THE GRAND CANYON CONTROVERSY -- 1967: FURTHER ECONOMIC COMPARISONS OF NUCLEAR ALTERNATIVES

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THE GRAND CANYON CONTROVERSY -- 1967: FURTHER ECONOMIC COMPARISONS OF NUCLEAR ALTERNATIVES

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Since our 1966 papers[1] questioning the economic feasibility of the proposed Grand Canyon dams, the costs of the alternative nuclear power sources we used have been revised and the relative importance of the two dams in the over-all Colorado River Basin Project has been reversed. The purpose of this paper is to present new calculations incorporating revised cost estimates of the nuclear powerplant alternatives and reflecting the increased importance of one of the proposed dams, the Hualapai (formerly Bridge Canyon) Project. The new calculations also introduce several refinements on our earlier methods.

Late in 1966 the General Electric Company substantially revised its 1965 price list for nuclear generating plants, on which our 1966

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[1] Alan P. Carlin and William E. Hoehn, "Is the Marble Canyon Project Economically Justified?" The RAND Corporation, P-3302, February 1966, reprinted in Alan P. Carlin, "Economic Feasibility of the Proposed Marble and Bridge Canyon Projects," in U.S. Congress, House, Committee on Interior and Insular Affairs, Lower Colorado River Basin Project, Hearings before Subcommittee, Part II, 89th Congress, 2nd Session, May 13, 1966, pp. 1497-1512 (hereafter referred to as Hearings); Alan P. Carlin and William E. Hoehn, "Mr. Udall's 'Analysis': An Unrepentant Rejoinder," ibid., pp. 1521-1535. The principal issues of economic interest arising out of the controversy over our 1966 papers are summarized in Alan Carlin, "The Grand Canyon Controversy: Some Lessons for Federal Cost-Benefit Practices," The RAND Corporation, P-3505, February 1967. A popularized summary of P-3505 is available as "The Grand Canyon Controversy or How Reclamation Justifies the Unjustifiable," The RAND Corporation, P-3541, February 1967.

calculations of alternative nuclear costs were largely based. The effect was to increase the list prices for the installation of nuclear boilers, to eliminate the turn-key prices for the complete installation of nuclear plants, and to reduce most fuel costs. In light of these changes and the upward trend in contract prices for nuclear plants during the last year, we have decided to base our new calculations on deliberately conservative (that is, overstated) assumptions as to nuclear costs. These (and other assumptions) have been made with a view to avoiding all controversy as to whether they might possibly understate nuclear costs.

In the spring of 1966 we foresaw little real possibility that Congress would give serious consideration to the (then) Bridge Canyon Project in light of the unfavorable decision on it by the Bureau of the Budget, and accordingly directed most of our attention to the other project, Marble Canyon. Subsequent events indicate that the present position is now just the reverse. For this reason we have undertaken much more detailed calculations on Bridge than those presented last year.[1]

We have also adopted a somewhat different approach to developing a lowest cost alternative to Hualapai. In the 1966 analysis we considered a lower cost alternative consisting of a 762 mw base loaded nuclear plant and a 588 mw pumped storage plant. Because of our decision to include energy value adjustments in our calculations (to be discussed shortly), nuclear plants alone become an even lower cost alternative. Use of an entirely nuclear alternative has the added advantage that it removes the possible uncertainty from the relationship between pumped storage costs and the geography and other peculiarities of particular sites. Unfortunately, it is not possible to evaluate this relationship without detailed engineering studies. Nuclear costs, on the other hand, are comparatively invariant with the particular site chosen, given reasonable care in avoiding

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[1] See Alan P. Carlin, "Economic Feasibility...," op. cit., Hearings, pp. 1511-1512.

geologically suspect areas and areas with extremely high land values.

The major innovation in our computational methods is the introduction of an energy value adjustment. In order to insure comparability with the dams in our 1966 papers we unfairly penalized our nuclear alternatives by assuming that they generated power only during the same hours as the dams, despite the fact that they would have the lowest operating costs of any non-hydro installations on the power systems concerned. This resulted in the economically unlikely assumption that the nuclear alternatives would stand idle[1] during off-peak hours while conventional plants generated power at much higher incremental costs. The real life situation, of course, would be just the reverse. The nuclear plants would be base loaded and a corresponding amount of thermal capacity would be relegated to peaking service. The Federal Power Commission's Technical Memorandum No. 1 recommends that under these circumstances the alternative be credited with the resulting savings when it is compared with a hydroelectric project.[2] Or more accurately, it recommends that the alternative be credited with one-half the savings on the argument that the cost of energy from other conventional plants will fall over the life of the hydroelectric project. It seems unlikely, however, that the operating costs of nuclear and conventional thermal plants will narrow very rapidly or that the inventory of conventional plants yet to be relegated to peaking service will vanish for many years to come either. Nevertheless, in the interests of conservatism, we have adopted the procedures of the FPC Memorandum.

The second major innovation is that we have calculated the benefit-cost ratio not only at the Bureau's preferred interest rate of 3-1/8 percent, but also at 5 percent. Although even this does

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[1] Except for the overly-generous 10 percent fuel consumption we assumed merely to keep the plants up to operating temperatures for quick start-up.

[2] Federal Power Commission, Bureau of Power, Instructions for Estimating Electric Power Costs and Values, Technical Memorandum No. 1, Revised Marcl 1960, pp. 9-11.

not adequately reflect the economic risks involved in Bureau of Reclamation hydroelectric projects, it does suggest the effect that higher, more realistic interest rates have on the benefit-cost ratios for the two dams.

It is important to point out that the use of either 3-1/8 or 5 percent does not imply anything about the type of financing that is assumed to be used in building either the dams or the alternatives. In an economic analysis of the benefits and costs of a project to the nation, the choice of interest rate should be based on the pure rate of interest for long-term investments plus an allowance for the economic risks of the project. This applies regardless of the type of financing that would actually be used if the project were built.

NEW CALCULATIONS

Table 1 shows average annual costs for nuclear alternatives to Hualapai and Marble Canyon dams under three sets of assumptions. The Hualapai alternative is assumed to be located on the ocean near Los Angeles and the Marble alternative on Lake Havasu near Parker Dam. The Marble alternative is assumed to supply 225 mw of power to the nearby Central Arizona Project pumps and to transmit the remainder to the Phoenix area over a 345 kv line (which is included in the costs).

Since our 1966 papers did not include an all-nuclear alternative to Hualapai, column (1) shows the costs of such an alternative using the assumptions as to its operating hours and interest rate used in our Marble alternative last year.[1] Column (2) reflects the use of the energy value adjustment at the same 3-1/8 percent interest rate, while column (3) is costed at 5 percent. Only the energy value adjustment cases are shown for the Marble alternative, once again at 3-1/8 (column 4) and 5 percent (column 5).

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[1] Except that only 5 percent of the full fuel cost is allowed for spinning reserve during off-peak hours, based on an analysis of decay-heat curves. The operating hours have, of course, been adjusted to fit the proposed Hualapai output.

Table 2 develops up-to-date capital costs for the two projects using Bureau of Reclamation indexes of project costs in 18 Western states and Alaska. The cost of an afterbay structure has also been added to the Marble costs (line 5).

The alternative costs developed in Table 1 and the project capital costs developed in Table 2 are then used to derive new benefit-cost ratios in Table 3. It is found that the Hualapai Project has a benefit-cost ratio of 0.78 to one without the energy value adjustment and 0.61 to one with it, while Marble has a ratio of 0.77 to one with the adjustment. At 5 percent interest the ratios are only 0.52 to one for Hualapai and 0.61 to one for Marble, thus suggesting that the ratios are quite sensitive to changes in the interest rate assumed.

But even the ratios at 3-1/8 percent interest imply that the Projects are not economically justified in terms of their costs and benefits to the nation. Furthermore, the ratios are so far below one-to-one that it appears most unlikely that the results would be reversed by still more detailed calculations. In fact, it can be shown that <u>even</u> if the Bureau's alleged $6 per kilowatt were used for the transmission costs of the alternatives, the benefit-cost ratios would still be less than one-to-one at 3-1/8 percent interest.[1]

In these calculations we have endeavored to quantify all reasonable but previously unquantified assumptions that have occurred to us[2] which if left unquantified tended to bias the conclusions

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[1] As explained in P-3505, <u>op. cit.</u>, pp. 12-17, the Bureau of Reclamation makes the highly questionable assertion that transmission costs of $6 per kw-yr should be charged against the alternatives (at least in the case of Marble and possibly Hualapai as well). This would add $8.10 million (1350 mw at $6,000 per mw) to Hualapai benefits, or $26.5 million in all, and $2.9 million (600 mw at $6,000 per mw minus about $0.7 million already included under line 6 of Table 1) to Marble benefits, or $13.1 million in all.

[2] And Representatives Morris Udall and Craig Hosmer, the Bureau of Reclamation, and other dam proponents.

against the dams. We have, however, left unquantified a number of other items which if quantified would be unfavorable to the dams. The effect of these remaining unquantified assumptions, the most important of which we shall enumerate in the next section, is obviously to further weaken the economic case for the dams. In order to show that our benefit-cost ratios are underestimates, it would first be necessary to show that whatever upward revisions may be desired in our alternative costs are greater than the net effect of the remaining unquantified assumptions favorable to the dams.

ASSUMPTIONS FAVORABLE TO THE DAMS

1. Use of Overstated Nuclear Costs

Nuclear costs in our previous papers were estimated from the 1965 edition of the General Electric Company pricing handbook.[1] It is evident from contract awards during that time period that this represented a conservative basis, as discounting of actual bids from the price list was widespread. Since that time, however, General Electric has discontinued turn-key contracting, resulting in the elimination of complete plant price lists, and has twice revised upwards its price list for nuclear steam supply systems (and widened the scope of supply). At the same time, nuclear fuel scope of supply has been broadened with more comprehensive warranty provisions added, and costs have been adjusted. The net effect has been to lower nuclear fuel costs for first and second cores and to raise slightly third core costs. Since no comprehensive cost studies similar to the TVA and Oyster Creek analyses have been published recently, the appropriate capital cost levels in relation to the latest General Electric nuclear steam supply price list is not clear.

In March 1966 Philip Sporn, Chairman of the System Development Committee of the American Electric Power Company, presented an analysis of nuclear power costs to the Joint Committee on Atomic

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[1] Atomic Power Equipment Handbook.

Energy based on recalculations of his 1964 analysis of the nuclear Oyster Creek and conventional Cardinal plants.[1] In that paper, he indicated that his original calculation of $139 per kw for post-Oyster Creek class reactors was a "handbook-type" price, that would have to be reduced to correspond to a negotiated price. As a discounting factor, he used the percentage discount from the handbook price that Dresden II enjoyed. This results in an adjusted 605 mw(e) plant cost of $128 per kw, a figure including switchyard costs. Our assumed plant costs for a 600 mw(e) net plant are $150 per kw and $155 per kw at 3-1/8 percent and 5 percent respectively, excluding switchyard costs but including an additional $2.50 per kw for field fabrication costs. Correcting for these differences, our plant costs represent a roughly 20 percent increase over the costs developed by Mr. Sporn, which is more than sufficient to cover increases in nuclear costs since that time.

For the twin unit plant of 1350 mw(e) net total capacity, the basic cost assumed for the first unit is $149 per kw and $154 per kw at 3-1/8 percent and 5 percent respectively, including switchyard; a discount of $10 per kw has been allowed for the second unit, based on low incremental land and site costs and on reported cost discounts for a second unit at a site.[2] If the intent of this paper were to evaluate current nuclear power economics for private utilities, we would be prepared to endorse figures at least $10 per kw lower than those used for the specific comparisons herein.

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[1] Philip Sporn, "Nuclear Power Economics: An Appraisal of the Current Technical-Economic Position of Nuclear and Conventional Generation" (March 17, 1966), in U.S. Congress, Joint Committee on Atomic Energy, AEC Authorizing Legislation, Fiscal Year 1967, Hearings, Part 1, 89th Congress, 2nd Session, 1966, Appendix 14, pp. 561-571.

[2] See, for example, Nucleonics Week, October 13, 1966, p. 4.

2. Exclusion of Other Hualapai Expenditures

In addition to the expenditures for the benefit of the Hualapai Indians included in line 5 of Table 2, H.R. 4671 (the Colorado River Basin Project considered by the 89th Congress), as revised, provided that the Government would "make available to the Hualapai Tribe up to twenty-five thousand kilowatts and up to one hundred million kilowatt-hours annually of power from the Hualapai unit at the lowest rate established by the Secretary [of the Interior] for the sale of firm power from said unit for the use of preferential customers."[1] We are unable to evaluate what the financial costs to the government of this provision would be. We note, however, that Representative Reinecke has stated that the Hualapai Tribe would receive $60.8 million in non-cash benefits[2] under H.R. 4671. If $12.3 million of this represents the Peach Springs-Diamond Point road, this would appear to leave $48.5 million as the cost of the power benefits. Although this may be distributed over a number of years, it does not appear to be included in the project costs shown in the project report.

3. Use of Bureau Cost Indexes

After reviewing a variety of construction price indexes we find that the Bureau of Reclamation's index used in Table 2 is one of the lowest composite indexes available. Most others, such as the Engineering News-Record construction price index, are much higher. The ENR index, for example, is over 20 percent higher than in October 1961, versus about 10 percent for the Bureau index.

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[1] U.S. Congress, House, Colorado River Basin Project, Report No. 1849, 89th Congress, 2nd Session, August 11, 1966, p. 5.

[2] Ibid, p. 127.

4. Exclusion of Value of Water in Bank Storage

No charge is made in Table 3 for the value of water that would be held in bank "storage" around the proposed Marble Canyon Reservoir. Unless the Reservoir can be filled during years when this water would otherwise run waste into the Gulf of California, an annual charge should be made for this water, which is unlikely to be recovered (as the Reservoir will eventually be filled with silt rather than emptied). This annual charge might be about $0.6 million.[1]

5. Exclusion of Effects on Aesthetic and Other Park Values

No value has been attributed to what many conservationists believe will be the impairment of the natural scenic beauty of what is commonly acknowledged to be an unusually scenic canyon and of other park values in Grand Canyon National Park and Monument that will result from the construction of either dam. Although it is difficult to attach an exact monetary value to this cost, it is not negligible, judging by the public response to the appeal of the conservationists to defeat the dams and the many man-hours that have been voluntarily poured into this effort. If no afterbay structure were included in the Marble costs shown in Table 2, this effect would be substantially greater.

6. Exclusion of Possible Effect of Marble on Boating Expeditions

Table 2 assumes that the Marble Canyon Project includes an afterbay structure that would be capable of reducing the peak flows in the River resulting from the operation of the Project as a peaking plant from 30,800 cubic feet per second to 20,500 cubic feet per second. Even with the structure, there is some dispute whether boating expeditions down the River would still be possible through Grand Canyon National Park. At the very least, the length of such trips would

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[1] Stewart Udall has stated that bank "storage" at Marble "could amount to between 300,000 and 400,000 acre-feet" (Hearings, p. 1403). At $54 per acre-foot (see note to Table 1, line 7), 350,000 acre-feet would be $0.59 million per year at 3-1/8 percent interest.

be greatly reduced. If they were no longer possible, the cost in terms of producers' and consumers' surplus foregone might be about $0.2 million per year.[1]

7. Use of Stream Flows Assumed in Project Reports

We have assumed the same stream flows used in the 1964 Bureau project reports. More recent studies have suggested that stream flow past the dam sites may be somewhat lower. The effect of such a reduction would be to further lower the benefit-cost ratios for the dams.[2]

8. Use of Heavily Subsidized Interest Rates

As the use of a 5 percent interest rate in Table 3 demonstrates, the use of higher, more realistic interest rates has a strong effect in lowering the benefit-cost ratios of the Projects. Use of even higher rates, which would be even more suitable from the standpoint of economic theory,[3] would only further lower the ratios since the Projects are more capital intensive.

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[1] According to the Sierra Club, National Park Service statistics show that 547 persons made the Canyon boat trip in 1965 and 1,067 in 1966 (see "Supplement to Petition of the Sierra Club for Leave to Intervene Pursuant to Rule 1.8 (d) before the Federal Power Commission in the Matter of Arizona Power Authority, Project No. 2248," January 30, 1967, p. 45). A conservative assumption would be that if Marble is not built, an average of at least 1,000 per year will make the trip over the next 100 years. If the average price paid is taken as $300 and the producers' and consumers' surplus as $175 per person, the net cost would be $0.175 million per year.

[2] See Alan P. Carlin, "Economic Feasibility ...," op. cit., Hearings, pp. 1510-1511.

[3] The interest rate question is discussed in P-3505, op. cit., pp. 18-19.

Table 1

AVERAGE ANNUAL COSTS OF ALTERNATIVE NUCLEAR POWER PLANTS
(millions of dollars)

Alternative to:	Hualapai (Bridge Canyon)			Marble Canyon	
Interest Rate (percent)	3-1/8	3-1/8	5	3-1/8	5
Energy Value Adjustment	No	Yes	Yes	Yes	Yes
	(1)	(2)	(3)	(4)	(5)
1. Capital	10.57	10.57	13.59	4.89	6.28
2. Fuel	7.33	2.22	2.61	1.43	1.59
3. Operating and maintenance					
a. Fixed	1.26	1.26	1.26	.84	.84
b. Variable	.49	.49	.49	.23	.23
4. Special nuclear insurance	.52	.52	.52	.31	.31
5. Hydro adjustment	.59	.59	.74	.29	.30
6. Transmission and substations	--	--	--	.86	1.08
7. Make-up water for cooling towers	--	--	--	.41	.41
8. Reserves	1.35	1.35	1.35	.60	.60
9. Total	22.11	17.00	20.56	9.86	11.64

Notes on line:

1. Columns (1) and (2): Capital costs of two 675 mw(e) net nuclear plants at 5.435 percent. The 5.435 percent is the sum of 3.125 percent interest, 0.25 percent for interim replacement, and 2.06 percent for depreciation (30-year sinking fund basis). The capital costs are computed on the basis of $145 per kw plus $4 per kw (for a switchyard) for the first 675 mw(e) unit and $135 per kw plus $4 per kw for the second (or an over-all average of $144 per kw). The total cost of $194.40 million includes $5.4 million for a switchyard and $4.9 million for marine lines. Column (3): Capital costs of $201.15 million (based on an over-all average of $149 per kw to account for the increased cost of interest during construction) at 6.755 percent. The 6.755 percent is the sum of 5.0 percent interest, 0.25 percent for interim replacement, and 1.505 percent for depreciation (30-year sinking fund basis). Column (4): Capital cost of one 600 mw(e) net nuclear plant at 5.435 percent. The capital costs are computed on the basis of $150 per kw (excluding a switchyard). The total cost of $90.0 million includes $4.8 million for cooling towers and a $1.5 million

Table 1 continued

differential for field rather than shop fabrication of the pressure vessel. Column (5): Capital cost of $93.0 million ($155 per kw, representing higher interest during construction) at 6.755 percent.

2. Column (1): Annual generation of 4.933 billion kwh per year (Hualapai production minus transmission losses) at 1.40 mills per kwh plus 5 percent of full load fuel requirements during off-peak hours when the reactor is not shutdown. The 5 percent is an upper estimate of the additional fuel that would be required to keep the system at operating temperature during off-peak hours. Because a nuclear reactor continues after shutdown to produce large amounts of heat from fission product decay, no load fuel requirements to keep the system at hot operating temperature are minimal. Fuel consumption would probably be required only over the week-end period, as decay heat should be sufficient for daily carryover; the 5 percent used here allows an additional margin above that requirement, however. Column (2): Annual generation of 4.933 billion kwh per year at 0.45 mill per kwh. The 0.45 mill is the difference between the average fuel cost at 80 percent load factor (1.34 mills per kwh) and X, the energy value adjustment according to the following formula given in Federal Power Commission, Bureau of Power, Instructions for Estimating Electric Power Costs and Values, Technical Memorandum No. 1, March 1960, p. 11:

$$X = \frac{F_p - F_a}{F_p} \cdot \frac{I_e - I_a}{2}, \text{ where}$$

X = adjustment in mills per kwh

F_a = average annual plant factor of alternative

F_p = average annual plant factor of hydro project

I_a = incremental cost in mills per kwh of alternative plants

I_e = incremental cost in mills per kwh of existing steam electric plants.

In this case, F_a = 80 percent, F_p = 41.7 percent, I_a = 1.44 (equal to 1.34 mills per kwh for fuel plus 0.10 mill per kwh for variable operating and maintenance), and I_e = 3.37 (the energy cost supplied by the FPC and used by the Bureau of the Reclamation for their thermal alternatives to the Grand Canyon dams, as given in a Memorandum dated May 11, 1966 to the Commission from F. Stewart Brown, Chief, Bureau of Power, on the subject of "Marble Canyon Project, Arizona," p. 2). Column (3): Annual generation at 0.53 mills per kwh. In this case I_a = 1.49 (corresponding to a fuel cost of 1.39 mills per kwh at a 5 percent interest rate). Column (4): Annual generation of 2.308 billion kwh (Marble production at site) at 0.62 mill per kwh. In this case F_p = 43.9 percent and I_a = 1.62 (equal to 1.34 mills per kwh for

Table 1 continued

fuel plus 0.10 mill per kwh for variable operating and maintenance plus 0.18 mill per kwh for cooling water). Column (5): Annual generation at 0.69 mill per kwh. In this case F_p = 43.9 percent and I_a = 1.67 (corresponding to a fuel cost of 1.39^p mills per kwh).

3a. Assumes average fixed operating and maintenance costs (in addition to the interim replacement included in line 1) of $1.40 per kw-year. This figure is taken from Atomic Energy Commission, Division of Reactor Development and Technology, Office of Civilian Power, "A Specific Comparison of Nuclear Electric Power and Hydro Electric Power -- Bridge and Marble Canyon Projects" (February 1965), printed in U.S. Congress, House, Committee on Interior and Insular Affairs, Lower Colorado River Basin Project, Hearings before Subcommittee, Part II, 89th Congress, 2nd Session, May 12, 1966, p. 1373. For the two units in Los Angeles, a reduction of 33 percent has been taken to reflect savings resulting from a twin-unit plant.

3b. Assumes average variable operating costs of 0.1 mill per kwh, ibid.

4. Estimates for the Marble alternative are based on the premium paid by Commonwealth Edison Company for their Dresden plant, as shown in U.S. Congress, Joint Committee on Atomic Energy, Subcommittee on Legislation, Selected Materials on Atomic Energy Indemnity Legislation, 89th Congress, 1st Session, June 1964, pp. 17 and 66. Private nuclear liability insurance rates for Dresden are used for the first $60 million of coverage. The remaining $14 million of private insurance is taken at the rate of 2.5 percent of the base rate per $1 million coverage. Price-Anderson Act insurance (to $486 million) is computed at the rate of $30/mw(t). These estimates are very conservative in that up to 75 percent of the private premiums is maintained in a special fund which is earmarked for refund on the basis of the first ten years of experience. The Bridge estimate for the private insurer portion of coverage on the two units is taken to be one and a half times the estimated amount for a single unit, reflecting an economy of multiple unit siting.

5. Five percent of annual fixed (capacity) costs (line 1 plus line 3a), as suggested by FPC Technical Memorandum No. 1, op. cit., pp. 7-9.

6. Cost of a sending switchyard at the plant, a receiving substation in Phoenix, and 130 miles of double circuit 345 kv line. Transmission line capital costs are taken as $85,000 per mile (based on $5,000/mile for right of way and clearing and $80,000/mile for structures as given in FPC, National Power Survey, Part II - Advisory Reports, October 1964, p. 87). Capital costs of switchyard, substation, and associated transmission facilities are taken as $5.0 million. Operating, maintenance, and interim replacement are based on FPC, Technical Memorandum No. 1, op. cit., pp. 45, 96, and 97. Also following the FPC, transmission lines are assumed to have a service life of 50 years and substations 35 years.

7. Value of 7,600 acre-feet per year required to make-up evaporation losses from cooling towers at $54 per acre-foot. This is based upon

Table 1 continued

expected water costs of $65 per acre-foot from the Metropolitan Water District's proposed water desalinization plant near Los Angeles (see Nucleonics Week, September 15, 1966, pp. 1-2), minus marginal pumping costs for the Colorado River Aqueduct of about $11 per acre-foot. The $54 per acre-foot is thus the net cost to the Metropolitan Water District of replacing water no longer available from the Colorado River. Use of this figure assumes that any additional evaporation from the reservoirs will reduce the water available to the MWD by an equal amount. Although there may be some years of surplus flow on the River, these are expected to be few once the Central Arizona Project is built and even fewer once the Upper Basin states use their entire allotments. Although the desalinized water would be of somewhat better quality than the Colorado River water it would replace, the $65 per acre-foot cost does not include the substantial subsidies that would be provided to the plant by the Federal Government under present plans.

Table 2

CAPITAL COSTS OF HUALAPAI AND MARBLE CANYON PROJECTS
(millions of dollars)

Project	Hualapai (Bridge Canyon)		Marble Canyon	
Interest Rate	3-1/8	5	3-1/8	5
	(1)	(2)	(3)	(4)
1. Construction costs shown in project reports	511.3		238.7	
2. Prices as of	Oct.'61		Oct.'63	
3. Construction costs in October 1966 prices	560.5		259.3	
4. Less investigation costs	-1.7		-1.1	
5. Other construction costs not shown in project reports	18.5		34.0	
6. Construction costs	577.3		292.2	
7. Interest during construction	40.5	62.1	25.8	39.7
8. Total capital costs	617.8	639.4	318.0	331.9
9. Annual capital costs	20.23	32.21	10.42	16.72

Notes on lines:

1 and 2. Columns (1) and (2): As given in U.S. Department of the Interior, Bureau of Reclamation, Pacific Southwest Water Plan, Supplementary Information Report on Bridge Canyon Project, Arizona, January 1964, p. 18. Columns (3) and (4): Ibid., Supplementary Information Report on Marble Canyon Project, Arizona, January 1964, p. 19.

3. Derived by applying Bureau of Reclamation cost indexes to each sub-item shown in the "Basic Estimate DC-1 Summary" for each project. The indexes used are those for October 1966 as given in Engineering News Record, December 15, 1966, p. 101.

4. As shown in Bridge Canyon Project report, op. cit., p. 23, and Marble report, p. 25.

5. Columns (1) and (2): Section 303 of H.R. 4671, 89th Congress, as revised, provided for the payment of $16,398,000 as "compensation" to the Hualapai Indians for the taking of "easements, rights-of-way, and other interests in

Table 2 continued

land within the Hualapai Indian Reservation ... for the construction, operation and maintenance of the Hualapai unit" (see U.S. Congress, House, Colorado River Basin Project, Report No. 1849, 89th Congress, 2nd Session, August 11, 1966, p.5). This exceeds by $6,283,000 the cost of "lands and rights" shown for Bridge Canyon Dam and Reservoir (see project report, op. cit., p. 18). Assuming (charitably) that no payments would be made for other lands or rights for the Project, it is evident that the project report underestimated this item by at least this amount. The same Section of H.R. 4671 also provided for Federal construction of a paved road from Peach Springs to Diamond Point (on the proposed Reservoir). This road, which the Department of the Interior has estimated would cost $12,260,000 (see U.S. Congress, House, Committee on Interior and Insular Affairs, Lower Colorado River Basin Project, Hearings before Subcommittee, Part II, 89th Congress, 2nd Session, May 12, 1966, p. 1411), does not appear to be included in the project report. Together, these items benefitting the Hualapai Indians add at least $18.5 million to the cost of the Bridge Canyon Project. Columns (3) and (4): Cost of an afterbay structure below Marble that would be capable of reducing the peak flows in the River from 30,800 cubic feet per second to 20,530 feet per second in order to preserve park values within Grand Canyon National Park and Monument and to improve the possibilities for boating expeditions down the Colorado through the Park if Marble should be built. The cost figure is based on a preliminary estimate supplied by Floyd E. Dominy, Commissioner, Bureau of Reclamation, to Representative Ed Reinecke in a letter dated September 6, 1966.

6. Line 3 minus line 4 plus line 5.

7. Derived by using the same percentage shown in the project reports for interest during construction as a percentage of construction costs, corrected for the differences in interest rates. The percentages for Hualapai are 7.01 at 3-1/8 percent and 10.77 at 5 percent. The corresponding Marble figures are 8.85 and 13.59 percent.

8. Columns (1) and (3): Line 7 at 3.28 percent (including depreciation of 0.15 percent on a 100 year sinking fund basis). Columns (2) and (4): Line 7 at 5.04 percent.

Table 3

BENEFITS AND COSTS OF GRAND CANYON DAMS
(millions of dollars)

Project	Hualapai (Bridge Canyon)			Marble Canyon	
Interest Rate (percent)	3-1/8	3-1/8	5	3-1/8	5
Energy Value Adjustment	No	Yes	Yes	Yes	Yes
	(1)	(2)	(3)	(4)	(5)
1. Benefits					
a. Power	22.17	17.00	20.56	9.67	11.45
b. Fish and wildlife	.66	.66	.66	.18	.18
c. Recreation	.33	.33	.33	.16	.16
d. Area redevelopment	.36	.36	.36	.15	.15
e. Total	23.46	18.35	21.91	10.16	11.94
2. Costs					
a. Capital charges	20.23	20.23	32.21	10.42	16.72
b. Operating costs	4.49	4.49	4.49	1.94	1.94
c. Power purchases	.91	.91	.91	.39	.39
d. Additional water evaporation	4.59	4.59	4.59	.54	.54
e. Total	30.22	30.22	42.20	13.29	19.59
3. Benefit-cost ratio (ratio to one)	0.78	0.61	0.52	0.76	0.61

IMPORTANT NOTE: LINE 3 OVERSTATES THE BENEFIT-COST RATIOS IN THAT THEY MAKE THE FOLLOWING ASSUMPTIONS FAVORABLE TO THE PROJECTS: (1) USE OF OVERSTATED NUCLEAR COSTS, (2) EXCLUSION OF OTHER HUALAPAI BENEFITS, (3) USE OF BUREAU COST INDEXES, (4) EXCLUSION OF VALUE OF WATER IN BANK STORAGE AT MARBLE, (5) EXCLUSION OF EFFECTS ON AESTHETIC AND OTHER PARK VALUES, (6) EXCLUSION OF POSSIBLE EFFECT OF MARBLE ON BOATING EXPEDITIONS, (7) USE OF STREAM FLOWS ASSUMED IN PROJECT REPORTS, AND (8) USE OF HEAVILY SUBSIDIZED INTEREST RATES.

Notes on lines:

1a. Columns (1) to (3): From Line 9, Table 1. Columns (4) and (5); Line 9, Table 1 minus $0.19 million representing the annual loss of revenue resulting from the reduction in energy generation from the Glen Canyon Power Plant if the Marble Gorge Project is built.

Table 3 continued

1b and c. One-half of the benefits shown by the Bureau of Reclamation in Pacific Southwest Water Plan, Supplemental Information Report on Bridge Canyon Project, Arizona, January 1964, p. 22 and the Supplemental Information Report on Marble Canyon Project, Arizona, January 1964, p. 24. The proposed reservoirs would be about equally far from major population centers as existing reservoirs, particularly Lake Powell and Lake Mead, which are by no means over-crowded. To the extent that recreational and fishing use of the proposed reservoirs would be likely to draw visitors away from the existing reservoirs, there would be no net increase in benefits to the nation. Since there is no evidence that the Bureau has taken this into account in its estimates, it seems safe to assume that at least one-half of the use assumed by the Bureau would not contribute any net benefits.

1d. From the Bridge and Marble Canyon Project reports, ibid.

2a. From Table 2.

2b and c. From project reports, op. cit.

2d. Additional evaporation resulting from construction of each reservoir as given by the Department of the Interior (see U.S. Congress, House, Committee on Interior and Insular Affairs, Lower Colorado River Basin Project, Hearings before Subcommittee, Part II, 89th Congress, 2nd Session, May 12, 1966, p. 1403) valued at $54 per acre-foot (see note to line 7, Table 1).