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PRELIMINARY INCREMENTAL ANALYSIS
COLORADO RIVER STORAGE PROJECT UNITS

10-8-53

Project Unit (In assumed order of construction)	To irrigation	To power	Specific power costs including transmission	Total power cost	Cost reassignments	Power costs assigned to unit	Annual operation, maintenance, and replacement: At site costs	Annual operation, maintenance, and replacement: assigned net costs	Annual operation, maintenance, and replacement: costs	Average annual salable energy (million kwh)	Cost of power delivered to market (Mills per kwh)	Cost of stream power to meet same market	Benefit Cost Ratios
	Million Dollars						(thousand dollars)						
1	2	3	4	5	6	7	8	9	10	11	12	13	14
INITIAL UNITS													
Glen Canyon	50.3	141.7	229.3	371.0	-16.9	382.0	4802	-336	4466	3813	4.7	7.3	1.71
Echo Park	48.0	76.8	51.6	128.4	- .5	137.5	1155	- 10	1145	1017	5.9	7.3	1.42
DATA ON UNITS IN ULTIMATE PLAN													
Cross Mountain	13.9	19.4	16.9	36.3	3.7	42.7	296	75	371	376	5.0	7.3	1.65
Split Mountain	--	--	84.4	84.4	7.2	96.9	644	144	788	643	6.5	7.3	1.26
Gray Canyon	9.2	127.4	54.3	181.7	6.0	201.3	1212	121	1333	1186	7.1	7.3	1.15
Flaming Gorge	28.9	39.8	14.3	54.1	.9	59.1	364	17	381	388	6.4	7.3	1.36
Curecanti	30.3	40.9	14.8	55.7	1.7	61.6	376	35	411	308	8.4	7.3	1.04
Crystal	--	--	40.9	40.9	- 1.2	42.3	325	- 26	299	227	7.9	7.3	1.00
Whitewater	5.0	20.4	18.9	39.3	- .9	40.9	360	- 20	340	232	7.7	7.3	1.05
TOTAL	185.8	466.4	525.4	991.8	0	1064.3	9534	0	9534	8190	--	--	--

NOTES:

Col. 6 Incremental power plant and transmission line costs reassigned among the project units in accordance with the energy credited to each site.

Col. 7 Total power costs assigned to each unit including allocated joint costs, powerplant, transmission, and interest during construction.

Col. 10 The estimated annual cost of operation, maintenance, and replacement assigned to each unit.

Col. 11 Average annual salable generation credited to each unit during 50 years of full operation.

Col. 12 Mill rate required to repay all costs allocated to power at each unit, including interest during construction, in 50 years of full operation with 2-1/2 % interest charged on the unpaid balance.

Col. 14 The benefit-cost ratios shown are based on primary power benefits only but give consideration to the expected useful life of facilities extending beyond 50 years by the present value of the estimated salvage after 50 years.

Curecanti (940,000 A. F.)	--	37.9	11.4	49.3	--	53.0	280	--	280	194	11.1	7.3	.75

REVISED SUMMARY OF ESTIMATED COSTS OF 940,000 A.F. CURECANTI
UTILIZING AVAILABLE POWER DROP TO CRYSTAL SITE

Construction Costs			
1. Land and land rights			$ 670,000
2. Relocation			6,280,000
3. Dam-spillway-outlet works			30,200,000
4. Power plant - original		$5,735,000	
" " "	increased	2,408,700	
	sub total	$8,143,700	$8,143,700
5. (Transmission line (Curecanti-Gunnison, and Grand Junction)			1,000,000
(Substation			750,000
6. General property			737,000
7. Build nine miles of tunnel @ $1,844,700			16,602,300
	total		$64,383,000
Credit for Costs Allocated to Other Benefits			
8. A. Stream regulation			8,300,000
9. B. Irrigation			no credit
10. C. Flood control			350,000
11. D. Industrial benefits			no credit
12. E. Domestic use			no credit
13. F. Recreation			no credit
14. G. Salvage value, @ 14.5%			9,336,000
			$17,985,000
Total investment to be charged to power production			$46,398,000
Annual Costs			
(Dam and tunnel	- O&M		17,348
(	- Replacement		10,533
15. (Power plant	- O&M		136,320
(	- Replacement		65,036
(Transmission	- O&M		15,089
(	- Replacement		23,785
	total		$ 268,111

COST COMPARISON

16. Initial construction costs allocated to power		$46,398,000
17. Interest during construction		3,482,000
18. Total initial investment		$49,880,000
19. Initial investment amortized over 50 year period @ 2-1/2%	int.	$1,551,460
20. Annual O&M		268,111
21. Total annual cost		$1,819,571
22. Total annual salable generation		331,500,000 kwh
23. Mill rate for repayment	5.49 or 5.5 mills /kwh	

COST OF ALTERNATE STEAM

24. Capacity charge, 68,000 KW. @ $25.40	1,727,200
Energy value $.00317, - 331,500,000	1,050,855
	$2,778,055

25. Benefit to cost ratio = $\frac{2,778,055}{1,819,571} = 1.526$

SOURCE OF FIGURES ON REVISED SUMMARY OF ESTIMATED COSTS OF 940,000

A.F. CURECANTI, UTILIZING AVAILABLE POWER DROP TO CRYSTAL SITE

1. Land and Land Rights

This figure taken from U. S. Bureau of Reclamation report

2. Relocation

This figure taken from U. S. Bureau of Reclamation report.

3. Dam-Spillway-Outlet Works

This figure taken from U.S. Bureau of Reclamation report.

4. Power Plant

The size of the power plant was calculated as follows: The original Curecanti figures were based on a rated head of 295 feet. From Curecanti to the high water level of the 40,000 A.F. Crystal unit is 295 feet. Allowing a loss of head of 10 feet per mile of tunnel, there is left an available head of 205 feet. Since the original unit as per U. S. Bureau of Reclamation report would be 40,000 KW., the increase of 28,000 kwh was arrived at as a ratio of the two heads, ie; 205/295 X 40,000 = 28,000. The net salable generation was arrived at as a ratio of 68,000/40,000 X 195,000,000 kwh = 370,000,000 kwh as shown in line 29.

7. Transmission Line and Substations

The U. S. Bureau of Reclamation report showed transmission costs of $5,680,000, which apparently was based on region wide costs per KW of installed capacity. However, in line with Bureau of the Budget circular No. A-47, it was felt that the only costs that should be shown are those necessary to connect the plant to the markets nearby, and the existing U. S. Bureau of Reclamation connection at Gunnison, and the Public Service Company at Grand Junction. The 1,000,000 figure was taken from recent study submitted by Laramore and Douglass Engineering firm of Chicago, Illinois, for 115 KV line.

In the above mentioned report by Laramore and Douglass, 115-44KV substations were listed at $20.00 per KVA in 10,000 KVA sizes. These included tap changing under load transformers. It is difficult to fix the requirements for the local market area, but the $750,000 allowance for substations is enough for 37,500 KVA of substation capacity at $20.00 per KVA. Since this is well over half the entire plant capacity, and since the entire capacity of the Western Colorado Power Co. is only 31,732 KW., it was felt that this amount was ample. The Western Colorado Power Co. serves nearly all of the existing local market.

6. General Property

This figure taken from U. S. Bureau of Reclamation report.

7. Nine Miles of Tunnel

To implement this plan it is necessary to build a nine mile tunnel from Curecanti to the high water mark of the Crystal reservoir. U. S. Bureau of Reclamation figures indicate that a 12.5 tunnel would be large enough. From the U. S. Bureau of Reclamation tunnel estimating chart 103-D-375, a 12.5 foot pressure tunnel would cost $130 per foot, based on 1940 costs. An additional 115 % was allowed to bring the costs up to date plus an additional 25% for engineering and contingencies, making a total of $1,844,700 per mile.

8. Stream Regulation

Figure allowed by U. S. Bureau of Reclamation as value of Curecanti for stream regulation.

9. Irrigation

No credit allowed as yet, but some credit surely should be given here.

10. Flood Control

This figure taken from U. S. Bureau of Reclamation report.

11. Industrial Benefits

No credit allowed as yet, but some credit surely should be given here.

12. Domestic Use.

No credit allowed as yet, but some credit surely should be given here.

13. Recreation

No credit allowed as yet, but some credit surely should be given here.

14. Salvage Value

14.5% estimated salvage value is the same percentage as U. S. Bureau of Reclamation estimated salvage value of 940,000 A.F. reservoir and power facilities.

15. Annual Costs

O&M and replacement costs were determined from a direct ratio between the costs shown in the U. S. Bureau of Reclamation report, and the costs shown in this report. For example, power plant costs were determined as follows:

U. S. Bureau of Reclamation total cost	$5,735,000
Revised total cost	8,831,900
Ratio = 1.54	
O&M, U. S. Bureau of Reclamation	96,000
Revised - 96,000 X 1.54 =	136,320
Replacement, U. S. Bureau of Reclamation	45,800
Revised - 45,800 X 1.54 =	65,036

All other O&M and replacement costs computed by same method.

17. Interest During Construction

This figure was derived from a direct ratio of the total cost to be charged to power in the U. S. Bureau of Reclamation report, and the revised cost to be charged to power, times the interest shown in the U. S. Bureau of Reclamation report, as follows:

47,965,200 / 49,302,000 = .9728
.9728 X $3,700,000 = $3,599,360

18. Total Initial Investment

Sum of total construction cost allocated to power, and the interest during construction, as in the U. S. Bureau of Reclamation report.

19. Initial Investment Amortized over 50 year period

The same procedure was followed here as in the U. S. Bureau of Reclamation report. 50 year interest plus the initial construction cost allocated to power, divided by 50, gives the annual capital costs.

20. Annual O&M

Total of all annual O&M and replacement costs, summarized in line 15.

21. Total Annual Cost

Sum of annual O&M and replacement and annual capital costs. Sum of lines 19 and 20.

22. Total Salable Generation

The 40,000 KW plant shown in the U. S. Bureau of Reclamation report was estimated to produce 195,000,000 kwh, salable generation. Therefore, a ratio of 68/40 X 195,000,000 gives a net salable generation of 331,500,000 kwh.

23. Mill Rate for Repayment

This figure was obtained by dividing total annual cost by total annual salable generation.

24. Cost of Alternate Steam

The U. S. Bureau of Reclamation report showed alternate steam at $25.40 per year for demand, and $.00317 as energy cost. Therefore, cost of steam is as follows:

capacity charge - - 68,000 X 25.40 - - - - - - - $1,727,200
energy charge - - - $.00317 X 331,500,000 - - - - 1,050,855
total $2,778,055

25. Benefit to Cost Ratio

This is the ratio of the cost of steam to the total annual cost of the revised Curecanti plan, as follows:

$$\frac{2,778,055}{1,819,571} = 1.56$$

COMMENTS ON ABOVE FIGURES

In the calculations on cost of alternate steam, it should be noted that the cost is figured only on salable generation. This seems to be in error, since the cost of steam should be on total generation. Since the U. S. Bureau of Reclamation report showed 209 million, kwh generated, with 40,000 KW plant, 68,000 KW would have a total generation of 355,300,000 kwh, to produce 331,500,000 kwh salable. Therefore, the cost of steam should read as follows:

capacity	@ 25.40 X 68000	$1,727,200
energy	@ $.00317 X 355,300,000	1,126,301
	total	$2,853,501

and the benefit to cost ratio as follows:

$$\frac{2,853,501}{1,960,996} = 1.455$$

COLORADO RIVER WATER SUPPLY IN COLORADO

December 10, 1953

1-Total Supply - This is not [illegible] misleading [illegible]

Total supply to Colorado as given in Hill Report page 10		3,100,000 A.F.

2-Present Irrigation in Basin

(a) Lands irrigated - 790,600 acres, as developed on page 35, Engineering Advisory Committee Report and used in Hill Report, page 19. Consumptive use is 790,600 x *1.265	1,000,000 A.F.	
(b) Additional lands not fully considered in Hill Report. Total irrigated lands is 790,600 + the 33,472 increase allowed by Hill + 35,928 not considered by Hill for a total of 910,000 acres. Additional land to (a) above is 33,472 + 85,928 for a total of 119,400 acres. Consumptive use is 119,400 x *1.265.	151,000 A.F.	
Total (Hill Report 1,035,000)	1,151,000 A.F.	1,151,000 A.F.
Balance		1,949,000 A.F.

3- Present Trans-Mountain Diversions

Reported on page 17 of Hill Report		377,000 A.F.
Balance		1,572,000 A.F.

*Rate of consumptive use developed in Hill Report page 19 as 1,000,000 divided by 790,600 or 1.265 A.F. per acre.

4- Other In-Basin Present Depletions

Reported on page 17 of Hill Report		37,000 A.F.
Balance (Hill Report 1,650,000)		1,535,000 A.F.

5- Committed Trans-Mountain Depletions

(1) Reported on page 18 of Hill Report as 100,000 + 28,000 or 128,000	128,000 A. F.	
(2) Reported on page 53 of Hill Report as 17,000 for Colorado Springs and 72,000 for Fryingpan-Arkansas	89,000 A.F.	
Total	217,000 A.F.	217,000 A.F.
Balance		1,318,000 A.F.

6- Industrial Use Allowance in Basin

Recommended in Hill Report on page 48 as 300,000 and increased 100,000 to 400,000 A.F. to allow for possible water use processes for shale and for other industrial uses in Western Colorado.	400,000 A.F.
Balance	918,000 A.F.

7- In-Basin Non-Subsidy Irrigation Expansion

Natural irrigation expansion in basin without subsidy estimated to take place in 30 years is 173,000 acres. Total land to be irrigated without subsidy is 790,000 + 119,400 + 173,000 for a total 1,083,000. Consumptive use 173,000 x *1.265.	219,000 A.F.
Balance	699,000 A.F.

*Rate of consumptive use developed in Hill Report page 19 as 1,000,000 divided by 790,600 or 1.265 A.F. per acre.

8- Mexican Treaty Obligation

Possible obligation due to Mexican Treaty; Estimated as 51.75 of 1/2 of 1,000,000 A.F. Page 66 of "The Colorado River", published by the Bureau of Reclamation in 1946.		259,000 A.F.
Balance		440,000 A.F.

9- Additional Water Uses Reported by Hill

A- Desirable Water Uses as Reported by Hill.

1- Irrigation expansion within the basin within a subsidy of *$400 per acre (new land equivalent) as given in Hill Report, pages 28, 29, 30 and 34.	366,000 A.F.	
2- City of Denver Blue River diversion as given on page 52 of Hill Report	177,000 A.F.	
	543,000 A.F.	543,000 A.F.
Deficient		103,000 A.F.

B- Other Water Uses Reported by Hill as too costly.

1- Blue-South Platte diversion requiring a subsidy of $1000 per acre as given on page 54 of Hill Report	253,000 A.F.	
2- Gunnison-Arkansas diversion requiring a subsidy of $1250 per acre as given on page 56 of Hill Report.	500,000 A.F.	
Total	753,000 A.F.	753,000 A.F.

* The subsidy of $400 per acre is less than the required subsidy for the Fryingpan-Arkansas Project.

Bureau Photographs

NOV 5 1953

COLORADO RIVER STORAGE PROJECT

CURECANTI UNIT

Over the past several years considerable work has been accomplished in an effort to set forth uniform standards and procedures for evaluating projects for the development of the Nation's water resources. While all agencies concerned with water resource project development are still not in full agreement, certain criteria have been recognized as necessary to assure the maximum returns from project investments. Present procedures require a demonstration of the economic feasibility of not only the over-all project but of each unit and separable purpose thereof. Expenditures for any purpose served by the project are limited to the lowest cost alternative development to provide the same benefits.

Power production and physical data are shown on sheet A for 2,500,000 acre-foot and 940,000 acre-foot reservoirs at the Curecanti site. For the purpose of comparing the large and small storage plans for developing the Curecanti site on the Gunnison River, all costs for each plan were first assumed allocated to power. These costs and the computation of the required unit cost per kilowatt-hour of salable energy for project repayment in 50 years with $2\frac{1}{2}$ percent interest are shown on sheets B and C. Also shown on sheets C and D are the computations of benefit-cost ratios for the two plans. The project benefits are based on the estimated annual cost of producing equivalent steam power in the area as shown on data summary sheet B. The project costs include construction costs, interest during construction at $2\frac{1}{2}$ percent, a salvage credit equal to the estimated present value of project facilities after 50 years of operation, and the estimated annual cost of operation, maintenance, and replacement.

The required unit energy sale rates and the benefit-cost ratios show that with all costs allocated to power neither plan can be justified economically since their costs exceed those of the lowest cost alternative. In both computations the 940,000 acre-foot reservoir, though it can't be economically justified under present conditions, appears more favorable than the larger development. This is the result of confining the analysis to at-site benefits and favors the small storage reservoir. In the case of a large reservoir a net contribution from storage to the dry period flow of the Colorado River at Lee Ferry can be shown as the basis for claiming an irrigation (hold-over storage) allocation. However, with the small reservoir the net contribution over successive 10-year periods is negligible. The active storage is so limited that it is of value only for regulation of seasonal runoff since in most years the runoff during May and June exceeds the active storage capacity. Also consideration must be given

in evaluating net contribution to the evaporation losses which in any 10-year period would total nearly one-half of the available active capacity.

The justifiable allocation of large Curecanti costs to irrigation under present evaluation criteria cannot be determined at this time, however, if procedures similar to those used in the December 1950 Colorado River Storage project report are followed, approximately $30,000,000 of the joint costs could be allocated to irrigation. This would result in a required sale rate of 8.4 mills per kilowatt-hour, still in excess of the cost of the steam alternate but when evaluated with the assumed salvage credit in an economic analysis would result in a benefit-cost ratio of approximately 1.0. Even though both the assumption as to salvage values and the irrigation allocation are still controversial subjects, it should be remembered that no claim for a "hold-over storage" allocation can be supported for the small reservoir plan.

A review of the data submitted by Mr. Larson to the Policy and Review Committee--Gunnison River Storage during December 1951 and January 1952 shows that the added potential downstream benefits with a large reservoir at Curecanti have already been outlined. As was pointed out in these letters any reduction in capacity from the large Curecanti would result in decreased power with comparable increases in unit costs at the Crystal and Whitewater. This would also apply to potential run-of-river developments such as utilization of the 1,000-foot power head through the Black Canyon.

REVIEW OF F. M. PETERSON PROPOSAL
940,000 a.f. Curecanti Reservoir
9-mile Pressure Tunnel and Power Plant
by
Region 4--Bureau of Reclamation
December 15, 1953

PHYSICAL FEATURES

Item	Peterson Study	Bureau Adjustment
Curecanti Reservoir capacity	940,000 a.f.	940,000 a.f.
Pressure tunnel length	9 miles	8.5 miles
Tunnel diameter 1/	12.5 feet	14.3 feet
Tunnel capacity 1/	-	1,585 cfs
Head loss	10 feet/mile	8.8 feet/mile
Powerplant firm capacity 1/	68,000 kw	48,000 kw
Energy generation (salable) 1/	331.5 million/kwh/yr.	(1931-1947 average 332 (M. kwh/yr
Energy generation (salable) 1/		(min. year 260 (M. kwh/yr.

COST ESTIMATES (Jan. 1953 Prices

Construction Costs		
Dam and Reservoir	$37,887,000	$37,887,000
Powerplant and appurtenances	8,143,700	8,640,000
Pressure tunnel	16,602,300	23,400,000
Transmission ~~Transmountain~~ 2/	1,750,000	4,652,000
Total construction cost	$64,383,000	$74,579,000
Interest during construction	3,482,000	4,670,000
Annual Costs (O&M & Replacement) 3/		
Dam and reservoir	$27,881	$18,000
Powerplant and appurtenances	201,356	184,500
Pressure tunnel (incl. in dam and reservoir costs)		16,000
Transmission	38,874	100,000
Total annual O&M& replacement	$268,111	$318,500

REPAYMENT ANALYSIS

	Peterson Study	Bureau Adjustment
Total construction cost	$64,383,000	$74,579,000
Interest during construction	3,482,000	4,670,000
Irrigation allocation	8,300,000	8,100,000
Flood control	350,000	350,000
Salvage	9,336,000	0
Power repayment	49,879,000	70,799,000
Annual payment 4/	1,551,460	2,496,200
Annual costs	268,111	318,500
Total annual repayment	1,819,571	2,814,700
Required mill rate	5.5	8.5

BENEFIT-COST ANALYSIS

Annual Economic Costs	1,819,571	2,814,700
From above		
Less salvage	(already included)	-359,000 5/
	$1,819,571	2,455,700
Annual Benefits		
Capacity value	1,727,000	1,222,000
Energy value	1,051,000	1,051,000
Total benefits	$2,778,000	$2,273,000

Benefit-Cost Ratios

Peterson Study: 1.53
Bureau adjustment values .92

1/ The cost of pressure tunnel was estimated using Bureau curves indexed up by a factor of 2.15. This value to present should be 2.56. The value of 25% for engineering, etc., should be 19%. The 12.5 foot diameter tunnel assumed for the estimate is not sufficiently large to accommodate even a 48,000 kilowatt power plant let alone a 68,000 kw plant. Based on an analysis to utilize up to 1,345 cfs through the tunnel and restrict the velocity to a maximum of 10 feet per second and a head loss of slightly less than 10 feet per mile it was found that a finished tunnel diameter of 14.3 feet was required. This would result in an average annual generation of 357 million kilowatt-hours per year during a period similar to 1931-1947. The firm capability for this diameter tunnel and net reservoir heads was 48,000 kilowatts which corresponds to an 85 percent plant factor with the average annual generation. This is very close to a practical maximum

when the 8½ to 9-mile tunnel length between reservoir and power plant is considered. With the 14.3 foot tunnel and appropriate indices the tunnel cost was estimated at over 23 million dollars, at minimum head would be 16½ feet.

2/ The cost of a 115 ~~kilowatt~~ kilovolt line from Curecanti to Gunnison, Montrose, and Grand Junction with step-up and step-down transformation was estimated at $4,652,000 which is $95 per ~~kva~~ kw and represents an energy cost of only .8 mills per kwh. The cost of alternate steam used for benefit-cost analysis includes transmission and substation costs totalling $60 per kw and was based on two separate 25,000 kw steam plants located at the best points to serve the local market area.

3/ The annual cost of O&M and replacement shown for the dam, tunnel and transmission system should be increased to compensate for the increased construction costs. The O&M and replacement cost for the powerplant of 68,000 kilowatts of $201,356 is much too low but is somewhat higher than the $184,500 estimated for the 48,000 kilowatt plant size that can be justified with this type of development.

4/ Their item 19 under cost comparison gives a value of 1,551,460 for amortization of $49,880,000 at 2½ percent interest over 50 years. This was computed wrong--a factor of ~~.1035258~~ .035258 should be used which when used with their cost would give $1,758,670.

5/ This is the annual equivalent of the present worth of salvage at the end of 50 years for the costs shown under Bureau adjustment.

P.O. Box 2100
Grand Junction, Colo.
December 31, 1953

Mr. Ivan C. Crawford, Director
Colorado Water Conservation Board
212 State Office Building
Denver 2, Colorado

Dear Mr. Crawford:

Attached is a summary of my study of the increase of irrigated land in Western Colorado by private initiative, as presented to the Conference Committee on December 10, 1953. I have attempted to prepare this summary for use in the minutes of the Committee and have, therefore, omitted any reference to the charts and graphs, as used in the discussion of this study with the Committee.

Yours very truly,

C. H. Jex

CHJ:bw

Enclosure

Appendix I

1953

SUMMARY OF STUDY BY C. H. JEX ON THE INCREASE OF IRRIGATED LANDS IN WESTERN COLORADO BY PRIVATE INITIATIVE

It appears to those acquainted with agricultural development in Western Colorado that the Hill Report has not given adequate consideration to the privately financed agricultural development now taking place in the basin. In recent years a large number of new irrigation ditches have been constructed for the diversion of irrigation water from the several streams of the area, and also a large number of water storage reservoirs have been constructed for irrigation purposes.

The Hill Report provided for only a very small increase in consumptive use of water above the figure reported by the Engineering Advisory Committee to the Compact Commission in 1948. Also, the report of the Engineering Advisory Committee shows only a small expansion over the irrigated lands, as measured by the Bureau of Reclamation in 1937. The 1937 survey of irrigated lands of Western Colorado is the only complete, detailed information available for the entire area of Western Colorado, requiring that estimates be used to reflect the expansion of irrigation that has taken place since 1937.

Using the figures of the 1937 land survey by the Bureau of Reclamation as a base for complete basin coverage, and knowing that the irrigated lands in at least three separate sections of

the basin have been re-surveyed and re-measured in recent years by the Bureau of Reclamation, and knowing also that crop report information or irrigated acreage is available for the year 1937 and the present time for the Uncompahgre Valley in Montrose and Delta Counties and for the Grand Valley in Mesa County, a tabulation of comparative irrigated land acreage figures were compiled for the five areas. The results of the tabulation for the five study or sample areas is as follows:

SUMMARY OF INCREASE OF IRRIGATED LANDS OF WESTERN COLORADO

Location of Sample Area	Irrigated 1937 (Acres)	Irrigated 1952 (Acres)	Increase in Acres	Percent Increase
Colo. River Basin above Palisade	162,910	195,300	32,390	19.9
San Miguel River Basin	19,980	24,270	4,290	21.5
Little Snake River Basin	11,180	13,740	2,560	22.9
Uncompahgre Valley	62,270	71,230	8,960	14.4
Grand Valley	63,200	74,980	11,780	18.6
TOTAL	319,540	379,520	59,980	18.8

The results of the study of the five sample areas, which constitute 42% of the irrigated lands of the basin show that an average increase of 18.8% has taken place between the years 1937 and 1952. If this same rate of expansion is applied throughout the basin, the increase in irrigated lands since 1937 is

143,500 acres. The lands irrigated in 1937 was 767,060, and with the 143,500 acre increase, the total presently irrigated lands would be 910,560 acres. The Hill Report (Page 15) gives a summary figure of 824,072 acres, which is 86,488 acres less than the total as determined from study of sample area data. ✓

With a total of 767,060 acres irrigated, as measured in 1937, and this increased by 143,500 during the last fifteen years, all by private initiative, the question may well be asked: What may we expect to take place during the next thirty years if sufficient water remains available for additional expansion? As a basis of estimate on the probable future expansion, we again turned to the recent study of the Bureau of Reclamation in the Colorado River Basin above Palisade.

After the completion of the land classification work in the basin, the Bureau of Reclamation made a study of what it termed "Lands Best Suited for Development by Private Interests". The lands thus considered are located such that they can be served water by extension and enlargement of existing irrigation facilities by the construction of new relatively inexpensive ditches for the serving of small tracts of land and the pumping of water under low pumping heads. The total acreage of land designated by the Bureau as likely to be developed by private interests is 40,215 acres for the Colorado River Basin above Palisade. By projecting the same allowance for other portions of Western Colorado for similar development, it is concluded that by private initiative we may expect an additional 190,000

acres to be irrigated. Based on the past rate of expansion, we may anticipate that 173,000 acres of this expansion will take place within the next thirty-year period.

From study of the Hill Report and from a check with Mr. J. R. Riter, who advised with Mr. Hill on irrigation depletions, it is concluded that the Hill Report failed to make any allowance for at least 266,000 acre feet of consumptive use water as discussed above. This figure is greater by 66,000 acre feet than the Hill Report (Page 53) shows as a total available for future trans-mountain diversion to Eastern Colorado.

BR-4 Feb. '55

STATEMENT ON CURECANTI UNIT, COLO.,
OF COLORADO RIVER STORAGE PROJECT
(Modified Plan)

The Curecanti unit of the Colorado River Storage project is located on Gunnison River, a tributary of the Colorado River, in west-central Colorado. The report of the Colorado River Storage project and participating projects of December 1950 included plans for development of the Curecanti and Crystal reservoirs and powerplants. The Curecanti unit recommended in that report was for a reservoir capacity of 2,500,000 acre-feet. The State of Colorado requested that the reservoir water surface is limited to elevation 7520 or a capacity of 940,000 acre-feet. As a result the committee reports on the Bills before the last session of the Congress contained the recommendation of the State of Colorado that the Curecanti unit be limited accordingly. Since the cost of power produced by the smaller dam was somewhat higher than the cost of power produced by alternate means, we have endeavored to work out a plan for improving the economic feasibility of this unit.

Reconnaissance studies of a modified plan are now well advanced and indicate that a greater and more economical utilization of the power resources on the Gunnison River could be made by adding two dams and powerplants between the Curecanti and Crystal Reservoir sites. The resulting unit would consist of an integrated system of four dams and powerplants. It is planned primarily for hydroelectric development and would also provide benefits from flood control, recreation, and ultimately from irrigation and other uses dependent upon river regulation or replacement storage. The reservoirs would extend some 40 miles along a section of the Gunnison River between the town of Gunnison and the Black Canyon National Monument but would lie above and outside the boundary of the monument. Each of the features included in the unit under the modified plan would be dependent for maximum economy upon other features of the unit, and each feature would be justified economically for inclusion in the unit.

The Curecanti Reservoir would be formed by the Blue Mesa Dam. It would be the largest and uppermost of the four reservoirs in the system and would provide the major portion of the system's stream regulation. The three downstream reservoirs referred to as the Narrow Gauge, Morrow Point, and Crystal Reservoirs, in that order, would be primarily for development of power head with only nominal active storage capacities. Sufficient active capacity, however, would be provided at the Morrow Point site for some seasonal regulation of stream inflows below Blue Mesa Dam. Small amounts of active capacity would also be necessary at the three downstream sites for successive re-regulation of releases from upstream reservoirs to permit flexibility of power production in conformance with power load patterns. Releases from the Crystal Reservoir, the lowest site in the system, would be maintained to provide optimum use of water downstream for irrigation and other uses in addition to generation of power at the Crystal site.

Physical data and estimated reconnaissance construction costs of the principal features in the unit are shown below.

Dam and powerplant or other feature	Height of dam above streambed (feet)	Reservoir capacity (acre-feet)		Installed generating capacity (kilowatts)	Estimated construction cost of dam and powerplants (July 1954 prices)
		Total	Active		
Blue Mesa	350	940,000	740,000	51,000	$36,500,000
Narrow Gauge	135	8,000	1,000	18,000	9,100,000
Morrow Point	260	82,000	42,000	60,000	20,700,000
Crystal	155	9,000	1,000	23,000	10,700,000
Transmission system					11,500,000
Total	900	1,039,000	784,000	152,000	88,500,000

Operation, maintenance, and replacement costs for the unit are estimated at a total of $863,000 annually.

Stream depletion (reservoir evaporation) attributable to development of the unit would total approximately 17,000 acre-feet annually.

An average of approximately 645,000,000 kilowatt-hours of energy deliverable to power load centers after allowing for transmission losses would be produced annually. Of the total, about 213,000,000 kilowatt-hours would be produced at the Blue Mesa powerplant. Market studies show that the potential power could be marketed within a reasonable period after completion of construction. The plan is adaptable to scheduling construction of the dams and powerplants to conform in general with growing market conditions. The most practical initial construction of the unit would probably include the Blue Mesa Dam (Curecanti Reservoir) and powerplant with the other dams and powerplants added later consistent with power load growth.

All of the flows of the Gunnison River would not be controlled by the reservoirs of the unit. Flows of flood magnitude, however, could be reduced and much of the flood damage along the river under present conditions would be reduced. The Corps of Engineers has tentatively estimated that flood control benefits would amount to $10,000 annually. The National Park Service has tentatively estimated that the recreational value of Curecanti Reservoir would amount to about $20,000 annually if adequate recreational facilities were provided. No evaluation of the recreational potentialities of the other three reservoirs has been made. The Fish and Wildlife Service is presently studying effects of the potential development on fish and wildlife values. No monetary appraisal has yet been made, but the studies made by the Service to date indicate that the development would have an adverse effect on present fish and wildlife values. The Service is therefore opposed to the development.

The following criteria and assumptions were used in the preliminary reconnaissance appraisal of the unit:

(a) Only direct power benefits are considered.

(b) No allocation of costs is made at this time to river regulation for future irrigation and other consumptive uses.

(c) Costs of the unit and of alternative steam power for comparative purposes are based on amortizing costs with an interest rate of 2.5 percent over a 50-year period of analysis. Taxes are not included in the analysis.

(d) Average firm energy production deliverable to load centers is based on estimated 20-year depleted streamflows for the 1931-44 streamflow conditions and estimated power transmission losses.

(e) Present worth of the estimated salvage value at the end of 50 years was deducted from construction costs in computing the benefit-cost ratio.

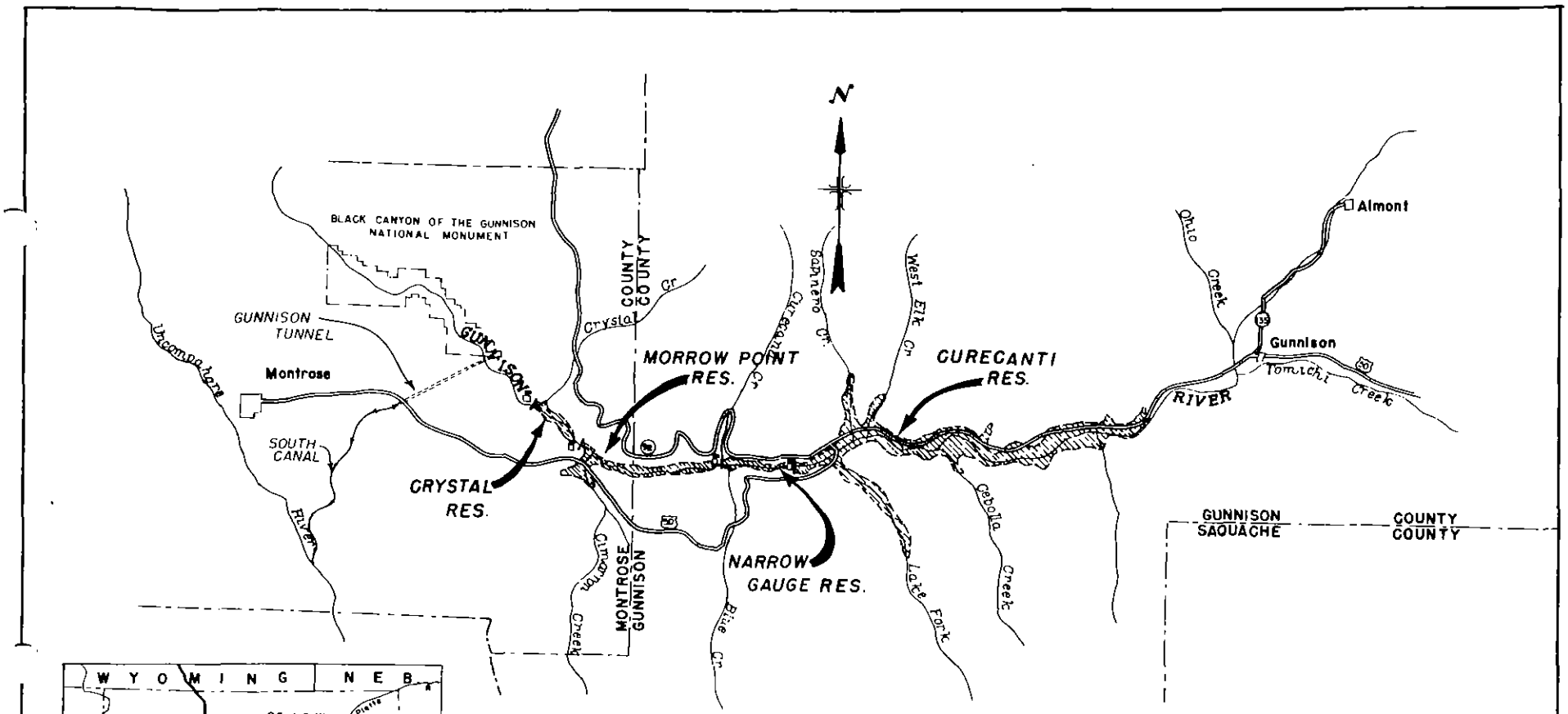
(f) Delta, Montrose, Grand Junction, Nucla, and Gunnison, Colo., were assumed as power market load centers for the study.

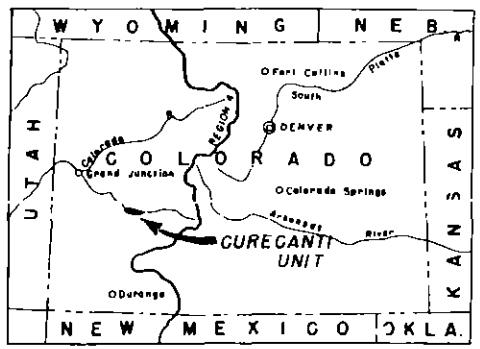
General results of the reconnaissance appraisal on the above basis for the Curecanti Reservoir and Blue Mesa Dam and powerplant alone and for the overall Curecanti unit are summarized below.

	Scale of development	
	Curecanti Reservoir, Blue Mesa Dam and powerplant alone	Curecanti unit (four dams and powerplants)
Average cost per kilowatt-hour	9.4 mills	6.5 mills
Cost per kilowatt-hour of alternative steam power	9.0 mills	8.3 mills
Benefit-cost ratio	1.1 to 1	1.4 to 1

Although the reconnaissance studies indicate that the Blue Mesa powerplant when considered alone would have a benefit-cost ratio slightly greater than unity if allowance is made for salvage value, the average cost of energy would slightly exceed the cost of alternative steam power. On the other hand, the benefit-cost ratio for the overall Curecanti unit would be well over unity and the average cost of energy would be 22 percent less than the cost of alternative steam power.

Detailed studies are necessary to refine the economic scale of development and to confirm the present reconnaissance appraisal.





LOCATION MAP

EXPLANATION

Potential Project Features

Reservoir

Power plant

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REGION 4

CURECANTI UNIT

COLORADO RIVER STORAGE PROJECT

SCALE OF MILES

JANUARY 1955

INTERIOR RECLAMATION, SLC UTAH

622-400-15

written post 1955

COMMITTEE AND BOARD ACTIONS RELATIVE TO CURECANTI PROJECT

Following, in chronological order, there is set forth the several Committee and Board actions which have taken place with regard to the Curecanti Project:

1. The Policy and Review Committee, Gunnison River Storage, a Committee authorized and appointed by the Colorado Water Conservation Board, recommended to the Colorado Water Conservation Board under date of April 3, 1952, that the Board approve Plan E which consists of storage at

Curecanti	940,000 a.f.
Whitewater	880,000 a.f.
Crystal	510,000 a.f.

The Board approved this report at its meeting on May 5, 1952 as shown in the Minutes for that date, page 68.

2. On account of misunderstanding and different interpretations of certain restrictive clauses in the Committee Report or April 3, 1952, the Committee was called together on May 25, 1953, at which time the Report was amended by stating that the points listed on page 19, Paragraph 13 be considered as conditions precedent and the points on pages 20 and 21 under Paragraph 14 be considered as recommendations. No change was recommended with regard to Plan E. This recommendation was brought to the Colorado Water Conservation Board at its August 6, 1953 meeting and was adopted by the Board at that time.

3. On October 6, 1953, Director Crawford addressed the following letter to Douglas McKay, Secretary of the Interior:

My dear Secretary McKay:

The Colorado Water Conservation Board at a meeting held on May 5, 1952 approved the Curecanti Storage Unit (940,000 acre feet) subject to the report of the Policy and Review Committee (committee authorized by the Board) of the Gunnison River Storage, a report made to, and approved by, the Colorado Water Conservation Board.

The Board urges that this project be included in the initial authorization by Congress for construction of units of the Colorado River Storage project.

Sincerely yours,

Ivan C. Crawford
Director

4. On October 19, 1953, Director Crawford addressed a letter to M. B. Bennett, Jr., Director of Planning, Bureau of Reclamation, Department of the Interior, and enclosed in that letter the resolution of the Policy and Review Committee passed at the meeting held May 25, 1953, relative to paragraphs 13 and 14 of the report of April 3, 1952.

5. At the meeting of the Colorado Water Conservation Board on November 10, 1953, "Mr. Dutcher moved that the Colorado Water Conservation Board go on record that it will favorably recommend the Curecanti project for the first phase of development under the Colorado River Storage Project and Participating Projects when final action is taken on the project report by this Board, and that the Board work energetically to bring about the feasibility of the

Curecanti (940,000 acre-feet) under the present order A-47, or if that is impossible to achieve, the Board will work actively to the end that the order A-47 be changed or modified so that Curecanti (940,000 acre-feet) be determined as a feasible project. (The 940,000 acre-feet reservoir has a maximum water surface elevation of 7,520 feet)." Motion carried 6-3.

6. At a meeting of the Colorado Water Conservation Board held on January 14, 1954, the Board by resolution pointed out that the known reservoir sites which together might store up to 3,000,000 acre feet of water were Curecanti on the Gunnison and DeBeque on the Colorado River. The Secretary of the Interior was urged to expedite the investigation and study of projects which will furnish the requested storage.

7. Resolution from Gunnison Watershed Conservation Committee.

"Gunnison, Colorado
May 4, 1954

Ivan C. Crawford
Director Colorado Water Board
State Office Bldg.
Denver, Colorado

Dear Mr. Crawford:

Enclosed is a copy of the resolution that was passed by the Gunnison Watershed Conservation Committee at a meeting held on April 22nd.

This resolution was passed after the committee held a series of meetings throughout the Gunnison area. At these meetings the people of the area were given the opportunity to express their wishes with respect to the large Curecanti Dam.

Thank you for your cooperation.

Yours truly,
/s/ Guy J. Cox
Mgr."

RESOLUTION

WHEREAS, in 1951 the Gunnison Watershed Conservation Committee passed a Resolution in support of the construction of a Curecanti Dam and Reservoir with a high water level of approximately 7,520 feet above sea level, affording total storage capacity in the neighborhood of 940,000 acre-feet; and

WHEREAS, it has been the desire of the members of this Committee to ascertain the present attitude of the residents of the upper Gunnison Watershed area on the question of the construction of a larger Curecanti Reservoir with a storage capacity of approximately 2,500,000 acre-feet, and in order to ascertain the present attitude of the people, a number of meetings have been held at various points in the area, and the opinion of various active representative organizations has been sought and obtained, and as a result of such meetings, it appears that the people of the area are overwhelmingly against the erection of the larger Curecanti Dam.

NOW, THEREFORE, BE IT RESOLVED that the Gunnison Watershed Conservation Committee reaffirms its commitment not to oppose the smaller dam and reservoir of not to exceed 940,000 acre-feet capacity, but is unalterably opposed to the construction of a dam and reservoir at or near Curecanti in excess of that capacity.

The above Resolution was duly adopted at a meeting of the Gunnison Watershed Conservation Committee held at Gunnison, Colorado on April 22, 1954.

/s/ Guy J. Cox
Secretary

8. At a meeting of the Colorado Water Conservation Board held February 4, 1955, the following motion was made by Mr. Moses: "I move that we approve the Curecanti Unit as revised as an initial project." The motion was seconded by Mr. Dille and unanimously carried.

written post 1955

Following in chronological order I am setting out the several Committee and Board actions which have taken place with regard to the Curecanti Project:

1. The Policy and Review Committee, Gunnison River Storage, recommended to the Colorado Water Conservation Board under date of April 3, 1952, that the Board approve Plan E which consists of storage at

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3. At the meeting of the Colorado Water Conservation Board on November 10, 1953, "Mr. Dutcher moved that the Colorado Water Conservation Board go on record that it will favorably recommend the Curecanti project for the first phase of development under the Colorado River Storage Project and Participating Projects when final action is taken on the project report by this Board, and that the Board work energetically to bring about the feasibility of the Curecanti (940,000 acre-feet) under the present order A-47, or if that is impossible to achieve, the Board will work actively to the end that the order A-47 be changed or modified so that Curecanti (940,000 acre-feet) be determined as a feasible project. (The 940,000 acre-feet reservoir has a maximum water surface elevation of 7,520 feet)."

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5. On October 6, 1953, Director Crawford addressed the following letter to Douglas McKay, Secretary of the Interior:

My dear Secretary McKay:

The Colorado Water Conservation Board at a meeting held on May 5, 1952 approved the Curecanti Storage Unit (840,000 acre feet) subject to the report of the Policy and Review Committee (committee authorized by the Board) of the Gunnison River Storage, a report made to, and approved by, the Colorado Water Conservation Board.

The Board urges that this project be included in the initial authorization by Congress for construction of units of the Colorado River Storage project.

Sincerely yours,

Ivan C. Crawford
Director

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WHEREAS, it has been the desire of the members of this Committee to ascertain the present attitude of the residents of the upper Gunnison Watershed area on the question of the construction of a larger Curecanti Reservoir with a storage capacity of approximately 2,500,000 acre-feet, and in order to ascertain the present attitude of the people, a number of meetings have been held at various points in the area, and the opinion of various activ e representative organizations has been sought and obtained, and as a result of such meetings, it appears that the people of the area are overwhelmingly against the erection of the larger Curecanti Dam.

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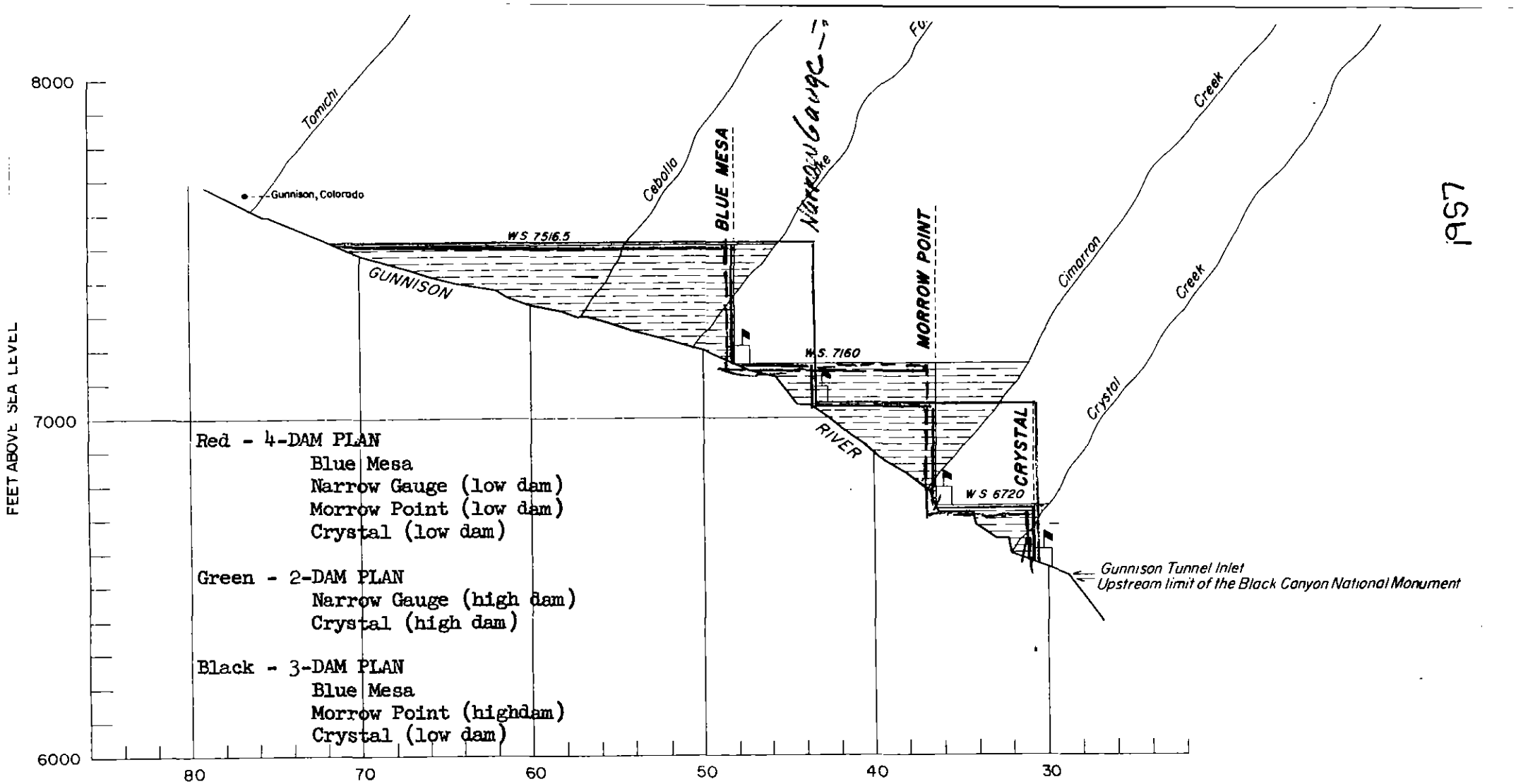


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER STORAGE PROJECT

CURECANTI UNIT

PROFILE

DRAWN . . G.N.J. . . SUBMITTED
TRACED . . G.N.J. . . RECOMMENDED
CHECKED E.C.H. . APPROVED

UPPER COLORADO RIVER OFFICE
SALT LAKE CITY JUNE 1957

622-414-

Supersedes drawing 622-417-2

no date

CURECANTI UNIT

SUMMARY OF PHYSICAL DATA ON DAM AND RESERVOIR

	2,500,000 af res.	940,000 af res.
Present river elevation	7,165'	
Max water surface elev.	7,635'	7,520'
Dam crest elevation	7,640'	7,525'
Initial total storage	3,500,000 af	940,000 af
Initial active storage	2,010,000 af	500,000 af
Sediment passing site	Est. at 300 af annual average	
Maximum water surface area	18,200 acres	9,400 acres
Height of Dam above River	475'	360'
Structural Height	510'	395'
Crest Length	1,240'	850'
Volume of concrete in dam	1,745,000 cu. yds.	720,000 cu. yds.
Spillway capacity	48,000 cfs	
1931-1940 average annual streamflow at site		
Initial conditions	876,000 af	
Year 20 conditions	774,000 af	
1914-1947 average annual streamflow at site		
Initial conditions	1,142,000 af	
Year 20 conditions	1,006,000 af	
Average annual evap. loss	32,000 af	18,000 af

SUMMARY OF DATA ON POWER PRODUCTION

Max. power head	470'	355'
Est. rated head	390'	295'
Est. average annual generation	330,000,000 kwh	209,000,000 kwh
Salable generation	308,000,000 kwh	195,000,000 kwh
Power plant capacity	54,000 kw	40,000 Kw

ALTERNATE COST OF STEAM POWER

(West Central Colorado Based on Federal Financing at 2½% interest and a 25,000 Kw plant)

Plant investment	at	$203.00 /kw
Substations	at	$ 30.00 /kw
Transmission	at	$ 30.00 /kw
Thermal efficiency	at	13,800 BTU per kwh generated
Fuel cost		$.246 per million BTU
Annual capacity value	=	$25,40 /kw
Annual energy value	=	$.00317 /kwh of salable energy

SUMMARY OF ESTIMATED COSTS

	2,500,000 af res.	940,000 af res.
Construction Costs		
Land and land rights	$815,000	$670,000
Relocation	7,860,000	6,280,000
Dam-spillway-outlet works	61,465,000	30,200,000
Power plant	7,054,000	5,735,000
Transmission	7,668,000	5,680,000
General property	1,106,000	[illegible]7,000
Totals	$85,968,000	$49,30[illegible],000
Annual costs		
Dam - O&M	19,000	11,200
- Replacement	14,200	6,800
Power Plant - O&M	112,900	96,000
- Replacement	68,700	45,800
Transmission - O&M	62,700	46,500
- Replacement	99,000	73,300
Totals	$376,500	$279,600

COST COMPARISONS - (All costs allocated to power)

Initial construction cost	$85,968,000	$49,302,000
Interest during construction	6,430,000	3,700,000
Total initial investiment	$92,398,000	$53,002,000
Initial investment amortized over a 50-year repayment period		
With interest at 2½%	3,258,000	1,868,900
Annual O&M & replacement	376,500	279,600
Total annual cost	$3,634,500	[illegible],148,500
Mill rate requirement for repayment	11.8 mills /kwh	11.1 mills /kwh

BENEFIT COST ANALYSIS

Benefits measured by annual cost of alternate steam --			
capacity - 54,000 kw at $25.40	= $1,372,000	40,000 Kw	= $1,016,000
energy - 308 million kwh at $.00317	= 976,000	195 million kwh	= 618,000
Annual benefits	$2,348,000		$1,634,000

For cost evaluation credit is taken for present value of reservoir salvage of dam and power facilities after 50 years estimated at $12,500,000 for large and $7,150,000 for small reservoir - resulting benefit-cost ratios are:

2,500,000 af res. = .74
940,000 af res. = .86

Curecanti Unit

(Cost Comparisons (consideration given to possible irrigation allocations))

The attached tables show results of preliminary incremental analyses of Colorado River Storage Project units with and without assumptions of cost allocations to irrigation (holdover storage or river regulation). It can be seen that even with a $30,300,000 (43%) allocation of joint costs of a large dam and reservoir at the Curecanti site to irrigation a rate of 8.4 mills per k.w.h. would be required to pay out remaining costs within the specified 50-year period. This is in excess of the cost of energy produced by an alternate steam development under Federal financing. With an assumed salvage of $12,000,000 in addition to the irrigation allocation, the benefit-cost ratio of the large development is approximately unity.

An analysis based on all costs allocated to power with salvage limited to the present value of the equivalent capital costs of an alternate steam development would result in a benefit-cost ratio far below unity (.59 for large Curecanti).

It can be seen from the preceding pages that a large irrigation allocation is required to show feasibility of any development at the Curecanti site. In the case of a large reservoir a definite net contribution to the flow at Lee Ferry can be shown as the basis for claiming an allocation. However, with a small reservoir at Curecanti, as with the limited storage at the Whitewater site, the net contribution over successive 10-year periods is negligible.

The active storage at both sites is of value only for seasonal regulation since in most years the runoff during May and June exceeds the active reservoir capacity. Also consideration must be given in analyzing any possible net contribution, to the evaporation losses which in a 10-year period at each site would total nearly one-half of the active capacity. Without a tie-in to irrigation through direct use of facilities the small development at Curecanti would have to be analyzed as a power project with the costs of development exceeding the cost of a steam power alternate and a benefit-cost ratio of less than unity.

100 Date

Probable Cost to Produce Electric Energy in a Steam Plant Near Gunnison, Colorado with Federal Financing at 2½% Interest

Basic Assumptions

Amortization period - 50 Years
Sinking fund requirement at 2½% interest = 1.03%
Useful life of equipment
Steam power plant 35 years
Interim replacement factor (2½% interest) = 1.82%
Transmission system 40 years
Interim replacement factor = 1.48%
Substation equipment 28 years
Interim replacement factor = 2.51%

Annual fixed charges exclusive of taxes.

	Power Plant	Transmission	Substations
Interest	2.50	2.50	2.50
Amortization	1.03	1.03	1.03
Interim Replacements	1.82	1.48	2.51
Insurance	.12	.12	.12
Total	5.47%	5.13%	6.16%

Investment

25,000 Kw Steam electric plant	$203.00/Kw
Associated Transmission	30.00/Kw
Substations	30.00/Kw

Plant Efficiency 13,800 BTU per net Kwh
Fuel Cost $ .246 per million BTU

Annual Cost of Capacity - per kw

Fixed Charges

Power Plant	$203.00 x 5.47%	=	$11.10
Transmission	30.00 x 5.13%	=	1.54
Substations	30.00 x 6.16%	=	1.85
Total fixed Charges			$14.49

Total Fixed Charges			$14.49
Annual operation and maintenance expense exclusive of fuel and interim replacements			
Steam Plant per Kw		5.00	
Transmission	$30.00 x 2%	.60	
Substations	30.00 x 2%	.60	
Total O & M		6.20	6.20
Total Annual Cost per Kw			$20.69

Energy charge per Kwh = $\frac{13,800 \times .246}{1,000,000}$ = $0.0034

Notes

1. Above makes no allowance for payments in lieu of taxes.
2. Fuel cost of $0.246 per million BTU is fairly high for the Gunnison area.
3. Transmission and substation estimate is very rough since extent of system is unknown.

No Date

File

CURECANTI PROJECT

Before approval by the Colorado Water Conservation Board, a committee was established to study the Curecanti problem. This committee was known as the "Policy and Review Committee, Gunnison River Storage". Membership of that committee included C. N. Feast then Director of the Colorado Game and Fish Department. It held its first meeting on September 28, 1951. Several more meetings were held in which representatives of the Game and Fish Commission participated and on ~~December~~ April 3 10, 1952, at a meeting of the Committee, a recommendation was approved which (1) designated the small Curecanti Dam as the one to be built and (2) asked for additional storage capacity on the Gunnison River or on its tributaries above the Gunnison Tunnel.

On April 11, 1952, the Game and Fish Commission by letter notified the Water Conservation Board of its approval of the report of the Gunnison River Storage Policy and Review Committee.

The recommendations of the Policy and Review Committee were approved by the Colorado Water Conservation Board at its meeting of May 5, 1952.

D. C. Crumpacker

Gatteran no date

Estimated Cost to Produce Steam Generated Electric Power in
Gunnison, Colorado area.

Assumed Conditions

Plant nameplate rating 60,000 Kw
units 2 - each rated 30,000 Kw
Guaranteed capability 33,000 Kw each
Total plant capability 66,000 Kw.
Steam conditions at turbine throttle 850# 900° F.
Probable average heat rate serving a commercial power system with annual load factor of 52.5% would be 13,500 BTU per net Kwh
Annual net generation 304,000,000 Kwh
Fuel - pulverized coal. Fuel Cost 20¢ per million BTU.

Investment

60,000 Kw at $200 per Kw		$12,000,000
Annual Fixed Charges - Private financing exclusive of income taxes		
Return on investment	6.00%	
Depreciation	2.75%	
Property Taxes & Insurance	2.25%	
Total	11.00%	
Total fixed charges on plant		$ 1,320,000
Annual Operation and Maintenance Expense		
Labor, materials and supplies exclusive of fuel		180,000
Fuel - 13,500 x 304,000,000 x .20 x 10^{-6}		820,800
Total operation and maintenance		$ 1,000,800
Total Annual Cost		$ 2,320,800
Cost per Kwh		7.63 Mills

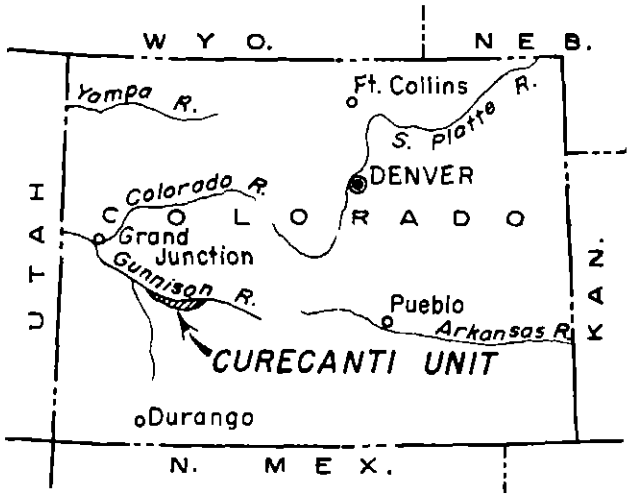
If such a plant is operated by a private utility company, present income tax rates are such that in order to receive a 6% return on investment (after taxes) the power would have to sold for 9.01 mills per Kwh.

If, on the other hand, the plant were built by an agency of the Federal government and financing was done at 3% and with no income taxes to pay, the power could be sold for 6.45 mills per Kwh. If no property taxes are paid the sale price for the power could be further reduced to 5.66 mills per Kwh.

All estimates above are for power plant only and do not include any transmission system.

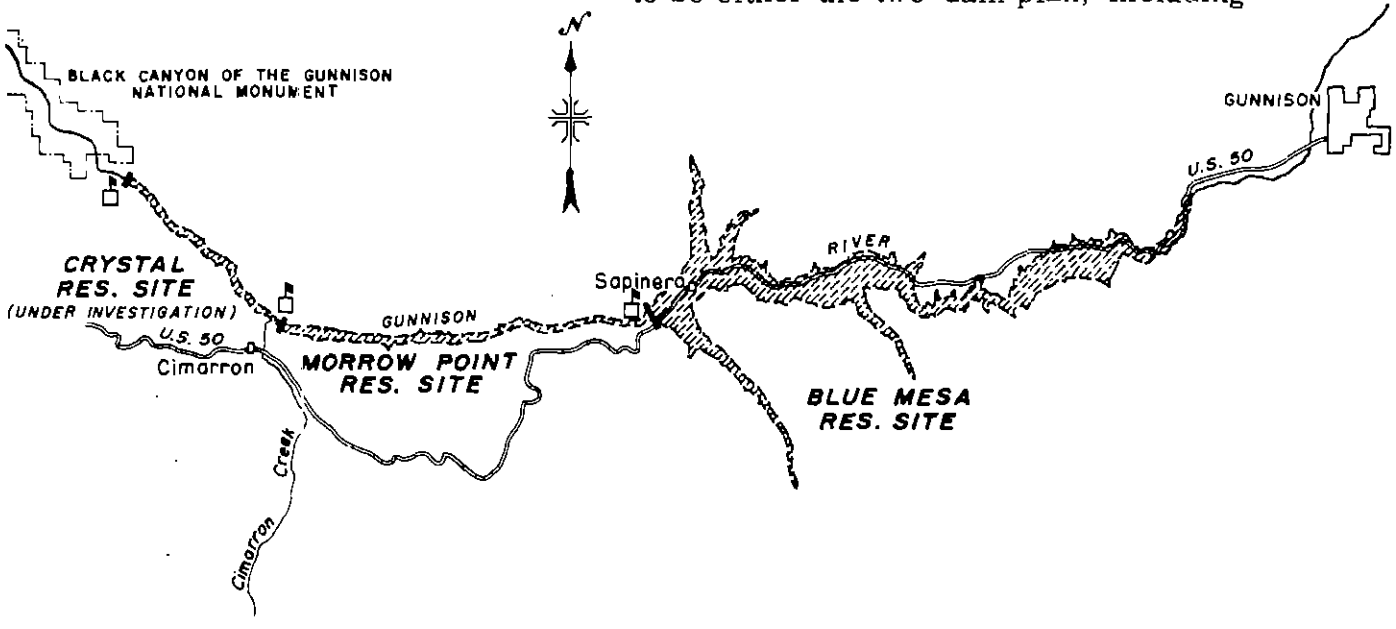
Staff Information Letter
October 3, 1960

INFORMATION SUMMARY OF CURECANTI UNIT



LOCATION MAP

The Curecanti Unit is one of the four initial units of the Colorado River Storage Project that were authorized by the Congress on April 11, 1956. The object of the unit is primarily to develop the water storage and hydroelectric power generating potentialities along a 40-mile section of the Gunnison River located below Gunnison, Colorado, and above the Black Canyon of the Gunnison National Monument. Other purposes of the unit are irrigation, recreation, and flood control. A number of plans that would accomplish these objectives have been considered. These included a series of two, three, and four dams, reservoirs, and powerplants along that section of the river, and in most instances alternative locations for such features. The most favorable development has been found to be either the two-dam plan, including



developments at two sites, the Blue Mesa and Morrow Point Damsites, or the three-dam plan, including developments at those two sites and also at a third site, the Crystal Damsite. Detailed feasibility investigations have been completed at the Blue Mesa and Morrow Point sites, but investigations have not yet been completed at the more inaccessible Crystal site farther downstream.

Preliminary data indicate that the Crystal Damsite, through its own power production and its effect in increasing power values at the upstream Morrow Point site, would improve the economy of the Curecanti Unit over that which would be provided by only the Blue Mesa and Morrow Point features. However, should detailed studies show the Crystal development to be unfavorable, the Blue Mesa and Morrow Point features together would comprise the most favorable plan for the Curecanti Unit. Inclusion of the Crystal feature in the unit plan would change the power operation at Morrow Point and would justify an increase in the installed generating capacity at Morrow Point. For this reason, construction of the Morrow Point features will not be undertaken until feasibility of the Crystal site has been finally determined.

The Blue Mesa and Morrow Point features will together develop 760 feet of the 1,000 feet of potential power head along the 40-mile reach of the deep canyon section of the river, producing 100,000 kilowatts of power. Each of these features consists of a dam and reservoir on the river and a powerplant at the toe of each dam. In both instances the name of the site applies also to the dam, reservoir, and powerplant.

Blue Mesa Dam will be about 30 miles below Gunnison and 1-1/2 miles below Sapinero. The earthfill structure will rise 347 feet above streambed. It will have a volume of 3,500,000 cubic yards and a crest length of 1,200 feet. Blue Mesa Reservoir will have a capacity of 915,000 acre-feet and will extend upstream from the dam for a distance of 24 miles to a point about 6 miles below Gunnison. The powerplant will have an installed capacity of 60,000 kilowatts.

Morrow Point Dam will be a concrete arch structure 470 feet high above the lowest foundation excavation, and will be constructed 12 miles below Blue Mesa Dam and about a quarter mile above the mouth of Cimarron Creek. The reservoir will have a capacity of 117,000 acre-feet and will extend upstream to near the toe of Blue Mesa Dam. Morrow Point Powerplant will have an installed capacity of 40,000 kilowatts. The powerplant will have an installed capacity of 80,000 kilowatts if the Crystal site is developed. No construction on the Morrow Point facilities is scheduled for the immediate future.

Substations and transmission lines will be constructed to connect the Curecanti Unit powerplants with main lines of the power system of the Colorado River Storage Project with other systems for the delivery of power to load centers.

Flows of the Gunnison River will be largely controlled by the Blue Mesa Reservoir, which will provide the greater part of the capacity for the Curecanti Unit. Water released through the Blue Mesa Powerplant together with minor downstream inflows, will receive short-term regulation at the smaller Morrow Point Reservoir. Releases through the Morrow Point Dam and Powerplant will be relatively uniform during the irrigation season to maintain flows needed for downstream water rights. These rights will not be adversely affected by operation of the Curecanti Unit. A flow of 100 cfs or more will be maintained at all times in the river through the Black Canyon of the Gunnison National Monument to preserve scenic and recreation attractions.

The two reservoirs and interconnected powerplants will permit considerable flexibility in daily and monthly power production operations. The power output of the Blue Mesa plant will fluctuate to meet variations in load requirements; the Morrow Point Powerplant will be operated largely for base loads during the irrigation season to permit release of near-uniform flows for downstream water users. During the remainder of the year, the Morrow Point plant will be operated on a variable production basis for integrated operation with other plants in the system in meeting load requirements. Above-normal water releases necessary during spring and early summer seasons of high runoff years will be utilized, so far as practicable, for power generation.

The Curecanti Unit will largely regulate the flow of the Gunnison River and, in turn, assist in regulating the flow of the Colorado River. Other units of the Colorado River Storage Project will likewise contribute to a regulated flow at the outlet of the Upper Colorado River Basin at Lee Ferry, Arizona. This will make more Colorado River water available at that point during prolonged dry periods, permitting water use in the Upper Basin to expand without diminishing Lee Ferry flows below the requirements of the Colorado River Compact of 1922 and the Mexican Water Treaty of 1945.

The Bureau of Reclamation's fiscal year 1961 program provides funds for the State of Colorado to make surveys and prepare an estimate of the cost of relocating U. S. Highway 50 around the Blue Mesa Reservoir. The contract for relocation of the highway is scheduled to be awarded by the State of Colorado in December 1960. The program also provides for preparation of designs of the dam and acquisition of right-of-way for the damsite and the area required for construction activities. Funds are also provided under the fiscal year 1961 program for the purchase of right-of-way required for the location of camp facilities and for the purchase of temporary homes and trailers at the Blue Mesa Damsite.

1962

HISTORY OF CURECANTI UNIT

COLORADO RIVER STORAGE PROJECT

It is only within the past 20 years that serious consideration has been given to the construction of dams and reservoirs on the Gunnison River, since the tracks of the Denver and Rio Grande Western Railroad were located in the valley and in the canyon section between Gunnison and Cimarron, and only general consideration was given to reservoir sites on the Gunnison in the 1946 comprehensive report of the Bureau of Reclamation on development of water resources of the Colorado River Basin.

The signing of the Upper Colorado River Basin Compact in 1948 paved the way for more detailed planning for the development of projects in the Upper Basin within the amounts of water allocated to the individual States of the Basin. The plan of the Colorado River Storage Project began to take shape. This plan envisioned the construction of large reservoirs on the main stem and principal tributaries of the Colorado River above Lee Ferry, Arizona, which is the division point between the Upper and Lower Colorado River Basins.

These reservoirs would provide holdover storage capacity to permit deliveries of water to the Lower Basin under terms of the Colorado River Compact in years of low water supply from water stored during periods of high runoff. Electric energy

would be generated at the dams. Power revenues, in excess of the amounts of money required to repay the costs of the dams and power plants, would be used to assist in the repayment of costs of irrigation projects in the different areas of the Upper Basin, which were termed Participating Projects.

In October, 1949, a series of meetings was sponsored by the Colorado Water Conservation Board. These were held at Craig, Grand Junction, Durango, Pueblo, and Denver. The Colorado River Storage Project plan was presented by the Bureau of Reclamation and discussed at the meetings, and general approval of the plan obtained.

Under date of December, 1950, the Bureau of Reclamation published a report on the Colorado River Storage Project and Participating Projects. This report was approved by the Secretary of the Interior, and early in the next year was transmitted to the interested States for comments. With regard to the Gunnison River, the report covered three reservoir sites: the Curecanti Reservoir, with a dam at the Blue Mesa site, and a capacity of 2,500,000 acre-feet; the Crystal Reservoir, with the dam about 14 miles east of Montrose, and a capacity of 40,000 acre-feet; and the Whitewater Reservoir, with a dam two miles south of Whitewater and a capacity of 800,000 acre-feet. The Whitewater Unit was one of the five scheduled for initial construction, the others being Echo Park, Glen Canyon, Navajo and Flaming Gorge.

The Water Conservation Board arranged meetings in Durango, Gunnison, Delta and Meeker in April, 1951, to explain and discuss the project report. It was requested that any and all interests should carefully consider the proposals in the report, and also the proposals in a reconnaissance report which had been submitted by the Bureau of Reclamation, dated February 1951, on proposed developments in the Gunnison River Basin. It was suggested that, after such consideration, they should submit their views and comments to the Board.

From the tenor of the resolutions and letters received from the various interests, it was apparent that many of them, along with some members of the Water Conservation Board, felt that the logical location of the initial reservoir to be constructed on the Gunnison should be in the upper portion of the river at the Curecanti site, rather than at the Whitewater site near its mouth. The Upper Gunnison residents, while approving this conclusion in general, had reservations as to some detrimental effects to the economy of the area which might result from the construction of a large Curecanti reservoir with a high water line extending to the edge of the City of Gunnison. Suggestions to alleviate this situation were made, including the possibility of a barrier dam to prevent inundation above the Iola Meadows, or one to prevent the water from approaching so closely to Gunnison,

and the feasibility of a dam at a site farther downstream from Sapinero than the Blue Mesa site.

In June, 1951, the Water Conservation Board formulated the official comments of the State on the Colorado River Storage Project report. With respect to the Gunnison River it stated that it was believed that full study had not been given to the potentials of the river. It requested that the Whitewater Unit should not be included in the initial list and that further study should be made on the location of storage units on the Gunnison to develop the full power potential and provide holdover storage with the least possible disruption of the local economy. It also stated the desire of Colorado that a unit of the storage plan located on the Gunnison be included in the initial authorizing legislation, and anticipated that the re-study and further comments by the State would be made in due time to accomplish this purpose.

At the same time the Board authorized the creation of a Policy and Review Committee to make further studies on, and consider policies in relation to storage in the Gunnison River Basin as a part of the Colorado River Storage Plan, such committee to consist of one representative each from the Counties of Gunnison, Montrose and Delta, one representative appointed by the Colorado River Water Conservation District Board, the Director of the Colorado Game and Fish Commission, and the Director,

Attorney, Consulting Engineer and Chief Engineer of the Colorado Water Conservation Board. The committee's function was to make such studies and prepare a report and recommendations for submission to the Colorado Water Conservation Board for final action in the matter.

The representatives appointed from Gunnison, Montrose, and Delta Counties were, respectively, Ed L. Dutcher, George Cory and F. M. Peterson. Silmon Smith was the representative of the Colorado River Water Conservation District. Clifford H. Stone, then Director of the Water Conservation Board, was elected to serve as Chairman of the committee. The Bureau of Reclamation agreed to assist the State of Colorado in expediting its study.

Following a hearing on the views of all interested parties, the first meeting of the committee was held in September 1951, and two subsequent meetings were held prior to the submission of a report to the Water Conservation Board, which was dated April 3, 1952.

During this period, numerous studies to bring out facts and solutions were made by the Bureau of Reclamation, the Water Conservation Board and members of the committee. These included feasibility of barrier dams; review and appraisal of benefits and detriments from a 2,500,000 acre-foot Curecanti Reservoir; inventory of real estate and livestock in the potential inundated area for tax-loss determinations; the amount and location of storage

required for irrigation and industrial use; feasibility of combinations of storage sites at various points in the Basin to maintain holdover capacity; the effects of decreased storage capacity on power production; and the effects on fish and wildlife values.

The report of the committee recommended that the Water Conservation Board approve a plan of storage on the Gunnison River which would include units and storage capacities as follows: Curecanti Reservoir, 940,000 acre-feet; Whitewater Reservoir, 880,000 acre-feet; and Crystal Reservoir, 510,000 acre-feet. It also recommended that the initial authorization by Congress for constructing units of the Colorado River Storage Project include and be limited to the Curecanti and Crystal Reservoirs, and that construction of Whitewater Reservoir be delayed. Further, that the approval of Gunnison storage be on condition that Highway 50 not be relocated so that it would not pass through Montrose and Gunnison, that Federal funds should be used for new school facilities resulting from construction activities, and that lands and waters of the project should be open to public hunting and fishing with public access maintained, and that the project be operated in accordance with Federal law concerning recreation, fish and wildlife.

The Water Conservation Board approved the report of the Policy and Review Committee on May 5, 1952. The matter was taken

up with the Bureau of Reclamation, which commenced studies in accordance with the action of the Board. As the investigation progressed it became evident that serious questions of feasibility would arise because of reduction in the capacity of Curecanti Reservoir to 940,000 acre-feet, with a high water line at elevation 7520 feet above sea level. It was suggested that possibly two or more small dams instead of a large Crystal Reservoir might better develop the power head in the river in conjunction with the smaller Curecanti Reservoir.

This and other matters relative to conditions of authorization of the Curecanti Unit were re-referred to the Policy and Review Committee, and the problems resolved as the studies of the Bureau of Reclamation were extended. Plans for both three dam and four dam units were considered. A status report on a four dam development was published by the Bureau in February, 1956, stating that additional studies would be required for the preparation of a feasibility or definite plan report.

Consequently, when the Act authorizing the Colorado River Storage Project was approved in April, 1956, it authorized the Curecanti Unit only on condition that its feasibility should be certified in the future by the Secretary of the Interior. The investigation finally definitely became centered on a two or a three dam unit and an economic justification report on the upper two potential developments was submitted by the Bureau of Reclamation under date of February 1959. These were a dam at the Blue Mesa

site with a reservoir capacity of 915,000 acre-feet and the Morrow Point Dam, 12 miles further downstream with a total capacity of 117,000 acre-feet of which only 15,000 acre-feet will be active. The report found the two-dam unit to be economically feasible. Studies are continuing with respect to the feasibility of inclusion of the Crystal Dam, still further downstream.

Shortly after the completion of this report, the Secretary of the Interior transmitted a report of the Bureau of Sport Fisheries and Wildlife on the Curecanti Unit to the State of Colorado. This report was intended for consideration by the Secretary in determining whether or not the Curecanti Unit was economically justified, and recommended that the Curecanti Unit be not constructed because it would destroy a nationally significant stream fishery. The Secretary requested the State to furnish its views on this matter and its official comments on the Bureau of Reclamation economic justification report.

Tremendous support for the construction of the unit was evidenced by interests in the Gunnison Basin and elsewhere in Colorado. The Colorado Game and Fish Commission reaffirmed its former approval of the report of the Policy and Review Committee and concurred in the desirability of the construction of the unit, providing due compensation for damages to fish and wildlife under Public Law 732. Unequivocal approval of the State of Colorado

was expressed by Governor McNichols in his reply to the Secretary of the Interior.

On the basis of the economic justification report, an appropriation for construction was made by the Congress in the spring of 1960. The State Highway Department had cooperated with the Bureau of Reclamation in the engineering work required for the relocation of Highway 50 to the extent that it was possible to let the contract for relocating some 6 miles of the highway early in 1961.

In March, 1962, the prime construction contract in the amount of approximately $14,000,000 was awarded for the dam and power plant house, and work has been commenced on a diversion tunnel, some 13 years after the first meetings were held for explanation and preliminary discussions on the Colorado River Storage Project.

RMG:lk

6/3/1962

CURECANTI UNIT - COLORADO RIVER STORAGE PROJECT

Construction of the Curecanti Unit of the Colorado River Storage Project was authorized by the Act of April 11, 1956, contingent upon a finding of the economic justification of the unit. It is contemplated that the unit will consist of three dams and reservoirs which will utilize the power head in a 20 mile reach of the Gunnison River. The dams would be the Blue Mesa, Morrow Point and Crystal. The authorizing legislation also limited the high water line of the Blue Mesa Reservoir site to 7,520 feet above sea level.

An economic justification report has been made for the unit including the Blue Mesa and Morrow Point Reservoirs which found the unit justified on the basis of the two dams, so that construction has been able to proceed with that portion of the unit. If it is found that the inclusion of Crystal Dam and Reservoir will not be economically justified, then that dam will not be constructed. However, present indications are that it will be part of the Curecanti Unit.

The Blue Mesa Dam is the key structure in the Curecanti Unit. At one time it was proposed to build only one dam for the unit at this site which would impound some 2,500,000 acre-feet. Objections from residents of the Upper Gunnison area resulted in the creation of a committee by the Colorado Water Conservation

Board to consider the effects of the unit on all interests in the Gunnison Basin. This committee determined that a smaller Blue Mesa Reservoir, together with one or more dams constructed below the Blue Mesa site would be in the best interest of all concerned and would adequately develop the available power head. Consequently the elevation of the high water line was limited as stated above. The State of Colorado furnished funds to assist in expediting the Bureau of Reclamation studies with respect to the multiple dam plan.

The Blue Mesa Reservoir will largely control the flows of the Gunnison River. The dam site is about 1½ miles below the town of Sapinero, which will be inundated, and about 30 miles below Gunnison, Colorado. When filled to the normal high water level the water will extend 24 miles upstream to within 6 miles of the town of Gunnison, and the reservoir will impound 915,000 acre-feet. For comparison, the Granby Reservoir, which is presently the largest water storage reservoir in Colorado, has a capacity of 539,000 acre-feet.

Blue Mesa Dam will rise 350 feet above the streambed, in the Black Canyon of the Gunnison. It will be an earth and rockfill dam, with over 3½ million cubic yards of material in the embankment, which will be obtained locally. The powerplant at the foot of the dam will have an installed capacity of 60,000 kilowatts. The average annual saleable energy will be over 270 kilowatt hours.

Releases from the Curecanti Unit reservoirs will be made in such a manner that flows in the lower Gunnison River will be ironed out and made more stable for downstream water rights. In order to not have a detrimental effect on the view of the Gunnison through the Black Canyon of the Gunnison National Monument, a flow of at least 100 second feet will be maintained through the Monument.

The Blue Mesa Dam and Reservoir will cost some 48 million dollars. Of this amount almost 20 million will be required to acquire lands in the reservoir basin and to relocate existing property and facilities which will be inundated. The relocation of Highway 50 is in itself a major undertaking. It is being carried out by the State Highway Department, which has worked very closely with the Bureau of Reclamation in arriving at the best route for the new road. This includes two new bridges across the Lake Fork of the Gunnison and an arm of the reservoir.

The recreation potential at Blue Mesa Reservoir is impressive. When filled, the 24 mile length of water surface will have an area of 9,000 acres. Even at the minimum expected operating levels the surface area will be over 3,000 acres. During normal years there will be little fluctuation between July 1 and October.

Two major recreational developments and 3 small ones are planned by the National Park Service. It has been estimated that 500,000 man-days of general recreational use annually will

be attributed to Curecanti Unit reservoirs. About 95 percent of the visitors are expected to come from outside Colorado. Net annual benefits from recreation use will be around $800,000.

Facilities will consist of picnic areas, beaches, boat launching ramps, camp grounds, trailer camps and a multiple of guest units with restaurants and swimming pools.

RMG:lk 6/8/62

Preliminary Summary Sheets
Colorado River Storage Project
Curecanti Unit

Location

On the Gunnison River, a tributary of the Colorado River in west-central Colorado.

Authorization

Public Law 485, 84th Congress, 2nd Session (70 Stat. 105), approved April 11, 1956, subject to certification by the Secretary of the Interior that the benefits will exceed the cost. On July 14, 1959, the Secretary certified that the Blue Mesa and Morrow Point features of the Curecanti Unit would be feasible. An Economic Justification Report, dated April 1962, justifying the inclusion of the Crystal features into the unit was approved by the Secretary in December 1962.

Current Status

Construction of the Blue Mesa and Morrow Point features are essentially complete.

Designs and specifications for the Crystal Dam, a thin arch double curvature dam, and associated powerplant facilities are in progress and it is anticipated issuance and award of contract will be made before June 30, 1973.

Construction of the Crystal Dam Diversion Tunnel is underway.

Plan of Development

The plan for the Curecanti Unit includes three dams, reservoirs, and powerplants which will fully develop the power head along a 40-mile canyon section of the Gunnison River below Gunnison, Colorado, and above the Black Canyon of the Gunnison National Monument.

In addition to power generation, the Curecanti Unit will regulate the flow of the Gunnison River, thus providing benefits to flood control and irrigation and other consumptive uses. The reservoirs will provide extensive recreational benefits, part of which will occur within the adjacent Gunnison National Forest. Final estimates of the effect of the Curecanti Unit on fish and wildlife are not yet available. A number of programs are being developed to offset any project-caused damage to fish and wildlife and also to provide for fish and wildlife enhancement.

Flows of the Gunnison River are largely controlled by the constructed Blue Mesa Dam and Reservoir, the largest and uppermost of the three unit reservoirs. Water released through the Blue Mesa Dam and Powerplant will receive short-term regulation at the constructed Morrow Point Reservoir and the potential Crystal feature immediately downstream. Water releases through Crystal

Dam and Powerplant will be relatively uniform in order to satisfy downstream water rights and to maintain a flow of 100 second-feet through the Black Canyon of the Gunnison National Monument.

The three powerplants, with a total installed capacity of 208,000 kilowatts will produce an average of 797 million kilowatt-hours of electric energy annually. Switchyards will be built at the powerplants to deliver the power into the Colorado River Storage Project transmission system which will be interconnected with the other power producing plants of the Colorado River Storage Project and participating projects as well as with other Federal and private power systems. The electric energy, through an interconnected transmission system, will be integrated with the energy produced at the other CRSP storage units and participating projects for sale to preference and other customers throughout the Storage Project market area. The powerplants will be operated from the CRSP Power Operations Office in Montrose, Colorado.

The two completed Curecanti Unit reservoirs are one of the outstanding recreation attractions of the Rocky Mountain region. To accommodate the many visitors to the area, recreation facilities have been constructed at various sites around the reservoirs. Steps are planned to assure that the area will provide good fishing. These include purchase of easements for public access, construction of fishing lakes, development of a fish hatchery, and reservoir-fishery studies.

Costs ($1,000)

	Costs through 6/30/72	Total
Project costs (Basin Fund)		
Blue Mesa Dam and Reservoir	31,872	32,696
Morrow Point Dam and Reservoir	20,598	20,758
Crystal Dam and Reservoir	4,178	33,422
Blue Mesa Powerplant & Switchyard	10,228	10,228
Morrow Point Powerplant & Switchyard	19,807	19,986
Crystal Powerplant & Switchyard	833	11,444
Operating and housing facilities	948	1,311
Total	88,464	129,845
Section 8 Costs		
National Park Service (recreation)		8,469
Bureau of Sport Fisheries and Wildlife		3,579
Total		12,048
Grand Total		141,893
Annual operation, maintenance, and replacement costs		
Bureau facilities (Reclamation) 1/		432
Bureau of Sport Fisheries and Wildlife (Section 8)		125
National Park Service (Section 8)		-375
Total		932

1/ Excludes wheeling costs and assigned cost of Hoover deficiency.

CRSP Curecanti Unit (Continued)

Water Supply

Water for consumptive use is available from or below Curecanti facilities. Some storage is also available to meet commitments to the Lower Basin, thus permitting upstream diversions by participating and other projects for M&I, irrigation, and other purposes.

Irrigable Area

No irrigation is provided directly by the unit.

Cost Allocation and Repayment

The authorized units of the CRSP including the Curecanti Unit are considered as one project in cost allocation and repayment studies. All reimbursable costs will be repaid from power and M&I water revenues through the Upper Colorado River Basin Fund. Power rate schedule R4-F1 was approved by the Secretary of Interior and became effective on March 6, 1962. Rates of $1.275 per month per kilowatt and 3.0 mills per kilowatt-hour will be increased effective January 1, 1974, by the equivalent of 3/4 of a mill per kilowatt-hour.

Distribution of CRSP Basin Fund cost allocation
($1,000)

	Construction cost
Power	124,813
Irrigation and other consumptive uses	3,065
Flood control	1,783
Highway relocation	184
Total	129,845

CRSP Curecanti Unit (Continued)

Repayment of Costs ($1,000)

	Construction costs[1]
Basin Fund Costs	
Reimbursable	
Power - repaid by CRSP power revenues	[2]/124,447
- prepaid with CRD funds	94
- prepaid with contributed funds	272
Subtotal	124,813
Irrigation and other consumptive uses by CRSP power revenues	3,061
Consumptive uses by CRD funds	3
Consumptive uses by contributed funds	1
Subtotal	3,065
Total	127,878
Nonreimbursable	
Flood control	1,783
Highway relocation	184
Total	1,967
Section 8 Costs - nonreimbursable	
Recreation	8,469
Fish and wildlife	3,579
Total	12,048

1/ Repayment to be accomplished within 50 years following completion of construction.

2/ Interest during construction will be added and both amounts will be repaid with interest.

Environmental Involvement

1. The Final Environmental Statement (INT-FES 71-21) for the Crystal Dam, Reservoir, and Powerplant was filed with CEQ on December 6, 1971.

2. An advance copy of Supplement to Final Environmental Statement for these features is being prepared by this office for submittal to Commissioner in final form so that it may be filed with CEQ at least 30 days before an award can be made for Crystal. This Supplement covers design changes and results of investigations which have occurred since submission of the previous statement.

3. The several changes in the preliminary design concepts and the additional investigations that were made to lessen the environmental impact of the proposed construction are covered in the supplement.

Project Administration and Repayment

The storage units, including the Curecanti Unit, perform two major essential functions. They regulate streamflow so that water commitments to

Project Data

nefit-Cost Analyses - 100 Years - 2½% (Unit--$1,000)

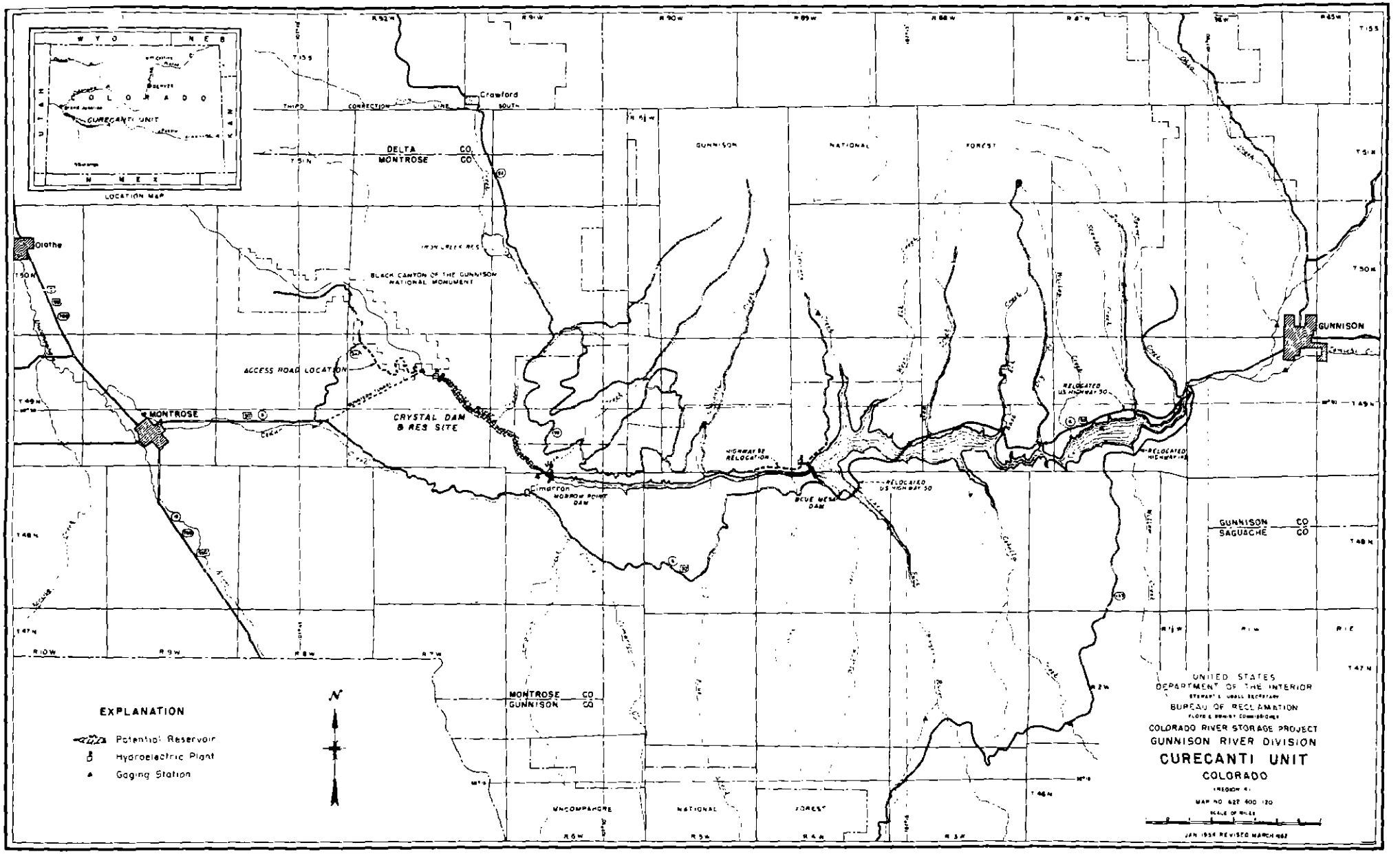
	Section 5 (Basin Fund)	Section 8			Total
		Recreation	Fish and wildlife Enhancement	Fish and wildlife Mitigation	
tal construction costs (rounded)	129,845	8,469	1,220	2,435	141,969
ss preauthorization investigation costs	175				175
ss funds contributed to expedite investigations	35				35
ss highway relocation costs (P.L. 87-874)	184				184
l share of Transmission Division costs	24,700				24,700
nstruction costs for benefit-cost analysis	154,151	8,469	1,220	2,435	166,275
terest during construction including a share of the interest on the Transmission Division	2/14,000				14,000
tal investment	168,151	8,469	1,220	2,435	180,275
nual equivalent of investment	4,593	1/457	33	67	5,150
l annual OM&R and wheeling, including share of Transmission Division and cost of Hoover deficiency	1,130	375	63	63	1,631
nual taxes foregone	1,649				1,649
tal annual costs	7,372	832	96	130	8,430
nual benefits					
Irrigation and other consumptive uses (direct)	80				80
Irrigation and other consumptive uses (total)	157				157
Power	6,902				6,902
Flood control	103				103
Reservoir fishery			96		96
Recreation		4,260			4,260
tal direct only	7,085	4,260	96		11,441
tal	7,162	4,260	96		11,518
nefit-cost ratios					
With direct benefits only	1.0:1	5.1:1	1.0:1		1.4:1
With total benefits	1.0:1	5.1:1	1.0:1		1.4:1

1/ Amortized over 25 years.
2/ Rough estimate.

to the Lower Colorado River Basin can be met in dry periods without curtailment of the development of water uses allotted the upper basin. Also, they produce hydroelectric energy. Revenues from the sale of the electric energy left after payment of the operating costs and the reimbursable construction costs of the storage units will be available for assistance in the repayment of costs of participating projects; namely, the irrigation costs of these projects that are beyond the payment ability of the irrigation water users. Transmission of the electric power to load centers will be a cooperative effort of existing public and private utilities and the Bureau of Reclamation. The combined power system of the storage units and participating projects is centrally operated from the Colorado River Storage Project Power Operations Office in Montrose, Colorado. Some of the storage project reservoirs will also directly supply some water for irrigation and municipal and industrial uses. Extensive power transmission lines and facilities have been and are being constructed in conjunction with the storage project. Facilities are being provided as appropriate for recreation and to mitigate losses of and improve conditions for the propagation of fish and wildlife. Flood control benefits will be provided through operation of the storage project.

Project Data

	Blue Mesa Feature	Morrow Point Feature	Crystal Feature
ower			
ıte of initial water storage	October 1965	January 1968	December 1975
ıte of initial power generation	October 1967	November 1970	January 1977
ıstalled generator capacity (kw)	60,000	120,000	28,000
verage annual equivalent saleable energy over 100 years (million Kw.-hr.)	280	350	162
ross maximum head (feet)	359.4	405	220
ross minimum head (feet)	233.0	345	170
ross rated head (feet)	280.0	345	175
roject Features			
torage Dams			
Location	1.5 miles below Sapinero, Colo.	11 miles below Blue Mesa Dam site	6.5 miles below Morrow Point Dam site
Type of structure	Earth and rock fill	Concrete arch	Earth and rock fill
Height above streambed (feet)	350	410	219
Crest length (feet)	810	680	660
Vollume of embankment	3,510,000	300,000	1,880,000
Spillway capacity (second-feet)	33,700	41,000	42,300
Outlet capacity (second-feet)	5,100	1,560	2,100
eservoirs			
Maximum water surface elevation (ft.)	7,519.4	7,165	6,750
Normal water surface area (acres)	9,200	817	310
Initial storage capacity (acre-feet)	940,800	117,000	27,240
Active	748,500	42,000	12,690
Inactive and dead	192,300	75,000	14,550


LOCATION MAP
CURECANTI UNIT
Crawford
THIRD CORRECTION LINE SOUTH
DELTA CO
MONTROSE CO
GUNNISON NATIONAL FOREST
Olathe
BLACK CANYON OF THE GUNNISON NATIONAL MONUMENT
ACCESS ROAD LOCATION
MONTROSE
CRYSTAL DAM & RES SITE
Cimarron
MORROW POINT DAM
HIGHWAY 92 RELOCATION
BLUE MESA DAM
RELOCATED US HIGHWAY 50
RELOCATED HIGHWAY 135
GUNNISON
GUNNISON CO
SAGUACHE CO
MONTROSE CO
GUNNISON CO
UNCOMPAHGRE NATIONAL FOREST
EXPLANATION
Potential Reservoir
Hydroelectric Plant
Gaging Station
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO RIVER STORAGE PROJECT
GUNNISON RIVER DIVISION
CURECANTI UNIT
COLORADO
JAN 1956 REVISED MARCH 1962

COLORADO WATER CONSERVATION BOARD
823 State Centennial Building
1313 Sherman Street
Denver, Colorado 80203

March 1977

COLORADO RIVER STORAGE PROJECT
CURECANTI UNIT

The Curecanti Unit is located on the Gunnison River, a tributary of the Colorado River in west-central Colorado.

Current Status

The Curecanti Unit was authorized by Public Law 485, 84th Congress, 2nd Session (70 Stat. 105), approved April 11, 1956, subject to certification by the Secretary of Interior that the benefits will exceed the cost. On July 14, 1959, the Secretary certified that the Blue Mesa and Morrow Point features of the Curecanti Unit would be feasible. An Economic Justification Report, dated April 1962, justifying the inclusion of the Crystal features into the unit was approved by the Secretary in December 1962.

The Blue Mesa and Morrow Point dams and powerplants of the Curecanti Unit are complete and operational.

The concrete placement for Crystal Dam is nearly complete, and powerplant construction is underway. Further work is being performed on downstream channel improvement and access roads to the facility.

Plan of Development

The plan for the Curecanti Unit includes three dams, reservoirs, and powerplants which will fully develop the power head along a 40-mile canyon section of the Gunnison River below Gunnison, Colorado, and above Black Canyon of the Gunnison National Monument.

In addition to power generation, the Curecanti Unit will regulate the flow of the Gunnison River, thus providing benefits to flood control and irrigation and other consumptive uses. The reservoirs will provide extensive recreational benefits, part of which will occur within the adjacent Gunnison National Forest. Final estimates of the effect of the Curecanti Unit on fish and wildlife are not yet available. A number of programs are being developed to offset any project-caused damage to fish and wildlife and also to provide for fish and wildlife enhancement.

Flows of the Gunnison River are largely controlled by the constructed Blue Mesa Dam and Reservoir, the largest and uppermost of the three unit reservoirs. Water released through the Blue Mesa Dam and Powerplant will receive short-term regulation as the constructed Morrow Point Reservoir and the potential Crystal feature immediately downstream. Water released through Crystal Dam and Powerplant will be relatively uniform in order

to satisfy downstream water rights and to maintain a flow of 100 second-feet through the Black Canyon of the Gunnison National Monument.

The three powerplants, with a total installed capacity of 208,000 kilowatts will produce an average of 797 million kilowatt-hours of electric energy annually. Switchyards at the powerplants deliver the power into the Colorado River Storage Project transmission system which is interconnected with the other power producing plants of the Colorado River Storage Project and participating projects as well as with other Federal and private power systems. The electric energy, through an interconnected transmission system, is integrated with the energy produced at the other CRSP storage units and participating projects for sale to preference and other customers throughout the Storage Project market area. The powerplants are operated from the CRSP Power Operations Office in Montrose, Colorado.

The two completed Curecanti Unit reservoirs are one of the outstanding recreation attractions of the Rocky Mountain region. To accommodate the many visitors to the area, recreation facilities have been constructed at various sites around the reservoirs. Steps are planned to assure that the area will provide good fishing. These include purchase of easements for public access, construction of fishing lakes, development of a fish hatchery, and reservoir-fishery studies.

Water Supply

Water for consumptive use is available from or below Curecanti facilities. Some storage is also available to meet commitments to the Lower Basin, thus permitting upstream diversions by participating and other projects for M&I, irrigation, and other purposes. No irrigation is provided directly by the unit.

Cost Allocation and Repayment

The authorized units of the CRSP including the Curecanti Unit are considered as one project in cost allocation and repayment studies. All reimbursable costs will be repaid from power and M&I water revenues through the Upper Colorado River Basin Fund. Power rate schedule R4-F1 was approved by the Secretary of the Interior and became effective on March 6, 1962.

no Date

U.S. DEPARTMENT OF INTERIOR
BUREAU OF RECLAMATION
ENVIRONMENTAL STATEMENT
CRYSTAL DAM OF THE CURECANTI UNIT,
COLORADO RIVER STORAGE PROJECT

Background Information

Curecanti Unit, of the Upper Colorado River Storage Project, is comprised of three reservoirs located on the Gunnison River with associated power generating facilities incorporated into each dam and reservoir. Other purposes of the reservoir complex are regulation of the river for irrigation projects, recreation enhancement, fishery mitigation and enhancement where possible, and flood control. The Curecanti Unit was authorized by the act of April 11, 1956, (70 Stat. 105). The dams, which have been constructed to date and are in operation, are Blue Mesa and Morrow Point. The construction of Crystal Dam and Reservoir is needed to maximize the peaking operation of the hydroelectric power generating units of Blue Mesa and Morrow Point Powerplants /existing, and to act as an afterbay to regulate the large water releases from Morrow Point Dam to the Gunnison River which flows through the Black Canyon National Monument. Releases from Crystal Reservoir will be made through a power generating plant, which is located at the base of Crystal Dam. This will provide additional sources of power.

The size of the facilities of the Curecanti Unit, including the 120,000-kw Morrow Point Powerplant and Crystal Reservoir, has been designed to utilize the total head of the Gunnison River between the downstream limit of Black Canyon National Monument and elevation 7,520 feet as provided by the CRSP authorizing legislation (70 Stat. 105).

The plan of operation contemplated in the formulation and justification of these facilities recognized that during critically low flow years or periods of years there would not be enough water to operate the Morrow Point Powerplant except to supply peak demands for about 8 hours during weekdays. For the remaining 16 hours each weekday and on weekends and holidays there would be no release from Morrow Point Reservoir. One of the prime functions of Crystal Reservoir in the plan was to re-regulate the fluctuating Morrow Point releases to maintain a constant 24-hour flow of about 1,000 c.f.s. through the Gunnison Tunnel and provide 200 c.f.s. in the river below the tunnel for fish and wildlife. On three-day weekends about 7,200 acre-feet of active capacity would be required to supply the needed 1,200 c.f.s. release when Morrow Point would not be releasing any water. This is the minimum size reservoir needed to re-regulate Morrow Point releases.

Crystal Dam will be constructed on the Gunnison River about 2 miles upstream from the Black Canyon of the Gunnison National Monument boundary. The access road to Crystal Dam touches on several corners of the Monument; however, only a very short segment of the road is visible from the overlooks within the National Monument boundary. The damsite, about 15 miles due east of Montrose, Colorado, is accessible by U.S. Highway 50 and Colorado State Highway 347 which leads to the dam access road. The V-shaped canyon at the damsite is over 1,500 feet deep as the elevation of the streambed is 6,550 and the canyon rim elevation being slightly less than 8,000 feet. Both sides of the canyon are extremely rugged, with sheer, near verticle rock walls making the river in the bottom of the canyon virtually inaccessible except by the access road constructed in

1965 to the damsite. Near the base of the canyon small alluvial fans and talus slopes are found. Many large boulders, up to car size, are found on these talus slopes and fans. The vegetation in the canyon is predominantly scrub oak with scattered conifers and deciduous trees. Some exploratory work in anticipation of a continued construction program in 1965 was initiated. The access road from State Highway 347 to the damsite and about 10 miles of a wood pole transmission line from the Curecanti Substation to the canyon rim have already been completed. The access road to Crystal Dam and Powerplant is approximately 7 miles long, varies in width from 20 to 24 feet, and road grades vary from 12 to 14 percent. This road will be used for construction access as well as permanent access for other purposes after the dam is completed. Once in the bottom of the canyon, the remaining length of the road parallels the stream channel to the damsite and will be built with construction of the dam. The entire road will be paved either prior to construction or upon completion of the dam at the discretion of the contractor. To date, no revegetation of the access road has been attempted. Most of the cut slopes contain a great deal of rock and are extremely steep, making any revegetation effort very difficult. Climate around the damsite is semiarid. Total precipitation of 17 inches is measured at Cimarron, a small community above the upper end of the reservoir. Most of this precipitation falls between October and April and in the form of snow. Temperatures are very pleasant in the summer and quite cold in the winter months. Temperature extremes range from a high of near 90° to a low of near -10° below zero Fahrenheit.

There are several small towns located near the proposed Crystal Dam and Reservoir site. The largest is Montrose, Colorado, located 23

miles west of the dam out of the Black Canyon with a 1970 population of 6,413 people which is a 27 percent increase over the 1960 estimate. Another town, Gunnison, Colorado, is located east of the reservoir and approximately 60 miles east of the dam with a 1970 population of 4,517 which represents a 30 percent increase over the 1960 population estimate. Cimarron is a small community located at the upper end of the reservoir on U.S. Highway 50 and has a population of under 25 people.

All the land immediately adjacent to and within 1/4 of a mile from the rim of the canyon and proposed reservoir is in public ownership. Two exceptions of private lands occur, however, one being an area at the very upper end of the reservoir near Cimarron, and the second, a small area below the proposed damsite where the Gunnison tunnel and diversion works are located. The public lands are administered by either the Bureau of Land Management or the U.S. Forest Service.

Environmental Impact

Crystal Dam Construction

Crystal Dam will be an earth- and rockfill structure 219 feet above the present streambed with a crest length of 760 feet and 30 feet wide on top. The reservoir behind the dam will hold approximately 27,240 acre-feet of water, has a shoreline of 20.5 miles, and 310 acres of water surface.

Materials for the dam embankment will come from required excavation and borrow areas in the canyon with the exception of one source for aggregate material. Borrow materials will be peeled off the side of the canyon walls. Foundation and abutment excavation will be stockpiled in

the canyon bottom adjacent to the river until used in the embankment. Vegetation present on the borrow areas is comprised mostly of scattered conifers, shrubs, grasses, and some deciduous trees. Revegetation of these areas will depend on the amount of soil remaining after borrow excavation is completed. If sufficient suitable soil is left, a grass seeding and tree planting program would be initiated. The possibility exists that the borrow areas will be fully exhausted leaving only barren rock surfaces eliminating any possible chance of reestablishing vegetation. Wherever possible, reshaping of borrow areas will be done to facilitate rehabilitation and restoration of native vegetation in an attempt to restore the aesthetic values disturbed in the construction of the dam. Specifications for the construction of the dam will include provisions for the prevention of water pollution during construction activities. The contractor will be required to comply with all Federal and state laws, orders, and regulations concerning the control and abatement of water pollution. The contractor's construction activities shall be performed by methods that will prevent entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants in the Gunnison River. Turbidity increases above the natural level of turbidity in the Gunnison River that are a result of construction activities shall be limited to those increases resulting from performance of required construction work in the river channel and will be permitted only for the shortest practicable period required to complete such work. Some siltation of the stream will occur in the construction of the dam due to stockpiling of foundation and abutment material adjacent to the river channel that will be utilized in the dam construction. All

practicable provisions will be taken to minimize the movement of stockpiled material into the river channel. The contractor may be required to cover the stockpile areas with the impervious membrane to reduce the amount of erosion from rain and wind which could contribute to the siltation of the Gunnison River. Ditches and catch drains will be required at the foot of the stockpiles to protect the stream below. The possibilities of providing offstream desiltation ponds and diversion of the river to these is not practical because of the very narrow width of the canyon and the size of the flows in the river that are expected to reach upwards of 7,000 second-feet during the construction period.

Borrow Areas

There are six potential borrow areas in the canyon bottom which have been selected to obtain borrow materials for the dam embankment. Most of the borrow material will be stockpiled for later sorting into impervious, aggregate, and riprap uses. The borrow areas are located near the base of the canyon adjacent to the stream and access road. The streambed will also be used to obtain aggregate and rock materials. The prime source of aggregate material is located outside the canyon approximately 17 miles from the damsite on land administered by the Bureau of Land Management. Stipulations in the special use permit from the Bureau of Land Management provide for stripping of top soil prior to aggregate processing, reshaping, and smoothing following the excavation of borrow material. Waste material will be stockpiled and after construction it too will be spread over the reshaped area, top soil replaced, and the area reseeded either by the Bureau of Land Management or the contracting agency, depending upon the immediate future needs by the Bureau of Land

Management or other agencies of this aggregate source for other uses. Natural springs in the vicinity will be protected to avoid their disturbance or pollution. All borrow areas will be stripped of soil and vegetation leaving bare rock exposed. Revegetation of the rock is impossible, and therefore, the rock scars will remain until natural weathering process blends the rock with adjacent area. However, because of the multicolor striation characteristics of the rock in the canyon, it is doubtful that very serious, obvious aesthetic damage will occur. The greatest aesthetic damage will result from reshaping and channeling of the river. The riprap for the face of the dam will be obtained from the rock stripped from the dam abutments, so in essence, these riprap sources will be covered by dam construction and will only be minimally visible. Access roads constructed for borrow area exploratory work will be obliterated when the borrow materials are excavated. Any other temporary access roads will be obliterated to the greatest extent possible and reseeded with grass and planting of trees wherever possible.

Crystal Powerplant

The powerplant, located at the base of the dam on the right abutment, will contain one generating unit with a capacity of 28,000 kilowatts. The plant will be constructed in an area excavated for dam embankment materials and will not create additional scars on the landscape. To provide ample head for maximum power generation, the powerplant will be located approximately 35 to 50 feet below the present river level which will necessitate the channelizing of the Gunnison River to deepen the present channel at the powerplant and coming ongrade in the Gunnison River approximately 1.5

miles downstream. Channelizing of this section of the river will eliminate any fishery habitat that is there at the present time. No plans have been made to restore the present fishery habitat in that section of the stream. Thorough studies will be made of the channelizing work proposed by the contractor to determine what the best method of doing the work is resulting in the least amount of disruption and siltation of the Gunnison River. Several alternatives are available. One is to restrict the flows of the river on a daily or on a seasonal basis in that area where channel work is necessary when the channelizing is being done to minimize the damage downstream. The other is to wait until the dam is essentially completed and then regulate stream flows with Crystal Dam to eliminate high flows which would increase siltation of the river during construction activity. One item that additional study is needed on is the possibility of flushing the total river below the dam after completion of the channelizing in the construction activity. This would mean releasing extremely high flows, the highest the river channel could handle without causing damage to /personal property downstream to flush out through the canyon and away any of the siltation that may have occurred in the river during construction, thus, restoring any fishery habitat that may have been damaged during the construction activity.

A field station nearly 2 miles downstream from the dam is to be built for Bureau of Reclamation construction employees and space will be available for the contractors to locate office facilities. Sewage and water treatment systems will be included and have been approved by EPA and the Colorado State Health Agency. No adverse environmental effects are anticipated from the location of the field station and

contractors' office. In fact, some of these facilities, such as the water and sewage, may ultimately have some benefit to recreational development in that area.

Transmission Lines

Eleven miles of transmission lines are required to convey power generated from the Crystal Powerplant to the Curecanti Substation. Slightly over ten miles of this line have already been constructed. The line is of wood pole type and follows the south slopes up the southern side of the canyon to the canyon rim in such a manner that it is inconspicuous, in fact, virtually inconspicuous from the National Monument. The final section of the transmission line from the canyon rim to the powerplant has not been constructed. A temporary line will be constructed before construction of a permanent line. Three alternatives are being investigated at the present time to get the transmission line down to the powerplant. The first is an overhead single span line from the top of the rim to the powerplant. The second would be a wood pole line with no access road down the face of the canyon to the powerplant. The third alternative being studied is slant drilling from the top of the canyon rim coming out at the bottom of the canyon and placing a cable for transmission of the power from the generating unit in the canyon up to the top of the rim in that manner. Presently no decision has been made as to which method would be used, but when all the details, the economics /environmental impact and practicability aspect of transmitting the power out by one alternative from the generating unit in the canyon is /completed a decision will be made. The temporary line, an armored cable, for construction activities will be laid on the surface of the ground and with no resulting damage to the aesthetics of the canyon.

Effects on Fish

Construction of the Curecanti Unit, especially Blue Mesa Reservoir, resulted in the loss of some of the best reaches of trout water along the Gunnison River. These losses cannot be replaced, but as partial mitigation, the preservation and improvement of the Lower Gunnison River downstream from the Gunnison Tunnel and Crystal Dam to the North Fork confluence is a desirable objective. To this end, minimum flows of sufficient magnitude through the Black Canyon will be possible by the construction of Crystal Dam which will meet the above stated objective--a minimum of 200 c.f.s. at all times and a minimum of 400 c.f.s. between March 1 and September 30 in those years when Blue Mesa is expected to fill which normally is 85 percent of the years. The historic low flow recorded for the river below the Gunnison Diversion Tunnel is 34 c.f.s., so a substantial improvement of the stream fishery below Crystal Dam should occur with the above minimum stream flows being guaranteed. No endangered species of fish nor aquatic biota is affected by this project.

Crystal Reservoir will inundate approximately 5 miles of the Gunnison River. It will provide additional fishing opportunities but may be only a less than mediocre fishery because of lack of organic matter entering head end of the reservoir or that is inherently present. Crystal Reservoir will, at most, result in a minor addition to total fishing use of the Curecanti Unit.

Effects on Wildlife

Crystal Dam and Reservoir will have an insignificant effect on wildlife since the reservoir pool is in the bottom of the canyon. No big game habitat nor migration route are affected and no endangered species

of wildlife are affected by this project.

Recreation

The construction of Crystal Dam and impoundment of the water for a reservoir will create a potential recreation area. Because the reservoir is located in the bottom of a very deep canyon with steep verticle side-slopes, access to the water surface will be severly restricted. Area to develop recreation facilities is practically nonexistent. There are two small areas available, one at the upper end of the reservoir, which requires the acquisition of 20 acres of private land and a small area below the dam just downstream from the Gunnison Diversion Works. The reservoir will fluctuate radically, as much as 3 feet in 8 hours, which also presents some potential water safety hazards to boaters using the reservoir and possible impairment of the ultimate recreation potential of the reservoir.

The initial plan for development of Crystal Dam included a rather ambitious recreation development recommendation to serve an annual visitation of 20,000 recreationalists. Presently, with a change in reservoir site and operation, the recreation potential and plan are being reanalyzed to determine the practicability of such development.

Alternatives to Project

The three alternatives, therefore, are to: (1) build Crystal Dam as planned with a powerplant, (2) build a small re-regulating reservoir without a powerplant so that Morrow Point can be operated efficiently, and (3) build nothing and operate Morrow Point Powerplant inefficiently.

No environmental alternatives were investigated for the dam and reservoir although several alternate dam sites were studied to determine

the most economically feasible location for a dam and reservoir. There are several alternatives for some of the incremental parts of the dam such as borrow area locations. It is possible to obtain all the borrow material from areas on the top of the rim of the canyon to the south. That is, there was sufficient borrow material out of the canyon bottom to meet the materials for constructing the dam. This alternative, however, was determined to be economically infeasible, so borrow areas in the bottom of the canyon are being used.

Relationship between Local Short Term Uses and Long Term Productivity

The construction of the dam will have long term effects on such items as the aesthetics, fishery and economic development touched by the construction of the dam. The reservoir access road has already damaged the aesthetics and stripping the borrow areas will also alter the present setting. Most of these changes will be of longer duration. The aggregate borrow area outside the canyon will have a short term affect as reshaping and reseeding of the borrow area will restore as much as possible the area disturbed by excavation.

Irreversible or Irretrievable Committments of Resources

Nearly all phases of the dam and reservoir complex would commit resources to an irreversible status. The access road, dam, reservoir, borrow area, and power plant has, or will alter the resources so they cannot be restored to their original status or be subsequently utilized for other purposes.

Coordination with Other Agencies

Agencies that assisted in the development of the project included the National Park Service, Bureau of Sport Fisheries and Wildlife, Bureau

of Mines, Geological Survey, Public Health Service, Corps of Engineers, U.S. Forest Service, Bureau of Public Roads, and Colo. Game Fish & Parks Div. Reports from these agencies did not address themselves specifically to environmental review or recommendations. However, some of their recommendations are concerned with the protection and/or improvement of the natural resources. The complete list of the agencies which this Environmental Statement was sent to for review and their appropriate comments will be attached.