14903
11	0.10511	0.10808	0.11109	0.11415	0.12039	0.12679	0.13336	0.14008
12	0.09749	0.10046	0.10348	0.10655	0.11283	0.11928	0.12590	0.13270
13	0.09105	0.09403	0.09706	0.10014	0.10646	0.11296	0.11965	0.12652
14	0.08554	0.08853	0.09157	0.09467	0.10102	0.10758	0.11434	0.12130
15	0.08077	0.08377	0.08683	0.08994	0.09634	0.10296	0.10979	0.11683
16	0.07660	0.07961	0.08268	0.08582	0.09227	0.09895	0.10586	0.11298
17	0.07292	0.07595	0.07904	0.08220	0.08870	0.09544	0.10243	0.10963
18	0.06967	0.07271	0.07582	0.07899	0.08555	0.09236	0.09941	0.10670
19	0.06676	0.06981	0.07294	0.07614	0.08275	0.08962	0.09675	0.10413
20	0.06415	0.06722	0.07036	0.07358	0.08024	0.08718	0.09439	0.10185
21	0.06179	0.06487	0.06804	0.07128	0.07800	0.08500	0.09229	0.09983
22	0.05965	0.06275	0.06593	0.06920	0.07597	0.08305	0.09041	0.09803
23	0.05770	0.06081	0.06402	0.06731	0.07414	0.08128	0.08871	0.09642
24	0.05591	0.05905	0.06227	0.06559	0.07247	0.07968	0.08719	0.09498
25	0.05428	0.05743	0.06067	0.06401	0.07095	0.07823	0.08581	0.09368
26	0.05277	0.05594	0.05921	0.06257	0.06956	0.07690	0.08456	0.09251
27	0.05138	0.05456	0.05785	0.06124	0.06829	0.07570	0.08343	0.09145
28	0.05009	0.05329	0.05660	0.06001	0.06712	0.07459	0.08239	0.09049
29	0.04889	0.05211	0.05545	0.05888	0.06605	0.07358	0.08145	0.08962
30	0.04778	0.05102	0.05437	0.05783	0.06505	0.07265	0.08059	0.08883
31	0.04674	0.05000	0.05337	0.05686	0.06413	0.07179	0.07980	0.08811
32	0.04577	0.04905	0.05244	0.05595	0.06328	0.07100	0.07907	0.08745
33	0.04486	0.04816	0.05157	0.05510	0.06249	0.07027	0.07841	0.08685
34	0.04401	0.04732	0.05076	0.05431	0.06176	0.06960	0.07780	0.08630
35	0.04321	0.04654	0.05000	0.05358	0.06107	0.06897	0.07723	0.08580
40	0.03984	0.04326	0.04683	0.05052	0.05828	0.06646	0.07501	0.08386
45	0.03727	0.04079	0.04445	0.04826	0.05626	0.06470	0.07350	0.08259
50	0.03526	0.03887	0.04263	0.04655	0.05478	0.06344	0.07246	0.08174

2. Discounting of a Replacement

When it is anticipated that an element of a project will require replacement during the period of analysis, the estimated replacement cost must be discounted to the present time by applying the Single Payment Present Worth Factor (T-1) and then this discounted value amortized over the full period of analysis in the same manner as the installation cost.

Example: In an irrigation project with economic life of 50 years, a pump, the cost of which was included in the project installation cost, must be replaced at the end of 25 years; estimated cost at that time - $30,000; interest rate is 6 percent. (1) The present amount required to provide for this future expenditure is $30,000 x 0.2330 (T-1) or $6,990. (2) This value is then amortized over 50 years by multiplying by the Capital Recovery Factor (T-3); $6,990 x 0.06344 = $443. This amount is a part of the annual cost of the project.

Simplified Method: If the cost of the initial pump in the above example was the same as the cost of the subsequent replacement ($30,000), then the annual cost of the two pumps over the 50 years can be computed by multiplying $30,000 by the Capital Recovery Factor (T-3) for 25 years, $30,000 x 0.07823 = $2346. This includes the annual cost of the initial pump investment which if computed separately would be $30,000 x 0.06344 = $1903. The difference ($443) is the amount to be added to annual cost of the total initial investment, agreeing with the figure computed in the Example above. It should be noted that this simplified method is strictly applicable only (1) if the initial and replacement expenditures are made by the same investor, (2) if the interest rate is the same in both cases, and (3) if the replacement period is an even factor of the number of years in the period of analysis (i.e. 2, 5, 10 or 25 years in a life of 50 years).

3. Discounting of Terminal Salvage Value

Salvage value of land, equipment and facilities which would have value for non-project uses at the end of the period of analysis may be discounted to the present time by applying the

Single Payment-Present Worth Factor and then deducting the discounted value from the installation cost. The value is likely to be small and is frequently disregarded.

Example: Assume that at the end of the 50-year economic life of a project, a piece of equipment will have a salvage value of $7,500, interest rate is 6 percent. The present value of this amount is $7,500 x 0.0543 (T-1) or $407. This amount is deducted from the installation cost before amortization. If the economic life is only 20 years, the present value is $7,500 x 0.3118 (T-1) or $2,338.

4. Lag in Accrual of Benefits

a. Complete lag refers to the situation where there are no benefits whatever for several years and the full annual benefit accrues uniformly thereafter. To compute the equivalent annual benefit, the procedure is as follows:

> (1) Multiply by the Uniform Series-Present Worth Factor (T-2) for the period during which the benefits occur; (2) then multiply by the Single Payment-Present Worth Factor (T-1) for the lag period; and finally (3) multiply by the Capital Recovery Factor (T-3) over the period of analysis.

A short-cut method is to apply the Single Payment-Present Worth Factor for the lag period to the annual benefit which accrues thereafter. This yields a slightly higher result, but the difference between the two methods decreases with increasing economic life.

Example: Lag 7 years, interest rate 6 percent, period of analysis 40 years, delayed benefit $1,000.00.

1. Exact method: Combined factor is 14.23 x 0.6651 x 0.06646 = 0.6290.

2. Short-cut method: factor is 0.6651.

The equivalent annual benefit is $1000 x the factor or $629.00 by the exact method or $665.10 by the short-cut method.

b. With straight line lag the benefit increases uniformly over a given number of years until full benefit is reached. To compute the equivalent annual benefit for the lag period, use is made of the accompanying table, which shows the present worth of a uniformly increasing annual series over a stated time period, in this case the lag period.

T-4

Uniformly Increasing Annual Series-Present Worth Factor

Lag Years	4%	5%	6%
1	0.9615	0.9524	0.9434
3	5.4776	5.3580	5.2423
5	13.0065	12.5664	12.1469
6	17.7484	17.0437	16.3767
7	23.0678	22.0185	21.0321
8	28.9133	27.4332	26.0514
9	35.2366	33.2347	31.3785
10	41.9923	39.3738	36.9624
15	80.8539	73.6677	67.2668
20	125.1550	110.9506	98.7004
25	171.7261	148.3215	128.7565
30	218.3539	183.9950	156.1236
40	306.3231	246.7043	201.0031
50	382.6460	296.1707	233.2192

The method is to determine the amount of the annual increase and apply the appropriate factor from the table. The resulting value is then amortized over the period of analysis.

Example: Lag 15 years; full benefit $60,000 per year, period of analysis 50 years. Interest rate 6 percent.

Annual increase $60,000 ÷ 15 = $4,000 per year.

Present Worth $4,000 x 67.267 (T-4) = $269,068.

Amortized for 50 years $269,068 x 0.06344 (T-3) = $17,070.

This is the annual equivalent benefit over the 50-year period resulting from the increasing benefits which accrue during the 15-year lag period.

In most cases, after the full benefit is attained, it continues to the end of the period of analysis. The benefits which follow the lag period are converted to an annual equivalent benefit by using the procedure for a complete lag (paragraph 4.a above). This value is then added to the value for the lag period.

Example: In the previous example, the full benefit of $60,000 per year accrues from the 16th through the 50th year or for 35 years, interest rate 6 percent.

Present Worth at beginning of 16th year,	$ 60,000 x 14.498 (T-2) = $869,880	
Present Worth at beginning of 1st year,	$869,880 x 0.4173 (T-1) = $363,000	
Equivalent Value 50 years,	$363,000 x 0.06344 (T-3) = $ 23,030	
Equivalent annual benefit for straight line lag period (from above)		$ 17,070
Total annual equivalent benefit		$ 40,100

If there is a complete lag preceding the beginning of the straight line increase, an additional step is necessary to obtain the annual equivalent benefit. After obtaining the present worth of the straight line lag, this value must be discounted by the Single Payment-Present Worth Factor for the period of complete lag. The result is then amortized over the period of analysis.

Example: Complete lag 5 years followed by straight line lag 15 years, full benefit $60,000 per year, period of analysis 50 years, interest rate 6 percent.

Annual increase	$ 60,000 ÷ 15 = $ 4,000 per yr.	
Present Worth at beginning of 6th year	$ 4,000 x 67.267 (T-4) = $269,068	
Present Worth at beginning of 1st year	$269,068 x 0.7473 (T-1) = $201,075	
Amortized for 50 years	$201,075 x 0.06344 (T-3) =	$12,756
Full benefit from 21st to 50th year		
Present Worth at beginning of 21st year	$ 60,000 x 13.765 (T-2) = $825,900	
Present Worth at beginning of 1st year	$825,900 x 0.3118 (T-1) = $257,515	
Amortized for 50 years	$257,515 x 0.06344 (T-3) =	$16,337
Total Annual equivalent benefit		$29,093

D. EXAMPLES OF BENEFIT-COST CALCULATION

For the purpose of illustrating the application of the procedures and factors described above, typical examples of water and related land resource projects are presented below. They cover hypothetical projects providing (1) irrigation, (2) domestic water supply, (3) hydroelectric power, and (4) a port development. An example of the method of distributing project costs among several purposes in a multipurpose project is also included.

The Annexes referred to are to be found in the Manual.

E. IRRIGATION PROJECT

1. Project Description

The project includes a storage reservoir to be used for irrigation purposes only and distribution of a regulated flow of water to 10,000 net irrigable acres of cleared land now divided into 30 farms. At present 2,000 acres are receiving a limited supply of

water from wells and the remaining 8,000 acres are used for dry farming and pasture. At full development of the project, there will be 100 farms with water delivery and drainage outlets at farm boundaries. Orchards requiring 7 years to mature will occupy 4,000 acres and general crops will be grown on the remaining 6,000 acres. The irrigation well water system will be abandoned.

2. Estimated Initial Investment

The Applicant will furnish land and right-of-way, relocate roads and utilities in the reservoir area, and contribute available local materials, including concrete for the dam and supplies. The breakdown of main cost items, which incorporate interest during construction, is as follows:

	Local Cost (equivalent U.S. $)	U.S. $ Cost
Purchase and clearing of reservoir, land and right-of-way	$105,000	$ 30,000
Relocation of roads and utilities	50,000	15,000
Dam, spillway and outlet works	350,000	350,000
Canals and main drains, earthwork	210,000	90,000
Minor structures	50,000	50,000
Subtotal	$765,000	$535,000
Engineering	-	71,000
Contingency	76,500	54,000
Total Initial Investment	$841,500	$660,000
Associated Costs:		
Land leveling	$200,000	
Farm distribution system	100,000	
Farm drainage ditches	50,000	
	$350,000	

3. Annual Costs

Maintenance and operation of dam, canals, and structures	$120,000	
Amortization of Investment Costs		
Local Cost		
841,500, 50 yrs. @ 6% (0.06344)	53,380	
U.S. Dollar Cost		
660,000, 50 yrs. @ 3-1/2% (0.04263)	28,140	
Total Annual Costs		$201,520

4. Associated Annual Cost Paid by Landowners

Maintenance and operation of distribution and drainage ditches	$ 22,800	
Amortization of Associated Costs		
350,000, 50 yrs. @ 6% (0.06344)	22,200	
Total Associated Annual Cost		$ 45,000

5. Primary Benefits to Landowners (See Annex M)

Production at present:

Gross agricultural yield, 10,000 acs.	$540,000	
Less farm input costs, such as farm labor, power, fertilizer, seeds, fuel, materials, tools, pest control, taxes, insurance, etc.	-300,000	
Net present yield		$240,000

Estimated production after completion of project:

Orchard products			
(4,000 acs) gross	$820,000		
Less farm input costs	-140,000		
Net, at full development		$680,000	
General crops			
(6,000 acs) gross	$690,000		
Less farm input costs	-330,000		
Net		360,000	
Total Net Annual Production			$1,040,000
Gain in net annual production (1,040,000 - 240,000)			$ 800,000

	Brought forward	$800,000

Segregation of gain:

Orchard land 4,000 acs	$(680,000 - \frac{4,000}{10,000} \times 240,000)$	584,000
General 6,000 acs	$(360,000 - \frac{6,000}{10,000} \times 240,000)$	216,000

Reduced gain on account of lag:
(by short-cut method)

Orchard, 7 yrs. @ 6% $584,000 x 0.6651	$388,000
General, no lag	216,000
Total adjusted gain	$604,000

Gain by elimination of well system operation and allowance for salvage	20,000
Less Associated Costs (see item 4 above)	-45,000
Net Annual Primary Benefits	$579,000

6. Benefit-Cost Ratio

Annual Benefit	$579,000
Annual Cost	$201,520
Ratio	2.87 to 1.00

7. Secondary Benefits (not used in above computation)

Increase in land values due to improvements	+ $140,000
Offsetting Loss: Former earnings of new farmers on project, 70 @ 500	- $ 35,000

F. WATER SUPPLY PROJECT

1. Project Description

The project includes a storage reservoir to be used for water supply only, two pumping stations, a pipeline and a treatment plant. It will supply 20 mgd of potable water to a growing city of 800,000 people. The present supply is of low quality and dependability and averages only 5 mgd (or 6.25 gpcd). The augmented supply will average 25 gpcd for a future population of 1,000,000 people. Revenues from water users will be sufficient to pay costs of operating, maintaining and extending the water distribution system but general tax funds must be used to cover project installation costs.

2. Estimated Installation Cost (Annex A) and Initial Investment

The city will furnish all land and rights-of-way and local concrete pipe will be used. The dam is to be earth fill and all major construction equipment will be imported from the U.S. Breakdown of main cost items including contingencies is as follows:

	Local Cost (equivalent U.S. $)	U.S. $ Cost
Purchase of Reservoir land and pipeline right-of-way	$ 300,000	
Concrete pipe	2,500,000	$ 500,000
Dam, spillway, and outlet works	1,575,000	2,635,000
Pumping stations (pumps to be replaced in 25 yrs. at a cost of $180,000)	90,000	200,000
Treatment plant (equipment to be replaced in 25 yrs. at a cost of $350,000)	240,000	350,000
Engineering	147,000	221,000
Total Installation Cost	$4,852,000	$3,906,000
Interest during construction (1)	291,120	136,710
Total Initial Investment	$5,143,120	$4,042,710

(1) An acceptable method of computing interest during construction is as follows: 1/2 x (construction time in years) x (interest rate). For this project, time is 2 years; for alternate, 2-1/2 years.

3. Annual Costs

Maintenance and operation of project facilities	$150,000	
Replacement of treatment plant equipment at 25 yrs. 6% $350,000 x 0.2330 x 0.06344	5,200	
Replacement of pumps, 25 yrs. 6% $180,000 x 0.2330 x 0.6344	2,700	
Amortization of Investment Costs		
Local Cost 5,143,120, 50 yrs. @ 6% (0.06344)	326,280	
U.S. Dollar Cost 4,042,710, 50 yrs. @ 3-1/2% (0.04263)	172,340	
Total Annual Cost		$656,520

Average annual supply 20 mgd x 365	7,300 million gals.
Cost of water at delivery point	8.99¢ per 1,000 gals.

4. Cost of Equivalent Supply from Best Alternate Source (Primary Benefit)

The only likely alternate supply of 20 mgd taken from another watershed would cost $8,342,150, some $843,680 less than the project installation cost. The earth dam would be smaller and the water would require less treatment. On the other hand, reservoir land would be more expensive, the pipeline longer, the pumps somewhat larger and the operation costs higher. Capital and annual costs are calculated as follows:

a. Estimated Installation Cost and Initial Investment

	Local Cost (equivalent U.S. $)	U.S. $ Cost
Reservoir land and right-of way	$ 700,000	
Concrete pipe	3,000,000	$1,000,000
Dam, spillway, and outlet works	880,000	1,470,000
Pumping stations (replace pumps in 20 yrs. at a cost of $250,000)	100,000	250,000
Treatment plant (no replacements)	40,000	60,000
Engineering	139,000	208,000
Total Installation Cost	$4,859,000	$2,988,000
Interest during construction (1)	364,425	130,725
Total Initial Investment	$5,223,425	$3,118,725

(1) See footnote page 17

b. Annual Costs

Maintenance and operation	$200,000	
Replacement of pumps		
20 yrs. 6%		
250,000 x 0.3118 x 0.06344	4,950	
40 yrs. 6%		
250,000 x 0.0972 x 0.06344	1,540	
(neglect salvage)		
Amortization of Investment Costs		
Local Costs		
5,223,425, 50 yrs. @ 6%		
(0.06344)	331,370	
U.S. Dollar Costs		
3,118,725, 50 yrs. @ 3-1/2%		
(0.04263)	132,950	
Total Annual Cost (Benefit)		$670,810

Cost of water at delivery point 9.19¢ per 1,000 gals.

5. Benefit-Cost Ratio

Annual Benefit	$670,810
Annual Cost	$656,520
Ratio	1.02 to 1.00

The cost per gallon at delivery point compares favorably with the cost of the present water supply and also with costs elsewhere in the vicinity.

6. Secondary Benefits (not used in above computation)

Value of additional residential developments, annual	$1,000,000
Reduction in fire insurance charges	200,000
Saving in health service costs	50,000

G. HYDROELECTRIC POWER PROJECT

1. Project Description

The project includes a powerhouse at the toe of a dam

built to store water for irrigation, a reregulating dam, a step-up substation and a 20-mile transmission line with steel towers terminating at an existing substation at the power load center. Of the total cost of dam, $1,800,000 has been allocated to power.* The powerhouse will have a rated capacity of 13,600 kw. Irrigation releases will be adequate to maintain a firm capacity of 7,500 kw. Power will be transmitted at 69,000 volts. Estimated useable power delivered is 80 million kwhr per year. There is a market for this power.

2. Estimated Initial Investment (Annexes A and H)

The Applicant will furnish all labor, land and rights-of-way. All materials for the dam with the exception of reinforcing steel are local. Major construction equipment, steel and other materials are to be imported from the U.S. Breakdown by main cost items which include engineering and interest during construction, is as follows:

	Life	Local Cost (equivalent U.S.$)	U.S.$ Cost
Dam costs allocated to power	50	$1,000,000	$ 800,000
Powerhouse and penstock	50	625,000	1,275,000
Turbines and generators	35	150,000	850,000
Transmission line	50	150,000	280,000
Substation	25	40,000	130,000
Contingency		190,000	330,000
Total Initial Investment		$2,155,000	$3,665,000

*Assumed to have been made in accordance with method described hereinafter for allocation of costs of a multipurpose project.

3. Annual Costs

Maintenance and operation including allocated amount for dam operation	$100,000	
Replacement of turbines and generators at 35 yrs. @ 6% 1,000,000 x 0.1301 x 0.06344	8,250	
Replacement of substation equipment 25 yrs. @ 6% 170,000 x 0.2330 x 0.06344	2,500	
Amortization of Investment Costs		
Local Costs 2,155,000, 50 yrs. @ 6% (0.06344)	136,710	
U.S. Dollar Cost 3,665,000, 50 yrs. @ 3-1/2% (0.04263)	156,240	
Total Annual Cost		$403,700
Total power delivery		80,000,000 kwhr
Cost per kwhr at load center		$0.005

At this cost it is economical for the large industrial power users to purchase their power from this source.

4. Cost of Same Amount of Power from Best Alternate Source (Primary Benefit)

The only possible alternate source of power would be a diesel-electric plant using fuel costing 15¢ per gallon. All generating equipment and steel would be obtained from U.S. sources. All other items can be furnished locally. The generating equipment would have to be replaced in 25 years. Annual cost for 80,000,000 kwhr delivered at load center is estimated as follows:

Diesel-electric equipment (U.S. Dollar Cost)

13,600 kw @ $200 per kw = 2,720,000 Amortized, 25 yrs. @ 3-1/2% (0.06067)	$165,000

Brought forward		$165,000	
Powerhouse, land, etc.			
Local Costs (equivalent U.S. $)			
$150,000, 50 yrs. @ 6% (0.06344)		9,500	
U.S. Dollar Costs			
$270,000, 50 yrs. @ 3-1/2% (0.04263)		11,500	
Station labor, supervision and administration	$ 90,000		
Maintenance	30,000		
Supplies and general expense	12,000		
Lubricating oil	30,000		
Fuel, 80,000,000 kwhr 0.076 gals. per kwhr @ 15¢ per gal.	912,000		
Total Maintenance and Operation		1,074,000	
Total Annual Cost			$1,260,000
Cost per kwhr (80,000,000 kwhr)			$0.0158

5. Benefit-Cost Ratio (Annex L)

Annual Benefit	$1,260,000
Annual Cost	$ 403,700
Ratio	3.12 to 1.00

6. Secondary Benefits (not used in above computation)

Anticipated investment in expanded and new industries, annual	$ 200,000
General increase in related business and industry	$ 100,000

H. PORT DEVELOPMENT

1. Project Description

The project includes enlargement of an entrance channel

from the ocean, navigation aids, a wharf, warehouses, and rail and highway terminal facilities. The project will bring ocean-going vessels to within 5 miles of a growing industrial city, which is now 100 miles by rail from the nearest existing seaport. Annual capacity will be 600,000 tons.

It is estimated that present local production of 300,000 tons per year will be shifted to the new port, thereby eliminating the rail haul to the existing port, also that production will increase from 300,000 tons to 600,000 tons per year in the first 10 years. It is assumed that this new production is a direct result of the new port facility.

2. Estimated Installation Cost and Initial Investment

The local government will furnish all land and rights-of-way, labor, and timber for the wharf. All major materials and equipment for railroads and utilities will come from U.S. sources. In addition, dredging will be done by a U.S. firm. Construction time shall be one year. Breakdown by main cost items including engineering and contingencies is as follows:

	Local Cost (equivalent U.S. $)	U.S. $ Cost
Land and right-of-way	$ 500,000	
Railroad, highway, and utilities	400,000	$ 800,000
Dredging		1,500,000
Navigational Aids	70,000	130,000
Wharf and Warehouses	1,740,000	760,000
Port roads, tracks, and utilities	120,000	80,000
Total Installation Cost	$2,830,000	$3,270,000
Interest during construction (1)	84,900	57,225
Total Initial Investment	$2,914,900	$3,327,225

(1) See footnote page 17

3. Annual Costs

Maintenance and operation of wharf and shore facilities	$400,000	
Annual dredging	100,000	
Replacement of navigational aids at 20 yr. intervals (no salvage)		
20 yrs. 200,000 x 0.3118 x 0.06344	3,960	
40 yrs. 200,000 x 0.0972 x 0.06344	1,230	
Amortization of Investment Costs		
Local Costs		
2,914,900, 50 yrs. @ 6% (0.06344)	184,900	
U.S. Dollar Costs		
3,327,225, 50 yrs. @ 3-1/2% (0.04263)	141,800	
Total Annual Cost		$831,890

4. Annual Primary Benefits

Saving in cost of hauling of produce now going to existing port		
300,000 tons, 95 miles @ 2¢	$570,000	
Gain from new production after first 10 years:		
Port charges, 300,000 tons @ $1.50 = $450,000		
Worth of 40 annual amounts at beginning of 11th year, 6%		
450,000 x 15.046 = $6,771,000		
Worth at beginning of 1st year		
$6,771,000 x 0.5584 = $3,781,000		
Equivalent value for 50 years		
$3,781,000 x 0.06344	240,000	
Gain from new production, first 10 years:		
Increase in port charges per year		
450,000 -:- 10 = $45,000		
Worth at beginning of 1st year		
45,000 x 36.9624 = $1,663,000		
Equivalent value over 50 years		
$1,663,000 x 0.06344	105,500	
Total Annual Benefits		$915,500

5. Benefit-Cost Ratio

Annual Benefit	$915,500
Annual Cost	$831,890
Ratio	1.10 to 1.00

6. Secondary Benefits (not used in above computation)

Increase in customs duties, annual	$40,000
Increase in annual general tax receipts resulting from increased economic activity	$50,000

I. MULTIPURPOSE PROJECT

Water resources projects frequently provide facilities that will serve several purposes such as a reservoir designed to supply water for irrigation, power and domestic use. In these instances it is necessary to allocate the costs to each purpose to be assured that each segment is justified.

The method adopted by U.S. agencies for making the allocation is known as the Separable Costs-Remaining Benefits Method. Application of this method is described in the Economic Guide for Watershed Protection and Flood Prevention published by the Soil Conservation Service in U.S.D.A., from which this text is quoted, with a few modifications and annotations. This procedure is derived from the publication, "Proposed Practices for Economic Analysis of River Basin Projects" prepared by the Subcommittee on Evaluation Standards in May 1958, often referred to as the "Green Book".

The Separable Costs-Remaining Benefits Method of cost allocation is a procedure for the equitable distribution of the cost of a multiple purpose project among the purposes served. Briefly, it provides for (1) assigning to each purpose its separable cost, i.e., the added cost of including the purpose in the project; and (2) assigning to each purpose a share of the remaining or residual joint cost in proportion to the remaining benefits, i.e.,

the benefits (as limited by alternative cost) less the separable cost. Thus the method provides for an equitable sharing of the savings from multiple purpose development among the various purposes included (see Case 1).

1. Definition of Terms and Their Use in Cost Allocation

a. Alternate Cost

The alternate cost for each purpose is defined as the lowest cost of achieving the same or equivalent benefits in single purpose structures that will accrue to each purpose in the multiple purpose structure. The least costly alternative single purpose means of providing benefits equivalent to those provided by each purpose of the multiple purpose structure should be used in cost allocation. The alternative should be real in the sense that it can be built and if built would produce equivalent benefits. It may, however, be entirely different in physical plan. There is a lack of agreement among economists and others as to whether or not the alternate cost must be figured at a site other than the multiple purpose structure site. For our purposes, it will be permissible to figure the alternate cost at the multiple purpose site.

b. Separable Cost

The separable cost for each project purpose is the difference between the cost of a multiple purpose structure and the cost of the structure with that purpose omitted.

In calculating separable costs, each purpose should be treated as if it were the last increment of a multiple purpose project. This calculation will show the added costs of increased size, changes in design, or other factors that would be necessary to add the purpose to the project.

In those cases where the calculation of separable cost may be unduly burdensome, specific cost as defined below may be used in lieu of separable costs in the Separable Costs-Remaining Benefits Method.

c. Specific Cost

The specific cost for each project purpose consists of the cost of facilities that exclusively serve only one project purpose. Special outlet works needed for irrigation or municipal water supply, but not needed for flood prevention, is an example of this kind of facility.

All readily identifiable costs of facilities which are clearly for one purpose only should be assigned as specific costs wholly to that purpose in the allocation process. Thus, care should be taken to make sure that all specific costs are properly assigned to each purpose. Separable costs include all specific costs, together with any other additional project costs attributable to the inclusion of a given purpose.

d. Joint Cost

Joint cost is the difference between the cost of the multiple purpose structure and the sum of the separable costs for each purpose. When the estimate of separable costs cannot be made or is unduly burdensome to make, joint costs may be considered to be the difference between the multiple purpose cost and the sum of the specific costs for each purpose.

2. Description of Method

The costs or benefits that are used in the method should be of the same nature for each purpose, i.e., installation costs, primary benefits, etc.

It should be noted that the Separable Costs-Remaining Benefits Method will allocate costs to purposes so that each purpose is economically justified, provided that two requirements of project formulation are met:

The overall benefit-cost ratio is favorable.

The cost of adding each purpose as the last increment (separable cost) does not exceed the benefits derived therefrom.

The Separable Costs-Remaining Benefits Method normally involves the following steps:

(1) Estimate the total cost of the multiple purpose structure including capitalized operation and maintenance costs when necessary.

(2) Estimate the benefits for each purpose.

(3) Estimate the alternate cost (including capitalized operation and maintenance costs when necessary) of achieving the benefits shown in step (2).

(4) Determine the maximum alternative justifiable expenditure for achieving benefits . This is equal to the lesser value of steps (2) and (3).

(5) Estimate separable cost (including capitalized operation and maintenance when necessary) for each purpose.

(6) Determine remaining benefits which are equal to the difference between (4) and (5).

(7) Determine the joint cost . This is the difference between the total cost of the multiple purpose project and the total of the separable costs for all project purposes. The joint cost is then allocated to each purpose in the same proportion as the remaining benefits for each purpose are to the total remaining benefits for all purposes.

(8) Determine total allocated cost for each purpose by adding the separable cost to the allocated joint cost.

3. Example of Cost Allocation - Where benefit for each purpose equals or exceeds its alternate cost.

Data applying to a dual-purpose structure are shown below. O & M costs are the capitalized values in all cases.

Basic Data

Item	Flood Prevention	Municipal Water	Total
Benefits	$50,000	$45,500 (Equal to Alt. Cost)	
*Alternate Installation Costs	35,000 (1)	40,000 (2)	
*Alternate O&M Costs	5,000 (1)	5,500 (2)	
*Separable Installation Costs	21,000 (3)	28,000 (4)	
*Separable O&M Costs	2,500 (3)	3,000 (4)	
Total Installation Costs			$62,000 (5)
Total O&M Costs			8,000 (5)

Notes:

* Must be determined by the design engineer.
(1) Alternate is a system of levees.
(2) Alternate is a system of wells and pumps.
(3) Cost of elements of the dual purpose structure which can be omitted if flood prevention is not provided.
(4) Cost of elements of the dual purpose structure which can be omitted if municipal water is not supplied.
(5) Applying to the dual purpose structure.

Computation

Item	Flood Prevention	Municipal Water	Total
1. Benefits	$50,000	$45,500 (1)	$95,000
2. Alternate Costs-Installation	35,000	40,000	75,000
O&M	5,000	5,500	10,500
Subtotal	40,000	45,500	85,500
3. Benefit limited by alternate cost (lesser of 1 or 2)	40,000	45,500	85,500
4. Separable Costs-Installation	21,000	28,000	49,000
O&M	2,500	3,000	5,500
Subtotal	23,500	31,000	54,500
5. Remaining Benefits (3-4)	16,500	14,500	31,000
6. Allocated Joint Costs			
Installation	6,920 (4)	6,080 (5)	13,000 (2)
O&M	1,330 (6)	1,170 (7)	2,500 (3)
Subtotal	8,250	7,250	15,500
7. Total Allocated-Installation	27,920 (8)	34,080 (9)	62,000
O&M	3,830 (10)	4,170 (11)	8,000
TOTAL	$31,750	$38,250	$70,000

Notes:

(1) For purpose of benefit evaluation, it is considered that water is worth at least its cost to a municipality.
(2) Total cost (62,000) less separable costs (49,000) = 13,000
(3) Total cost (8,000) less separable costs (5,500) = 2,500
(4) Prorated - 16,500 x 13,000/31,000 = 6,920
(5) Prorated - 14,500 x 13,000/31,000 = 6,080
(6) Prorated - 16,500 x 2,500/31,000 = 1,330
(7) Prorated - 14,500 x 2,500/31,000 = 1,170
(8) 21,000 + 6,920 = 27,920
(9) 28,000 + 6,080 = 34,080
(10) 2,500 + 1,330 = 3,830
(11) 3,000 + 1,170 = 4,170

4. Example of Cost Allocation - Where benefit for each purpose is equal to or less than its alternate cost.

Data applying to a triple-purpose project are shown below. O&M costs are the capitalized values in all cases.

Basic Data

Item	Flood Prevention	Irrigation	Municipal Water	
Benefits	$30,000	$100,000	$50,000	
*Alternate Installation Costs	35,000	95,000	45,000	
*Alternate O&M Costs	5,000	25,000	5,000	
*Separable Installation Costs	7,000 (1)	35,000 (1)	30,000 (1)	
*Separable O&M Costs	3,000 (1)	15,000 (1)	10,000 (1)	
Total Installation Costs				$117,000 (2)
Total O&M Costs				$ 43,000 (2)

Notes:

* Must be determined by the design engineer.

(1) Costs of the elements of the triple-purpose structure which can be omitted if the respective features (flood prevention, irrigation or municipal water) are not provided.

(2) Applying to the triple purpose structure.

Computation

Item	Flood Prevention	Irrigation	Municipal Water Supply	Total
1. Benefits	$30,000	$100,000	$50,000 (1)	$180,000
2. Alternate Costs				
Installation	35,000	95,000	45,000	175,000
O&M	5,000	25,000	5,000	35,000
Subtotal	40,000	120,000	50,000	210,000
3. Benefits limited by alternate costs (lesser of 1 or 2)	30,000	100,000	50,000	180,000
4. Separable Costs				
Installation	7,000	35,000	30,000	72,000
O&M	3,000	15,000	10,000	28,000
Subtotal	10,000	50,000	40,000	100,000
5. Remaining Benefits (3-4)	20,000	50,000	10,000	80,000
6. Allocated Joint Costs				
Installation	11,250 (4)	28,125 (4)	5,625 (4)	45,000(2)
O&M	3,750 (5)	9,375 (5)	1,875 (5)	15,000(3)
Subtotal	15,000	37,500	7,500	60,000
7. Total Allocated Costs (6)				
Installation	18,250	63,125	35,625	117,000
O&M	6,750	24,375	11,875	43,000
TOTAL	$25,000	$87,500	$47,500	$160,000

Notes:

(1) For purposes of benefit evaluation, it is considered that water is worth at least its cost to a municipality.
(2) Total cost (117,000) less separable costs (72,000) = 45,000.
(3) Total cost (43,000) less separable costs (28,000) = 15,000.
(4) 45,000 prorated in proportion to Remaining Benefits, Item 5.
(5) 15,000 prorated in proportion to Remaining Benefits, Item 5.
(6) Separable cost (Item 4) + Allocated Joint Cost (Item 6).