83d Congress, 1st Session - - - - - - House Document No. 187

FRYINGPAN-ARKANSAS PROJECT

LETTER

FROM

ACTING SECRETARY OF THE INTERIOR

TRANSMITTING

REPORT ON THE FRYINGPAN-ARKANSAS PROJECT, COLORADO, PURSUANT TO SECTION 9 (A) OF THE RECLAMATION PROJECT ACT OF 1939 (53 STAT. 1187)

JUNE 18, 1953.—Referred to the Committee on Interior and Insular Affairs and ordered to be printed with illustrations

UNITED STATES
GOVERNMENT PRINTING OFFICE
35002 WASHINGTON : 1953

LETTER OF TRANSMITTAL

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., June 9, 1953.

Hon. JOSEPH W. MARTIN, Jr.,
Speaker of the House of Representatives,
Washington, D. C.

MY DEAR MR. SPEAKER: My report on the Fryingpan-Arkansas project, Colorado, is transmitted herewith pursuant to section 9 (a) of the Reclamation Project Act of 1939 (53 Stat. 1187).

The waters of the Arkansas River in the upper Arkansas River Basin are overappropriated, resulting in serious loss in crop production on presently irrigated farmland. Stabilized agricultural economy in the area requires supplemental water supplies. Additional quantity and better quality of domestic and municipal water is critically needed in the Arkansas Valley, Colo. There is a need for additional electric energy in the project power-market area, and normal uses of electric energy would expand rapidly if not restricted by a limited supply. Floods in the upper Arkansas Valley threaten the loss of property and discourage investment. Sediment and pollution control are needed. The most pressing and immediate needs of the upper Arkansas River Basin can be met by the Fryingpan-Arkansas project, which is herein recommended for authorization and construction.

The report has been transmitted to the States of the Colorado River Basin, to the States of Kansas and Oklahoma, and to the Secretary of the Army, for their views and recommendations as required by the provisions of the Flood-Control Act of 1944 (58 Stat. 887); to the State of Colorado for the comments of the head of the agency exercising administration over the wildlife resources of the State, as required by the provisions of the act of August 14, 1946 (60 Stat. 1080); and to the Departments of Agriculture and Commerce, the Federal Power Commission, the Corps of Engineers, and the Public Health Service, in accordance with interagency agreements. Copies of all the comments received are enclosed with the report.

The report and the comments received were submitted to the President, and the Bureau of the Budget has advised that there would be no objection to the submittal of the report to the Congress. A copy of Assistant Budget Director Rowland Hughes' letter of June 8, 1953, is attached.

Sincerely yours,

RALPH A. TUDOR,
Acting Secretary of the Interior.

Approved for printing, June 17, 1953.

K. M. LECOMPTE,
Chairman, Committee on House Administration.

FRYINGPAN-ARKANSAS PROJECT, COLORADO

LETTER TO THE SECRETARY FROM BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., June 8, 1953.

The honorable the SECRETARY OF THE INTERIOR.

MY DEAR MR. SECRETARY: Receipt is acknowledged of your letter of April 30, 1953, submitting your revised report on the Fryingpan-Arkansas project, Colorado, and requesting advice as to its relationship to the program of the President.

This proposed multipurpose project would provide irrigation, power, flood control, municipal water, and other benefits. The plan contemplates several small powerplants and a system of canals, reservoirs, and tunnels to divert water from the western to the eastern slope of the Continental Divide and to produce better control and utilization of upper Arkansas River water.

The estimated cost is $172,898,000, of which $75,128,000 is allocated to irrigation, $41,945,000 to power, $32,654,000 to municipal water supply—reimbursable items—and $20,341,000 to flood control and $2,830,000 to fish and wildlife—nonreimbursable items. The benefit-cost ratio is stated as 1.48 to 1.00.

The repayment plan contemplates that the power and municipal water-supply investments would be entirely repaid with interest at 2½ percent in 53 and 63 years, respectively, or within 50 years after all facilities are placed in operation. The plan also contemplates that the irrigation investment would be returned without interest over a period of 69 years, in part from payments by irrigation-water users and in part by revenues from power and municipal water supply after these latter investments are fully repaid. The irrigators would repay $622,000 annually for 69 years, based on an ad valorem tax of 1 mill and payments ranging from $5.40 per acre-foot for water diverted from the Colorado River Basin to $2.25 per acre-foot for reregulated Arkansas River winter flow. Irrigators now have prior water rights to the Arkansas River winter flow at no cost.

This office believes that a reasonable basis for appraising the repayment of Federal irrigation projects should be not more than 50 years, and that this would be consistent with the general practice of most Federal agencies in determining the economic evaluation and financial feasibility of water resources developments. On the basis of a 50-year repayment and the Department of the Interior's estimate of the water users' ability to repay, the water users would return $31,100,000 of the $75,128,000 allocated to irrigation, leaving unpaid at the end of 50 years $44,028,000, or 60 percent of the estimated construction cost. Thus, the water users would have paid $100 per acre out of a total investment of $243 per acre.

The proposed project report, on the other hand, contemplates repayment by the water users within 69 years rather than 50 years. During the additional 19 years, the above-mentioned balance of $44,028,000 would be repaid. Irrigators would pay $11,818,000, and the remainder of the unpaid construction cost amounting to $32,210,000 would be met from revenues on power and municipal water supply. As noted above, the allocation of costs to power and municipal water supply, under the proposed project, would be fully repaid with interest within 50 years after completion of all facilities. Revenues derived after the 50 years would be used to show repayment of the irrigation investment.

Federal and State agencies, in commenting on the original project report, questioned (1) the high cost of a limited supply of supplemental irrigation water, (2) the ability of the water users to repay annually as much of the irrigation costs as proposed, and (3) the ultimate amount of transmountain diversion and its effect on the quality and use of Colorado River water available to the lower basin. Notwithstanding the substantial increases in the estimated project costs and the greater estimate of the ability of the irrigators to repay, as shown in the revised report as compared with the original report, the comments of the States and Federal agencies have not been furnished on the revised report.

Approximately 63 percent of the irrigation benefits of the project are of an indirect character, consisting of additional business from increased purchases, marketing, and processing activities. Without these indirect benefits the project over a period of 50 years would not show a favorable benefit-cost ratio. While this office recognizes that there are definite indirect benefits, we believe that they should not be assigned a monetary value and should not be relied upon for the primary justification of a project. It is our understanding that this is in accord with your present views.

In the consideration of irrigation projects, it should be noted that, under existing law, the interest cost on the irrigation investment is not charged to the water users but is borne by the Federal Government. In the case of the Fryingpan-Arkansas project, the average annual interest cost on the irrigation investment during the first 50 years would amount to about $1,500,000, on the basis of simple interest at 2½ percent, or approximately $5 per acre per year.

As indicated by the comments of the Department of Agriculture on the original report, under dates of October 10, 1951, and May 23, 1952, in view of the obvious high cost of importing water from the Colorado River Basin, a separate evaluation should be made of the feasibility of importing water from the Colorado River Basin, considered as an incremental addition rather than an integral part of the project. Furthermore, there is no evidence in the report indicating a willingness by the irrigators to repay the proposed charges for an average annual supplemental water supply of about one-half acre-foot per acre.

Plans for municipal water supplies appear doubtful because of the high water rates, optimistic estimates of average water deliveries, and uncertainty of including all proposed facilities and functions in the ultimate plans. We also believe that costs of correcting damages to fish and wildlife resources caused by the building of the project should be treated as part of the construction costs and allocated to the

various purposes in the same manner as other damages, including relocations.

Our review indicates that further study of various aspects of the project might be warranted. If, however, you deem it advisable, particularly in the light of the committee's desire for an early hearing, there would be no objection to the transmittal of the report, together with a copy of this letter, for the consideration of the Congress.

Sincerely yours,

ROLAND HUGHES,
Assistant Director.

SECRETARY McKAY'S REPORT TO THE PRESIDENT, THROUGH BUREAU OF THE BUDGET

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., April 30, 1953.

THE PRESIDENT,
THE WHITE HOUSE:
(Through the Bureau of the Budget).

MY DEAR MR. PRESIDENT: On October 19, 1951, my predecessor in office submitted his report on the Fryingpan-Arkansas project, Colorado, a multiple-purpose project for partial development of the water resources of the upper Arkansas River Basin and involving transmountain diversion of water from the Roaring Fork River, a tributary of the Colorado. By letter of January 27, 1953, Budget Director Dodge called my attention to this report, among others, and asked that it be reviewed to determine whether it conforms to the present program of the Department of the Interior, and whether any modification or revision should be made.

The report, as previously submitted, recommended immediate authorization for the construction and operation of a system of reservoirs, canals, tunnel, diversion dams, powerplants, and municipal water supply facilities for irrigation and municipal water supply, flood control, power, sediment control, stream pollution abatement, and preservation and propagation of fish and wildlife.

After review of the report and study of the data and information presently available, I have determined that no modification in the plan of development is required. However, the recommendations in the report are hereby modified to recommend, instead of the application of the so-called interest component as heretofore contemplated, the return of that part of the construction cost of the project which is allocated to irrigation and assigned to be repaid from net power and municipal water revenues subsequent to the repayment of the commercial power and municipal water investments—these latter investments to bear interest, on the unamortized balances, at a rate equal to the average rate paid by the United States on its long-term loans outstanding at the date of authorization of the project. We do not favor the use of the so-called interest component as an aid in paying out the irrigation costs of this project.

The repayments and economic analyses have been revised to reflect the increased costs since the basic report was prepared. Summaries of these revised studies are enclosed. The repayment analysis

includes, as a part of the construction cost to be repaid, interest during construction on power and municipal water investments. In the economic analysis the power benefits are calculated on the basis of the value of power in the area and an analysis by functions is included.

The estimated cost of the Fryingpan-Arkansas project is $172,898,000 at January 1953 price levels. If the allocations are revised to incorporate the increased costs and the repayment plan is set up on the alternative basis hereinbefore suggested, with an interest rate estimated at 2.5 percent, return of irrigation costs which exceed those that can be repaid by the water users themselves could be accomplished in an overall period of 69 years or 17 additional years after the power investment is returned and 6 years after the municipal water investment is returned.

The revised economic analysis indicates that the benefits from construction of the project would exceed the costs in a ratio of 1.48 to 1.00 and that the inclusion of all functions is justified.

Supplemental water supplies, both for irrigation and for municipal use, are sorely needed in the Arkansas River Basin. Serious losses occur annually in crop production on presently irrigated farmland while the need for additional and better quality municipal water is fast becoming critical. Protection is needed against floods which result in extensive damages in the upper Arkansas Valley. Also, there is a need in the area for the electric energy from the project and normal uses for electricity would expand rapidly if not restricted by a limited supply.

This project and the report as herein modified conform to my program. Therefore, I transmit, pursuant to section 9 (a) of the Reclamation Project Act of 1939, this report which incorporates the report of the previous Secretary of the Interior and the comments of the affected States and Federal agencies as my report on the Fryingpan-Arkansas project.

I shall appreciate receiving advice concerning the relationship of this project to your program before I transmit the report to the Congress in accordance with the provisions of the Reclamation Project Act of 1939.

Sincerely yours,

DOUGLAS MCKAY,
Secretary of the Interior.

TABLE I.—*Fryingpan-Arkansas project—Summary of benefit-cost analysis*

Item	Amount	
Public investment:		
Estimated construction costs		$172,898,000
Interest during construction [1]		6,594,000
Total		179,492,000
Annual costs:		
Equivalent of public investment		4,902,000
Operation, maintenance, and replacement:		
Municipal water	$412,000	
Irrigation	59,000	
Power	842,000	
		1,313,000
Regulation by upper Colorado storage project [2]		163,000
Total		6,378,000
Annual benefits:		
Municipal water		1,662,000
Irrigation: [3]		
Direct	1,598,000	
Indirect	2,757,000	
		4,355,000
Power [4]		2,702,000
Flood control [5]		598,000
Sediment control		141,000
Total		9,458,000
Benefit-cost ratio:		
Total benefits		1.48:1.00
Direct benefits		1.05:1.00

[1] Interest during construction computations appearing in report have been reanalyzed; realistic construction periods were set up by features and made consistent with development periods.
[2] Annual cost of regulation provided by Upper Colorado River Storage Project at $2.35 per acre-foot.
[3] Adjusted to 215 agricultural price index; excludes interest and wages shown in report as direct benefits to others; indirect benefits reflect increased marketing and processing activities and increases in farm purchases.
[4] Benefits reflect prospective value of power in area.
[5] Adjusted to reflect projected prices, Engineering News-Record Index of 180 (1939=100).

FRYINGPAN-ARKANSAS PROJECT

TABLE IA.—*Summary of benefit-cost analysis by functions*

Item	Total project	Municipal water	Irrigation	Power	Flood control	Fish and wildlife
Public investment:						
Estimated construction costs	$172,898,000	$32,654,000	$75,128,000	$41,945,000	$20,341,000	$2,830,000
Interest during construction	6,594,000	1,154,000	3,143,000	1,330,000	849,000	118,000
Total	179,492,000	33,808,000	78,271,000	43,275,000	21,190,000	2,948,000
Annual costs:						
Equivalent of public investment	4,902,000	923,000	2,138,000	1,182,000	579,000	80,000
Operation, maintenance, and replacement	1,313,000	412,000	59,000	842,000	----------	----------
Regulation by upper Colorado storage project [1]	163,000	----------	----------	----------	----------	----------
Total	6,378,000	1,335,000	2,197,000	2,024,000	579,000	80,000
Annual benefits:						
Direct	[2] 6,701,000	1,662,000	1,598,000	2,702,000	598,000	----------
Indirect	2,757,000	----------	2,757,000	----------	----------	----------
Total	9,458,000	1,662,000	4,355,000	2,702,000	598,000	----------
Benefit-cost ratio:						
Total benefits	1.48	1.24	1.98	1.33	1.03	----------
Direct benefits	1.05	1.24	.73	1.33	1.03	----------

[1] Not distributed to functions.
[2] Includes $141,000 benefits from sediment control.

TABLE II.—*Segregation of costs*

Feature	January 1953 construction costs					Annual operation, maintenance, and replacement					
		Specific costs				Total			Specific operation, maintenance and replacement		
	Total	Power	Municipal water supply	Fish and wildlife[1]	Joint costs	Operation and maintenance	2½ percent, 50-year replacement	Operation, maintenance and replacement	Power	Municipal water	Joint operation, maintenance and replacement
Aspen Dam and Reservoir	$8,102,000				$8,102,000	$2,000	$1,880	$3,880			$3,880
Sugar Loaf Dam and Reservoir	7,248,000				7,248,000	2,760	1,680	4,440			4,440
Twin Lakes Dam and Reservoir	10,222,000				10,222,000	3,900	2,370	6,270			6,270
Salida Afterbay	310,000	$310,000				1,870	70	1,940	$1,940		
Pueblo Dam and Reservoir	43,453,000				43,453,000	6,200	10,090	16,290			16,290
Main purification plant	7,148,000		$7,148,000			33,750	10,290	44,040		$44,040	
Pueblo pumping plant	1,470,000		1,470,000			93,320	18,340	111,660		111,660	
Colorado Springs pumping plant	155,000		155,000			4,780	1,930	6,710		6,710	
Hunter Creek-Aspen Canal	288,000				288,000	2,150	70	2,220			2,220
Hunter Creek extension canal	409,000			$409,000		4,700	90	4,790			4,790
South Side collection system	9,263,000			806,000	8,457,000	2,800		2,800			2,800
North Side collection system	21,126,000			383,000	20,743,000	29,530	940	30,470			30,470
Fryingpan-Arkansas tunnel	10,111,000			1,232,000	8,879,000	3,030		3,030			3,030
Snowden Canal	792,000				792,000	7,000	180	7,180			7,180
Arkansas power canal:											
Elbert Canal	1,759,000	1,759,000				26,250	410	26,660	26,660		
Twin Lakes-Otero Canal	1,623,000	1,623,000				11,460	380	11,840	11,840		
Otero-Wapaco Canal	2,188,000	2,188,000				15,470	510	15,980	15,980		
Wapaco diversion	266,000	266,000				1,990	60	2,050	2,050		
Wapaco-Princeton Canal	2,466,000	2,466,000				18,370	570	18,940	18,940		
Chalk Creek diversion	96,000	96,000				720	20	740	740		
Princeton-Pancho Canal	2,023,000	2,023,000				15,100	470	15,570	15,570		
Pancho-Salida Canal	2,508,000	2,508,000				17,800	580	18,380	18,380		
Oil Creek-Brush Hollow Canal	361,000		361,000			4,390	80	4,470		4,470	
Pueblo water conduit	1,735,000		1,735,000			26,020	7,810	33,830		33,830	
Arkansas Valley water conduit	10,631,000		10,631,000			159,460	47,840	207,300		207,300	
Powerplants	14,917,000	14,917,000				378,540	161,510	540,050	540,050		
Powerplant switchyards	3,885,000	3,885,000				34,940	39,030	73,970	73,970		
Transmission lines	5,079,090	5,079,000				31,150	58,950	90,100	90,100		
Transmission substations	2,091,000	2,091,000				31,130	21,010	52,140	52,140		
General property	1,173,000				1,173,000						
Total	172,898,000	39,211,000	21,500,000	2,830,000	109,357,000	970,580	387,160	1,357,740	868,360	408,010	81,370

[1] These amounts represent the costs of enlargement of the collection and diversion system specifically for fish and wildlife purposes. They are shown as specific costs because the allocation to this function is limited to the costs of these added facilities totaling $2,830,000, as described in report of the regional director for mitigation of losses.

TABLE III.—*Cost allocation*

Item	Total	Municipal water	Irrigation	Power	Flood control	Fish and wildlife
Annual benefits	$9,317,000	$1,662,000	$4,355,000	$2,702,000	$598,000	
Less annual operation, maintenance and replacement costs	1,313,000	412,000	59,000	842,000	0	0
Annual net benefits	8,004,000	1,250,000	4,296,000	1,860,000	598,000	
Justifiable investment	295,910,000	45,771,000	157,305,000	68,107,000	21,897,000	[1] $2,830,000
Alternative expenditure	184,161,000	33,575,000	81,097,000	42,148,000	27,341,000	
Alternative justifiable expenditure	181,547,000	33,575,000	81,097,000	42,148,000	21,897,000	
Less specific costs	60,711,000	21,500,000	0	39,211,000	0	2,830,000
Remainder	120,836,000	12,075,000	81,097,000	2,937,000	21,897,000	
Percent distribution	100.0	10.2	68.7	2.5	18.6	
Joint costs	$112,187,000	$11,154,000	$75,128,000	$2,734,000	$20,341,000	
Specific costs	60,711,000	21,500,000	0	39,211,000	0	$2,830,000
Allocation	172,898,000	32,654,000	75,128,000	41,945,000	20,341,000	2,830,000

[1] Incremental costs of features on western slope, as described in report of the regional director for mitigation of losses.

TABLE IV.—*Interest during construction*

Feature	Code	Construction cost	Construction period years	Interest 2½ percent
Replacement Reservoir, Aspen, 28,000 acre-feet	J	$8,102,000	4	$405,100
Sugar Loaf Reservoir enlargement, 117,000 acre-feet	J	7,248,000	3	271,800
Twin Lakes Reservoir enlargement, 260,000 acre-feet	J	10,222,000	4	511,100
Salida Afterbay Reservoir, 200 acre-feet	P	310,000	1	3,900
Pueblo Reservoir, 400,000 acre-feet	J	43,453,000	4	2,172,600
Main purification plant (Pueblo) (7,500,000 gallons)	M	7,148,000	2	178,700
Hunter Creek diversion dam	J	48,000	1	600
Hunter Creek extension diversion works	J	15,000	1	200
Chapman Gulch diversion dam	J	54,000	1	700
Lime Creek diversion dam	J	30,000	1	400
Last Chance diversion dam	J	30,000	1	400
North Fork diversion dam	J	30,000	1	400
Ivanhoe diversion dam	J	30,000	1	400
Fryingpan River diversion dam	J	16,000	1	200
Snowden diversion dam	J	205,000	2	5,100
Wapaco diversion dam	P	228,000	2	5,700
Chalk Creek diversion dam	P	62,000	1	800
Oil Creek diversion dam	M	138,000	1	1,700
Main municipal pumping plant	M	1,470,000	3	55,100
Colorado Springs pumping plants	M	155,000	2	3,900
Hunter Creek, Aspen Canal—Q=200 cubic feet per second	J	240,000	1	3,000
Hunter Creek Extension Canal—Q=20–100 cubic feet per second	J	394,000	3	14,800
South Side collection conduit	J	9,209,000		
.01 Hunter Creek-Chapman tunnel	J	(2,578,000)	2	64,400
.02 Chapman-South Fork tunnel	J	(3,380,000)	2	84,500
.03 South Fork-Fryingpan siphon tunnel	J	(2,706,000)	2	67,600
.04 Fryingpan siphon	J	(545,000)	1	6,800
Northside collection conduit	J	21,006,000		
.01 Lime Creek Canal	J	(1,182,000)	3	44,300
.02 Last Chance-North Fork section	J	(2,952,000)	2	73,800
.03 North Fork-Ivanhoe Creek section	J	(11,674,000)	3	437,800
.04 Ivanhoe Creek-Fryingpan siphon	J	(2,002,000)	2	50,000
.05 Fryingpan siphon–Fryingpan-Arkansas tunnel	J	(3,196,000)		
Fryingpan-Arkansas divide tunnel	J	10,095,000	3	378,600
Elbert power canal	P	1,795,000	3	67,300
Snowden Canal	J	587,000	2	14,700
Twin Lakes-Otero Canal	P	1,623,000	2	40,600
Otero-Wapaco Canal	P	2,188,000	3	82,000
Wapaco diversion canal	P	38,000	1	500
Wapaco-Princeton Canal	P	2,466,000	3	92,500
Chalk Creek diversion canal	P	34,000	1	400
Princeton-Pancho Canal	P	2,023,000	3	75,900
Pancho-Salida Canal	P	2,508,000	3	94,000
Pueblo municipal water supply conduit	M	1,735,000	2	43,400
Arkansas Valley municipal water supply conduit	M	10,631,000	3	398,700
Oil Creek-Brush Hollow Canal	M	223,000	3	8,400
Elbert powerplant, 8,700 kilowatts	P	1,137,000	3	42,600
Otero (Granite) powerplant, 19,200 kilowatts	P	2,711,000	3	101,700
Wapaco powerplant, 16,500 kilowatts	P	2,214,000	3	83,000
Princeton powerplant, 11,700 kilowatts	P	1,733,000	3	65,000

TABLE IV.—*Interest during construction*—Continued

Feature	Code	Construction cost	Construction period years	Interest 2½ percent
Pancho (Princeton) powerplant, 15,000 kilowatts	P	$2,500,000	3	$93,800
Salida powerplant, 22,700 kilowatts	P	2,908,000	3	109,000
Pueblo powerplant, 11,000 kilowatts	P	1,714,000	3	64,300
Dillon-Elbert, 51 miles	P	755,000	2	18,900
Elbert-Otero, 11 miles	P	127,000	1	1,600
Otero-Wapaco, 7 miles	P	104,000	1	1,300
Wapaco-Princeton, 15 miles	P	174,000	1	2,200
Princeton-Pancho, 7 miles	P	80,000	1	1,000
Pancho-Salida, 3 miles	P	35,000	1	400
Gunnison-Salida, 66 miles	P	1,020,000	2	25,500
Saguache-Salida, 47 miles	P	504,000	2	12,600
Salida-Pueblo, 97 miles	P	1,124,000	2	28,100
Pueblo-Colorado Springs, 44 miles	P	472,000	1	5,900
Colorado Springs-Limon, 73 miles	P	684,000	2	17,100
Leadville, 15,000 kilovolt-amperes	P	118,000	1	1,500
Salida, 5,000 kilovolt-amperes	P	139,000	1	1,700
Gunnison, 3,750 kilovolt-amperes	P	253,000	1	3,200
Saguache, 10,000 kilovolt-amperes	P	149,000	1	1,900
Canon City, 15,000 kilovolt-amperes	P	302,000	1	3,800
Pueblo, 25,000 kilovolt-amperes	P	205,000	1	2,600
Colorado Springs, 30,000 kilovolt-amperes	P	925,000	1	11,600
Elbert, 9,670 kilovolt-amperes	P	482,000	1	6,000
Otero, 21,330 kilovolt-amperes	P	558,000	1	7,000
Wapaco, 18,330 kilovolt-amperes	P	540,000	1	6,800
Princeton, 13,000 kilovolt-amperes	P	507,000	1	6,400
Pancho, 16,670 kilovolt-amperes	P	434,000	1	5,400
Salida, 25,220 kilovolt-amperes	P	770,000	1	9,600
Pueblo, 12,220 kilovolt-amperes	P	594,000	1	7,400
General communication system	J	105,000	2	2,600
General service equipment (25 percent construction facility)	J	1,053,000	7	79,000
Gunnison maintenance shop	J	15,000	1	200
Total		172,898,000		6,593,500

J=Joint ($4,691,000); P=Power ($1,212,500); M=Municipal water ($690,000).

Breakdown of the interest during construction to the allocated use of the features:

Joint use	$4,691,000
Specific power	1,213,000
Specific municipal water	690,000
Total	6,594,000

The distribution of the joint interest during construction was made to the various functions by the same percentages that the functions share in the joint construction costs. This distribution is as follows:

Irrigation	$3,143,000
Power	117,000
Municipal water	464,000
Flood control	849,000
Fish and wildlife	118,000
Total	4,691,000

The total reimbursable amounts of interest during construction are—

Power	$1,213,000+$117,000=	$1,330,000
Municipal water	$690,000+$464,000=	1,154,000
Total		2,484,000

The nonreimbursable interest during construction is $4,110,000.

FORMER SECRETARY CHAPMAN'S REPORT TO THE PRESIDENT

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington 25, D. C., October 19, 1951.

THE PRESIDENT,
THE WHITE HOUSE
(Through Bureau of the Budget).

MY DEAR MR. PRESIDENT: My report on the Fryingpan-Arkansas project, Colo., is transmitted herewith pursuant to section 9 (a) of the Reclamation Project Act of 1939 (53 Stat. 1187).

The waters of the Arkansas River in the upper Arkansas River Basin are overappropriated, resulting in serious loss in crop production on presently irrigated farmland. Stabilized agricultural economy in the area requires supplemental water supplies. Additional quantity and better quality of domestic and municipal water is critically needed in the Arkansas Valley, Colo. There is a need for additional electric energy in the project power-market area and normal uses of electric energy would expand rapidly if not restricted by a limited supply. Floods in the upper Arkansas Valley threaten the loss of property and discourage investment. Sediment and pollution control are needed. The most pressing and immediate needs of the upper Arkansas River Basin can be met by the Fryingpan-Arkansas project which is herein recommended for authorization and construction.

The report has been transmitted to the States of the Colorado River Basin, to the States of Kansas and Oklahoma, and to the Secretary of the Army for their views and recommendations as required by the provisions of the Flood Control Act of 1944 (58 Stat. 887); to the State of Colorado for the comments of the head of the agency exercising administration over the wildlife resources of the State, as required by the provisions of the Act of August 14, 1946 (60 Stat. 1080); and to the Departments of Agriculture and Commerce, the Federal Power Commission, the Corps of Engineers, and the Public Health Service, in accordance with interagency agreements. Copies of all the comments received are enclosed with the report.

I shall appreciate having advice concerning the relationship of this proposed project to your program before I transmit the report to the Congress for its consideration and appropriate action in accordance with the provisions of the Reclamation Project Act of 1939.

Sincerely yours,

OSCAR L. CHAPMAN,
Secretary of the Interior.

REPORT OF THE COMMISSIONER OF RECLAMATION

DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
Washington 25, D. C., September 11, 1951.

The SECRETARY OF THE INTERIOR.

SIR: This is my report on the Fryingpan-Arkansas project, Colorado, formerly called the initial development, Roaring Fork diversion, Gunnison-Arkansas project.

In your behalf, copies of the report on this project, which you approved and adopted as your proposed report on May 4, 1951, were

sent to the Secretary of the Army and to designated officials of the States of Arizona, California, Colorado, Kansas, Nevada, New Mexico, Oklahoma, Utah, and Wyoming for their views and recommendations in accordance with the provisions of section 1 of the Flood Control Act of 1944 (58 Stat. 887), and to the Governor of Colorado for the report and recommendations of the head of the agency exercising administration over the wildlife resources of the State of Colorado in accordance with the requirements of the act of August 14, 1946 (60 Stat. 1080). Copies of the proposed report were sent also to the Federal Power Commission, the Departments of Agriculture and Commerce, the Corps of Engineers, and the Public Health Service for their comments. Copies of the written views of the States and of the Federal agencies which have been received in response to these transmittals are attached with a copy of your proposed report.

The reviewing officials of Colorado, which is the State directly affected, concur in the findings of the project report that the products and services which this proposed development would provide or make possible are greatly needed and that the project is engineeringly feasible, economically justified, and financially feasible. They approve the proposed development conditioned upon compliance with the operating principles set forth in the report and full recognition of and compliance with certain portions, quoted in Colorado's letter of comments, of the report of the Colorado Water Conservation Board's policy and review committee as it was approved by the board on February 22, 1951. We approve of the proposed operating principles and have every intention of complying with them if and when the project is authorized, constructed, and in operation. Colorado objects to the name heretofore given the project and recommends that it be known and referred to as the Fryingpan-Arkansas project. As this development is designed as a self-contained unit and its construction would not imply a commitment to develop future water supplies in the Gunnison River Basin for diversion to the Arkansas River Basin, as the diversion is from the Fryingpan River to the Arkansas River, and in view of the desires of the State of Colorado, I recommend that this proposed development, identified in your proposed report as the initial development, Roaring Fork diversion, Gunnison-Arkansas project, be hereafter known as the Fryingpan-Arkansas project.

The State of Kansas, which is a party to the Arkansas River compact and has a strong interest in any proposed development and use of the water of that stream, has no objection to the development as set forth in the project report.

The States of Arizona, California, Utah, and Wyoming have no objection to the authorization and construction of this project.

The Public Health Service suggests revision of statements relative to water pollution in the Arkansas River Valley. As these revisions are based on data compiled in recent joint studies by the Public Health Service and the State of Colorado, I have no objection to this suggestion and recommend that, by this reference, the report be considered modified as suggested by the Public Health Service in its attached letter of comments.

Other comments have been made which are set forth in the attached digest. The 90-day period specified by law for receipt of comments on this report expired on August 16, 1951. Submittal of the report to you was deferred until now in anticipation that additional comments

would be received. If other comments are received, they will be forwarded to you.

After consideration of all comments received, I recommend that your proposed report be modified only as set forth above; that you adopt as your final report on the Fryingpan-Arkansas project the report which you approved and adopted as your proposed report on May 4, 1951, with the above modifications: and that you transmit it, together with copies of the attached comments, to the President and, subsequently, to the Congress in accordance with the provisions of the Reclamation Project Act of 1939.

Respectfully,

MICHAEL W. STRAUS, *Commissioner.*

Approved and adopted: October 19, 1951.

OSCAR L. CHAPMAN,
Secretary of the Interior.

PROPOSED REPORT OF THE COMMISSIONER OF RECLAMATION

DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
Washington 25, D. C., April 16, 1951.

The SECRETARY OF THE INTERIOR.

SIR: This is my proposed report on the initial development, Roaring Fork diversion, of the potential Gunnison-Arkansas project, Colorado. My report is based on and incorporates the accompanying report of the regional director, Bureau of Reclamation, Denver, Colo., dated February 23, 1951.

The potential Gunnison-Arkansas project is a major unit in the comprehensive plan of development of the water resources of the upper Arkansas River Basin. The initial development (Roaring Fork diversion) is a multiple-purpose project involving transmountain diversion of water from the Roaring Fork River, a tributary of the Colorado. This development is designed as a self contained unit, and its construction would not imply a commitment for developing future water supplies in the Gunnison River Basin for diversion to the Arkansas River Basin. This development would provide (*a*) about 185,000 acre-feet of supplemental irrigation water at canal headgates in the Arkansas Valley through transmountain diversion, conservation of flood flows, re-regulation of winter flow, and reuse of return flows for water-thirsty lands which, even with this additional supply, will experience an average annual headgate shortage of about 16 percent; (*b*) about 15,000 acre-feet of municipal water to supplement the municipal supply for Colorado Springs, Pueblo, and several Arkansas Valley towns where additional quantity and better quality water is critically needed; (*c*) about 467 million kilowatt-hours of electric energy to help meet the critical need for electric power in the project service area and permit expansion in the normal uses of electric energy; (*d*) flood protection which would eliminate 66 percent of the probable annual flood damages between Pueblo and the John Martin Reservoir, estimated to be about $890,000; (*e*) sediment control, stream-pollution abatement, and preservation and propagation of fish and wildlife in certain areas; all of which are important and valuable contributions of the project.

These purposes would be accomplished through construction of (*a*) a system of about 50 miles of canals and tunnels on the western slope of the Continental Divide, for the collection of water from Hunter Creek and Frying Pan River, tributaries of the Roaring Fork River; (*b*) Aspen Reservoir, with an active capacity of 28,000 acre-feet near the town of Aspen on the western slope to provide replacement water and water for future use in meeting the demands in western Colorado; (*c*) the Frying Pan-Arkansas tunnel, about 6 miles in length, for diverting water collected on the western slope to the eastern slope; (*d*) the Sugar Loaf Reservoir on the eastern slope of the upper Arkansas Basin, enlarged from its present capacity of 17,000 acre-feet to 117,000 acre-feet for storage and regulation of water imported from the western slope; (*e*) the Snowden diversion dam on the Arkansas River above Snowden, Colo., and the Snowden diversion canal which would convey water from the Arkansas River to the enlarged Twin Lakes Reservoir; (*f*) the Twin Lakes Reservoir in the upper Arkansas Basin, a few miles south of Snowden, Colo., enlarged from its present active capacity of 56,000 acre-feet to 260,000 acre-feet, for storage and regulation of water imported from the western slope by the Frying Pan-Arkansas diversion, water imported by existing Twin Lakes diversion, and water diverted from the Arkansas River by the Snowden Canal; (*g*) the Pueblo Reservoir on the Arkansas River west of Pueblo, Colo., with a capacity of 400,000 acre-feet to store water for irrigation and municipal use and for flood control; (*h*) a project power system comprising 60 miles of canals, 7 powerplants having an installed capacity of 104,800 kilowatts, 7 switchards, 9 substations, and about 400 miles of transmission lines; (*i*) specific municipal water supply facilities for furnishing additional municipal water to Colorado Springs, Pueblo, and several Arkansas Valley towns, which supply facilities would be constructed by the United States only after construction by the communities themselves proves infeasible. These proposed works, which make up the initial development, are estimated to cost $147,440,000 on the basis of October 1949 price levels which are just slightly lower than present price levels. The cost of operation and maintenance, including reserves for replacement, is estimated to be $1,335,200 annually.

The initial development of the Gunnison-Arkansas project has engineering feasibility. It represents the minimum practical project. It is designed as a self-contained unit and its construction would not imply a commitment for expansion, extension, or enlargement; neither would it impair or duplicate future development. It would be operated in accordance with the principles set forth in the regional director's report. The Twin Lakes Reservoir & Canal Co. has expressed a willingness to execute the water exchange agreement which is prerequisite to the prevention of damage to the fisheries of the Roaring Fork River, and which is contemplated by the operating principles. The water to be imported from the Colorado River watershed is to come from Colorado's apportionment under the upper Colorado River Basin compact, and there is sufficient water supply for the project.

The initial development of the Gunnison-Arkansas project is economically justified and financially feasible. The ratio of annual benefits to annual costs is about 1.7 to 1.0. Net annual revenues would amount to about $2,870,000. It is estimated that all reimbursable

costs would be returned to the United States in 50 years. The tentative allocation of costs among the various purposes and the estimated payments are summarized in the following tabulation:

Function	Allocation	Probable repayment
Reimbursable:		
Irrigation	$59, 930, 000	
Probably can be returned in 40 years without interest through payments by irrigation water users and district beneficiaries		$10, 881, 600
Probably can be returned in 40 years without interest through application of interest on power and municipal water investment		49, 048, 400
Power	40, 032, 000	
Probably can be returned in 50 years with interest at 3 percent		40, 032, 000
Municipal and industrial water supply	29, 522, 000	
Probably can be returned in 40 years with interest at 2 percent		29, 522, 000
Total, reimbursable	129, 484, 000	129, 484, 000
Nonreimbursable:		
Flood control	15, 777, 000	
Fish and wildlife	2, 179, 000	
Total nonreimbursable	17, 956, 000	
Grand total	147, 440, 000	129, 484, 000

Irrigation repayment will be accomplished under a contract with a water conservancy district. Municipal and industrial water repayment will be accomplished under contracts with this district or possibly another entity. Separate contracts will cover specific municipal water supply works if they are constructed by the United States and will require repayment of the cost of these works with interest over a period of 40 years. Power payments will be accomplished under contracts for furnishing electric energy at the lowest prices consistent with sound business principles in order to encourage the most widespread use of power throughout the area of service.

I concur in and adopt the recommendations of the regional director as set forth in his report.

I recommend that you approve and adopt this report as your proposed report on the initial development, Roaring Fork diversion, Gunnison-Arkansas project, Colorado, and that you authorize me, in your behalf, to transmit it to the Secretary of the Army; to the States signatory to the Colorado River compact, and to the States of Kansas and Oklahoma in accordance with the provisions of section 1 of the Flood Control Act of 1944 (58 Stat. 887); to the head of the agency of the State of Colorado exercising administration over the wildlife resources of that State, in accordance with the provisions of the Act of August 14, 1946 (60 Stat. 1080); and to other interested Federal agencies for their views and comments.

Respectfully,

MICHAEL W. STRAUS, *Commissioner.*

Approved and adopted: May 4, 1951.

OSCAR L. CHAPMAN,
Secretary of the Interior.

35002—53—2

UNITED STATES DEPARTMENT OF THE INTERIOR
DOUGLAS McKAY, *Secretary*

BUREAU OF RECLAMATION
WILBUR A. DEXHEIMER, *Commissioner*

REGION 7—DENVER, COLO.
AVERY A. BATSON, *Regional Director*

Regional Director's Report on

INITIAL DEVELOPMENT
GUNNISON-ARKANSAS PROJECT
ROARING FORK DIVERSION
COLORADO

January 1950

CONTENTS

REPORT OF THE REGIONAL DIRECTOR

DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
REGIONAL OFFICE, REGION 7,
Denver, Colo., July 5, 1950.
Revised February 23, 1951.

To: The Commissioner, Bureau of Reclamation.

From: The Regional Director, Region 7, Denver, Colo.

Subject: Report on the initial development, Roaring Fork Diversion, of the Gunnison-Arkansas project, Colorado.

TRANSMITTAL AND AUTHORITY

1. This is my report on the initial development, Roaring Fork Diversion, of the potential Gunnison-Arkansas project, Colorado. The initial development, a multiple-purpose project involving transmountain diversion of water, is designed as a major step in optimum utilization of water and related resources in the upper Arkansas River Basin. The report and substantiating documents are submitted for your approval and for departmental action with a view toward securing congressional authorization for development of the project.

2. Authority to make this report and supporting investigations is provided in the Federal reclamation laws (act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto).

INTRODUCTION

3. From its origin on the snowcapped mountains of Lake County, Colo., the Arkansas River (pronounced Ar-kan-saw) flows eastward 1,500 miles to its confluence with the Mississippi. The river's drainage from the Continental Divide to Ellinwood, Kans., comprises the upper Arkansas River Basin. The economy of that semiarid section of the Nation is bound closely to its natural resources. Their conservation and development are essential if the economy of the basin is to be stabilized and expanded. Water is the key resource and its utilization for all beneficial purposes is of prime importance. The Arkansas River is the hydrologic artery of the basin. It furnishes municipal water, industrial water, and irrigation water. The behavior and the yield of the river are, therefore, of concern to all interested in irrigation agriculture, in the protection and expansion of business investments, and in the wise and orderly development of the resources of the basin.

4. The potential Gunnison-Arkansas project is a major unit in the comprehensive plan of development of the water resources of the upper Arkansas River Basin which is being investigated by the Bureau of Reclamation. The project is adaptable to construction by suc-

cessive cumulative stages. The initial development is planned as a completely independent multiple-purpose unit that could be the first stage of a much larger project. The comprehensive project would require exportation of a relatively large amount of Colorado River water eastward through the Continental Divide to the Arkansas Valley of Colorado. The full potential uses of water in western Colorado have not been completely determined; therefore, only the amount of water assuredly beyond the requirements for development on the western slope is proposed for diversion at this time.

5. This report and attached substantiating report have been sponsored and prepared by the Bureau of Reclamation for the United States Department of the Interior. All agencies of the Department concerned with the development and administration of resources in the project area have made important contributions. Other Federal agencies, numerous State and local governmental agencies, water districts, civic organizations, corporate enterprises, and private individuals have given substantial aid in the development of the report. Preliminary drafts of the report were furnished to the States of Colorado and Kansas, and to the field offices of affected Federal agencies. These drafts were reviewed by the two States and at field level by the following agencies:

Department of Agriculture:
- Forest Service
- Soil Conservation Service

Department of the Army:
- Corps of Engineers

Federal Power Commission

Department of the Interior:
- Bureau of Mines
- Bureau of Land Management
- Fish and Wildlife Service
- Geological Survey
- National Park Service

Description of Area

PHYSICAL FEATURES

6. Two distinct areas are involved in the project. They are separated by the Continental Divide, which exceeds an altitude of 12,000 feet. The western slope diversion area, where transmountain water would be obtained, is located in the Roaring Fork River Basin of the Colorado River drainage. Water would be diverted from tributaries of the Fryingpan River and from Hunter Creek—both tributaries of the Roaring Fork. The diversion area is mountainous and primitive. It is located within the boundaries of the White River National Forest at elevations above 10,000 feet. Most of the 100-square-mile area is accessible only by trails.

7. The eastern slope project area extends from the headwaters of the Arkansas River, near Leadville, to the Colorado-Kansas boundary. The upper reaches of the Arkansas Valley are as rugged as the diversion area. The Rocky Mountains reach their highest elevation near Leadville at Mount Elbert, 14,431 feet above sea level. Close by are Mount Massive, 14,419 feet, and Mount Harvard, 14,399 feet. Elbert and Massive are the second and third highest peaks in the continental United States. Originating high above timberline, the Arkansas River flows south and east—successively through canyons and foothills to the gently rolling high plains. Approximately 38 percent of the eastern slope project area is below an altitude of 5,000 feet, relatively level, and suitable for farming.

CLIMATE

8. The project area has a range of climate from subhumid in the high mountains to semiarid in the lower altitudes. On the western slope, the village of Nast, located just below the diversion area at an altitude of 8,800 feet, has a mean annual precipitation of 17.86 inches, an average temperature of 36.6° Fahreinheit, and a frost-free period averaging only 66 days. Corresponding data for representative weather stations on the eastern slope are:

Station	Altitude (feet)	Precipitation (inches)	Temperature (°F.)	Frost-free period (days)
Leadville	10,182	18.63	35.6	83
Canon City	5,343	12.98	53.4	168
Pueblo	4,808	11.67	52.0	173
Rocky Ford	4,117	12.30	52.1	165
Lamar	3,615	16.05	54.4	168

POPULATION

9. Unofficial estimates place the population of the upper Roaring Fork River Basin at about 1,000 permanent residents. Aspen, the largest community, had a population of 777 in 1940. Other residents live on ranches or at resorts or in the smaller villages. Few, if any, persons live in the diversion area proper.

10. The population of the eastern slope project area reached 278,000 in 1940. Unofficial local estimates placed the 1948 population at 362,000—a 35 percent increase over 1940. Preliminary unofficial returns of the 1950 census disclose that Pueblo's 1940 population of 52,162 had increased to 63,561 and Colorado Springs' population from 36,789 to 45,269. Other sizable communities in the valley and their 1940 populations are: Leadville, 4,774; Salida, 4,969; Canon City, 6,690; La Junta, 7,040; and Lamar, 4,465.

PRESENT DEVELOPMENT

11. Livestock ranching and the recreational industry are the principal business activities in the upper Roaring Fork Basin. In times past, mining was extensive. This activity had diminished but the latent industry may be revived. Registered Hereford cattle from the western slope have received national recognition. Winter sports, vacationing, and sport fishing are becoming increasingly important throughout the basin. The diversion area proper has no farming although the forest is used for grazing.

12. The upper part of the Arkansas Valley is similar in many respects to the upper Roaring Fork Basin. Mining is important at and near Leadville and winter and summer sports bring many persons to the area. The city of Pubelo is the focal center for the varied industrial development of the valley. The most important industrial enterprises, based upon the 1939 Census of Business, included 1 steel mill, a cement plant, smelters, iron foundries, brick and tile plants, machine shops, and agricultural processing plants, including 23 grain elevators, 3 flour mills, 8 feed grinding and mixing plants, 9 alfalfa mills, 4 meat-packing plants, 3 beet-sugar factories, and 5 canning plants.

13. Agriculture, however, is the most important industry of the valley. More than 87 percent of the land area, including timberland, is used for grazing. Cultivated lands comprise 10 percent of the area of which about one-fourth, or 322,000 acres, is irrigated. The irrigated land exerts an extremely significant influence on the economy of the valley. It stabilizes the economy of an area many times greater than that actually irrigated.

14. Many irrigated crops are grown successfully in the Arkansas Valley when water supplies are adequate. In the higher elevations hay, tame pasture, and small grains predominate. They are marketed chiefly through livestock. The foothills area in Fremont and Pueblo Counties, in addition to general irrigated crops, produce fruits, vine, and truck crops. Below Pueblo the principal irrigated crops are alfalfa, corn, grain sorghum, sugar beets, barley and wheat, truck crops, and dry beans. Cantaloupes, onions, cucumbers, pickles, tomatoes, and red beets are highly successful truck crops. Dairying and poultry raising are important enterprises near market outlets.

15. The size of irrigated farms varies from small truck farms and orchards to general-purpose farms of several hundred acres. In 1940 the average irrigated farm below Salida consisted of 356 acres of which 81 acres were irrigated. Irrigated land values range up to $250 an acre depending upon soils and water rights. Gross crop values also vary considerably. On the basis of 1939–44 crop prices, the average irrigated gross crop values ranged from $30 to $40 an acre over the critical 1930–41 period. Specialty crops and seed crops often provide gross returns many times the average.

16. Ninety-six percent of the irrigated land in the Arkansas Valley is identified as classes 1 and 2 according to Bureau of Reclamation standards. It is of high to medium productive capacity, consists of silty loam, clay loam, and clay soils, and generally has good surface drainage. Alkalinity and salinity are not serious problems.

Need for Development

17. The western slope diversion area proper is national forest land not suitable for irrigation. Other areas in the Colorado River Basin have irrigated and irrigable lands. Present water uses in western Colorado will undoubtedly expand and new uses may materialize. The increased uses may result from expansion of irrigation and from such potential industrial developments as mining, lumbering, woodpulp production, and oil-shale refining. Investigations of the Gunnison-Arkansas project were based upon the principle that all present and potential uses of Colorado River water in the natural basin in Colorado must be protected. Extensive studies by the Bureau and by committees appointed by the Colorado Water Conservation Board confirm the existence of a plentiful supply of water in the diversion area. The studies also substantiate the conclusion that part of that water can feasibly be diverted without detriment to the diversion area or to other existing and potential water uses on the western slope—even though complete future water requirements for all possible uses cannot be foreseen for all of western Colorado. The relatively small diversions proposed for the initial development—replaced in time, quantity, and place by a reservoir near Aspen and by judicious operation of the project based on the operating principles herein-

after set forth—will not impair the future economic growth of the western slope, harm present water users, or create a risk in meeting the Lee Ferry obligation of the Colorado River compact.

IRRIGATION

18. The main agricultural part of the eastern slope project area is in the semiarid zone of 11 to 16 inches of annual precipitation. Seventy to eighty-six percent falls during the April to October growing season. Dry farming is and probably will continue to be practiced extensively. Livestock grazing on the ranges and in the forests is also an extensive enterprise. However, both types of agriculture require large land areas, and dry farming particularly depends upon the vagaries of the weather. General cultivated agriculture and specialty high-value crops, many of which are required to stabilize the agricultural economy of the area, require more water than typical dryland crops. Irrigation is the only means of providing a dependable supply.

19. Early irrigation in the Arkansas Valley coincided with available stream runoff. As ready markets developed, irrigation farming was expanded and a demand developed for late season water which could not be supplied by unregulated streamflow. Consequently, between 1890 and 1910, 3 reservoirs in the headwaters area and 11 off-stream reservoirs below Pueblo were constructed. In 1949 the John Martin Reservoir on the Arkansas River was completed by the Corps of Engineers for conservation storage and flood control. It also has an irrigation storage space of 420,000 acre-feet. The 3 headwaters reservoirs have a capacity of 84,400 acre-feet. The 11 off-stream reservoirs have a present capacity of 300,000 acre-feet which represents about 75 percent of the original capacity as a consequence of sedimentation. Eight privately owned transmountain diversion systems import about 48,000 acre-feet annually.

20. More than 40 canals and ditches supply irrigation water to lands in the valley between Canon City and the Colorado-Kansas boundary. Sediment deposition in canals and ditches has become a major irrigation problem in the Pueblo-Las Animas reach. In some instances long reservoir feeder canals have lost 50 percent of their capacity because of sedimentation.

21. The amount of irrigation water available for the 322,000 acres of irrigated land in the project area varies considerably from year to year. Seldom is the supply adequate for maximum crop production. Irrigation water shortages as high as 78 percent of crop requirements have occurred. The estimated average canal headgate diversion requirement is 3.19 acre-feet an acre. Allowing for tolerable shortages, that headgate requirement can be reduced to 3.10 acre-feet. The average amount of seasonal irrigation water historically available between Pueblo and the Kansas State line has ranged from 0.9 acre-feet an acre in 1934 to 2.7 acre-feet in 1942. The base flow of every stream in the valley is overappropriated. Enhancement of the irrigation water supply depends upon regulation of existing supplies for more efficient use, additional storage capacity for the conservation of excess flood flows, reservoir space for holdover storage, and new water supplies for which the only apparent source is transmountain diversion from the Colorado River drainage.

POWER

22. Power facilities of the initial development will be designed for integration with the power facilities of the Bureau's Colorado-Big Thompson project and with local utilities to serve a combined power-market area. The combined area, which consists of the entire eastern slope of Colorado and Grand and Summit Counties on the western slope, comprises roughly two-thirds of the State and contains a large majority of the State's population and industries. The area is served with electricity by 15 private utilities, 25 municipal organizations, 11 REA cooperatives, and the Bureau of Reclamation. Although not considered a permanent part of the power-market area, loads in the vicinity of Gunnison and Saguache may be served originally by the initial development because of their proximity to the project power system. The Colorado-Big Thompson project has, among other features, the 21,600-kilowatt Green Mountain hydroelectric plant now in operation on the western slope, and, when completed, will also have hydroelectric plants on the eastern slope north of Denver.

23. In December 1948—the latest year of complete record—installed generating capacity in the combined power-market area totaled 347,105 kilowatts. Of that total, 339,000 kilowatts were dependable capacity. Only about 20 percent of the installed capacity was hydropower. Steam capacity comprised 73 percent. A number of industrial plants in the area have their own generating systems which, combined, have an installed capacity of about 85,000 kilowatts.

24. The noncoincident peak demand for power in the market area in 1948 reached 300,000 kilowatts—about 12 percent more than the net assured capacity of 267,000 kilowatts. Forecasts indicate that the dependable capacity requirements will be about 632,000 kilowatts by 1960 and 966,000 kilowatts by 1970. On the basis of 1948 installations, plus all known additions scheduled or projected, less normal or necessary retirements, the market area will still have a deficiency in power supply.

25. As of 1950, eastern Colorado does not have a high-voltage transmission system interconnecting all important load centers. Ties of utilities to enable interchange of power are essential for maximum efficiency of service and utilization.

MUNICIPAL WATER

26. Most of the Arkansas Valley towns below Pueblo obtain municipal water from pumped wells. Other valley communities use water from streams and springs. In general, the quality is poor because of excessive hardness.

27. Colorado Springs obtains excellent water from the slopes of Pikes Peak. The city experienced water shortages prior to 1937. Since then, its water-storage capacity has been doubled and all service connections have been metered. The city has indicated an urgent need of 4,000 acre-feet of supplemental municipal water immediately and a probable need for an additional 16,000 acre-feet by the year 2000. In 1949, Colorado Springs started drilling the Hoosier Pass transmountain diversion tunnel which would import western-slope water from the Blue River. The city has expressed interest in obtaining supplemental municipal water from the initial development by exchange methods.

28. Pueblo obtains its municipal water from the Arkansas River. During periods of low flows the water is of poor quality. The water is relatively hard and unpalatable. In 1938, Pueblo acquired the Wurtz ditch which imports annually about 2,000 acre-feet of water from the western slope. Much of the yield from that transmountain project is lost to municipal use for lack of storage space. The city has indicated an immediate need for 5,000 acre-feet of municipal water (including the 2,000 acre-feet of Wurtz ditch water) and an ultimate additional need of 15,000 acre-feet by the year 2000. The city has also expressed interest in obtaining treatment of its present supply of 21,000 acre-feet.

29. Canon City and Rocky Ford obtain municipal water from the Arkansas River. Canon City has not requested project water.

30. The towns of Manzanola, Rocky Ford, La Junta, Las Animas, and Lamar, and the offstream towns of Crowley, Wiley, and Eads have requested treated municipal water from the project to replace entirely their present supplies. Their immediate needs are about 8,000 acre-feet.

FLOOD CONTROL

31. Few damaging floods of record have occurred in the diversion area and in the Arkansas Valley down to Canon City. From there eastward, however, damaging floods increase in frequency and volume to the mouth of the Purgatoire River. The largest flood of record in the project area occurred in June 1921. Intense rains caused flows at Pueblo estimated at 103,000 second-feet. Downstream tributaries contributed to the flood until the peak of 200,000 second-feet was reached at La Junta. The flood killed at least 78 persons; property damages exceeded $19 million, including $10 million in Pueblo.

32. As a result of that disastrous flood, a barrier dam across the Arkansas River, 6 miles west of Pueblo, and an improved floodway channel through the city were completed in 1926. Another flood-control structure, the John Martin Reservoir, located on the Arkansas River near Lamar, Colo., was completed in 1949 by the Corps of Engineers. A multiple-purpose project, 281,000 acre-feet of its 701,000 acre-foot capacity are allocated to flood control.

33. A flood danger still exists from Pueblo downstream to the John Martin Reservoir. The Corps of Engineers has estimated that the annual damages along that reach of the river average $890,000. The initial development could eliminate about 66 percent of that probable damage.

ASSOCIATED NEEDS

34. Sediment control, stream-pollution abatement, enhancement of the environment for fish and wildlife, and provision for recreation are other needs of the project area associated with water development. Industrial expansion, conservation of forest and range lands, and stabilization of the entire economy by balanced diversification of interest are recognized as long-range objectives. The initial development could immediately ameliorate some of the problems stemming from those needs. Resolution of the long-range objectives will require coordinated and unselfish cooperation by all citizens, agencies, and entities concerned.

35. Mention has already been made of the acute sedimentation problem affecting irrigation in the main Arkansas Valley. At Pueblo the river annually transports about 944 acre-feet of sediment. Approximately 42 percent of that sediment is deposited in reservoirs, canals, and laterals; about 38 percent becomes undesired deposition on the irrigated lands. Aggradation of the river channel has made some irrigation diversion structures inoperative; other diversion structures have necessarily been raised. Removed sediment now lines some canal banks and further disposal has become very expensive. Canal sand traps have become inoperative. The only apparent immediate solution is provision of reservoir space specifically for the disposition of sediment.

36. Stream pollution has not reached dangerous or serious proportions in the Arkansas Valley. The most noticeable effects of industrial pollution are found below Leadville as a result of mine drainage and tailings.

37. Fishing is a summer sport of considerable financial significance in the diversion area and in the upper Arkansas Valley. The Fish and Wildlife Service has prepared a preliminary report on the subject and has made tentative recommendations concerning minimum flows needed to preserve fishery values in the diversion area. The project has been so planned and operating rules have been so formulated as to prevent the diversion of water which would reduce the flows below the specified minimum. Continued studies of the requirements of the fishery resources are needed to develop refinements under the terms of the operating rules.

38. The mountainous portions of both slopes of the project area—and especially the diversion area—combine such desirable qualities as scenic attractiveness, wilderness character, remoteness, water for fishing, and skiing facilities. Consequently, they are important recreational areas at all seasons. The National Park Service has made a preliminary report on the project area and on the recreational aspects of the initial development. Its recommendations will be followed to the fullest extent possible.

Plan of Development

39. The initial development is keyed to transmountain diversion of water from the Colorado River drainage eastward to the upper Arkansas River Valley. The diverted water and reregulated native eastern-slope water would provide for supplemental irrigation, furnish supplemental and new supplies of municipal water, and enable the generation of hydroelectric power. Other multiple-purpose aspects of the project include flood and sediment control, stream-pollution abatement, fish and wildlife conservation, and enhancement of recreational opportunities. All estimates, specifications, and description of features are necessarily preliminary and subject to some modification and refinement when detailed data become available.

40. As a result of the diversion of water from the Colorado River Basin, this potential initial development is consistent with the purposes of the Colorado River storage project. The extent of its relationship to the upper Colorado River Basin development and to the upper Arkansas River Basin development can be more firmly established as those developments proceed. In its plan for the Colorado River storage project the Bureau of Reclamation contemplates at least six

major regulatory reservoirs in the upper Colorado River Basin. The need for the storage project stems from the compacts pertaining to Colorado River waters. The Colorado River compact apportions the use of 7.5 million acre-feet of water annually to the upper Colorado River Basin. It also provides that the States of the upper division (Colorado, New Mexico, Utah, and Wyoming) will not cause the flow of the river at Lee Ferry, Ariz., to be depleted below an aggregate of 75 million acre-feet for any period of 10 consecutive years. This compact was signed November 24, 1922, and made effective pursuant to the terms of the Boulder Canyon Act. The upper Colorado River compact in turn apportions the use of Colorado River water to the 4 States and Arizona, and provides for the sharing of joint water obligations of the 4 States. The upper Colorado River compact was signed October 11, 1948, subsequently ratified by the Upper Basin States and approved by the Congress. Full consummation of the apportioned uses of Colorado River water in the Upper Basin States, consistent with the rights and obligations of the compacts and the Mexican Treaty of 1945, would require construction of major regulatory reservoirs in the upper basin.

WESTERN-SLOPE FEATURES

41. A system consisting of about 50 miles of canals and tunnels would enable the collection of water from Hunter Creek and the Fryingpan River—both tributaries of the Roaring Fork River. The water so collected would be diverted to the eastern slope through the potential Fryingpan-Arkansas tunnel, about 6 miles in length. Since 1935, the Twin Lakes Reservoir & Canal Co. has diverted western-slope water from the Roaring Fork drainage to its reservoir on the eastern slope. The company has a legal right to divert more water than it has diverted to date; but such increased diversions would be detrimental to fishery values in the Roaring Fork River and its tributaries above Aspen. In order to preserve those fishery values the project plan includes an extension of the collection system to the South Fork of Hunter Creek and enlargement of other project facilities to permit an exchange of water with the Twin Lakes Co. This plan hinges upon the execution of agreements whereby the company would refrain from certain diversions through its own system whenever the natural flow of the Roaring Fork River falls below a specified minimum in exchange for an equivalent supply delivered on the eastern slope through project facilities. The cost of these specific facilities and enlargements is estimated at $2,179,000 and is considered economically justifiable by the Fish and Wildlife Service on the basis of resulting benefits.

42. The Aspen Reservoir would be constructed near the town of Aspen to provide replacement water and also to provide water for future use in meeting demands in western Colorado. The reservoir, which would inundate about 650 acres and have an active capacity of 28,000 acre-feet, would be created by an earth-fill dam about 90 feet in height. A short supply canal would divert water from Hunter Creek to the reservoir.

43. The Aspen Dam site is at an altitude of 8,017 feet. The collection system for the transmountain diversion would be entirely above 10,000 feet altitude. The chief construction problems will be the short working season and transportation of materials.

44. The western-slope features would enable the average annual diversion of an estimated 69,200 acre-feet of project water. As a result of eastern-slope storage to be provided by the project, about 14,900 acre-feet of water could also be diverted annually by the Twin Lakes Co., which cannot now be diverted for lack of storage capacity. This would be in addition to its present average diversion of 38,000 acre-feet.

EASTERN SLOPE SUPPLY AND POWER FEATURES

45. In round figures, the major potential eastern slope project facilities include 3 earth-fill dams, 60 miles of power canal ranging in capacity from 300 to 1,000 second-feet, 3 diversion dams, over 10 miles of diversion canals, 7 hydroelectric powerplants and switchyards, 3 small forebays and 2 afterbays, 9 substations, about 400 miles of transmission line, and a municipal water supply system. The latter system includes: 1 diversion dam, 15 miles of reservoir supply canal for irrigation replacement water, 3 pumping plants, 1 small regulating reservoir, 1 treatment plant, and about 175 miles of pipelines. Other structures and equipment would be required for construction and operation such as one permanent camp, caretakers' residences and shops, warehouses, construction camps, offices and laboratories, and a communications system.

46. Imported and native water would be stored first in an enlarged Sugar Loaf Reservoir on the Lake Fork of the Arkansas River. Releases would flow about 20 miles south in the Elbert section of the Arkansas power canal, then through the Elbert hydroelectric powerplant and into the enlarged Twin Lakes Reservoir. The 10-mile Snowden Canal would divert additional Arkansas River water into the Twin Lakes Reservoir. From there, the water—increased by tributary interceptions and by the Wapaco diversion from the river—would flow south some 40 miles in the Arkansas power canal and be returned to the main stream near Salida. Power would be generated en route in the Granite, Wapaco, Princeton, Johnson, and Salida hydroelectric powerplants. Forebays would be provided above the Princeton, Johnson, and Salida plants. The existing Clear Creek Reservoir (capacity about 11,400 acre-feet) would be adapted for use as an afterbay for the Granite powerplant. An afterbay would be provided on the Arkansas River for the Salida plant. Near Salida and Canon City some water might be diverted for irrigation. The remainder would continue down the river to the potential Pueblo Reservoir. Most of the supplemental irrigation releases from that reservoir would be made through the Pueblo hydroelectric powerplant.

47. Summarized data on the three major eastern slope dams and reservoirs are as follows:

Dam or reservoir	Present reservoir capacity (acre-feet)	Potential dimensions			
		Total capacity (acre-feet)	Active capacity (acre-feet)	Normal surface area (acres)	Height of dam (feet)
Sugar Loaf	17,000	117,000	117,000	1,550	140
Twin Lakes	56,000	260,000	260,000	4,160	105
Pueblo	----------	400,000	390 000	6,700	180
Total	73,000	777,000	767,000	12,410	----------

48. The Colorado Fuel & Iron Corp., owner and operator of the Sugar Loaf Reservoir, has informally requested 10,000 acre-feet of project reservoir storage space in addition to replacement of its present capacity. The Twin Lakes Reservoir & Canal Co. has made a similar request for 54,000 acre-feet of additional reservoir storage space. Both companies would pay a service charge. Capacities of the potential eastern slope reservoirs have been tentatively allocated as follows:

Function	*Acre-feet*
Conservation	315, 600
Power	135, 000
Flood control (Pueblo Reservoir)	93, 000
Sediment control (Pueblo Reservoir)	94, 400
Dead storage (Pueblo Reservoir)	2, 000
Colorado Fuel & Iron Corp	27, 000
Twin Lakes Co	110, 000
Total	777, 000

49. The 7 powerplants would have a total installed capacity of 104,800 kilowatts and an annual average output of 505 million kilowatt-hours of which 400 million kilowatt-hours would be firm energy. Losses would reduce the salable energy to approximately 467.2 million kilowatt-hours of which 370 million kilowatt-hours would be firm. Associated major power facilities include 7 switchyards with a combined capacity of 116,440 kilovolt-amperes and a transmission system consisting of about 400 miles of 115-kilovolt lines with 9 substations. The transmission system would serve customers of the United States and would interconnect with other utilities and enable the interchange and wheeling of power from various sources. The Colorado Fuel & Iron Corp. intermittently produces waste-heat electric energy as a result of steel mill operations. If agreements could be reached, such energy might be fed into the project system on an exchange basis or under some other arrangement whereby more efficient project power operation would result. Additional generation in the Elbert powerplant might accrue from the exchange of Twin Lakes water involved in the maintenance of fish flows in the Roaring Fork River.

50. The Pueblo Reservoir would inundate some 500 acres of irrigated land. All other lands in the Eastern Slope reservoir sites and for the canals are either low value private land or public land. The eastern slope reservoirs would require the relocation of about 20 miles of State highway and 20 miles of railroad, but no unusually difficult construction problems have become apparent. The high altitude and short working season pose some problems for the Sugar Loaf and Twin Lakes enlargements and associated facilities. The dam and reservoir sites are situated over glacial moraines which may result in some seepage; however, tightness beyond stability is not necessary.

MUNICIPAL WATER SYSTEM

51. The project could provide supplemental municipal water for Colorado Springs and Pueblo. Complete replacement of existing municipal supplies has been requested by the valley towns of Manzanola, Rocky Ford, La Junta, Las Animas, Lamar, Crowley, Wiley, and Eads. Tentatively, 15,000 acre-feet of project water have been

reserved annually for municipal use. Specific municipal supply facilities outlined hereafter in paragraphs 52 and 56 are included in the project plan as a requested service. Such construction is proposed only if construction by the communities themselves proves to be infeasible. This phase of the project is flexible and susceptible of modification or elimination, in whole or in part, without rendering the remainder of the project economically infeasible.

52. A supplemental municipal supply for Colorado Springs would involve an exchange of irrigation water by means of project facilities. A pumping plant on upper Middle Beaver Creek would lift water to the city's system on Pikes Peak. En route to the city, the water would generate energy in two municipal powerplants, the output of which would exceed the loss in the Skaguay hydroelectric powerplant, on Middle Beaver Creek, owned by the Southern Colorado Power Co. Colorado Springs could reimburse the company for the lost power value. Replacement of the diverted water for irrigation use near Penrose would be accomplished by diverting water from Oil Creek to the existing Brush Hollow Reservoir. A diversion dam and a 15-mile supply canal would be necessary. Through a series of exchanges and coordinated operation of the Mount Pisgah Reservoir on Oil Creek and the Skaguay Reservoir, satisfactory replacement of irrigation water in the Arkansas Valley could be achieved.

53. Four thousand acre-feet of project water annually have been allotted to Colorado Springs for its immediate requirements. Of this 4,000 acre-feet, 2,700 acre-feet could be pumped into the city's system from Beaver Creek. Replacement of this 2,700 acre-feet for irrigation would require 3,200 acre-feet of project water due to transit and other losses. The remaining 800 acre-feet of project water represents reserve for replacement of possible diversions to the city from other tributaries of the Arkansas River.

54. Pueblo requires 3,000 acre-feet of project water annually. Project facilities would also enable the conservation of 2,000 acre-feet of Wurtz ditch transmountain water for municipal use and treatment of Pueblo's present supply of 21,000 acre-feet. Delivery of water to Pueblo would be accomplished from the Pueblo Reservoir through a central system for all valley towns.

55. The valley towns require 8,000 acre-feet of project water annually of which 460 acre-feet represents a reserve for those communities and others. The water would entirely replace existing unsatisfactory supplies.

56. Specific facilities for supplying Pueblo and the valley towns with municipal water include a pumping plant at the Pueblo Reservoir, a water-treatment plant, a dual pipeline to Pueblo and a small regulating reservoir, a trunk pipeline about 130 miles in length to Lamar, and about 36 miles of branch pipelines to Crowley, Wiley, and Eads.

57. The municipal water-supply system would involve no unusual construction problems or difficulties in securing rights-of-way.

CONSTRUCTION SCHEDULE

58. About 10 years would be required to construct the initial development. Early concurrent construction of the Aspen, Twin Lakes, and Pueblo Reservoirs, the Fryingpan-Arkansas Tunnel, and several

eastern slope canals is planned to facilitate filling the reservoirs. The western slope collection system would be expanded gradually from the transmountain tunnel. All hydroplants except Pueblo have been scheduled for simultaneous completion so their operation can be integrated as a unit.

WATER SUPPLY

59. The first phase of the Gunnison-Arkansas project (Roaring Fork diversion) contemplates the average annual consumptive use of water from the Colorado River Basin as follows (measured at points of diversion):

Explanation	*Acre-feet*
Diversion from project collection system of project water	69, 200
Diversion for fish-preservation purposes	3, 000
Losses from Aspen Reservoir and consumptive losses in collection conduit	3, 000
Total	75, 200

60. The water to be imported from the Colorado River watershed is to come out of Colorado's apportionment under the upper Colorado River Basin compact of October 11, 1948. Under that compact, the State of Colorado is apportioned the consumptive use of 51.75 percent of the water available for use in the upper Colorado River Basin, after deducting a use of not to exceed 50,000 acre-feet annually in Arizona. Colorado's apportionment of Colorado River Basin water is estimated to be about 3,855,000 acre-feet annually. It is estimated that about 1,590,000 acre-feet will be required for use by existing and authorized projects, leaving 2,265,000 acre-feet annually for use by future projects. Of this amount it is estimated that 440,000 acre-feet should be reserved to meet Colorado's share of depletions caused by main stem reservoirs required for long-time holdover storage to make the water available for use under the Colorado River compact. About 1,825,000 acre-feet annually would remain for use by potential projects. These figures indicate the availability of about 1,750,000 acre-feet of water annually, after full development of the proposed initial development, Gunnison-Arkansas project, to meet other potential uses of Colorado River water in Colorado.

61. The 1947 report on the Colorado River (H. Doc. 419, 80th Cong., 1st sess.) shows estimated uses by potential irrigation projects, within the natural Colorado River Basin in Colorado, of 870,000 acre-feet annually. Studies are under way to refine the estimate of potential within-basin uses in Colorado for all purposes including industrial uses. Review of available information shows that the total of all such potential uses will likely be less than the figure of 1,750,000 acre-feet.

62. Present and prospective uses from Fryingpan River would be supplied by the bypass of water from the collection canals. Storage releases from the Aspen Reservoir would replace water diverted that would otherwise be needed by present and prospective users along the Roaring Fork and Colorado Rivers.

63. During the 1911–44 period of study the natural water supply of the project area between Pueblo and the Colorado-Kansas boundary averaged 1,143,000 acre-feet annually, including return flows but

excluding about 48,000 acre-feet from 8 transmountain diversions. Disposition of the average annual supply was as follows:

Disposition	*Acre-feet*
Summer irrigation	656, 000
Winter irrigation	160, 000
Reservoir evaporation	50, 000
Outflow to Kansas	277, 000
Total	1, 143, 000

64. The estimated ideal headgate diversion requirements during the irrigation season average 983,000 acre-feet. Reconstructed data showing the effect of Twin Lakes diversion and the John Martin Reservoir—had they been in operation for that entire period—disclose that the historical headgate diversions would have averaged 720,000 acre-feet seasonally, of which 643,000 acre-feet would be within the ideal irrigation schedule. The difference of 340,000 acre-feet represents the average annual headgate shortage. Through optimum utilization of all available supplies, new transmountain diversions, and reuse of return flows, the project could effectuate an estimated supply of 184,600 acre-feet of supplemental irrigation water at the canal headgates in the main valley. That supply would reduce the average annual headgate shortage to about 155,000 acre-feet, a reduction from 35 percent shortage of ideal requirements to about 16 percent shortage.

65. The total irrigation water supply to be made available by the project would consist of imported water, conserved floodflows, private supplies reregulated in project reservoirs, and usable return flows. Reregulated private supplies include some winter flows of the Arkansas River that are presently diverted for direct-flow use but which, by agreement, could be converted to more beneficial summer use through storage in the Pueblo Reservoir. Return flows of the project municipal water are estimated at 70 percent. The total irrigation headgate supply is estimated at 50 percent more than the initial supply, based upon successive reuses of the water at the rate of 40 percent return flow from each application. The next table shows the source of water to be made available for the Arkansas Valley, reconstructed as annual averages for the 1911–44 period of study.

[Thousands of acre-feet]

Source	Gross	Losses	Net	Headgate supply
Fryingpan diversion	69.2	15.5	53.7	
Arkansas River floods	50.0	32.0	18.0	
Total project water	119.2	47.5	71.7	
Less municipal water	15.0		15.0	
Project irrigation supply	104.2	47.5	56.7	85.1
Municipal return flow: Arkansas Valley	7.0	2.5	4.5	6.7
Additional Twin Lakes diversion	14.9	2.4	12.5	18.8
Converted winter flow	93.0	19.0	74.0	74.0
Total valley irrigation supply	219.1	71.4	147.7	184.6
Tributary municipal return flow			3.5	5.2
Total usable irrigation supply			151.2	189.8

FINANCES AND PROJECT OPERATION

66. Based upon preliminary designs, and upon prices prevailing in October 1949, the estimated construction cost of the project is

$147,440,000. About 25 percent of that cost would be for western slope structures and the transmountain tunnel. The annual operation, maintenance, and replacement expense is estimated to be $1,335,200.

Feature	Construction cost	Annual operation, maintenance, and replacement
Dams and reservoirs	$64,334,000	$30,760
Diversion canals and conduits	30,499,000	65,870
Power features	34,021,000	846,990
Municipal supply systems	18,050,000	391,580
Operation and maintenance during construction	536,000	0
Total	147,440,000	1,335,200

COST ALLOCATION

67. Construction costs have been allocated to the various project functions through use of the alternative justifiable expenditure method. That method utilizes the estimated cost of the most economical substitute single-purpose facility which would provide benefits equivalent to those accruing in a multiple-purpose development. The tentative allocation of construction costs and distribution of annual operation, maintenance, and replacement expenses are as follows:

Function	Construction cost	Annual operation, maintenance, and replacement
Irrigation	$59,930,000	$76,080
Power	40,032,000	854,050
Municipal water	29,522,000	405,070
Total returnable	129,484,000	1,335,200
Flood control	15,777,000	(1)
Fish and wildlife	2,179,000	(1)
Total nonreturnable	17,956,000	
Total costs	147,440,000	1,335,200

[1] Included above.

PROJECT OPERATION AND RETURN ON INVESTMENT

68. The plan of operation calls for the formation of a water conservancy district, under the Colorado Water Conservancy District Act of 1937, as amended, which would contract with the Government for payment of project services performed in the collection, storage, regulation, and release of water. Supplemental irrigation water at specified rates would be released to the district at reservoir outlets or possibly along the river, depending upon circumstances. The proposed basic rate of $3.60 per acre-foot at the Pueblo Reservoir has been determined to be within the payment capacity of the water users. The district would assume responsibility for delivery of irrigation water. This district, or possibly another entity, would contract with the Government for Federal construction of the specific municipal water system, for district operation and maintenance of that system, and for delivery of water from the joint water supply

system. The district would also have other sources of annual revenue: levies from an ad valorem tax on taxable property benefited by the project, a service charge for the storage of the additional Twin Lakes irrigation water, and a service charge for project storage of the additional C. F. & I. industrial water which is included with municipal supplies for payout analysis. Estimated annual project revenues, exclusive of revenues expected from the regulation of winter water, are shown in the following table:

Function and source of revenue	*Annual value*
Irrigation and district:	
Project water (56,700 acre-feet, at $3.60)	$204, 120
Twin Lakes service (12,500 acre-feet, at $2)	25, 000
District tax ($132 million, at 1 mill minus 10 percent)	119, 000
Subtotal	348, 120
Less operation, maintenance, and replacement	76, 080
Net irrigation revenues	272, 040
Power:	
370,000,000 kilowatt-hours, at 5.5 mills; 97,125,000 kilowatt-hours, at 3.5 mills	2, 374, 938
Less operation, maintenance, and replacement	854, 050
Net power revenues	1, 520, 888
Municipal and industrial water:	
Municipal supplies (38,000 acre-feet, at various rates)	1, 476, 410
Colorado Fuel & Iron (4,000 acre-feet, at $2)	8, 000
Subtotal	1, 484, 410
Less operation, maintenance, and replacement	405, 070
Net municipal water revenues	1, 079, 340
Total annual net project revenue	2, 872, 268

69. Parts of the interest on return payments from power (3 percent) and municipal water (2 percent) would be applied to the irrigation investment. The sources of revenue for retirement of returnable costs are shown below.

Source	Project revenue	Cost allocation
Irrigation:		
Net revenue, irrigators and district, 40 years	$10, 881, 600	
From power revenue, 38 years	35, 478, 000	
From municipal water revenue, 38 years	13, 570, 400	
Retired allocation		$59, 930, 000
Power:		
Net revenue, 53 years	80, 324, 113	
Less interest to irrigation, 38 years	−35, 478, 000	
Less unapplied interest	−4, 570, 849	
Less earned surplus, 53d year	−243, 264	
Retired allocation		40, 032, 000
Municipal water:		
Net revenue, 40 years	43, 173, 600	
Less interest to irrigation, 38 years	−13, 570, 400	
Less unapplied interest	−72, 669	
Less earned surplus, 40th year	−8, 531	
Retired allocation		29, 522, 000
Total allocation returned by revenues		129, 484, 000

70. If the value for the regulation of winter water is estimated at $1.25 per acre-foot, which is comparable to current costs for like services, an additional return of $3,700,000 or more can be expected from irrigation over the repayment period. The actual value remains to be determined. The value of this service must be an amount substantially less than $3.60 per acre-foot, which is the value at the Pueblo Reservoir established for a new supplemental water supply.

BENEFITS

71. The economic justification of any project can be tested by a benefit-cost ratio which measures the benefits obtainable contrasted with the attendant Federal costs of bringing about those benefits. The net Federal project investment consists of the total construction cost plus interest at the rate of 2½ percent during construction less the present worth of the hundredth-year terminal salvage value of principal project works. That investment is translated into an annual equivalent by amortization over 100 years at 2½ percent. The annual project investment cost is obtained by adding to the annual equivalent the adjusted annual operation, maintenance, and replacement expense.

Annual benefits:	
Irrigation	$3, 339, 000
Power	4, 064, 000
Municipal water	1, 662, 000
Flood control	583, 000
Sediment control	141, 000
Total annual benefits	9, 789, 000
Annual costs:	
Project investment	4, 165, 000
Adjusted operation, maintenance, and replacement	1, 403, 000
Total annual costs	5, 568, 000

Benefit-cost ratio: 1.76 to 1.00.

72. The preceding calculation includes direct and indirect benefits for the initial development. It is significant that the sum of direct irrigation benefits to farmers of $1,065,000, direct power benefits of $2,375,000, and benefits to municipal water, flood control, and sediment control is sufficient to support the annual project costs.

73. The report on the Colorado River storage project and participating projects presents a plan for a system of regulatory reservoirs that would permit maximum development of the upper Colorado River Basin water resources for beneficial consumptive uses and assure the required deliveries of water at Lee Ferry to meet the requirements of the Colorado River Compact. If it is assumed that the Colorado River storage project will be constructed, and if it is considered proper in analyzing the Gunnison-Arkansas project to assign an appropriate share of the cost of the Colorado River storage project, then the assignable annual cost to the Gunnison-Arkansas project is estimated at $2.35 per acre-foot of consumptive use of water. The net effect, so far as the Gunnison-Arkansas project is concerned, would be to alter slightly the economic justification. The annual cost would increase from $5,568,000 to $5,731,000, and the benefit-cost ratio would be reduced slightly from 1.76:1.00 to 1.71:1.00.

OPERATING PRINCIPLES

74. On November 24, 1948, a policy and review committee was organized by the Colorado Water Conservation Board to study and review plans and reports on the first stage of the Gunnison-Arkansas project. The committee was composed of representatives of the board, the Colorado Game and Fish Commission, western Colorado, the Arkansas Valley, and the city of Colorado Springs. The committee recommended the following principles of project operation on January 19, 1951:

The construction and operation of the project involve the diversion of water from the headwaters of the Fryingpan River and other tributaries of the Roaring Fork River to the Arkansas River Basin. The project contemplates—

(*a*) The maximum conservation and use of the diverted waters;

(*b*) The protection of western Colorado water uses, both existing and potential, in accordance with the declared policy of the State of Colorado; and

(*c*) The preservation of recreational values.

In order to accomplish such purposes the project shall be operated by the United States in compliance with the Federal reclamation laws, the laws of the State of Colorado relating to the appropriation, use, or distribution of water, and the following operating principles:

1. As used herein:

(*a*) "Project" means that certain enterprise planned and designed by the Bureau of Reclamation, Department of the Interior, for the transmountain diversion of water from the headwaters of the Fryingpan River and other tributaries of the Roaring Fork River to the basin of the Arkansas River, together with all of its appurtenant works and facilities in both eastern and western Colorado.

(*b*) "Eastern Colorado" means that portion of the State of Colorado lying within the natural drainage basin of the Arkansas River.

(*c*) "Western Colorado" means that portion of the State of Colorado lying within the natural drainage basin of the Colorado River and served by diversions made from the Colorado River, or its tributaries, above its confluence with the Gunnison River.

(*d*) "Eastern Colorado Conservancy District" means that entity to be hereafter created to contract for payment to the United States of an appropriate portion of project costs allocated to certain water uses in eastern Colorado.

(*e*) "Aspen Reservoir" means not only the reservoir presently planned for construction near the town of Aspen as part of the project but also, unless the context requires otherwise, any other reservoir that may be constructed in western Colorado above the town of Aspen in lieu of that reservoir for the purpose of protecting water users in western Colorado.

(*f*) "c. f. s." means cubic feet of water per second of time.

2. The Aspen Reservoir shall be constructed and maintained on the Roaring Fork River above the town of Aspen, Colo., with an active capacity of about 28,000 acre-feet and with a reasonable expectancy that it will fill annually. The 28,000 acre-feet of water stored therein shall be available for replacement purposes in western Colorado. All of such stored water shall be released under the conditions and limitations hereinafter set forth.

3. The cost of construction and perpetual operation and maintenance of the Aspen Reservoir shall be a charge against the project and shall be paid from project revenues or as otherwise provided by the Congress of the United States.

4. The Aspen Reservoir shall be completed before any water is diverted to eastern Colorado by means of the project.

5. The primary purpose of Aspen Reservoir is to furnish, in like manner as if the project were constructed by a water conservancy district organized pursuant to the laws of the State of Colorado, the water required for the protection of western Colorado water users by the provisions of section 1, chapter 192, Colorado Session Laws, 1943, reading as follows: "*Provided, however*, That any works or facilities planned and designed for the exportation of water from the natural basin of the Colorado River and its tributaries in Colorado, by any district created under this chapter, shall be subject to the provisions of the Colorado River Compact and the Boulder Canyon Project Act, as amended; that any such works or facilities shall be designed, constructed and operated in such a manner that the present appropriations of water, and in addition thereto prospective uses of water

for irrigation and other beneficial consumptive-use purposes, including consumptive uses for domestic, mining and industrial purposes, within the natural basin of the Colorado River in the State of Colorado, from which water is exported, will not be impaired nor increased in cost at the expense of the water users within the said natural basin; and that the facilities and other means for the accomplishment of said purpose shall be incorporated in, and made a part of, any project plans for the exportation of water from said natural basin in Colorado."

6. The replacement capacity of the Aspen Reservoir is that portion of the total reservoir capacity required to protect existing rights to the use of water in western Colorado for domestic, irrigation, and manufacturing purposes (including power generation) and hereafter acquired rights to the use of water in western Colorado for domestic irrigation, and manufacturing purposes (excluding power generation) against any and all losses of needed water because of stream depletions resulting from project operations. In the determination of such replacement capacity, consideration shall be given to, but not necessarily limited to, needs for water for the following purposes, such needs, however, not to be for quantities in excess of those quantities of water which would have been available from the Roaring Fork River to supply such needs if the project had not been constructed:

(*a*) To supply existing rights below Aspen Reservoir;

(*b*) To irrigate new land and provide for supplemental irrigation in western Colorado;

(*c*) To satisfy the obligation of the Roaring Fork River to contribute its proportional share of the required winter flows at a point immediately below the confluence of the Roaring Fork River and the Colorado River; and

(*d*) To satisfy the obligation of the Roaring Fork River to contribute its proportional share of a demand of at least 300,000 acre-feet of water annually in the Colorado River below its confluence with the Roaring Fork River, for domestic and manufacturing uses. Said demand for use in western Colorado is to be met at the times and in the amounts required.

Water stored in the replacement capacity of the Aspen Reservoir shall be released by the United States, upon the request of the State administrative agency having responsible charge of the distribution of the water of the stream or streams affected, whenever the needs in the Colorado River Basin in western Colorado below the project diversion points for the uses covered by this paragraph 6 exceed the available supply of water; provided that the rate of release of such stored water shall be reasonable and proper with due regard for the needs in western Colorado for replacement water and with due regard, also, for the obligation of the project to supply such water.

No charge shall ever be imposed for water released from, or made available by reason of releases from, the replacement capacity of the Aspen Reservoir.

7. That portion of the total capacity of the Aspen Reservoir not needed as replacement capacity constitutes surplus capacity. Water stored in such surplus capacity may be sold or leased by the United States to water users in western Colorado. Charges for the use of such water shall be comparable to charges for use of project water for similar purposes in eastern Colorado with appropriate adjustment for the repayment ability of such water users. If it hereafter appears that the cost of procuring water, from sources other than the surplus capacity of the Aspen Reservoir, for the same uses as those to which water from the surplus capacity of the reservoir is to be made available shall have been increased by reason of the construction and operation of the project, then the charges for water released from the surplus capacity shall be diminished by the amount of such increase in cost.

8. Project diversions from Lime Creek shall be made only in the months of May and June of each year.

9. To protect recreational values, including fishing, no diversions from western Colorado will be made which reduce the remaining aggregate stream flows to less than either of the following minimum standards:

(*a*) The Fryingpan collection system at the points of diversion collectively, exclusive of Lime Creek: 15 c. f. s. October 1 through March 31; 30 c. f. s. April 1 through September 30;

(*b*) Near Norrie (immediately below the junction of North Fork and Fryingpan River): 30 c. f. s. October 1 through March 31; 100 c. f. s. April 1 through April 30; 150 c. f. s. May 1 through May 31; 200 c. f. s. June 1 through June 30; 100 c. f. s. July 1 through July 31; 75 c. f. s. August 1 through August 31; 65 c. f. s. September 1 through September 30.

In maintaining the above minimum standards, the project diversions shall be regulated, so far as is practicable, in such a manner that the North Fork, the Fryingpan River, and each of the tributaries of those streams, shall contribute

to the residual stream flows required by those minimum standards quantities of water in proportion to their natural contributions.

10. An appropriate written contract shall be made whereby the Twin Lakes Reservoir and Canal Co. shall refrain from diverting water whenever the natural flow of the Roaring Fork River and its tributaries shall be only sufficient to maintain a flow equal to or less than that required to maintain the recommended average flows in the Roaring Fork River at the head of the proposed Aspen Reservoir in a quantity proportionate to the respective natural contributions of those streams from which diversions are made to the natural flow of the Roaring Fork River. The recommended average flows above mentioned are flows in quantities equal to those recommended as a minimum at the head of the Aspen Reservoir according to the following schedule submitted by the United States Fish and Wildlife Service and the Colorado Game and Fish Commission:

Month	Average second-feet	Acre-feet (1,000)	Month	Average second-feet	Acre-feet (1,000)
October	44	2.7	May	100	6.2
November	35	2.1	June	120	7.1
December	29	1.8	July	100	6.2
January	26	1.6	August	63	3.9
February	25	1.4	September	44	2.6
March	24	1.5			
April	64	3.8	Total		40.9

In maintaining the above averages, at no time shall the flow be reduced below 15 c. f. s. during the months of August to April, inclusive, or below 60 c. f. s. during the months of May to July, inclusive, providing the natural flow during said period is not less than these amounts. The obligation to supply the minimum stream flow as set forth in the above table on the Roaring Fork River shall, to the extent of 3,000 acre-feet annually, be a project obligation to be supplied from any waters diverted from the south tributaries of Hunter Creek, Lime Creek, Last Chance Creek, or any of them.

The Twin Lakes Reservoir & Canal Co. shall not be required to refrain from diverting water under its existing decrees from the Roaring Fork River except to the extent that a like quantity of replacement water is furnished to said company without charge therefor through and by means of project diversions.

If by reason of storage capacity in the Aspen Reservoir, the Twin Lakes Reservoir & Canal Co. derives additional water or other benefits or advantages it would not have realized had this project not been constructed, then nothing herein contained shall prevent the project from making appropriate charges for such water or other benefits or advantages.

11. All lands acquired for project construction and operation and water surfaces of project reservoirs will be open to the public for recreational purposes, excepting those areas reserved by the operating agency.

12. The project will be operated in such a manner that those in eastern Colorado using project water imported from the Colorado River Basin for domestic purposes shall have preference over those claiming or using water for any other purpose.

13. The project is to be operated in such a manner as to secure the greatest benefit from the use and reuse of imported project waters within project boundaries in the State of Colorado.

14. Any and all benefits and rights of western Colorado water users in and to water stored in Green Mountain Reservoir, as described and defined in Senate Document 80, 75th Congress, 1st session, shall not be impaired or diminished by this project.

15. The project, its operation, maintenance, and use shall be subject to the provisions of the Upper Colorado River Basin compact of October 11, 1948 (Public Law 37, 81st Cong., 1st sess.), the Colorado River compact of November 24, 1922 (H. Doc. 605, 67th Cong., 4th sess.), and the Boulder Canyon Project Act of December 21, 1928 (45 Stat. 1057–1064). In the event any curtailment of use of Colorado River water in the State of Colorado is necessary to satisfy the provisions of the Colorado River compact or the Upper Colorado River Basin compact, then the diversions by the project for use in eastern Colorado shall be curtailed before there is any curtailment of the right to store water in Aspen Reservoir in a quantity not in excess of the capacity of that reservoir for use in western Colorado in accordance with these operating principles.

16. The Secretary of the Interior shall at any time have the option to obtain or require the transfer to the United States of any and all rights initiated or

acquired by the appropriation or use of water through the works of the project in eastern Colorado, except vested rights to present appropriations; provided, however, that the title so taken shall be subject to a beneficial use of such water as may be provided in the payment contract or contracts. The rights to store water in Aspen Reservoir under the applicable laws of the State of Colorado shall be initiated and acquired by and held in the name of the United States pursuant to those laws.

17. To assure project operation in conformity with the operating principles heretofore stated, to provide a means for the collection and interchange of information, and to provide a method for the continued study of project operations to the end that, if the stated operating principles may be improved upon, recommendations for changes may be made to the contracting parties, a commission shall be created in an appropriate manner to be composed of 1 representative of the Eastern Colorado Conservancy District, 1 representative of the Colorado River Water Conservation District, 2 representatives of the United States, and 1 representative of the State of Colorado appointed by the Colorado Water Conservation Board after consultation with the Colorado Game and Fish Commission. The powers of such commission shall be limited to the collection of data, the making of findings of fact, and the suggestion of changes in operating principles.

CONCLUSIONS

75. The waters of the Arkansas River in the Colorado portion of the upper Arkansas River Basin are overappropriated. Serious distress is caused to the economy of the basin in short water years through loss in crop production. Supplemental irrigation water supplies are needed. The additional crop production would find a ready market in the urban centers of Colorado and the Nation.

76. No new sources of water within the means of the municipalities and industries are apparent. Present municipal supplies, even after substantial acquisition of irrigation rights, are barely adequate to supply existing requirements. Additional quantity and better quality of water are critically needed.

77. Normal uses of electric energy would expand rapidly in the power market area if not restricted by a limited supply. Resource development would be encouraged if energy were available in plentiful supply.

78. Floods in the upper Arkansas Valley threaten the loss of property and discourage investment. Sediment deposition chokes channels, increases flood threats, and raises maintenance costs of extensive irrigation systems. Stream pollution threatens health and destroys fish habitat. Flood, sediment, and pollution control would lower costs and remove threats.

79. Recreational, fish, and wildlife resources are valuable assets of Colorado and of the Nation. These resources should be protected and enhanced to the greatest extent practicable.

80. Misuse of forests and ranges reduces production and contributes to the sedimentation of streams. Tailings from mines add to the silt burden and pollution of otherwise usable water supplies. Better management practices and silt-prevention methods should be encouraged.

81. The initial development of the Gunnison-Arkansas project would supply the most pressing and immediate needs of the upper Arkansas River Basin.

82. The diversion area has a plentiful supply of water, part of which could feasibily be diverted without detriment to that area or to downstream users. Although all possible future water requirements for the entire western slope have not been fully determined, it is concluded that there is an adequate water supply from Colorado's allocated share

of the Colorado River Basin water for the proposed initial development of the Gunnison-Arkansas project, Roaring Fork diversion, over and above present and prospective consumptive uses within the natural basin of the Colorado River in Colorado. Western slope interests would be protected by the Aspen Reservoir, by special provisions for preservation of fish and wildlife, by equitable operation of the project, and by assurance of noninterference in the use of the replacement facilities provided by the Colorado-Big Thompson project.

83. The initial development is engineeringly feasible and economically justified. It represents the minimum practical project. It is designed as a self-contained unit and its construction would not imply a commitment for expansion, extension, or enlargement. Neither would it impair nor duplicate future development.

84. The estimated cost of the initial development of the Gunnison-Arkansas project based on October 1949 prices is $147,440,000.

85. The tentative allocation of this total cost among the various functions to be served is as follows:

Function	*Allocated cost*
Irrigation:	
Probably can be returned in 40 years without interest through payments by the irrigation water users and district beneficiaries	$10, 881, 600
Probably can be returned without interest through application of interest on power and municipal water investment	49, 048, 400
Power: Probably can be returned in 50 years with interest at 3 percent	40, 032, 000
Municipal and industrial water supply: Probably can be returned in 40 years with interest at 2 percent	29, 522, 000
Flood control	15, 777, 000
Mitigation of losses to fish and wildlife resources: In accordance with Public Law 732, 79th Cong., 2d sess. (60 Stat. 1080)	2, 179, 000
Total	$147, 440, 000

86. The project would provide other benefits for which allocations are not authorized under existing law. Subsequent allocation of project construction costs to such beneficial functions should be made in the event of future legislation.

87. Continued studies and investigations in the project area and in contiguous areas within the drainage of both slopes should be pursued vigorously on a Departmental basis, in cooperation with other Federal, State, and local agencies, toward the objective of wise conservation and beneficial use of all natural resources.

RECOMMENDATIONS

88. It is my recommendation that:

A. The Secretary of the Interior approve this report and substantiating documents.

B. This report together with the substantiating documents be transmitted for review to all Federal agencies having an interest in the project, to the states signatory to the Colorado River compact and to the States of Kansas and Oklahoma.

C. This report and substantiating documents, together with such amendments as may be appropriate pursuant to review comments by the Federal agencies and States, be submitted to the President and the Congress with the recommendation that the plan for the initial development of the Gunnison-Arkansas project including transmission facilities be approved and authorized.

D. Congress authorize the appropriation of funds for construction, operation, and maintenance of the proposed works, under the direction of the Secretary of the Interior, in accordance with the Federal reclamation laws (act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto) except to the extent otherwise specifically set forth in this report, with such modifications, omissions, or additions to the works as the Secretary may find proper from time to time for accomplishing the objectives of the project.

E. The project be operated under the direction of the Secretary of the Interior in accordance with the operating principles set forth in this report or as the principles may be modified in the future by agreement between the Secretary and the commission established by the State of Colorado.

F. All or any part of the specific municipal water supply systems described in this report be constructed by the Secretary of the Interior, only after satisfactory evidence is presented to the Secretary of the Interior that it would be infeasible for the communities involved to construct or to finance the construction of such work themselves, singly or jointly.

G. In the event it is determined that said specific municipal water systems are to be constructed by the Secretary of the Interior, a contract, providing among other things for payment to the United States of the actual cost of construction over a period of 40 years from the year in which the municipal water is first delivered with interest at the rate of 2 percent per annum and providing that operation, maintenance, and replacement of the works be assumed by the contracting party or parties, be a condition precedent to the start of construction of such works.

H. The Secretary of the Interior be authorized to establish rates for collection, transportation, regulation, and delivery of water at a designated point or points in the supply system to the municipalities and industries at the lowest price consistent with sound business principles, including interest at the rate of 2 percent per annum, but in no case higher than the cost of an alternative single purpose supply of equal quantity and quality. The contracts providing for such deliveries should be long term or short term but not to exceed 40 years. Each such contract should include appropriate provision for one or more renewals, the terms and conditions of the renewed contract or contracts to be determined in the light of the situation at the time of renewal.

I. The Secretary of the Interior be authorized, upon agreement with the water users, to make either short-term or long-term contracts for collection, transportation, regulation, and delivery of water for irrigation purposes at a designated point or points in the supply system. Such contracts should be for such period, not to exceed 40 years, and at rates, either fixed or variable, by the application of such formula as the parties shall have agreed upon to reflect improvement in, or deterioration of, the payment ability of the water users, and which will, in the Secretary's judgment, produce revenues at least sufficient to cover an appropriate share of the annual operation and maintenance cost and an appropriate share of such fixed charges as the Secretary deems proper. Due regard being given to income from the contracting organization's other sources, the rates provided in such contracts should be such that the water users shall return within the shortest period, consistent with their ability, that part

of the cost of construction of works connected with water supply and allocated to irrigation and assigned to be returned by the contracting organization. Such contracts should require payment of said rates each year in advance of delivery of water for said year. Such contracts should include provisions for the right of renewal thereof, once or more than once, under stated terms and conditions mutually agreeable to the parties and subject to increase or decrease in rates corresponding to increase or decrease of costs of construction and of operation and maintenance or improvement or deterioration in the payment ability of the water users. Such right of renewal should be exercised within such reasonable time prior to the expiration of the contract as the parties shall have agreed upon. All amounts paid to the United States in excess of operation and maintenance during the period of water deliveries thereunder should be credited to the payment of that appropriate share of the cost of construction of works connected with water supply and allocated to irrigation and, when the total of such credits equals the amount allocated to irrigation and assigned to be paid by the contracting organization, the charges should be reduced to cover only operation, maintenance, and replacement costs.

J. Contracts for the collection, transportation, regulation, and delivery of water supplies at designated points in the supply system be subject to section 8 of the Reclamation Act of June 17, 1902 (32 Stat. 388), provided that this provision be construed neither as vesting rights to the delivery of water in quantities greater than those specified in any such contract or vesting rights to continue to receive water in the event of default in payment thereunder, nor as preventing the delivery elsewhere of the water covered thereby in the event of default in payment continuing over a period of 5 consecutive years or the failure to renew such contract.

K. The Secretary of the Interior establish rates for the sale of power at the lowest price consistent with sound business principles but in no case higher than the cost of power from alternate sources in order to encourage the most widespread use of power throughout the area of service.

L. Suitable language be included in the authorizing document whereby assurance is given that any and all benefits and rights of western Colorado water users in and to water stored in Green Mountain Reservoir, as described and defined in Senate Document 80, 75th Congress, 1st session, shall not be impaired or diminished by this project.

M. The Congress authorize the appropriation of such sums as may be necessary for the continued investigation of the comprehensive plan by the agencies of the Department of the Interior in cooperation with other Federal, State, and local agencies for the development of the natural resources of the upper Arkansas River Basin including importation of additional supplies of water into the basin which may be determined to be in excess of the present and potential requirements of the basin from which exportation may be proposed.

N. Suitable language be included in the authorizing document clearly stating that authorization or appropriation of funds for the project or for the continued investigations stated above shall not in any way constitute a commitment, real or implied, to further importations.

AVERY A. BATSON.

SUBSTANTIATING REPORT

LIST OF SUPPORTING APPENDIX REPORTS

This report is supported by data and findings contained in the following detailed appendix reports that are on file in the Regional Office, Bureau of Reclamation, Denver, Colo.:

Appendix designation	*Title*	*Volume number*
A	General discussions	I
B	Potential development	I
C	Designs and estimates	II
D	Water supply	III
E	Project lands	IV
F	Agricultural economy	IV
G	Power	V
H	Flood control	V
I	Sedimentation	V
J	Drainage	V
K	Municipal and industrial water supplies	VI
L	Fish and wildlife	VI
M	Recreation	VI
N	Stream pollution	VI
P	Financial analysis	VII
Q	Alternative plans	VII

CONTENTS

List of Chapters

Detailed Contents

35002—53——4

CHAPTER X. FISH AND WILDLIFE

CHAPTER XI. RECREATION

CHAPTER XII. STREAM POLLUTION ABATEMENT

CHAPTER XIII. FINANCIAL ANALYSIS

CHAPTER XIV. RELATED INVESTIGATIONS

CHAPTER XV. THE COMPREHENSIVE PLAN

CHAPTER XVI. REPORTS BY COOPERATING AGENCIES

LIST OF TABLES

LIST OF EXHIBITS

SUBSTANTIATING REPORT

CHAPTER I. THE PROJECT PLAN

INTRODUCTION

The potential Gunnison-Arkansas project is the major unit in the comprehensive plan of development for the upper Arkansas River Basin which is being investigated by the Bureau of Reclamation. The project is adaptable to construction by successive cumulative stages. This report presents the plan for the initial development, which involves transmountain diversion of western slope water from the Roaring Fork River drainage only. The plan of initial development has evolved after consideration of many factors and represents the most practicable plan for the minimum diversion of Colorado River water. It is not dependent upon subsequent stages or additional importation of western slope water.

SUMMARY

A multiple-purpose project, the initial development would, among other things:

Import about 69,200 acre-feet of water from the western slope, conserve 20,000 acre-feet of Arkansas River floodwater, and convert 77,000 acre-feet of winter irrigation water to more beneficial summer use, all figures representing annual averages.

Enable the additional average annual importation of 14,900 acre-feet of water through the Independence Pass diversion system, now owned by Twin Lakes Reservoir & Canal Co.

Provide supplemental water for high grade land within an irrigated area of 322,000 acres in the Arkansas Valley.

Provide 17,000 acre-feet of supplemental municipal water yearly.

Generate annually an average of 505 million kilowatt-hours of hydroelectric energy.

Control floods originating above Pueblo.

Trap an average of 944 acre-feet of sediment each year.

Preserve fish and wildlife conditions.

Provide recreational opportunities.

Furnish some stream pollution abatement.

Have a useful life in excess of 100 years.

Cost $147,440,000 to construct and $1,335,200 per year to operate and maintain.

Provide benefits amounting to $9,789,000 annually—approximately 1¾ times all annual project costs.

Retire the total investment within the provisions of existing law.

The cost of importing additional water to the Arkansas Valley solely for irrigation would be excessive. Multiple uses of the water, however, not only make the importation economically feasible, but the multiple-purpose structures and facilities would also enable a more effective utilization of existing water supplies. Thus, approximately 69,200 acre-feet of Colorado River water annually is the key to the conservation and more valuable use of over 200,000 acre-feet of water each year for irrigation, municipal supplies, generation of hydroelectric power, and other purposes on the eastern slope.

DESCRIPTION OF PLAN

The plan for the initial development is shown by solid red lines on the general map in the front of this report and on the map in the back entitled "Potential Features." Western slope waters would be collected and diverted from the upper Roaring Fork River Basin to the Arkansas Valley. In order to protect western-slope interests, a reservoir would be constructed near the town of Aspen to furnish replacement water for prior rights as well as for future requirements along the Colorado River. The imported water would be stored in the Sugar Loaf Reservoir which would be enlarged to nearly 7 times its present capacity. Another reservoir, Twin Lakes, also in the headwaters region of the Arkansas River and used for the storage of transmountain water, would be enlarged almost 5 times its present capacity. It would be used in conjunction with the Sugar Loaf Reservoir to store and regulate the present and extended diversions. The potential Snowden diversion dam and canal would divert Arkansas River water to the Twin Lakes Reservoir. In exchange, an equivalent amount of water would be released from the potential Pueblo Reservoir with the proper timing as determined by the State engineer. The terminal Pueblo Reservoir would be located on the Arkansas River, 6 miles west of the city of Pueblo, to store and distribute the municipal and irrigation water conserved by the project; provide flood protection to downstream areas; and alleviate the damaging effects of sediment deposition. The total capacity of the 3 reservoirs would be 777,000 acre-feet. The project power system, needed to obtain maximum utilization of the water, would consist of about 60 miles of canals, 7 powerplants and switchyards, 9 substations, and an estimated 421 miles of transmission lines.

In order to preserve the natural fishery values in the upper Roaring Fork River, an extension of the collection system would provide water in exchange for that which could be diverted by the Twin Lakes system. Existing recreational values would be preserved to the maximum degree compatible with optimum overall benefits.

Because of the complex integration of its multiple-purpose functions, the initial development probably could be most economically constructed in its entirety by the Bureau of Reclamation. However, the plan is sufficiently flexible so that the municipal pipelines, filter plant, and other features of the municipal water-distribution system could readily be constructed by municipalities or other entities if adequate financial arrangements could be made. The plan of operation would require a payment contract between the Government and a conservancy district or other entity which in turn would contract with the direct beneficiaries, such as irrigation districts and munici-

palities, for the services provided by the supply and control works. The collection system, canals, reservoirs, hydroelectric powerplants, and transmission system would be operated and maintained under the direction of the Secretary of the Interior. The plan of operation would require payment contracts for the municipal water-distribution system constructed by the Bureau of Reclamation, between the Government and the conservancy district or the municipalities served by such distribution works. Municipal water facilities would be operated and maintained by the conservancy district or by other entities.

Chapter II. General Description

Throughout this report the upper Roaring Fork and Fryingpan River areas on the western slope in the Colorado River Basin where the water to be diverted originates, are referred to as the "diversion area," and that portion of the Arkansas Valley where the imported water would be used is referred to as the "eastern slope project area."

PHYSICAL GEOGRAPHY

The area included in the initial development is located in southern Colorado. The diversion area is in west-central Colorado in Pitkin County and a small part of Eagle County and covers about 100 square miles approximately 20 miles long and 5 miles wide. The irrigated land in the eastern slope project area which would benefit directly from the initial development consists of 322,000 acres located principally along the Arkansas River in Lake, Chaffee, Fremont, Pueblo, Crowley, Otero, Bent, and Prowers Counties. The project area is situated in the broad Arkansas River drainage basin which is 340 miles long and 170 miles wide and includes an area of 26,150 square miles and all or parts of 18 counties.

The diversion area is in the upper Roaring Fork River basin in the high mountain region on the western slope of the Continental Divide. The Roaring Fork River and its tributaries rise in the Elk Mountains at altitudes upward of 14,000 feet, descending to its junction with the Colorado River at Glenwood Springs at 5,800 feet elevation. The initial development would divert water from the Fryingpan River and Hunter Creek, tributaries of the Roaring Fork. Streams in the diversion area are all above 9,000 feet altitude and are typical mountain torrents that have cut through rough terrain to form extremely steep, narrow valleys.

About 17 percent of the Arkansas Basin is at an altitude above 8,000 feet and principally mountainous. Almost 45 percent of the basin ranges in altitude from 5,000 to 8,000 feet and contains small scattered areas of land suitable for cultivation. The remaining 38 percent, which is relatively level and suitable for agricultural production, is below 5,000 feet altitude.

The mountainous area was formed by ancient geologic upheavals and structural disturbances which resulted in an extensive uplift and subsequent erosion. Former glacial activity has left moraines, and prominent terrace deposits are evidence of changes in stream courses. Along the east base of the mountains where sedimentary beds have been tilted, the less resistant formations have been eroded leaving ridges or hogbacks exposed. The formations vary considerably in thickness, and many are folded and exposed at the surface. In the Great Plains area the regional dip of the strata generally is to the north.

Through this area flows the Arkansas River which is formed by the junction of Tennessee Fork and East Fork Rivers at an altitude of

9,700 feet about 3 miles west of Leadville on the east side of the Continental Divide. It flows south and east through mountainous terrain to Canon City, thence eastward through foothills to Pueblo where it enters the high plains of southeastern Colorado. The river continues in an easterly direction to leave the eastern slope project area at the Colorado-Kansas boundary at an altitude of about 3,350 feet.

Wide variations of climate occur in the project area. On both sides of the Continental Divide the climate in the high mountain regions is subhumid with considerable precipitation of low intensity and an extremely short growing season. In the plains region of the eastern slope project area, the growing season and temperature are favorable to agricultural production, but precipitation is not sufficient to produce profitable yields consistently, and only by irrigation can continuous high-crop production be assured. Average annual precipitation in the eastern slope project area varies from 18.63 inches at Leadville to 8.78 inches at Buena Vista, 11.67 inches at Pueblo, and 16.05 inches at Lamar. The precipitation record at Las Animas, which is the most complete and extensive record in the Arkansas Valley, is shown in table 1 and exhibit 2. They clearly indicate the wide fluctuations of annual precipitation in the plains region.

TABLE 1

SUMMARY OF CLIMATOLOGICAL DATA

Station	General location	Elevation (m.s.l.)	Precipitation			Temperature				Frost data			
			Years record	Average annual (in.)	Percent April to October	Years record	Average annual (deg.)	Max. (deg.)	Min. (deg.)	Years record	Avg. date last killing frost in Spring	Avg. date first killing frost in Fall	Avg. frost free period (days)
WESTERN SLOPE													
Aspen	Mountains	7,913	19	19.04	56.1	13	40.8	94	-25	12	June 9	Sept. 18	103
Wast	"	8,800	23	17.86	56.0	20	36.6	87	-36	17	June 26	Aug. 31	66
EASTERN SLOPE													
Leadville	Mountains	10,152	47	18.63	66.1	45	35.6	86	-29	44	June 17	Sept. 8	83
Buena Vista	"	7,980	40	8.78	72.3	33	41.8	105	-37	32	June 4	Sept. 22	110
Salida	"	7,050	37	12.43	70.4	36	45.3	100	-35	35	May 23	Sept. 19	119
Canon City	Foothills	5,343	55	12.98	77.4	53	53.4	104	-30	48	April 27	Oct. 12	168
Colo. Springs	"	6,098	64	14.47	85.7	64	47.9	98	-27	48	May 6	Oct. 3	150
Pueblo	Plains	4,808	74	11.67	80.9	67	52.0	104	-27	54	April 22	Oct. 12	173
Rocky Ford	"	4,117	56	12.30	83.7	54	52.1	106	-32	49	April 26	Oct. 8	165
Las Animas	Plains	3,892	78	12.30	84.5	74	52.6	114	-32	50	April 30	Oct. 8	161
Lamar	"	3,615	54	16.05	82.6	52	54.4	110	-30	46	April 25	Oct. 10	168
Eads	"	4,262	31	13.67	87.8	28	52.0	106	-24	24	May 4	Oct. 7	156
Holly	"	3,385	48	15.37	84.2	41	54.0	109	-20	41	April 26	Oct. 11	168

Source: Weather Bureau Records.

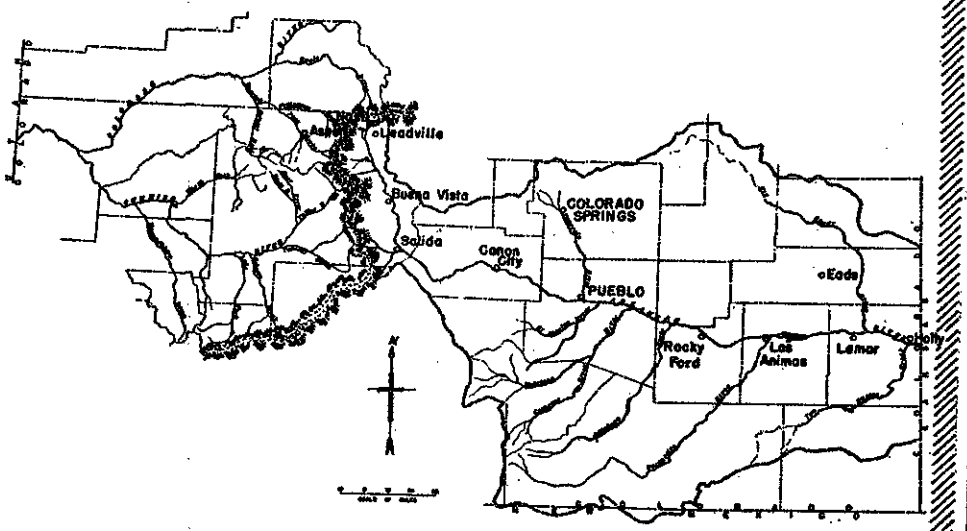
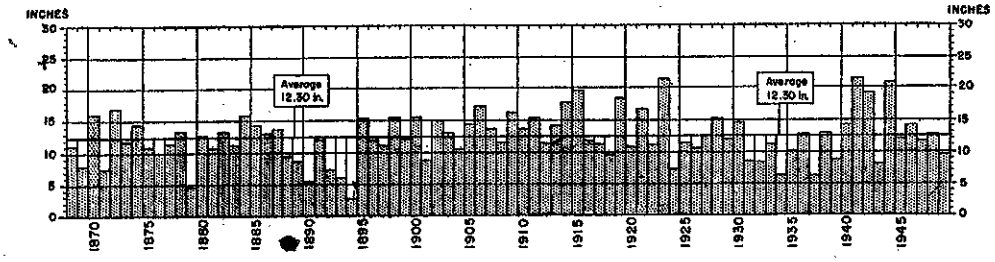


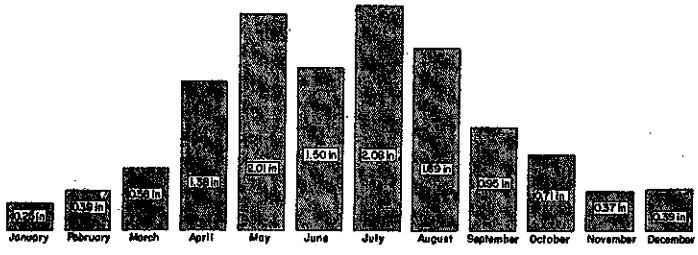
EXHIBIT 2

PRECIPITATION
LAS ANIMAS, COLORADO
1868 - 1949

ANNUAL PRECIPITATION



AVERAGE MONTHLY DISTRIBUTION OF PRECIPITATION



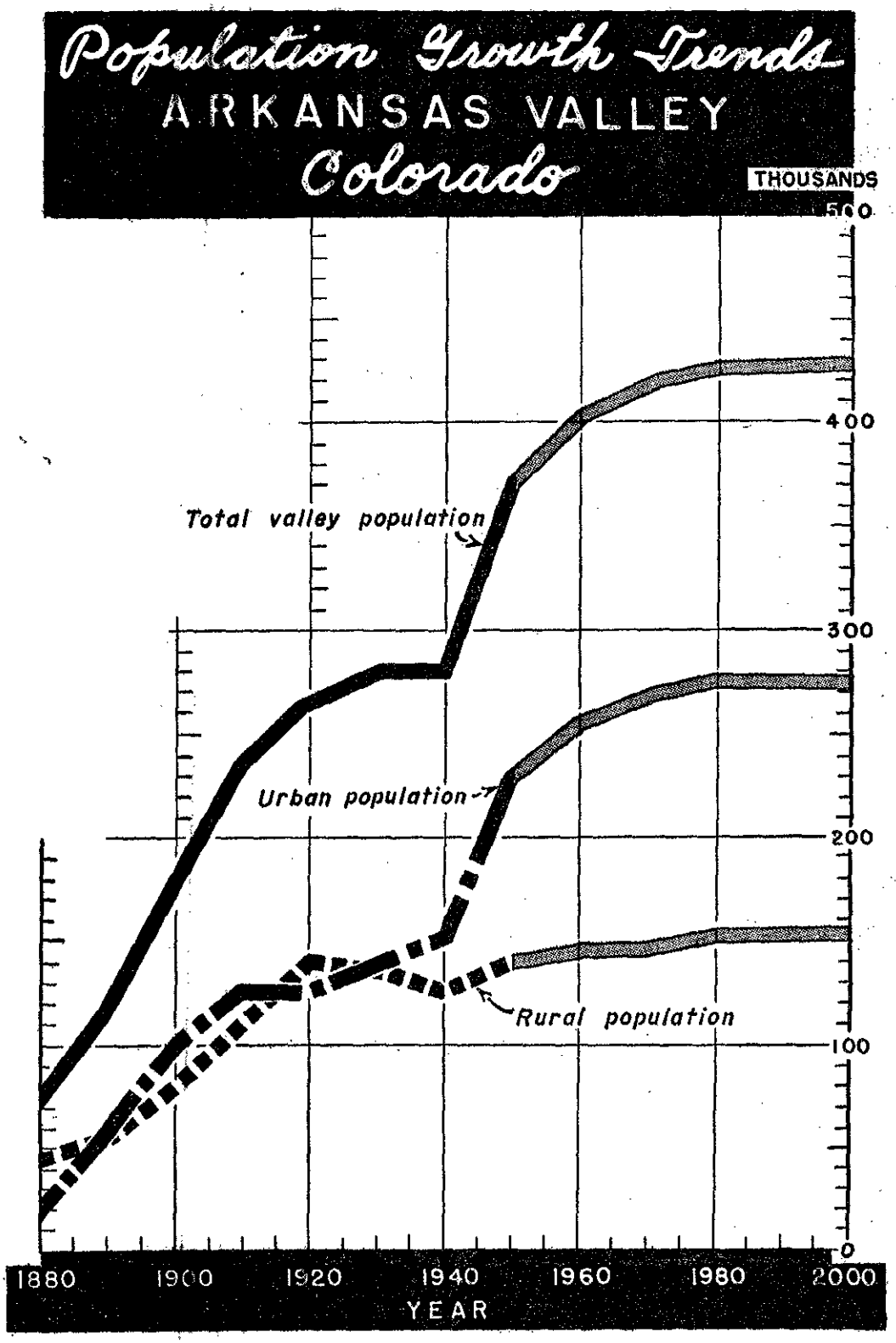
POPULATION

The population of the Arkansas Basin contiguous to, and including the eastern slope project area, where agriculture and some manufacturing are the basic industries, has shown a steady increase from 73,370 in 1880 to 279,030 in 1930, dropping slightly during the Dust Bowl era to 278,700 in 1940. The population of the principal towns in the project area was as follows in 1940:

Leadville	4,774	Fowler	922
Buena Vista	779	Manzanola	531
Salida	4,969	Rocky Ford	3,494
Canon City	6,690	La Junta	7,040
Florence	2,632	Las Animas	3,232
Colorado Springs	36,789	Lamar	4,465
Pueblo	52,162	Holly	864

Since 1940, the population of the eastern slope project area has increased due to manufacturing activities, most of which were associated with war production. However, that population increase may not be permanent unless an adequate and dependable water supply becomes a reality. The estimated future population of the Arkansas Valley is expected to reach 432,000 by A. D. 2000 based on the national growth rate and assuming water and power supplies would be made available from the initial development of the Gunnison-Arkansas project proposed herein (exhibit 3).

EXHIBIT 3



UTILITIES

Both the eastern and western slopes are accessible to main and feeder lines of railroads, airlines, bus and truck lines, and highways. Pueblo is the division point of 4 major railroads and the common junction point of 3 major airlines.

The project area is served by public and private utilities with energy requirements totaling 327,375,000 kilowatt-hours of electricity in 1946. Natural gas is supplied to the eastern slope by pipeline from fields near Amarillo, Tex., and Hugoton, Kans.

Modern telephone and telegraph systems serve most communities on both sides of the Continental Divide. Twelve radio stations operate in the area.

INDUSTRIAL DEVELOPMENT

The most important industries in the region are mining and smelting, agriculture, and manufacturing. Agriculture is discussed in detail in chapter V–Agriculture, and the other topics are discussed in the following paragraphs.

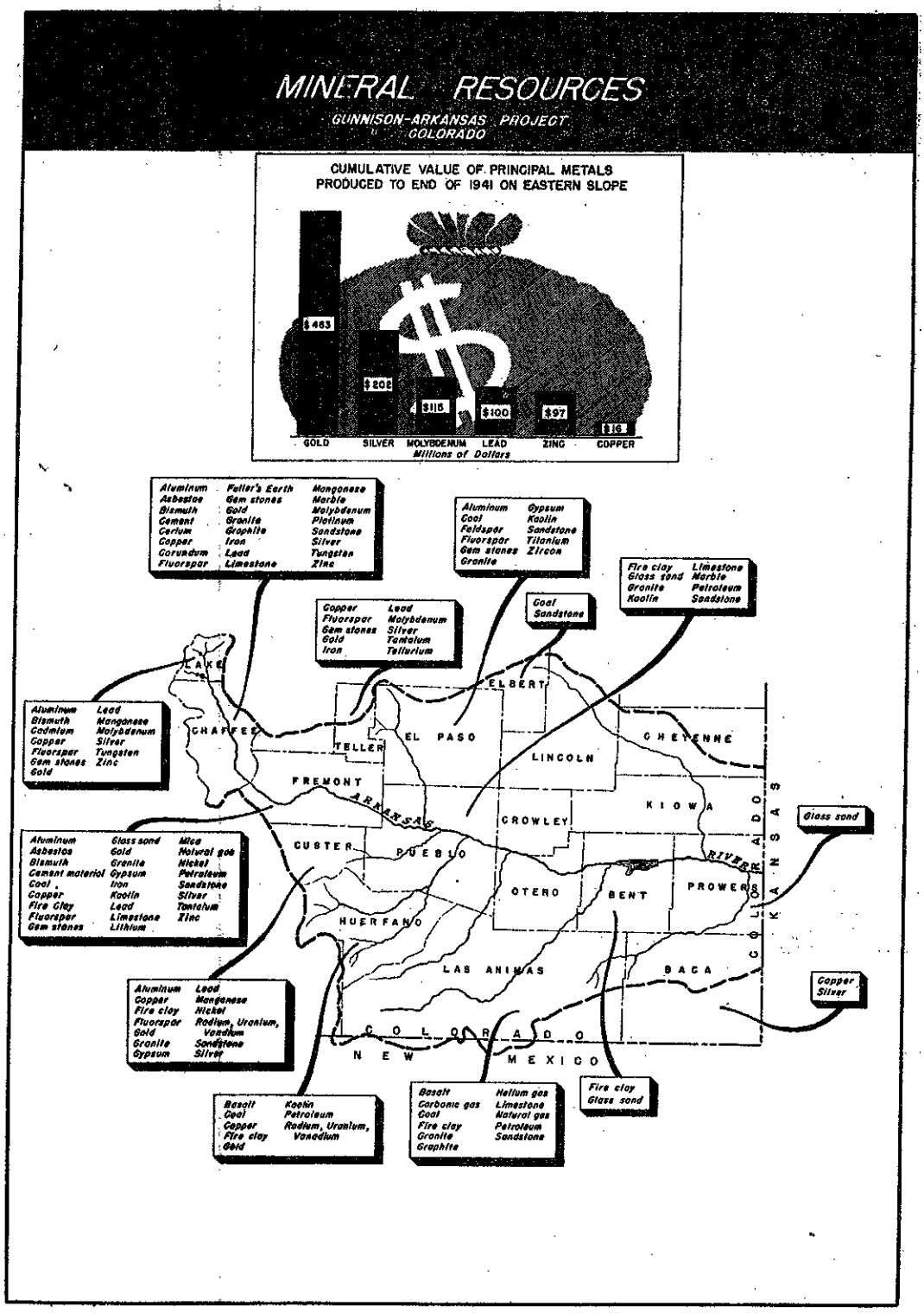
Coal, gold, silver, copper, lead, and oil shale are the principal minerals produced on the western slope. The largest known uranium deposits in the country are located in this area, and the mineral fuel reserves exceed those of any like area in the world.

Abundant mineral resources exist on the eastern slope. At present, deposits of molybdenum rank first, reserves of which are known to exceed 100 million tons; this is deemed sufficient to meet the world demand for 200 years. Other deposits, in order of abundance are coal, gold, silver, lead, and zinc. Many other metals and nonmetals are found in varying quantities throughout the area. Known reserves of subbituminous and anthracite coal are estimated at 23 billion tons. Some petroleum and natural gas are produced in the Arkansas Valley (exhibit 4).

Manufacturing industries on the western slope include processing of dairy products, printing, construction and assembly of agricultural implements, canning, food freezing, and lumbering. Although extensive manufacturing has not been developed to date, the presence of abundant raw materials provides a manufacturing potential in the area. The vast resources of uranium, oil shale, and pulp timber offer possibilities for the industrial development of the western slope.

In the eastern slope project area and the adjacent areas in the Arkansas Basin, the most outstanding manufacturing industry is steelmaking by the Colorado Fuel & Iron Corp. at Pueblo. Two other major industrial establishments are (1) the Golden Cycle Corp. which operates a large mill at Cripple Creek for the treatment and extraction of gold and other ores, and (2) the Ideal Portland Cement Co. which operates a plant at Portland. Other eastern slope industries include brick manufacturing, sugar refining, flour milling, meatpacking, vegetable packing, canning, alfalfa milling and dehydrating, feed mixing and grinding, and grain milling.

EXHIBIT 4


MINERAL RESOURCES
GUNNISON-ARKANSAS PROJECT
COLORADO
CUMULATIVE VALUE OF PRINCIPAL METALS
PRODUCED TO END OF 1941 ON EASTERN SLOPE
$463
$202
$116
$100
$97
$16
GOLD
SILVER
MOLYBDENUM
LEAD
ZINC
COPPER
Millions of Dollars
Aluminum Asbestos Bismuth Cement Cerium Copper Corundum Fluorspar
Fuller's Earth Gem stones Gold Granite Graphite Iron Lead Limestone
Manganese Marble Molybdenum Platinum Sandstone Silver Tungsten Zinc
Aluminum Coal Feldspar Fluorspar Gem stones Granite
Gypsum Kaolin Sandstone Titanium Zircon
Fire clay Glass sand Granite Kaolin
Limestone Marble Petroleum Sandstone
Copper Fluorspar Gem stones Gold Iron
Lead Molybdenum Silver Tantalum Tellurium
Coal Sandstone
Aluminum Bismuth Cadmium Copper Fluorspar Gem stones Gold
Lead Manganese Molybdenum Silver Tungsten Zinc
Aluminum Asbestos Bismuth Cement material Coal Copper Fire clay Fluorspar Gem stones
Glass sand Gold Granite Gypsum Iron Kaolin Lead Limestone Lithium
Mica Natural gas Nickel Petroleum Sandstone Silver Tantalum Zinc
Aluminum Copper Fire clay Fluorspar Gold Granite Gypsum
Lead Manganese Nickel Rodium, Uranium, Vanadium Sandstone Silver
Basalt Coal Copper Fire clay Gold
Kaolin Petroleum Rodium, Uranium, Vanadium
Basalt Carbonic gas Coal Fire clay Granite Graphite
Helium gas Limestone Natural gas Petroleum Sandstone
Fire clay Glass sand
Glass sand
Copper Silver
LAKE
CHAFFEE
TELLER
EL PASO
ELBERT
LINCOLN
CHEYENNE
FREMONT
ARKANSAS
CROWLEY
KIOWA
CUSTER
PUEBLO
OTERO
BENT
PROWERS
HUERFANO
LAS ANIMAS
BACA
COLORADO
KANSAS
NEW MEXICO

Recreation, including the tourist industry, is a real and valuable asset to Colorado. Even though its development in Colorado may be considered in its infancy, it is one of the top sources of business income. The western slope has developed important recreational areas at Aspen, Grand Mesa, Glenwood Springs, near Gunnison, and at other places. Both slopes of the Continental Divide—with their majestic scenery including heavily forested areas, high mountains, and many rivers—are potential recreational areas with almost unlimited possibilities.

ECONOMIC CONDITIONS

In the eastern slope project area and contiguous areas within the Arkansas Basin, the per capita general property assessed valuation was $974 in 1940. The average county tax totaled 32.62 mills for 1944. Local government indebtedness was relatively high in 1941 as a result of an expanded building program in the 1920's, the ensuing depression, and the drought years in the 1930–40 decade when tax collections declined and very little of the debt could be retired.

As of December 1941, banks in the area had $16,237,000 in loans and discounts, $82,491,000 in deposits, and a total of $90,502,000 in assets. The ratio of deposits to loans and discounts was 5.1 to 1 compared to a State ratio of 3.1 to 1 for the same year. The stabilization of agriculture and development of industry and business resulting from adequate and dependable water supplies, hydroelectric power, flood control, and related developments would provide a basis for sound investments which would in turn increase the prosperity of the area.

Retail and wholesale trade volume and postal receipts were slightly below those of other counties in the State in 1940.

CHAPTER III. DESIGNS AND ESTIMATES

INTRODUCTION

Many plans, structures, alternate routes, and diversion potentialities were studied in devising the initial development. The selected plan is the most feasible from engineering and economic standpoints. Structures have been designed on the basis of preliminary field investigations, and cost estimates have been prepared on a similar basis. Construction costs are based on prices prevailing in October 1949.

Of the total estimated cost, 25 percent represents the cost of the structures on the western slope and the transmountain tunnel. Roughly, 43 percent of the total cost would be for dams and reservoirs, 21 percent for diversion canals and conduits, 23 percent for power features, and the remaining 13 percent for municipal supply systems and operation and maintenance during construction.

Features	Construction cost	Annual cost, operation, maintenance, and replacement
Dams and reservoirs	$64,334,000	$30,760
Diversion canals and conduits	30,499,000	65,870
Power features	34,021,000	846,990
Municipal supply systems	18,050,000	391,580
Operation and maintenance during construction	536,000	0
Total	147,440,000	1,335,200

The designs and estimates were reviewed by the Board of Engineers, Branch of Design and Construction, and were revised in accordance with the recommendations of that Board. The feasibility of the designs and estimates has been established on the basis of data available. Economical alternate routes for the initial development are limited to possible modifications in the interest of better design after more extensive field data are obtained. As the investigation progresses, modifications in locations, alinement, and design may be made; potential power drops may be divided into two or more sections; and the substitution of canals or other types of aqueducts for tunnels and vice versa may be necessary if the studies disclose that such modification would improve efficiency.

Additional studies and detailed surveys are needed for the preparation of a definite plan which would include gathering and assembling all data necessary for plans and specifications. Further exploration of foundation conditions at the dam sites and more detailed information on the availability of construction materials must be obtained. Exploration of tunnel lines to determine the character of the material to be encountered is required. Powerplant foundation conditions should be accurately determined. More detailed topographic and

35002—53——5

other survey data on all features will be required to definitely fix locations and provide information for more detailed designs and estimates. It is estimated that designs, specifications, and estimates for initiation of construction could be accomplished within a year after authorization, and construction could be carried on concurrently with preconstruction investigations on the remaining features of the initial development.

A site plan or general layout drawing would be prepared for all construction sites showing structures peculiar to the construction period and their relation to the ultimate installations. Consideration would be given to proposals of the National Park Service, Fish and Wildlife Service, Forest Service, and other Government agencies as a means of coordinating the activities and recommendations of all agencies concerned with the location of Bureau of Reclamation structures.

Land acquisition for reservoir sites, canal rights-of-way and related facilities would include consideration for maximizing, within statutory limitations, fish, wildlife, and recreational values. This consideration is essential if full public values are to be realized and if use problems, which have developed at existing Bureau features, are to be minimized on new projects.

In addition to buildings provided at individual features for the housing of Government personnel and equipment, a permanent camp would be established near the town of Granite on the Arkansas River to serve for the construction and later operation and maintenance of features between Sugar Loaf Reservoir and the Salida Afterbay. The estimated cost of the camp at Granite is $582,000, a proportionate share of which is chargeable to each feature on the eastern slope above Salida, with the exception of the transmission system. As some of the personnel could be accommodated in Leadville, Buena Vista, and Salida, no other construction camp would be necessary for Government personnel in that area. Temporary camps for construction workers, other than Government personnel, would be needed near most project features. Although these camps have not been specifically designated, their costs have been taken into consideration in computing the project estimates.

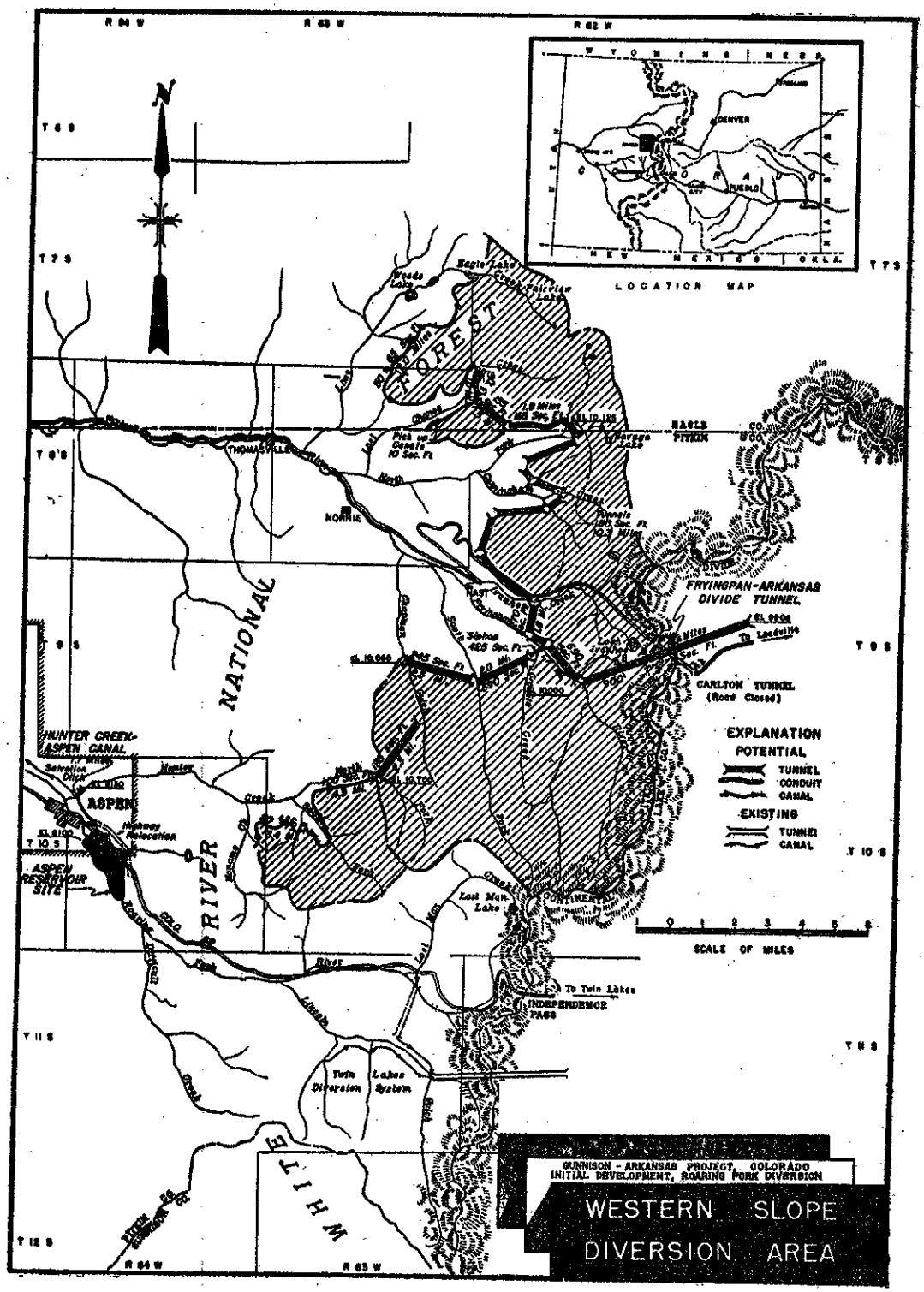
PROJECT WORKS

Aspen Dam and Reservoir

The potential Aspen Reservoir would more than provide replacement storage for water users on the western slope affected by the initial development. As shown on exhibit 5, the dam site is located on the Roaring Fork River about 1 mile east of the town of Aspen in Pitkin County and is in a glaciated valley in which the glacial, fluvioglacial, alluvial and rock-slide sediments are over 200 feet deep. Storage capacity of the reservoir would be 28,000 acre-feet. The reservoir, which would inundate an area of 650 acres, would be created by an earth-fill dam about 88 feet high. The outlet capacity would be 800 second-feet and the spillway capacity, 8,000 second-feet.

Colorado State Highway No. 82, open for traffic throughout the year, provides access to the Aspen Reservoir site 42 miles southeast of Glenwood Springs. The Denver and Rio Grande Western Railroad operates a branch line between Glenwood Springs and Aspen.

EXHIBIT 5



Construction camps at the Aspen Dam site may be necessary to house Government employees and construction workers.

The dam site and part of the reservoir area is in private ownership; the remainder of the reservoir area lies in the White River National Forest. No difficulties in obtaining rights-of-way are anticipated.

The reservoir would necessitate relocation of about 3 miles of gravel-surfaced State Highway No. 82 above the high-water line on the north and east sides of the reservoir.

Special problems that may be encountered in the construction of the Aspen Dam and Reservoir are the short season, seepage, and possible scarcity of impervious material.

Hunter Creek-Aspen Canal

A diversion dam across Hunter Creek, a tributary of the Roaring Fork River, would divert water into a canal with a capacity of 200 second-feet which would carry the water about 2 miles to the Aspen Reservoir. The present Salvation ditch traverses approximately the same territory except that it flows in the opposite direction. Cross slopes are fairly steep, ranging from 25 to 35 percent. It may be necessary to concrete line more than half the length of the canal which crosses an area of glacial moraine. Foundation conditions appear to be favorable for a diversion dam on Hunter Creek.

The canal site is served by the same highway and rail facilities as the Aspen Dam site. Construction camps at the Aspen Dam site would be available to Government employees and construction workers on the Hunter Creek-Aspen Canal.

Fryingpan River diversion

The Fryingpan River diversion would include that portion of the project on the headwaters of the Fryingpan River and Hunter Creek in the Roaring Fork River Basin, as shown on exhibit 5. Water from this basin would be collected by a series of tunnels and canals and transported to the eastern slope via the Fryingpan-Arkansas tunnel.

The Fryingpan collection system would consist of a north-side collection system and a south-side collection system. All interceptions would be made above elevation 10,000. Cross slopes would be fairly steep, up to 30 percent.

The north-side collection system would intercept runoff from the north tributaries of the Fryingpan River. Included in the system are about 34 miles of canals and tunnels ranging in capacity from 10 to 690 second-feet. The system extends from the Lime Creek drainage to the west portal of the Fryingpan-Arkansas tunnel, intercepting south-side collection system waters 2 miles from the main tunnel portal.

The south-side collection system would intercept runoff from the south tributaries of the Fryingpan River and about 15 square miles of the Hunter Creek drainage. The collection system would consist of tunnels and canals varying in capacity from 20 to 425 second-feet and having a total length of about 15 miles. Water from the south side would be carried under the Fryingpan River by means of a siphon to join the water from the north-side collection system at the east portal of a tunnel from Ivanhoe Creek.

Included in the south-side collection system is the interception of about 10 square miles of drainage area on the south forks of Hunter Creek for the purpose of obtaining replacement water for flows that

would be bypassed by the Twin Lakes (Independence Pass) diversion to preserve natural fishery values in the Roaring Fork River above Aspen. That replacement water would be diverted through project structures to the eastern slope in order to compensate the Twin Lakes Reservoir & Canal Co. for the water it would bypass to the Roaring Fork River during low flow periods. The extension of the south forks of Hunter Creek would consist of a canal with a capacity ranging from 20 to 100 second-feet and a total length of 8 miles. About 100 second-feet of capacity of the remaining collection system would be required to carry the replacement water intercepted by the extension.

The Fryingpan-Arkansas tunnel would transport water intercepted from the Fryingpan River immediately above its west portal and water from the Fryingpan collection system through the Continental Divide. The 6-mile tunnel would have a capacity of 900 second-feet, of which 100 second-feet is required to carry the Twin Lakes replacement water that would be intercepted from the South Fork Hunter Creek tributaries.

The sites of the Fryingpan collection system and the west portal of the Fryingpan-Arkansas tunnel are accessible by Colorado State Highway No. 82 from Glenwood Springs to Basalt, thence by former State Highway No. 104 to the Fryingpan River headwaters. Under normal conditions roads in that area are open only from the 1st of April to late November. Nearest railway facilities are at Basalt, 31 miles from the west portal of the main tunnel. Construction camps near the village of Thomasville may be necessary to house Government employees and construction crews working on the collection system and the west portal of the tunnel. The east portal of the potential Fryingpan-Arkansas tunnel may be reached by former State Highway No. 104 west of Leadville. Leadville and nearby Malta, served by the Denver & Rio Grande Western Railroad, are the nearest railheads. Employees working on the east portal could be housed at Leadville.

The Fryingpan collection system would be located in an area of pre-Cambrian igneous granites and metamorphic schists and gneiss. Tunnel conditions should offer no serious difficulties during construction.

The potential collection system and transmountain tunnel lie within the White River National Forest, and no difficulties are anticipated in acquiring necessary rights-of-way. The Twin Lakes Reservoir & Canal Co. has indicated its willingness to cooperate with the Government in regard to the exchange to be effected for preserving fishery values on the Roaring Fork River.

Chief difficulties presented by the Fryingpan River diversion would be the transportation of materials and equipment from the railhead at Basalt to the projected tunnels and canals on the Fryingpan River. Access roads would be constructed to help alleviate the problem.

Sugar Loaf Dam and Reservoir

Enlargement of Sugar Loaf Reservoir, now owned and operated by the Colorado Fuel & Iron Corp., would be necessary to store and regulate project waters imported from the western slope. The existing reservoir, known also as Turquoise Lake, is formed by an earth dam across the Lake Fork of the Arkansas River in T. 9 S., R. 80 W., sixth principal meridian, about 5 miles west of Leadville. The present

capacity is 17,000 acre-feet at elevation 9,788 and the surface area is 800 acres.

Total storage capacity of the enlarged Sugar Loaf Reservoir would be 117,000 acre-feet at normal water surface elevation, 9,880. The enlarged reservoir, which would inundate an area of 1,550 acres, would be created by an earth dam about 140 feet high. The outlet capacity would be 800 second-feet, and the spillway would have a capacity of 2,000 second-feet.

The surrounding topography is the result of glaciation which has left high, curved, lateral moraines forming the sides of the present reservoir basin. The stream has cut a narrow channel through a large terminal moraine at the proposed dam site. The abutments are large lateral moraines consisting of many large boulders and gravel, sand, and silt deposits more than 100 feet deep. The bottom of the present lake is blanketed by stream silt, and it is believed that the basin area is reasonably tight.

Three churn drill holes ranging in depth from 57 to 100 feet were drilled at the proposed site. Sand, gravel, and clay were consistently encountered in all drill holes, and granite boulders and residual granite showed up at intervals.

The dam would be constructed mostly of pervious glacial material which would be obtained in the vicinity. An impervious core would be provided from selected material also obtainable locally. Rock for riprap is available from granite cliffs located about 3 miles from the dam site.

The Sugar Loaf dam site can be reached via gravel-surfaced former State Highway No. 104. The nearest railhead is at Malta about 7 miles from the dam site. Construction camps could be established near the village of Granite.

The reservoir area consists mostly of San Isabel National Forest and grazing lands. Although a few cabins used for recreational purposes are located within the area, most of the land is of little value, and no unsurmountable difficulties are anticipated in securing the necessary rights-of-way. In regard to the acquisition of the existing dam and reservoir, the Colorado Fuel & Iron Corp. has stated its willingness to cooperate with the Government, provided that rights of the corporation are not adversely affected.

The design flood of the potentially enlarged Sugar Loaf Reservoir was based on flood hydrographs which show a peak flow of 17,000 second-feet. The routing of these floods through the reservoir gave a maximum discharge of 2,000 second-feet through the spillway.

The reservoir enlargement would necessitate relocation of about 3 miles of gravel-surfaced secondary former State Highway No. 104, which would be rerouted to cross the dam and follow the west and south side of the reservoir above the high-water line.

Difficulty may be encountered in making the enlarged Sugar Loaf Reservoir completely tight because of the glacial moraines on which the dam would be located. Because of the demand for base flow, water tightness beyond the stability point would not be required.

Snowden diversion

Water would be diverted by a dam on the Arkansas River above Snowden, about 5 miles southwest of Leadville. The diversion dam would be a concrete overflow type with protecting earth dikes. The

dam would have a crest length of 150 feet and a height of 7 feet. The earth dikes would have an overall length of 1,700 feet. The Snowden diversion canal, which would convey the water to the enlarged Twin Lakes Reservoir for storage and regulation, would be unlined and would have a capacity of 600 second-feet. The lower 5 miles of the canal would be constructed on cross-slopes having grades as steep as 30 percent, in contrast to the 5 percent cross-slopes of the upper section. The area to be traversed by the canal consists mostly of gravel, riverwash, and glacial moraine, except for about one-half mile of solid rock near the lower end.

United States Highway No. 24 would provide easy access to the Snowden diversion canal as it is parallel and adjacent to the canal location. The Denver and Rio Grande Western Railroad parallels the highway.

Construction camps which may be constructed near Granite would house Government employees and construction workers.

In order to obtain rights-of-way for the canal it would be necessary to acquire 120 acres of privately owned land. Clearing of about 23 acres of sparsely timbered land would be required.

Twin Lakes Dam and Reservoir

The existing Twin Lakes Reservoir in T. 11 S., R. 80 W., sixth principal meridian is now owned and operated by the Twin Lakes Reservoir & Canal Co. The present active capacity of 56,000 acre-feet is largely in natural lakes with an excavated outlet. The natural capacity was increased by the addition of some earth embankment. The low-water surface elevation of 9,163 is that of the natural lake. Surface area of the existing lakes is about 2,300 acres.

The new Twin Lakes Dam site is located about 2,000 feet downstream from the existing embankment. The enlarged reservoir would be used to store and regulate: (1) Water imported by the Fryingpan-Arkansas diversion and released through the Sugar Loaf Reservoir, (2) water imported by the existing Twin Lakes diversion, and (3) water to be diverted from the Arkansas River by the Snowden Canal. The potential earth- and rock-fill dam, 105 feet high, would create a reservoir of 260,000 acre-foot capacity, inundating 4,160 acres of land at normal water surface elevation 9,256. The outlet capacity would be 1,000 second-feet and the spillway capacity, 2,640 second-feet.

The present lakes were formed by a glacial depression underlain at unknown depth by granite and schist. Leakage from the present lakes is negligible. The floor of the basin consists of a mixture of boulders, gravel, sand, and rock. The abutments are high, steep, lateral moraines, consisting of coarse gravel and sand. Due to the composition of the abutments, probable percolation losses are anticipated and provided for in the design.

Three holes, ranging in depth from 100 to 230 feet, were drilled at the dam site. Large boulders, gravel, and fine sand were encountered in all holes. No solid foundation, such as granite or schist, was encountered. The composition of both abutments is essentially the same as that of the valley floor, and the probable percolation losses through abutments might be high. The presence of a deep percolation path beneath the right abutment should be given careful consideration in future exploration. Present plans call for an extensive clay blanket to cover the area between the present impervious lake bed and the projected dam site.

Impervious and pervious materials could be obtained from the moraines in the vicinity, but screening would be required. Rock screenings appear to be adequate in quantity and quality for riprap but, in any event, riprap material can be obtained from granite cliffs about 6 miles from the Twin Lakes Dam site. The estimates submitted include the price of rock obtained at the distant location.

The enlarged Twin Lakes Reservoir would be located along Colorado State Highway No. 82 about 2 miles above the junction of that highway with United States Highway No. 24. The small village of Granite, about 3 miles south of the highway junction, is the nearest railhead. A permanent camp near Granite could serve both the dam and the upper canal system.

Except for the small village of Twin Lakes and several resort cabins, the reservoir area consists chiefly of grazing and San Isabel National Forest lands. No insurmountable problems in securing rights-of-way are anticipated. The Twin Lakes Reservoir & Canal Co. has signified its willingness to cooperate with the Government so long as the rights of the company are fully protected. Acquisition of the existing dam and reservoir is, therefore, not expected to be a difficult problem.

The hydrograph for the potential Twin Lakes Reservoir enlargement shows a maximum inflow of 3,100 second-feet. Routing of these flows through the reservoir gave a maximum spillway discharge of 2,640 second-feet.

It would be necessary to relocate 7 miles of State Highway No. 82 by rerouting the highway around the north side of the reservoir above high-water elevation. The town of Twin Lakes and several resort cabins would be moved. Very little clearing would be required on forest and grazing lands.

Clear Creek Reservoir

The existing Clear Creek Reservoir, owned and operated by the Otero Irrigation Co., would be utilized as an afterbay for the Granite powerplant. Located on Clear Creek adjacent to United States Highway No. 24 about 5 miles south of Twin Lakes, the reservoir has a capacity of 11,400 acre-feet at elevation 8,881. No enlargement is contemplated but about 7,800 acre-feet of reservoir capacity would be utilized above elevation 8,858.

Necessary modifications would include the construction of an outlet structure for the power canal.

Rights of the Otero Irrigation Co. would be fully protected, and no difficulty is expected in acquiring the use of the reservoir.

Pueblo Dam and Reservoir

Water released from the Arkansas Power Canal near Salida would flow down the Arkansas River Channel to the Pueblo Reservoir where it would be stored and released for municipal and irrigation use.

The Pueblo Dam site on the Arkansas River is located 6 miles west of Pueblo in T. 20 S., R. 66 W., sixth principal meridian. The site is 250 feet downstream from the existing flood control barrier dam. The dam would be an earth-fill structure 180 feet high above stream bed. Initial capacity of the reservoir would be 400,000 acre-feet with a surface area of 6,700 acres at elevation 4,902. At the end of 100 years the capacity is expected to be depleted approximately 94,400 acre-feet by deposition of sediment.

Preliminary reservoir data are summarized in the following tabulation:

Use	Elevation	Initial capacity	Capacity at end of 100 years
	Feet	*Acre-feet*	*Acre-feet*
Water conservation	4,885	290,000	210,600
Flood control	4,902	100,000	93,000
Dead storage [1]	4,778	10,000	2,000
Sediment storage			94,400
Total		400,000	400,000

[1] Decreed rights of the Bessemer ditch, which has its headgate in the reservoir site, determined the dead storage elevation.

The spillway would have a maximum discharge of 107,000 second-feet. The river outlet capacity would be 4,000 second-feet at elevation 4,778, and a second outlet provided for the Bessemer ditch would have a capacity of 400 second-feet.

Topography of the area in the vicinity of the dam site is typical of the Great Plains Province which is characterized by low, flat-topped ridges and rolling hills. The geology of the dam and reservoir area consists of Cretaceous deposits of Dakota sandstone along the stream bed at the dam site, overlain farther upstream in the reservoir area and along the banks by Graneros shale, Greenhorn limestone, and Carlile shale. The hard Greenhorn limestone is the caprock which forms conspicuous cliffs extending for many miles along the Arkansas River. As the shales are relatively impervious, the reservoir, which would be located over these formations, would be tight.

The highest portion of the dam would be constructed on Dakota sandstone which is exposed at the site. From the log of an old oil well drilled nearby, the Dakota sandstone is known to reach a depth of 215 feet. The Bureau of Reclamation drilled 12 holes, ranging in depth from 14 to 197 feet at this dam site. The abutments were found to be covered by up to 30 feet of clay and silt derived from the Graneros and Carlile shales. The shales are impervious to percolating water, but necessary precautions should be taken by providing cutoff trenches in the soil or alluvium overlying these sedimentary formations. Some minor folding on a small scale may be present, but faults are rare in the area. Suitable earth-fill materials for the Pueblo Dam are obtainable on the south side of the river near the dam site. Coarse concrete aggregates are available from the Arkansas River burdens above and below the dam site. Fine aggregate can be obtained from existing plants located at the junction of the Fountain and Arkansas Rivers at Pueblo.

The Pueblo Reservoir site is accessible from Colorado State Highway No. 96, which traverses the Arkansas River in that section. The highway is an all-weather, gravel-surface road. The main line of the Denver and Rio Grande Western Railroad parallels the Arkansas River and passes through an opening in the existing barrier dam. It may be necessary to establish construction camps for Government employees and construction workers.

The reservoir would inundate about 500 acres of irrigated agricultural land along the Arkansas River. The balance of the inundated

area would be grazing land. No difficulty is anticipated in securing the necessary rights-of-way.

Construction of the Pueblo Reservoir would require the relocation of 20 miles of single track on the main line of the Denver and Rio Grande Western Railroad. The relocation could be accomplished by shifting the tracks northward to higher benchland above the high-water line. No increase in length would be necessary, maximum grades of 0.7 percent could be maintained, and the degree of curvature for the entire line could be reduced.

Colorado State Highway No. 96 would be relocated above the high-water line on the south side of the reservoir. About 9 miles of highway relocation would be required.

A peak flood hydrograph of 180,000 second-feet has been used in preliminary studies of the potential Pueblo Reservoir.

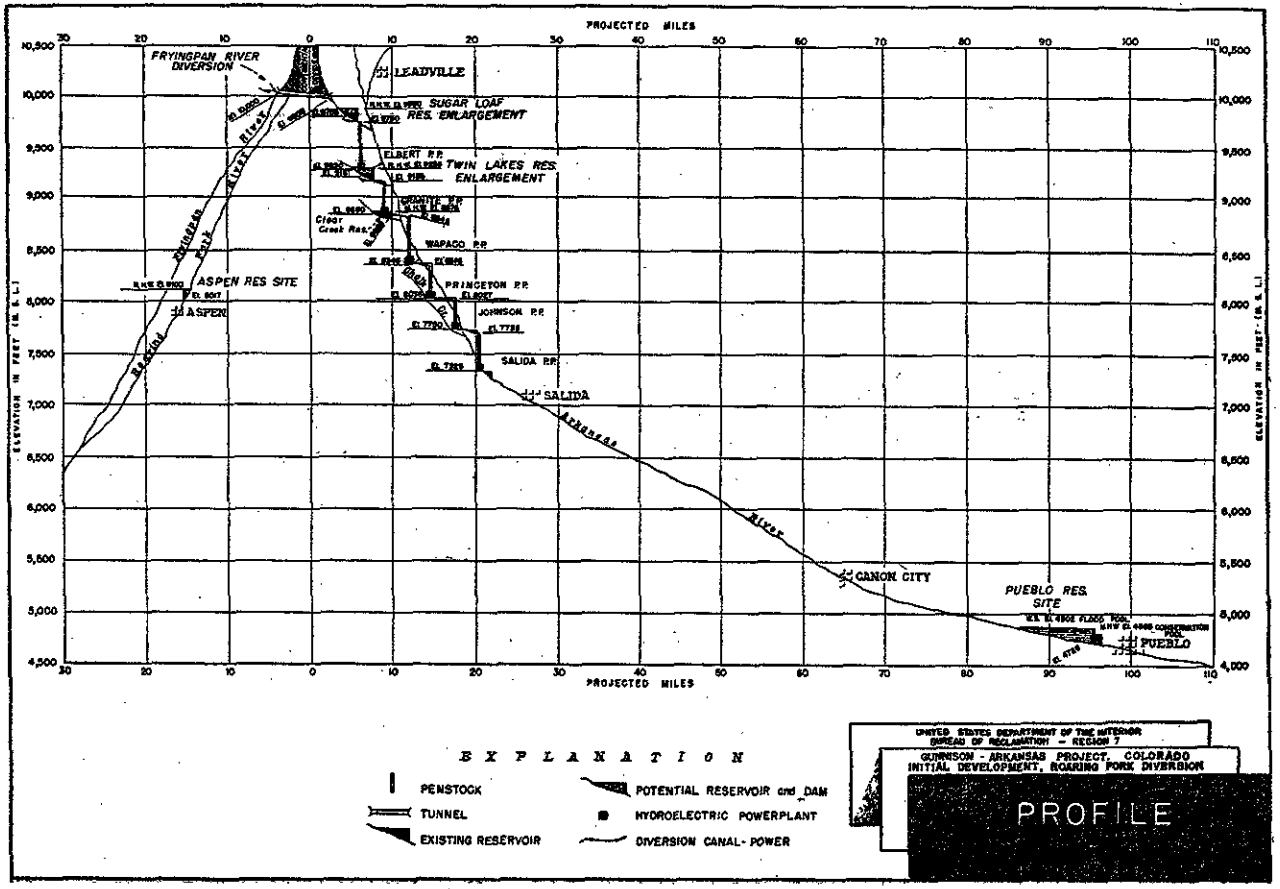
Project power system

The project power system as planned would include 60 miles of canals, 7 powerplants and switchyards, 9 substations, and an estimated 421 miles of transmission lines. Water from the western slope and from the upper Arkansas River (by exchange) would be collected in the Sugar Loaf and Twin Lakes Reservoirs and released into the Arkansas power canal system to satisfy downstream irrigation and domestic water needs. Six powerplants on the canal system would generate power from that water flowing through the differential of 2,440 feet in elevation from Sugar Loaf to Salida. The water released from Salida powerplant at the southern end of the Arkansas power canal would flow down the Arkansas River into the potential Pueblo Reservoir. Power would be generated at the Pueblo powerplant by required releases from the Pueblo Reservoir. A profile of features is shown on exhibit 6. The transmission system, illustrated on exhibit 11, would be required to interconnect the seven powerplants and the principal load centers to permit effective coordination of the plants to obtain optimum power generation and to provide for delivery of the power to principal load centers.

The Arkansas power canal area is bounded on the west by the Sawatch Range and on the east by the Arkansas River. Drainage of the area is to the east, entering the Arkansas River. The canal, which would parallel the Arkansas River on the west side, would intercept Halfmoon Creek, Pine Creek, Chalk Creek, and the Arkansas River at Wapaco. Most of the soil in the area consists of alluvial terrace deposits. Small localized areas, consisting of glacial moraine, exist along the upper half of the canal in the vicinity of the Sugar Loaf, Twin Lakes, and Clear Creek Reservoirs. The terrace and glacial deposits are underlain by pre-Cambrian granite and schist at unknown depth. The deposits are made up of gravel, sand, silt, clay and in some places boulders up to 30 feet in diameter. Outcrops of granite occur in the extreme lower section of the canal site. Gravel and sand for aggregate are ample in quantity at numerous places along the route. Some silt and clay may have to be removed by washing to provide clean aggregate in certain sections.

A wasteway and siphon spillway would be provided at the inlet of each penstock. Forebays would be provided above Princeton, Johnson, and Salida powerplants, and an afterbay would be located below the Salida powerplant on the Arkansas River.

EXHIBIT 6



The Arkansas power canal would be about 60 miles long and would consist of several sections ranging in capacity from 300 to 1,000 second-feet. The first section is the Elbert Canal which would carry water from the Sugar Loaf Dam outlet to the Elbert powerplant at the enlarged Twin Lakes Reservoir. The canal would be unlined, have a capacity of 300 second-feet, and a length of approximately 19 miles. Halfmoon Creek would be intercepted en route.

The next section, the Twin Lakes-Granite Canal, would carry water from the outlet of the Twin Lakes Dam to the Granite powerplant which would utilize the existing Clear Creek Reservoir as an afterbay. The canal, about 5 miles in length, would be concrete-lined and have a capacity of 1,000 second-feet.

From Clear Creek Reservoir the Granite-Wapaco Canal would be constructed a distance of about 8 miles to the Wapaco powerplant. The canal would be concrete-lined and have a capacity of 600 second-feet. Provision would be made to intercept Pine Creek en route.

The Wapaco-Princeton section of the power canal includes the Wapaco diversion dam and canal, the Princeton forebay, and the Wapaco-Princeton Canal. The diversion dam, which would be located across the Arkansas River 8 miles below the village of Granite, would be a concrete overflow type with protecting earth dikes. The length of crest of the dam would be 300 feet and the height, 10 feet. Each dike would be 300 feet in length. The diversion canal, about 0.4 mile long and unlined, would have a capacity of 600 second-feet. It would join the Wapaco-Princeton Canal 0.5 mile below the Wapaco powerplant. The Wapaco-Princeton Canal would have a capacity of 600 second-feet and would extend about 16 miles to the Princeton forebay. The canal would be 50 percent earth-lined and 50 percent unlined. A forebay of 500 acre-feet capacity would be constructed to regulate waters entering the Princeton powerplant. From the forebay to the top of the Princeton penstock the canal would be 0.5 mile long and have a capacity of 750 second-feet.

The Princeton-Johnson section of the power canal includes the Chalk Creek diversion dam and canal, the Johnson Forebay, and the Princeton-Johnson Canal. The Chalk Creek diversion dam, which would be located 0.5 mile above the Princeton powerplant, would be a concrete overflow type dam with a crest length of 50 feet and a height of 8 feet. The Chalk Creek diversion canal would carry water from Chalk Creek to a junction with the Princeton-Johnson Canal immediately below the Princeton powerplant. The canal, which would be unlined, would have a capacity of 375 second-feet and a length of 0.5 mile. The Princeton-Johnson Canal would transport water from the Princeton powerplant to the Johnson powerplant. The 7-mile unlined section of canal from Princeton powerplant to the Johnson Forebay would have a capacity of 750 second-feet. Capacity of the Johnson Forebay would be 200 acre-feet. The 1.2 miles of canal from the forebay to the Johnson penstock would have a capacity of 1,000 second-feet. It would be concrete-lined for a distance of 0.4 of a mile and unlined the remaining 0.8 of a mile.

The Johnson-Salida section would include the Johnson-Salida Canal, the Salida Forebay, and the Salida Afterbay. The Johnson-Salida Canal, which would carry water from the Johnson powerplant to the Salida powerplant, would have a capacity of 1,000 second-feet. The first 1.4 miles of canal to the Salida Forebay would be unlined, and the

remaining 2.7 miles from the forebay to the Salida powerplant would be concrete-lined. The Salida Forebay would have a capacity of 250 acre-feet. The Salida Afterbay, which would be formed by a concrete dam across the Arkansas River 8 miles north of Salida, would have a capacity of 200 acre-feet. The dam would be 32 feet high and 100 feet long with 2 earth dikes 210 and 40 feet long on either side.

Powerplants, powerplant switchyards, and penstocks are tabulated below:

Feature	Average head (feet)	Number of units	Powerplant installed capacity (kilowatts)	Switchyard capacity (kilovolt-amperes)	Penstock	
					Length (feet)	Diameter (inches)
Elbert	515	2	8,700	9,670	1,400	58
Granite	287	2	19,200	21,330	1,000	114
Wapaco	495	2	16,500	18,330	2,100	82
Princeton	278	2	11,700	13,000	1,100	90
Johnson	268	2	15,000	16,670	2,500	104
Salida	405	2	22,700	25,220	990	104
Pueblo	120	2	11,000	12,220	----------	----------
Total	2,368	----------	104,800	116,440	----------	----------

Although the present plan for powerplant installation is entirely feasible, incomplete reconnaissance studies indicate that greater economy may be effected by dividing the Elbert powerplant into 2 plants each utilizing about one-half the 515 feet of head indicated. Furthermore, additional studies may show that greater economy could be obtained by installation of a large portion of the required peaking capacity at Granite powerplant rather than at plants downstream. In addition to reducing the capacity of certain downstream plants, this would also reduce the amount of forebay capacity needed. Detailed surveys beyond the scope of present investigations will establish the most efficient installations.

The Colorado Fuel & Iron Corp. has indicated that it could dump off-peak energy into the initial development power system on an exchange basis. If more efficient power system operation would result, modifications to present plans would be made to take advantage of this energy. This might require a pumping plant at Granite powerplant for pumped storage hydroelectric power.

The transmission system of the initial development would interconnect the project powerplants, principal load centers in southern Colorado, and adjacent Bureau of Reclamation transmission systems for the most efficient operation of the power system. The transmission system as planned would consist of an estimated 421 miles of 115-kilovolt lines with 9 substations which would be located at Dillon, Leadville, Salida, Gunnison, Saguache, Canon City, Pueblo, Colorado Springs, and Limon. The system is subject to modifications that could be economically justified to serve loads which might develop at future dates and which may not be taken care of by other facilities.

At Dillon, the 115-kilovolt transmission system would have an interconnection with the existing Colorado-Big Thompson project power system for efficient interchange of power. The transmission system would extend from Dillon southward through Leadville and interconnect the 6 potential project powerplants from Elbert to Salida. From Salida one leg of the system would extend southward to Saguache

and one westward to Gunnison. The system would extend eastward from Salida through Canon City to Pueblo, serving local loads at each of these places and connecting with the Pueblo powerplant near Pueblo. From Pueblo it would extend north to Colorado Springs to serve local loads and thence to Limon to supply power to that area and form a tie with the Colorado-Big Thompson project system.

	Voltage	Length (miles)
TRANSMISSION LINES		
Dillon-Elbert	115 kilovolt	51
Elbert-Granite	do	11
Granite-Wapaco	do	7
Wapaco-Princeton	do	15
Princeton-Salida	do	7
Johnson-Salida	do	3
Salida-Gunnison	do	66
Salida-Saguache	do	47
Salida-Pueblo	do	97
Pueblo-Colorado Springs	do	44
Colorado Springs-Limon	do	73
Total		421

	Transformer capacity (kilovolt-amperes)
SUBSTATIONS	
Dillon (interconnections)	
Leadville	15,000
Salida	5,000
Gunnison	3,750
Saguache	10,000
Canon City	15,000
Pueblo	25,000
Colorado Springs	30,000
Limon (interconnection)	

Existing transmission lines of other agencies in the area may be used for wheeling power to preference customers if suitable capacity is available and satisfactory arrangements can be made. Additional or alternate transmission lines, such as a Pueblo-Walsenburg line to serve loads south of Walsenburg in the northern New Mexico-southern Colorado market area, may also be required to adequately dispose of the available power and meet the power-marketing criteria as established by law. If these lines prove to be economically justified, they would be constructed as required.

A communication system would be included for efficient operation of the power system.

Access to the project power system is provided by United States Highway No. 24 from Leadville to a point 2 miles below Buena Vista where a junction is made with United States Highway No. 285 which parallels the Arkansas power canal from that point to the Johnson powerplant. Both highways are open throughout the year. Several short county roads cross the canal site at several places. Access to any point along the canal site could be gained by construction of short spur roads from the main highway. The main line of the Denver & Rio Grande Western Railroad from Salida to Leadville roughly parallels the canal route. Housing for personnel could be made available at the potential Granite camp at Leadville, Buena Vista, and Salida.

Right-of-way for the power canal would require acquisition of 528 acres of privately owned lands. The remaining right-of-way would be in the San Isabel National Forest. The private property involved is land of little value.

Winter operation of the power canal and ice formation therein have been given considerable study. Experience and records of actual operation indicate that with judicious operation of the project during the winter months no serious reduction in power production would result.

Municipal water supply features

Further discussion of the plan for supplying additional municipal water to cities and towns in the Arkansas Valley is presented in Chapter IX—Municipal Water.

Colorado Springs.—Additional municipal water can be furnished to Colorado Springs from the south slopes of Pikes Peak. A pumping plant would be constructed on Middle Beaver Creek to lift water about 140 feet into reservoir No. 4 of the Colorado Springs municipal supply system. The pumping plant, which would require 144 kilowatts of power, would have a capacity of 10 second-feet. A potential adjacent substation would obtain power from a transmission line to be built by Colorado Springs between municipally owned powerplants and the existing Skaguay hydroelectric powerplant. The penstock would be 20 inches in diameter and approximately 5,300 feet in length. Features required for replacement of the water diverted from the Beaver Creek watershed include a diversion dam on Oil Creek and a canal from that dam to the existing Brush Hollow Reservoir. The diversion dam would be located 5 miles above the confluence of Oil Creek and the Arkansas River and would contain a concrete section 50 feet long and 10 feet high with earth dikes 100 feet long on either side. The unlined Oil Creek Canal would be 15 miles long and have a capacity of 50 second-feet. No alterations to the Brush Hollow Reservoir would be required.

The Oil Creek Canal would cross sedimentary beds of Cretaceous age. Most of the canal alinement is through the Niobrara formation and the Pierre shale. Small areas of the Dakota and Benton formations would be encountered in the canal construction. As all of those formations are relatively impervious, no canal lining would be required. Suitable construction materials are available in ample quantity in the vicinity of the canal route.

Access to the pumping plant at Middle Beaver Creek would be provided by Colorado State Highways Nos. 67 and 336 and a county dirt road up Middle Beaver Creek, which is closed during the winter. The nearest railhead is Colorado Springs about 50 miles away. No difficulty should be encountered in securing the necessary rights-of-way. The chief construction problem would be the long haul of materials. All but a few miles of the road is satisfactory for haulage.

The diversion dam on Oil Creek and the upper canal sections are accessible by a gravel-surfaced county road up Oil Creek. State Highway No. 120 and United States Highway No. 50 provide access to the remaining canal section. Canon City, Florence, and Portland are the nearest railheads to the diversion dam and canal. The canal, located entirely on private grazing land, would require acquisition of 180 acres of right-of-way.

Pueblo and valley towns.—Additional water to be supplied to Pueblo and the valley towns would be pumped from the potential Pueblo Reservoir to a purification plant from which pipelines would distribute the water. The pumping plant would be located on the south side of the reservoir near the dam. It would have a capacity of 90 second-feet and would lift the water about 386 feet through two 42-inch penstocks, 7,300 feet long to the purification plant. The purification plant, which would not include chlorination, would have a capacity of 55.5 million gallons per day. A reservoir of 7 million gallons' capacity would be constructed near the plant to provide the additional storage capacity required to supply Pueblo's peak demand. From the purification plant a 30-inch dual pipeline would carry the water supply for Pueblo 7 miles to the municipal supply system which would distribute the water. Another pipeline also beginning at the purification plant would carry municipal water down the Arkansas Valley to Manzanola, Rocky Ford, La Junta, Las Animas, and Lamar. That main trunk line would be 130 miles long and would have a capacity ranging from 15.00 to 4.27 second-feet. About 36 miles of branch pipelines could be constructed to serve Crowley and Eads and other towns along the lines desiring additional water. The pipelines have been designed to carry the average daily demand for the maximum month. Where necessary, the individual towns would provide storage for supplying their daily and hourly peak demands.

The entire valley pipeline would be laid in soil overlying sedimentary deposits of Cretaceous age.

Access to the pumping plant near the Pueblo Reservoir is provided by State Highway No. 96. The valley pipeline route extending eastward from Pueblo is accessible by United States Highway No. 50. The branch line to Crowley may be reached by State Highway No. 207, and the branch line to Eads, by United States Highway No. 287. The Santa Fe Railway roughly parallels the trunkline, and the Missouri-Pacific Railroad serves the towns of Crowley and Eads.

No difficulties are anticipated in securing the necessary rights-of-way. The land is fairly level with several drainages crossing the pipeline route.

COST ESTIMATE AND CONSTRUCTION PROGRAM

Based on October 1949 prices, the total estimated cost of the features of the initial development, including purchase of rights-of-way, cost of clearing timber, severance damages, cost of operation and maintenance during construction, and additional costs for contingencies and overhead, would be $147,440,000, as shown on exhibit 7. The estimated total annual costs, based on October 1949 prices, including operation and maintenance, overhead and administration, and replacement reserve, would be $1,335,200.

The periods of construction for all features and the estimates of annual appropriations necessary to permit efficient construction and optimum operation of the project are shown on the control schedule, exhibit 8.

Completion of the Aspen Reservoir for replacement purposes is scheduled before transmountain diversions. Concurrent construction has been scheduled for other project features, the most significant

being the Fryingpan-Arkansas tunnel, Snowden Canal, Twin Lakes Reservoir, and the Pueblo Reservoir. Some transmountain water could be diverted immediately upon completion of the tunnel, prior to construction of the entire western slope collection system. Such initial diversions and native Arkansas river floodwater would hasten filling the reservoirs for ultimate full operation. Gradual expansion of the western slope collection system would enable corresponding increases of diversions.

Construction of the power system would be concurrent with other construction. The Pueblo powerplant would be completed in the 10th year. All other powerplants are scheduled for completion and operation in the seventh year in order to permit their operation as a unit. Deferment of the Pueblo powerplant is deemed advisable to allow sufficient time for the resolution of storage agreements and to enable establishment of definite tailwater elevations prior to final powerplant design.

35002—53——6

EXHIBIT 7.—*Official estimate of total project cost, Gunnison-Arkansas project*

[Region 7; date of estimate Jan. 20, 1950, revised Feb. 7, 1950; prices as of October 1949]

Class and account reference	Property and description	Previous official estimate	Detail of current estimate of project cost							Current official estimate
			Land and land rights	Labor and materials		Materials and equipment permanently installed	Temporary construction property	Investigations and engineering	Administrative and general expenses	
				By contractor	By Government					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	DAMS AND RESERVOIRS									
01.01	Replacement Reservoir, Aspen, 28,000 acre-feet	----------	$600,000	$5,078,000	$23,000	$197,000	----------	$742,000	$106,000	$6,746,000
01.02	Sugar Loaf Reservoir enlargement, 117,000 acre-feet	----------	100,000	5,452,000	11,000	298,000	----------	806,000	115,000	6,782,000
01.03	Twin Lakes Reservoir enlargement, 260,000 acre-feet	----------	136,000	7,375,000	13,000	511,000	----------	1,091,000	156,000	9,282,000
01.04	Pueblo Reservoir, 400,000 acre-feet	----------	947,000	31,370,000	30,000	3,480,000	----------	4,985,000	712,000	41,524,000
	DIVERSION CANALS AND CONDUITS									
05.01	Hunter Creek, Aspen Canal, 200 cubic feet per second	----------	----------	143,000	----------	21,000	----------	23,000	3,000	190,000
05.02	Hunter Creek extension canal	----------	----------	210,000	----------	31,000	----------	34,000	5,000	280,000
05.03	Fryingpan collection system	----------	----------	15,219,000	36,000	2,355,000	----------	2,465,000	352,000	20,427,000
05.04	Fryingpan-Arkansas divide tunnel, 800 cubic feet per second	----------	----------	6,881,000	----------	739,000	----------	1,067,000	152,000	8,839,000
05.05	Snowden Canal, 600 cubic feet per second	----------	----------	610,000	----------	48,000	----------	92,000	13,000	763,000
	UPPER ARKANSAS RIVER POWER SYSTEM									
05.06	Elbert power canal, 300 cubic feet per second	----------	1,000	1,344,000	1,000	58,000	----------	197,000	28,000	1,629,000
05.07	Twin Lakes to Granite power canal, 1,000 cubic feet per second	----------	----------	711,000	1,000	277,000	----------	139,000	20,000	1,148,000
05.08	Granite to Wapaco power canal, 600 cubic feet per second	----------	----------	1,052,000	1,000	351,000	----------	197,000	28,000	1,629,000
05.09	Wapaco to Princeton power canal, 600 cubic feet per second	----------	1,000	1,672,000	2,000	147,000	----------	255,000	36,000	2,113,000
05.10	Princeton to Johnson power canal, 750 cubic feet per second	----------	2,000	1,116,000	1,000	202,000	----------	185,000	26,000	1,532,000
05.11	Johnson to Salida power canal, 1,000 cubic feet per second	----------	----------	1,379,000	2,000	219,000	----------	224,000	32,000	1,856,000
01.05	Salida Afterbay, 250 acre-feet	----------	----------	218,000	----------	47,000	----------	37,000	5,000	307,000
11.01	Elbert powerplant, 8,700 kilowatts	----------	----------	414,000	97,000	669,000	$37,000	171,000	24,000	1,412,000
11.02	Granite powerplant, 19,200 kilowatts	----------	----------	781,000	184,000	1,263,000	69,000	321,000	46,000	2,664,000
11.03	Wapaco powerplant, 16,500 kilowatts	----------	----------	694,000	163,000	1,123,000	61,000	285,000	41,000	2,367,000
11.04	Princeton powerplant, 11,700 kilowatts	----------	----------	530,000	125,000	858,000	47,000	218,000	31,000	1,809,000

11.05	Johnson powerplant, 15,000 kilowatts	----------	----------	693,000	163,000	1,120,000	61,000	285,000	41,000	2,363,000
11.06	Salida powerplant, 22,700 kilowatts	----------	----------	894,000	211,000	1,447,000	79,000	368,000	53,000	3,052,000
11.07	Pueblo powerplant, 11,000 kilowatts	----------	----------	631,000	148,000	1,020,000	56,000	360,000	37,000	2,152,000
13.01	Switchyards (included in cost of powerplants)	----------	----------	(797,000)	(111,000)	(2,019,000)	(53,000)	(497,000)	(71,000)	(3,548,000)
14.01	Transmission system	----------	222,000	6,331,000	67,000	220,000	46,000	964,000	138,000	7,988,000
16.01	Permanent camp at Granite	----------	----------	(231,000)	(32,000)	(226,000)	----------	(81,000)	(12,000)	(582,000)
16.02	Caretaker's residence, garage, and utilities	----------	----------	(34,000)	(5,000)	(33,000)	----------	(12,000)	(2,000)	(86,000)
16.03	Warehouses	----------	----------	(147,000)	(17,000)	(77,000)	----------	(40,000)	(6,000)	(287,000)
17.01	Construction camps	----------	----------	(679,000)	(78,000)	----------	----------	(126,000)	(18,000)	(901,000)
17.02	Construction office and laboratory	----------	----------	(64,000)	(6,000)	----------	----------	(12,000)	(2,000)	(84,000)
	Additional facilities for delivery of municipal water	----------	456,000	3,232,000	----------	11,872,000	----------	2,179,000	311,000	18,050,000
	Operation and maintenance during construction	----------	----------	----------	536,000	----------	----------	----------	----------	536,000
	Total project cost	----------	2,465,000	94,030,000	1,815,000	28,573,000	456,000	17,590,000	2,511,000	147,440,000

NOTE.—Cost of items shown in parentheses are included in costs of other features.

002452

FRYINGPAN-ARKANSAS PROJECT

LEGEND: Types of Activity

Preconstruction — Construction

Line No.	Class and Account	Program Item	Quantity	Unit	Total Estimated Cost 1/	Cost to June 30, 1950	1951	1952	1953	1954	1955	1956	1957	Balance to Complete	Estimated Completion Date	Line No.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1		Rate of Irrigation Development-Supplemental	322,000	AF											F.Y. 1958	1
2		Rate of Power Development	104,800	KW										104,800 KW	F.Y. 1961	2
3																3
4	00.	Development of Project Plan			2,213,000	591,000	302,000	660,000	300,000	210,000	90,000	60,000				4
5		JOINT FACILITIES														5
6	01.01	Aspen Dam and Reservoir	28,000	AF	6,653,000			400,000	1,680,000	2,600,000	1,973,000	Start of Storage				6
7	01.04	Pueblo Dam and Reservoir	400,000	AF	40,901,000			700,000	12,960,000	16,120,000	9,017,000	2,104,000	Start of Storage			7
8	01.03	Twin Lakes Dam and Reservoir Enlargement	260,000	AF	9,010,000			300,000	3,200,000	3,750,000	1,460,000	300,000	Start of Storage			8
9	01.02	Sugar Loaf Dam and Reservoir Enlargement	117,000	AF	6,580,000					178,000	2,331,000	3,771,000	300,000 Start of Storage			9
10	05.04	Fryingpan Arkansas Tunnel	900 5.8	SF Mi	8,706,000			30,000	1,930,000	2,793,000	3,953,000	Initial Water Delivery				10
11	05.05	Snowden Canal	300 10.0	SF Mi	740,000					250,000	460,000	Initial Water Delivery				11
12	05.03	Fryingpan Collection System	40.6	Mi	20,119,000				90,000	400,000	4,551,000	6,296,000	7,994,000	788,000	FY 1958 3/	12
13	05.01	Hunter Creek-Aspen Canal	200 1.7	SF Mi	187,000					17,000	170,000					13
14	15.	Permanent Improvements (Granite Camp)			572,000			50,000	300,000	222,000						14
15	16.84	O. & M. during construction			536,000						45,000	100,000	173,000	218,000	FY 1958	15
16		POWER FACILITIES														16
17	05.	Upper Arkansas Power Canals 4/	61	Mi	9,620,000					200,000	1,040,000	2,257,000	3,506,000	2,617,000	FY 1958	17
18	01.05	Salida Afterbay	200	AF	297,000							140,000	157,000			18
19	11.	Powerplants (including penstocks) 5/	104,800	KW	15,385,000				340,000	630,000	1,810,000	4,692,000	4,092,000	3,821,000	FY 1961 6/	19
20	13. 13.	Powerplant Switchyards (incl. in P.P. costs) Transmission system	421	Mi	7,868,000			60,000	1,150,000	1,200,000	1,700,000	1,700,000	1,100,000	958,000	FY 1958	20
21		OTHER FACILITIES														21
22	05.02	Hunter Creek Extension Canals for Fish & Wildlife	8	Mi	275,000							30,000	195,000	50,000	FY 1958	22
23		Additional facilities for delivery of municipal water			17,776,000					300,000	1,300,000	7,400,000	6,583,000	2,195,000	FY 1958	23
24		Extension of collection system for Fish and Wildlife			(2,179,000)			(47,000)	(200,000)	(329,000)	(603,000)	(270,000)	(370,000)	(360,000)	FY 1958	24
25		Materials and Supplies					15,000	0	50,000	100,000	100,000	-50,000	-100,000	-115,000		25
26		Total Construction Cost			147,440,000	591,000	317,000									26
27		Obligations not in cost				15,000	-15,000									27
28		Total obligations			147,440,000	606,000 2/	302,000									28
29																29
30		Allotments					302,000									30
31		Prior year's unobligated balance					0									31
32		Allotment Requirements						2,000,000	22,000,000	29,000,000	30,000,000	29,000,000	24,000,000	10,532,000	FY 1961	32
33		Denver Office					(17,000)	(890,000)	(923,000)	(212,000)	(297,000)	(651,000)	(246,000)	(187,000)		33

Notes:
1/ Cost of items enclosed in parentheses included in cost of other features.
2/ G.I. funds, $366,000. U.C.R. funds, $50,000. C.R.D. funds, $190,000.
3/ Initial delivery of water.
4/ Elbert Canal - 300 SF, 19.2 mi.; Twin Lakes-Granite Canal - 1,000 SF, 5.3 mi.; Granite-Wapaco Canal - 600 SF, 7.6 mi.; Wapaco-Princeton Canal - 600-750 SF, 16.1 mi.; Princeton-Johnson Canal - 750-1000 SF, 8.2 mi.; Johnson-Salida Canal - 1000 SF, 4.1 mi.
5/ Powerplants: Elbert - 5,700 kw; Granite - 29,200 kw; Wapaco - 16,500 kw; Princeton - 11,700 kw; Johnson - 15,000 kw; Salida - 22,700 kw; Pueblo 11,000 kw.
6/ All powerplants except Pueblo to be completed FY 1958 (93,800 kw). Pueblo Powerplant to be completed FY 1961 (11,000 kw).

Recommended: B. F. [illegible] 5-22-50 (Date)
Recommended: [signature] 8-5-50 (Date)
Recommended: (Director of ...) (Date)
Approved: (Commissioner) (Date)
Sheet 1 of 1 sheets

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CONTROL SCHEDULE
FOR THE
INITIAL DEVELOPMENT
GUNNISON-ARKANSAS
PROJECT OR UNIT
Pueblo, Colorado — May [illegible], 1950 — 7
☐ General investigations ☒ Construction ☐ Operation & maintenance ☐ Other

EXHIBIT 8

Chapter IV. Water Supply

WATER RESOURCES

Available supply

Runoff in the western slope diversion area is derived primarily from melting snow. The streamflow is in excess of present utilization in that area. Each year thousands of acre-feet of water, which could be used to develop the arid eastern slope, flow down the Colorado River and are lost to the State. During the period October 1910 through September 1944, which represents prevailing conditions in the area, flows averaging approximately 69,200 acre-feet were available for diversion to the eastern slope from the 95-square mile drainage area of the upper Roaring Fork River Basin. An additional 14,900 acre-feet of water was available for diversion through the Twin Lakes (Independence Pass) system, now owned and operated by the Twin Lakes Reservoir & Canal Co., but reservoir capacity in the Arkansas Valley was insufficient to store the additional water.

On the eastern slope, seasonal runoff from melting snow often coincides with rainfall. Too often the consequences are damaging floods and undivertible flows. During the growing season (April 1 to October 31) the dependable flow of the Arkansas River and its tributaries is fully utilized each year for irrigation and for other water uses. Flood flows are conserved to some extent by means of storage. Although the present annual Arkansas River water supply in the Arkansas Valley below Pueblo totals 1,143,000 acre-feet, as shown in table 3, the 656,000 acre-feet available for use during the summer months is entirely inadequate.

In addition to the eastern slope water, an average of 48,000 acre-feet of water is imported annually by 7 transmountain diversions from the Colorado River Basin and 1 transmountain diversion from the Rio Grande River Basin. The largest of these diversions is the Twin Lakes (Independence Pass) system which imports annually about 38,000 acre-feet to the Arkansas Valley. The remaining systems divert about 10,000 acre-feet annually. Most of the imported water is used for irrigation. One diversion, the Wurtz ditch, is owned by the city of Pueblo; most of its annual yield is lost for municipal use due to lack of storage facilities.

TABLE 2.—*Historic annual comparison of diversions from Arkansas River below Pueblo in Colorado and flow passing the Colorado-Kansas boundary*

[Unit: 1,000 acre-feet]

Water year	Headgate diversions from Arkansas River [1]	Flow at State line	Water year	Headgate diversions from Arkansas River [1]	Flow at State line
1911	778	61	1929	981	240
1912	970	241	1930	940	167
1913	660	133	1931	613	201
1914	1,164	567	1932	656	65
1915	1,118	492	1933	776	169
1916	922	147	1934	486	62
1917	916	74	1935	757	187
1918	894	51	1936	887	340
1919	914	201	1937	725	142
1920	1,065	193	1938	878	192
1921	882	988	1939	700	72
1922	817	105	1940	423	31
1923	969	629	1941	1,023	210
1924	934	478	1942	1,204	1,342
1925	702	247	1943	1,035	241
1926	928	133	1944	830	298
1927	914	444			
1928	998	263	Average	866	277

[1] Annual headgate diversion of Arkansas River water only—Bessemer ditch to Colorado-Kansas boundary. Does not include imported water of existing trans-mountain diversions.

TABLE 3.—*Natural water supply for seasonal irrigation use, Pueblo to Colorado-Kansas State line (1911–44)*

		Acre-feet
Supply:		
Inflow at Pueblo and from tributaries below Pueblo		893, 000
Estimated return flow		250, 000
Total water supply		1, 143,, 000
Disposition:		
Outflow, flow at State line		277, 000
Historic use of Arkansas River water:		
Winter diversions to irrigation	160, 000	
Valley reservoir evaporation	50, 000	
Summer use (includes releases from valley reservoir)	656, 000	
Subtotal		866, 000
Total		1, 143, 000

Suitable water-bearing formations, such as gravel beds, are not independent of the surface water supply. Numerous small pumps below irrigation ditches recover a portion of the water lost by percolation between irrigation ditches and the rivers, but those pumps depend upon continued irrigation to maintain the water table. Rainfall in the area is not sufficient to replenish the depleted groundwater supply each year. Recharge is generally accomplished by direct flow from contiguous streams.

Quality of water

The water of the streams in the headwaters region is relatively pure. The amount of solids in solution, however, increases down the Arkansas River from its source due to accumulations of salts from return flows from irrigated lands and from solids picked up from the soluble rock strata along the tributary streams. Table 4 summarizes the quality of water in the eastern slope project area,

and in order that the quality of water may be classified, the general standards for classification of irrigation waters are presented in the following tabulation.

Class	Conductance K×10 [5]	Sodium percentage	Chloride (e. p. m.)	Boron (p. p. m.)
I. Excellent to good, under	100	60	5	0.5
II. Good to injurious	100–300	67–75	5–10	0.5–2.0
III. Injurious to unsatisfactory, over	300	75	10	2.0

TABLE 4.—*Mean quality of water, October 1940 to September 1941*

Station	Discharge (acre-feet)	Dissolved solids (tons/acre-feet)	Dissolved solids (p. p. m.) [1]	Conductance K×10 [5]	Sodium percentage [2]	Chloride (e. p. m.) [3]	Boron (p. p. m.) [1]
Lake Creek below Twin Lakes Reservoir	53	0.11	84	8	10	0.20	(5)
Pueblo [4]	503,200	.47	346	51	16	.20	(5)
Nepesta	567,800	.74	542	81	21	.33	(5)
La Junta	107,600	1.48	1,088	141	27	.75	(5)
Caddoa	309,900	1.87	1,376	171	34	1.01	(5)

[1] P. p. m.=parts per million.

[2] Percent $Na=\frac{(Na+K)}{(Ca+Mg+Na+K)}\times 100$.

[3] E. p. m.=equivalents per million.

[4] Pueblo gage at South Side Water Works Dam, October 1940 to September 1941.

[5] Negligible.

All western slope water imported for project use would be at least as good as the quality of Lake Creek water shown in the preceding table.

Some areas above Pueblo, to which a full water supply has been available at all times, contribute large amounts of dissolved solids to the river. Accretion of salts and alkali from those areas would not be magnified by the project. Below Pueblo the return of salts and alkali to the river is largely a function of the pattern of irrigation, and it is not likely that water applied to the crop area at a uniform rate during the irrigation season would produce as much return of dissolved solids as water applied in excessive amounts in and out of season.

During the years around 1915, the amount and incidence of runoff was so favorable that the irrigated condition of the valley existed for 3 or 4 years under an unregulated water supply adequate for maximum crop production. This irrigation water supply produced conditions for return flow which set the pattern for drainage structures that have since been installed to relieve injurious effects from a complete water supply. Consequently, no additional drainage is contemplated as a result of the project.

WATER REQUIREMENTS

In the determination of water requirements, the Arkansas River Valley below Pueblo, which contains most of the area to receive irrigation water from the potential Gunnison-Arkansas project, was divided into two reaches because of slightly different climatological

conditions. Data for the two reaches over the 1911–44 period were averaged together to determine the irrigation water consumed in the production of crops and the effective precipitation for the entire valley. The consumptive use of water averaged 2.39 acre-feet per acre per year, and the average annual effective precipitation was 0.87 feet. The irrigation water consumed in the production of crops would then average 1.52 acre-feet per acre per year (2.39–0.87) for the period 1911–44.

In order to deliver 1.52 acre-feet per acre to the irrigated crops, a much greater quantity of water would be needed at the canal headgate in the river due to canal, lateral, and farm losses. Losses in existing canals varied from 47 to 13 percent and averaged about 32 percent for the area from Pueblo to the Colorado-Kansas boundary. Lateral losses were estimated at 5 percent and farm losses at 25 percent. By allowing for those losses the average canal headgate diversion requirement for the period 1911–44 would be 3.19 acre-feet per acre in order to deliver 1.52 acre-feet per acre to the irrigated crops. For the critical period 1930–41 the canal headgate diversion requirement would average 3.46 acre-feet per acre in order to deliver 1.65 acre-feet per acre to the irrigated crops. Utilization of each headgate diversion would be as follows:

Item	1911–44 (acre-feet/annual consumption)	1930–41 (acre-feet/annual consumption)
Consumptive use	2.39	2.44
Less effective precipitation	.87	.79
Consumptive use of irrigation water	1.52	1.65
Usable return	1.25	1.36
25 percent loss (nonirrigable land, etc.)	.42	.45
Total farm, lateral, and canal losses	1.67	1.81
Canal headgate diversion requirement	3.19	3.46

RETURN FLOW

The usable return flow is estimated at 1.25 acre-feet of the 3.19 acre-feet diverted at the canal headgate, or approximately 40 percent of each headgate diversion. Due to the length of the irrigated area below Pueblo and the relative location of canal headgates, at least 4 reuses of the 40 percent project return flow (or 64 percent) would be made when part of the valley irrigation shortage in Colorado occurs below the John Martin Reservoir. When operation of the John Martin Reservoir eliminates all Colorado irrigation shortages below that reservoir, only one reuse (or 40 percent) would be made. This is conservative when compared with results of a study made for the Arkansas Valley for the years 1922–25 which showed a return flow of 54 percent from one complete diversion after all losses, excepting nonrecurrent reservoir and river valley vegetation losses, were considered. In 1942 the Bessemer ditch area showed overall return flows as high as 60 percent; however, the consumptive use included an appreciable amount used by native vegetation bordering the Arkansas River so that the return flow from the irrigated lands would be somewhat greater than 60 percent. It is estimated that return flow in excess of 40 percent may be expected under project operation.

WATER RIGHTS

Existing rights

Western slope streamflow is not overappropriated. After due allowance has been made for all present and probable future western slope use, streamflow is available for transmountain diversion and use subject to the terms of the upper Colorado River Basin compact.

The Upper Arkansas River is overappropriated. Decreed direct diversion rights from the main stem of the Arkansas River in Colorado total more than 7,400 second-feet—roughly 10 times the average flow of the Arkansas River at Pueblo. Virtually all tributary flow is likewise overappropriated.

Present storage capacities of private reservoirs along the Arkansas River total about 80,000 acre-feet for the reservoirs located above Pueblo and about 300,000 acre-feet for the 11 off-stream reservoirs located below that city. The capacities of these reservoirs are rapidly becoming depleted due to sediment deposition. The eventual result of such uncontrolled sedimentation will be a return to the river flow conditions that existed when the overappropriations were first apparent and the reservoirs were originally constructed. Both Colorado and Kansas will be affected by this situation because the water supply will be even more inadequate and unreliable than at present. In order to prevent this condition it is necessary to provide more storage to control sediment and to replace storage capacity being depleted.

Compacts

Colorado River compact.—Under terms of the Colorado River compact, States of the upper division, viz, Colorado, New Mexico, Utah, and Wyoming, may not cause the flow of the Colorado River at Lee Ferry to be depleted below 75 million acre-feet for any consecutive 10-year period. This compact also allocates the use of 7,500,000 acre-feet of water annually to the upper basin States.

Mexican Treaty.—As concerns the Colorado River the treaty of 1945 between the United States and Mexico guaranteed delivery to Mexico of 1,500,000 acre-feet of water annually subject to certain curtailments in case of extraordinary drought, etc. in the Colorado River Basin. The treaty also provides for the delivery to Mexico of certain additional quantities of water in years when such additional water is available in the Colorado River Basin.

Upper Colorado River Basin compact.—The upper Colorado River Basin compact allocates to each of the upper basin States portions of the 7,500,000 acre-feet available annually for their consumptive use under terms of the Colorado River compact, as follows:

To Arizona	acre-feet annually	50,000
To the following States, the remainder:		
Colorado	percent	51.75
New Mexico	do	11.25
Utah	do	23.00
Wyoming	do	14.00

Assuming 7,500,000 acre-feet of water available to the upper basin, the Colorado share would be 3,855,375 acre-feet. The present consumptive use of Colorado River water in Colorado and the estimated future uses by authorized projects are estimated to total about 1,600,000 acre-feet. This leaves about 2,300,000 acre-feet of Colorado River water for additional beneficial uses in Colorado.

Arkansas River compact.—The Arkansas River compact apportions the waters of the Arkansas River and the benefits arising from the John Martin Reservoir between the States of Colorado and Kansas. The compact provides specifically that: (*a*) the flood-control storage of John Martin Reservoir will be operated by the Corps of Engineers for flood-control purposes; (*b*) the conservation pool will be operated for the benefit of water users in Colorado and Kansas, both upstream and downstream from John Martin Reservoir; and (*c*) the compact is not intended to impede or prevent future beneficial development of the Arkansas River Basin in Colorado or Kansas by Federal or State agencies, by private enterprise, or by combination thereof, which may involve construction of dams, reservoirs, and other works for the purpose of water utilization and control; provided, that the waters of the Arkansas River shall not be materially depleted in usable quantity or availability for use to the water users in Colorado and Kansas under the compact by such future development or construction.

The studies presented herein of the use and regulation by the project reservoirs of the Arkansas River waters are in conformity with the provisions of the Arkansas River compact.

Project rights

The critical project rights are those necessary to obtain water for diversion to the Arkansas River Basin. Those rights would be junior to all existing western slope rights and to previously established transmountain diversion rights. Coupled with a replacement reservoir, the potential initial development would divert from the western slope only those flows indicated to be available under the broad policy of development adopted by the State of Colorado.

Storage rights for project reservoirs on the eastern slope would be established according to State laws. Although such rights would be junior to existing rights in the Arkansas Valley, they would be of value in storing flood flows, particularly during years of high runoff. Project storage of Arkansas River water in project structures could also be effected by exchange or by agreement with owners of existing water rights. The project plan encompasses such agreements, particularly with regard to irrigation flows below Pueblo. In such event, part of the Arkansas River winter flow appearing at Pueblo would be stored in the Pueblo Reservoir and released to the present irrigators during the succeeding growing season or seasons.

By mutual agreement of the water users, considerable savings in evaporation from shallow valley reservoirs could be effected by transfer of storage from the valley reservoirs to project reservoirs during the summer months. For purposes of this report, possible evaporation saving was not evaluated and no estimate of possible benefits was prepared.

In order that all direct beneficiaries contribute to the cost of the benefits derived, State legislation permitting recapture and reuse of return flow from water imported into the area should be considered. The capture and transfer by operation agreements of Arkansas River water from off-season use to seasonal use could be accomplished by agreement among the present appropriators.

WATER UTILIZATION

Canal and reservoir capacities

The canal capacities for the project power system were determined mainly by considering the intermediate flow to be intercepted by canals and the quantity of water to be released from the Sugar Loaf and Twin Lakes Reservoirs to meet power generation demands. Although the two conditions do not occur simultaneously, the capacity selected is adequate for either situation.

The combined capacities of the potential project reservoirs would enable efficient operation of the project for irrigation and municipal purposes. The production of hydroelectric power would be incidental to those primary functions. Enlargement of the existing Sugar Loaf and Twin Lakes Reservoirs and construction of the potential Pueblo Reservoir would provide storage capacity as follows (in acre-feet):

Reservoir	Total capacity	Dead storage	Active capacity
Sugar Loaf	117,000	0	117,000
Twin Lakes	260,000	0	260,000
Pueblo	400,000	10,000	390,000
Total	777,000	10,000	767,000

After deducting capacity for other uses, as shown in the following table, about 315,600 acre-feet of reservoir capacity would remain for project conservation use.

TABLE 5.—*Project reservoir conservation storage*

Item	Amount (acre-feet)
Total capacity	777,000
Present capacity Sugar Loaf Reservoir	17,000
Present capacity Twin Lakes Reservoir	56,000
Added capacity for Colorado Fuel & Iron Corp	[1] 10,000
Added capacity Twin Lakes Reservoir and Canal Co	[2] 54,000
Capacity for power purposes	[3] 135,000
Capacity for flood control (Pueblo Reservoir)	[4] 93,000
Capacity for sediment control (Pueblo Reservoir)	[5] 94,400
Dead storage (Pueblo Reservoir)	[6] 2,000
Subtotal	—461,400
Active storage capacity for conservation use	315,600

[1] Informally requested by Colorado Fuel & Iron Corp., owner and operator of Sugar Loaf Reservoir.
[2] Informally requested by Twin Lakes Reservoir and Canal Co., owner and operator of Twin Lakes Reservoir.
[3] Estimated as minimum storage needed to maintain firm power generation during winter months.
[4] Recommended by Corps of Engineers.
[5] Estimated sedimentation for 100 years in Pueblo Reservoir.
[6] Dead storage after sedimentation (10,000 acre-feet minus 8,000 acre-feet sediment in dead storage capacity).

Evaporation losses from project canals would be negligible. Evaporation from project reservoir surfaces has been estimated to amount to about 15 percent of the imported transmountain water. Seepage losses from the project power canals were estimated at one-half of 1 percent per mile for unlined sections, and appropriate allowances were made in project operation studies.

Operation studies

In operation, the enlarged Sugar Loaf and Twin Lakes Reservoirs would control intercepted Arkansas River flow and transmountain water for power purposes. Arkansas River flow could be stored only when sufficient project water is available for release to irrigators in exchange. Sufficient water would be bypassed at project diversion structures to maintain adequate fish flows and provide adequate water supply for presently irrigated lands above Salida, up to the natural flow. Releases from the upper reservoir system would be scheduled to meet the power generation demand within the limits required for irrigation operations. Releases for winter power generation will be regulated in the Pueblo Reservoir for subsequent municipal or irrigation use during the following season.

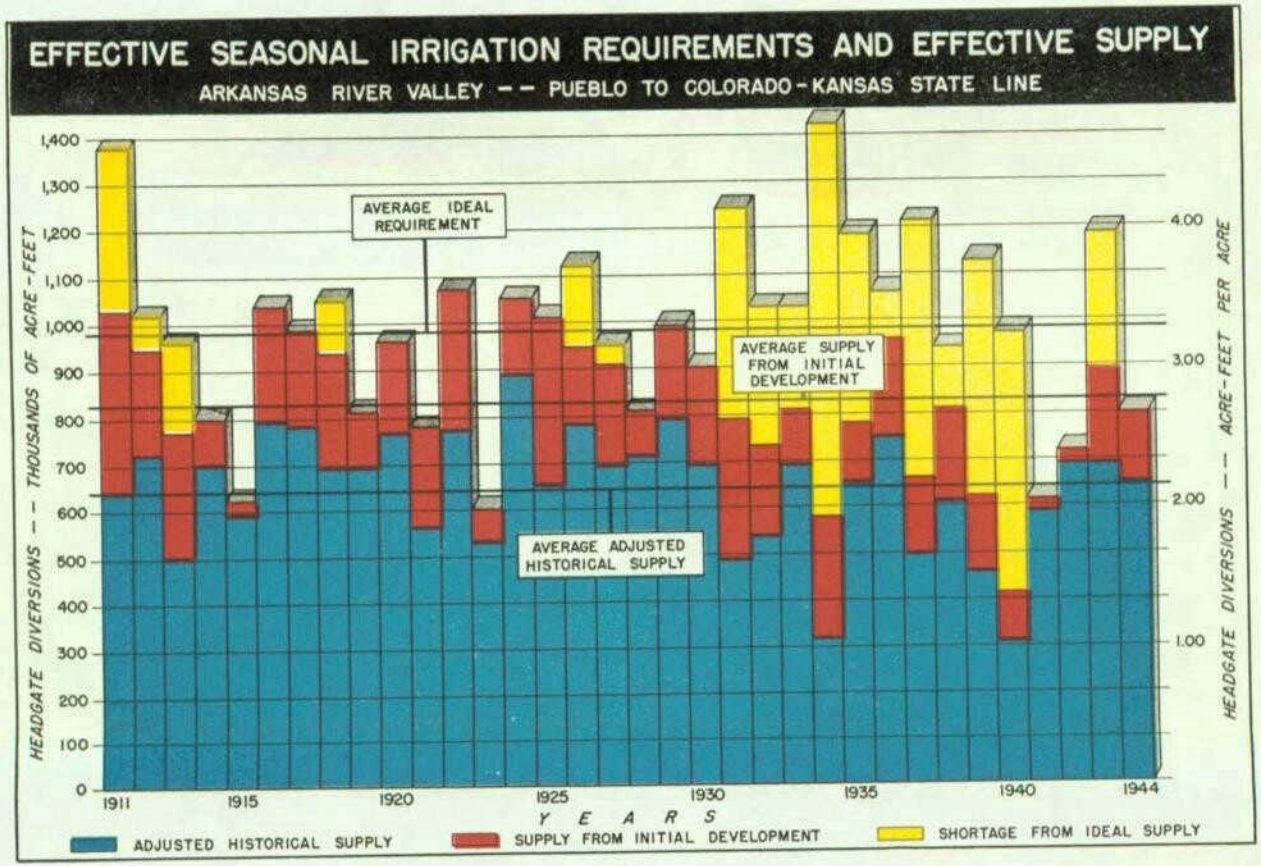
The project plan provides 17,000 acre-feet of water for municipal purposes. More information on municipal water supply is contained in chapter IX. The net irrigation water made available by features of the initial development would amount to 151,200 acre-feet of imported and reregulated water, as shown in table 6. When converted by reuse of return flows, partly on tributary streams, the total irrigation supply would be 189,800 acre-feet. Transmountain water would be stored in the Sugar Loaf, Twin Lakes, and Pueblo Reservoirs and released as required. The owners of the existing Sugar Loaf and Twin Lakes Reservoirs and also the Otero (Clear Creek) Reservoir have

TABLE 6.—*Water available for irrigation use in Arkansas River Valley as a result of initial development. Average for period 1911–44*

[Unit: 1,000 acre-feet]

Item	Gross water	Spills [1]	Losses		Net virgin water at Pueblo Reservoir	Headgate supply [2]
			Transportation	Reservoir evaporation [1]		
Fryingpan diversion [3]	69.2		7.5	8.0	53.7	
Arkansas River flood [4]	50.0	30.0		2.0	18.0	
Wurtz Ditch [5]	2.0				2.0	
Municipal water [6]	−17.0				−17.0	
Subtotal					56.7	85.1
Return flow from municipal water [7]	7.0	2.5			4.5	6.7
Additional Twin Lakes imports [8]	14.9		1.4	1.0	12.5	18.8
Winter flow, Arkansas River [9]	93.0	16.0		3.0	74.0	74.0
Subtotal, Arkansas Valley	219.1	48.5	8.9	14.0	147.7	184.6
Estimated municipal return flow in tributary streams [7]					3.5	5.2
Total					151.2	189.8

[1] Determined from reservoir operation study, distribution by items based on operating assumptions.
[2] The original water supply plus use and reuse of return flow. Except for reregulated winter flow, the headgate supply at 1.5 times the original supply.
[3] Divertible from Fryingpan watershed and Hunter Creek.
[4] Water at Pueblo Dam site which would spill from John Martin Reservoir largely in years of high runoff such as 1915, 1921, 1923, 1924, and 1942.
[5] Additional usable water (for municipal purposes) due to more efficient use of the water yielded by the Wurtz Ditch.
[6] Wurtz Ditch importation (2,000 acre-feet plus 15,000 acre-feet project water).
[7] Estimated as 70 percent of 15,000 acre-feet project water diverted. Of these diversions, about 10,000 acre-feet are for municipalities located along the Arkansas River and about 5,000 acre-feet for Colorado Springs and Eads located on tributaries.
[8] Additional imports made possible by provision of additional storage capacity in Twin Lakes Reservoir and replacement capacity at Aspen Reservoir.
[9] Estimated winter flow now being diverted for direct flow use which could be stored in Pueblo Reservoir, by agreement, without depleting winter inflow to John Martin Reservoir.


EFFECTIVE SEASONAL IRRIGATION REQUIREMENTS AND EFFECTIVE SUPPLY
ARKANSAS RIVER VALLEY -- PUEBLO TO COLORADO-KANSAS STATE LINE
HEADGATE DIVERSIONS -- THOUSANDS OF ACRE-FEET
HEADGATE DIVERSIONS -- ACRE-FEET PER ACRE
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
4.00
3.00
2.00
1.00
AVERAGE IDEAL REQUIREMENT
AVERAGE SUPPLY FROM INITIAL DEVELOPMENT
AVERAGE ADJUSTED HISTORICAL SUPPLY
1911
1915
1920
1925
1930
1935
1940
1944
YEARS
ADJUSTED HISTORICAL SUPPLY
SUPPLY FROM INITIAL DEVELOPMENT
SHORTAGE FROM IDEAL SUPPLY

signified their willingness to cooperate in the development. Part of the winter flow of the Arkansas River would be stored and released upon demand from the Pueblo Reservoir during the following irrigation season to irrigators having direct-flow rights to the winter water. Except for unappropriated floodwaters, the summer flow of the Arkansas River at Pueblo would not be controlled.

Table 7 shows, for the Arkansas River Valley between Pueblo and Kansas, preproject irrigation conditions and the effect of the initial development. Preproject conditions are reflected in the columns showing (1) estimated headgate diversion requirements, (2) historic headgate diversions to the lands, adjusted to simulate Twin Lakes diversion imports prior to 1936 when the diversion system was completed and operation of John Martin Reservoir prior to its completion in 1948, (3) the effective headgate diversions, and (4) the irrigation shortages. Ditches having senior water rights often divert more water than is needed for a full water supply, and ditches having junior water rights do not receive the required quantities of water. Therefore, the historic headgate diversions have been adjusted to show the past effective headgate diversions. The past shortages have been obtained by subtracting the effective headgate diversions from the estimated headgate diversion requirements.

TABLE 7.—*Seasonal (Apr. 1 to Oct. 31) irrigation requirements, diversions, and shortages: Arkansas River Valley-Pueblo to Colorado-Kansas boundary*

[Unit: 1,000 acre-feet]

Year	Headgate diversion requirement	Adjusted historical conditions (preproject)			Estimated effect of project	
		Headgate diversion to lands	Effective headgate diversion	Shortage	Additional headgate supply	Residual shortage
1911	1,375	687	645	730	389	341
1912	1,016	777	721	295	230	65
1913	958	548	498	460	273	187
1914	803	863	697	106	106	0
1915	619	772	589	30	30	0
1916	1,038	856	792	246	246	0
1917	986	861	777	209	209	0
1918	1,052	786	687	365	240	125
1919	808	820	686	122	122	0
1920	958	884	764	194	194	0
1921	780	686	562	218	218	0
1922	1,073	779	766	307	307	0
1923	600	690	543	57	57	0
1924	1,051	934	887	164	164	0
1925	1,010	694	650	360	360	0
1926	1,119	801	777	342	170	172
1927	949	762	689	260	218	42
1928	809	805	706	103	103	0
1929	988	907	788	200	200	0
1930	900	792	693	207	207	0
1931	1,242	495	486	756	308	448
1932	1,026	568	535	491	195	296
1933	1,033	702	669	364	144	220
1934	1,425	323	319	1,106	261	845
1935	1,181	698	653	528	130	398
1936	1,058	808	750	308	215	93
1937	1,210	530	503	707	158	549
1938	942	741	610	332	197	135
1939	1,130	530	457	673	166	507
1940	968	319	310	658	97	561
1941	608	776	590	18	18	0
1942	725	853	694	31	31	0
1943	1,183	736	693	490	197	293
1944	795	682	653	142	142	0
Average	983	720	643	340	185	155

The adjusted 1911–44 irrigation headgate shortage for the irrigated area between Pueblo and the Colorado-Kansas boundary averaged about 340,000 acre-feet per year or about 35 percent of the estimated ideal headgate diversion required. A full supplemental supply of irrigation water for presently irrigated lands in the project area could not be provided by the initial development. However, by utilization of water made available by features of the initial development, the headgate shortage on presently irrigated lands could be eliminated in about one-half of the 34 years in the 1911–44 study period and reduced to an average of about 155,000 acre-feet per year (340,000 acre-feet minus 185,000 acre-feet, exclusive of the tributary areas) or 15 percent of the headgate diversion requirements. Exhibit 9 is a graphic presentation of data from tables 6 and 7 and shows pre-project conditions and the effect of the initial development, Gunnison-Arkansas project.

Chapter V. Agriculture

PROJECT LANDS

The lands between Leadville and the Bessemer ditch were classified in 1941–42 in accordance with Bureau standards for reconnaissance survey. Lands located below Pueblo were similarly classified in accordance with Bureau standards using semidetailed survey procedures. This latter work was accomplished during 1939–40. The surveys covered an irrigated area of 322,000 acres along the main stem of the Arkansas River, of which 309,000 acres were found to be irrigable. The deduction of 13,000 acres was made because of extreme deficiencies in soil, topography, or drainage. The irrigable lands have a productive capacity under sustained irrigated agriculture sufficient to meet all production expenses, including a reasonable return on the investment, repay reasonable irrigation and improvement costs, and provide a satisfactory level of living for the farm family. The survey results are given in table 8.

Table 8.—*Land classification by canals or areas: Leadville to Holly irrigated area*

[Acres]

Canal or area	Class 1	Class 2	Class 6	Total
Leadville to Bessemer Ditch area	6,238	9,729		15,967
Bessemer	17,953	4,154	70	22,177
Collier	0	617	31	648
Booth-Orchard	154	1,292	5	1,451
Excelsior	361	1,499	138	1,998
Colorado	19,070	21,639	3,080	43,789
Rocky Ford Highline	12,466	10,514	1,127	24,107
Oxford Farmers	4,141	1,497	181	5,819
Otero	2,369	3,288	338	5,995
Catlin	11,938	6,028	794	18,760
Rocky Ford	4,188	3,719	299	8,206
Holbrook	7,475	6,740	754	14,969
Fort Lyon	51,710	36,212	3,422	91,344
Amity	20,333	13,974	477	34,784
Hyde	0	911	60	971
Buffalo	1,212	1,944	170	3,326
Las Animas Consolidated	2,468	3,861	496	6,825
Las Animas Town	234	1,463	119	1,816
Keesee	0	1,317	55	1,372
Fort Bent	2,428	2,831	170	5,429
Lamar	2,336	2,427	57	4,820
Manvel	1,610	1,113	109	2,832
Graham	757	2,462	546	3,765
Sisson	115	427	104	646
Total	169,556	139,658	12,602	321,816
Rounded to	169,000	140,000	13,000	322,000

Of the 309,000 irrigable acres, 169,000 were found to be class 1 land. The class 1 land represents lands of potentially high productive capcity. They are characterized by soil textures ranging from sandy loams to friable clay loams. The minimum depth of the soil to sand, gravel, and cobble is at least 30 inches. In areas where relatively impervious subsoil material is encountered the depth of soil is at least 48 inches. The class 1 soils are predominately calcareous,

evidence of black alkali is absent, and pH values are less than 9.0. The total salts do not exceed 0.2 percent except in areas where the soils are open, permeable, and have good drainage. The class 1 lands are located on smooth slopes having gradients of less than 5 percent and are generally comprised of reasonably large-size bodies sloping in the same plane. The land surfaces are even enough to require only a small amount of leveling and no heavy grading. No specific drainage requirements are anticipated on the class 1 lands.

Of the 309,000 acres found to be irrigable 140,000 were mapped as class 2. These lands have an intermediate productive capacity and are characterized by soil textures ranging from loamy sands to slowly permeable clays. Minimum soil depths to sand, gravel, or cobble is 20 inches and to impervious subsoil material, 36 inches. Alkalinity on the class 2 lands is similar to that of the class 1 lands. Total soluble salts of these soils, except on permeable soils with good drainage, does not exceed 0.5 percent. The class 2 soils occur on smooth general slopes having gradients up to 10 percent. This land is in reasonably large-size bodies sloping in the same plane. On the rougher slopes the general gradient does not exceed 5 percent. Although these lands are being satisfactorily irrigated, moderate grading would improve the efficiency of irrigation which would be reflected in increased crop yields.

In summarizing, the soil in the area to be benefited by the initial development consists principally of silty loam, clay loam, and clay soil occurring on river bottomlands, terraces or benches, and alluvial fans. Taken as a whole the lands have favorable topography for irrigation. Surface drainage for nearly the entire area is good except for part of the first bottomlands which comprise a minor portion of the total area. The internal drainage of the soils is considered to be generally satisfactory. Alkalinity and salinity will not be a problem except on small isolated areas.

Although 309,000 acres have been classed as irrigable it is reasonable to assume that the additional water supplies made available by the initial development would be applied to those lands with the most favorable productive capacity.

IRRIGATION

No land is irrigated in the western slope diversion area. However, in the Roaring Fork River Basin and the Colorado River Basin between Glenwood Springs and the Colorado-Utah State line, a total of about 184,000 acres receive irrigation water, of which 60,000 acres receive water diverted from the Colorado River below Glenwood Springs and the remainder is serviced by tributaries of the Colorado River. Included in that area is the productive fruit district in the vicinity of Palisade. Shortage of water is seldom experienced, and an average of 7 acre-feet are diverted for each acre of irrigated land. Studies made by the Bureau of Reclamation and the Colorado Water Conservation Board indicate that the consumptive use of water in those irrigated areas is only about 1.2 acre-feet per acre.

In the eastern slope project area an average of 322,000 acres are irrigated from the main stem of the Arkansas River. The amount of water available for irrigation varies from year to year, but is seldom adequate for maximum crop production. Irrigation water

shortages as high as 78 percent of the crop requirements have occurred even though the available water supplies were fully utilized during the growing season, April 1 through October 31. At the canal headgates or at points where irrigation water is diverted from the Arkansas River below Pueblo, the amount of water needed to meet crop requirements is 3.1 acre-feet per acre including a reduction for allowable shortages. The average amount of irrigation water available between Pueblo and the Colorado-Kansas State line has varied during the growing season from a high in 1942 of 2.7 acre-feet to a low in 1934 of 0.9 acre-foot per acre.

Small tracts of land from the headwaters of the Arkansas River to Canon City are irrigated by direct diversion ditches, usually operated without elaborate diversion dams. The irrigated areas between Canon City and Florence are served by 9 ditches; between Florence and Pueblo, by 11 ditches, and between Pueblo and the Colorado-Kansas boundary, by 23 canals and ditches. Location of the principal irrigation systems is shown on exhibit 10.

PRESENT ECONOMY

Fiscal aspects

Taxes, mortgages, and irrigation costs.—Average annual taxes and irrigation charges per irrigated acre along the Arkansas River are as follows for the 1939–44 period:

Taxes—State, county, and school	$0.35
Irrigation charges	1.55
Total	1.90

The relatively low average annual irrigation charges per acre when reported for all enterprises reflects the low construction and maintenance costs of many small individual enterprises built during the early stages of irrigation development.

The present price of water imported into the Arkansas Valley varies from $2.50 to $4 per acre-foot. The largest body of imported water costs $3.20 per acre-foot at the storage dam. The unit cost of the effective supply at the farms is increased by the losses en route to the farms. Adequate storage is not available for water imported by existing transmountain diversions.

The depression and a concurrent succession of drought years seriously impaired the economy of the region. Distress was widespread and people necessarily were recipients of extensive direct and credit relief. Conditions were so bad that many farmers were forced to quit and accept other employment.

In 1940, 46 percent of the farms were mortgaged in the counties that would receive the major benefits from the initial development. The ratio of debt to value on mortgaged farms increased materially during the 10-year period prior to 1940. That period was one of short water supply and low farm prices. Since 1940, however, the water supply has been above average nearly every year, and farm prices have been high due to the war stimulus. These two factors, although of a temporary nature, have enabled many of the farmers to retire much of their indebtedness and improve their financial position. Should there be a recurrence of a period of short water supply, the financial structure would again be weakened as a result of low crop yields.

35002—53——7

Value and size of farms.—The value of irrigated land is estimated to vary from a low of $25 per acre for inferior land or land with a poor water right to as high as $250 per acre for land with a good water right and capable of high production.

The size of farms in the project area varies from small irrigated truck farms and orchards to general purpose farms of several hundred acres. Fremont and Pueblo Counties have the greatest number of small farms. In 1940 the average size of irrigated farms in the project area was 342 acres, of which 81 acres were irrigated. The remaining acreage was utilized for grazing and nonirrigated crops.

Crops and livestock

The major portion of the cultivated land on the western slope is irrigated and used chiefly for the production of native hay and pasture in connection with the livestock industry. In some sections, however, the production of peaches, apples, and other types of fruit is of great importance. General farm crops, sugar beets, potatoes, onions, and truck crops are also produced rather extensively in other sections of the western slope. Livestock raising is the western slope's largest agricultural industry. Registered Hereford cattle of that area are nationally recognized. Dairying and pork and poultry production are also carried on.

Agricultural production in the eastern slope project area is widely diversified because of the variations of soils, altitude, growing season, precipitation, irrigation developments, and other factors. In the high-altitude counties where the growing season is short, large acreages of hay, tame pasture, and small grain predominate and are used for livestock production. Fruit production is of major importance in Fremont County because of good air drainage and the absence of late spring frosts. Truck crops for local and commercial markets are produced around Pueblo and in Fremont County. Below Pueblo the principal irrigated crops in the order of acreage harvested are alfalfa, corn, grain sorghum, sugar beets, barley, wheat, truck crops, and dry beans. Cantaloups, onions, tomatoes, and red beets are successfully grown under the high temperatures and long growing seasons that prevail in Pueblo, Otero, Crowley, Bent, and Prowers Counties. The average annual gross crop income per acre for that portion of the area capable of receiving project water shows superior returns due to irrigation. During the period 1930–41, on the basis of 1939–44 average crop prices, the average gross crop return in the project area ranged from $30 to $40 per acre whereas the average for nonirrigated cropland in adjacent areas was less than $5 per acre.

Livestock and livestock products are important components of the agricultural economy of the project area. Most of the crops produced on the irrigated land in the high altitudes are used for supplemental feed to carry livestock through the winter. During the summer months many head of livestock are taken to higher altitudes to graze, usually in the national forests. Large numbers of cattle, sheep, and lambs are fattened for market in the irrigated area. However, that industry was greatly curtailed during the 1930's due to a shortage of feed resulting from an inadequate supply of irrigation water.

Dairying near market outlets is important and will become increasingly significant as the population grows and the demand for dairy products increases.

Poultry raising is a recent industry in the area. Production of turkeys for the fall and holiday markets is constantly increasing in importance. Chickens are raised for egg production and for meat—primarily for local markets.

ANTICIPATED ECONOMY

Introduction of transmountain water, together with the conservation of present water supplies to be made possible by the initial development of the Gunnison-Arkansas project, would have a stabilizing effect upon the agricultural production of the valley. No material change in the number of farms or in the crop pattern is anticipated; however, higher average crop yields and increased feeding operations are expected. Those changes should increase the profit margin and cause corresponding improvement in the general economy.

The markets for the products of the project area are nationwide. Beet sugar, cantaloups, onions, flower seeds, celery, and alfalfa meal are particularly important in national trade. The industrialization of Pueblo, Colorado Springs, and Denver, together with the increasing tourist trade in the Rocky Mountain area, furnish an expanding nearby market.

Farm budgets

Farm costs, crop and livestock values, etc., for the initial development were calculated by the use of farm budgets prepared in cooperation with the boards of directors of three representative ditch companies. Budgets were prepared to represent various sizes of units and types of agricultural operation. The boards of directors set up the labor standards, farm inventories, crop and livestock practices, and yields, and supplied all of the pertinent information needed for the analysis.

Four types of farms were studied in compiling representative budgets for the Arkansas Valley: intensive general agriculture with truck crops, intensive general agriculture, extensive agriculture, and mountain valley agriculture.

Intensive general agriculture with truck crops.—The average size of this type of farm was estimated to be 60 acres, with 56 acres irrigated. The agriculture found on these farms involves intensive practices employing large amounts of hand labor, heavy applications of fertilizer, and correspondingly high crop yields (table 8A). Most of these farms are located near the larger municipalities and on the better land with the more reliable water supply. The shortages appear during the late summer months. Early spring irrigation water and a fair supply for midseasonal use are usually available. This budget applies to areas around Pueblo and Canon City.

Intensive general agriculture.—The average size of this type of farm was estimated to be 120 acres, with 114 acres irrigated. Farmers in the area represented by this type of farm use intensive practices on general agricultural crops (table 8A). These practices involve heavier application of fertilizer, more intensive insect control, and larger amounts of hand labor than are used on the extensive types. Areas represented by this budget have a calculated full annual water supply; but distribution during the year is not in accordance with needs. Shortages occur during the fall seasons and an oversupply is frequently

available in the spring and early summer months. The land, in some cases, is somewhat inferior to the land usually found on the farms practicing intensive general agriculture with truck crops and livestock feeding is a much larger enterprise.

Extensive agriculture.—The average size of this type of farm was estimated to be 160 acres, with 150 acres irrigated. Farmers in the areas represented by this type of farm practice extensive agriculture. A maximum of the work is done with equipment, and hand labor is largely restricted to beets, onions, and melons. Livestock feeding plays a large role on these farms (table 8C). Soil fertility practices in the past have been restricted largely to the production of alfalfa and the application of barnyard manure produced by the livestock-feeding operation. The quality of the land is on a par with the previous group, but the water supply is less reliable during droughts and in late summer seasons. This budget applies to all ditches north of the Arkansas River and a major portion of ditches below Pueblo south of the river.

Mountain valley agriculture.—The average size of this type of farm was estimated to be 160 acres with approximately 155 acres irrigated. The type of agriculture found on these farms is extensive in nature, coupled with a livestock program. This program at present centers largely around the production of dairy products and feeder cattle (table 8D). Cattle are run on the forest land during the summer months and wintered on the farms. The land is of relatively poor quality and yields are limited by the short growing season and water supply. These ditches are extremely short of water during the late seasons and in drought years. The water shortage has necessitated the abandonment of an estimated 30 acres of land on each 160-acre unit. It is assumed these 30 acres will be irrigated as a result of the initial development of the project. Areas represented by this budget are located above Canon City in the upper Arkansas Valley.

Table 8A.—Intensive general agriculture with truck crops, 60-acre farm with 56 acres irrigated—without and with project water

Item	Unit	PRODUCTION: Acres or number		Yield per unit		Amount		1939-44 prices ($)		Value ($)		DISPOSITION (VALUE): Farm ($)		Home ($)	Sales ($)	
		Without	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without and With	Without	With
Alfalfa	acre	11	11	3 T	5 T	33	55	11.86	11.86	391.38	652.30	40.32	48.63		351.06	603.67
Alfalfa pasture	acre	1	1	3 T	5 T	3	5	11.86	11.86	35.58	59.30	35.58	35.58			23.72
Corn	acre	10	10	55 bu.	75 bu.	550	750	.94	.94	517.00	705.00	277.30	353.44		239.70	351.56
Barley	acre	5	5	40 bu.	50 bu.	200	250	.61	.61	122.00	152.50	122.00	151.28			1.22
Beets	acre	12	12	12 T	16 T	144	192	9.01	9.01	1,297.44	1,729.92				1,297.44	1,729.92
Beans	acre	4	4	900 cwt	1200 cwt	3,600	4,800	4.26	4.26	153.36	204.48				153.36	204.48
Onions	acre	4	4	450 bgs	500 bgs	1,800	2,000	.72	.72	1,296.00	1,440.00				1,296.00	1,440.00
Melons	acre	5	5	125 cts	140 cts	625	700	1.24	1.24	775.00	868.00				775.00	868.00
Truck crops	acre	2	2	$250.00	$450.00	$500.00	$900.00	250.00	450.00	500.00	900.00			175.00	325.00	725.00
Popcorn	acre	2	2	3,000 lb.	4,000 lb.	6,000	8,000	.035	.035	210.00	280.00				210.00	280.00
Aftermath	acre	60	60	.5 A.U.M.	.5 A.U.M.	30 A.U.M.	30 A.U.M.	2.00	2.00	60.00	60.00	60.00	60.00			
Beet tops							27.4	3.50	3.50	72.10	95.90	42.00	49.00		30.10	46.90
Subtotal										5,429.86	7,147.40	577.20	697.93	175.00	4,677.66	6,274.47
Milk cows	No.	1	1							20.00	20.00				20.00	20.00
S. M. calves	No.	1	1							20.00	20.00			20.00		
Feeder cattle	Lb.					12,127	14,553	.11	.11	1,333.97	1,600.83				1,333.97	1,600.83
Feeder lambs	Lb.					893	1,072	.129	.129	115.19	138.37				115.19	138.37
Feeder pigs	Lb.					675	900	.107	.107	72.23	96.30			24.08	48.15	72.22
Dairy products										79.39	79.39	9.52	9.52	69.87		
Poultry products										200.48	200.48			159.56	40.92	40.92
Subtotal										1,841.26	2,155.37	9.52	9.52	273.51	1,558.23	1,872.34
Total										7,271.12	9,302.77	586.72	707.45	448.51	6,235.89	8,146.81

FARM INVESTMENT

	Without	With
Land and land improvements	$10,980.00	$10,980.00
Farm buildings	4,675.00	4,675.00
Farm machinery and equipment	3,325.00	3,325.00
Livestock inventory	144.04	150.06
Feed	121.36	136.61
Total investment	$19,245.40	$19,266.67

a/ Value of water delivered to the farm, computed on the basis of farm headgate shortage of .68 acre-feet per acre or a main ditch headgate shortage of 1.05 acre-feet per acre.

CURRENT FARM EXPENSE

	Without	With
General:		
Interest cost	$ 663.87	$ 668.49
Taxes	327.33	339.21
Insurances	31.75	21.75
Improvements-depreciation and repair	415.00	415.00
Truck, gas and oil	32.01	45.75
Tractor, gas and oil	375.15	416.83
Utilities, etc.	100.00	100.00
Crop:		
Seed	139.50	139.50
Harvesting	666.80	762.78
Fertilizer	110.40	216.00
Spray and dust	75.00	137.00
Machinery-depreciation and repair	546.23	546.23
Irrigation water expense	168.00	168.00
Hired labor	904.41	1,282.86
Contract labor	0	0
Livestock expense	1,126.31	1,299.48
Total expense	$ 5,671.76	$ 6,558.88

FINANCIAL SUMMARY

	Without	With
Receipts	$ 6,235.89	$ 8,146.81
Farm privileges and rent	688.51	688.51
Gross farm income	6,924.40	8,835.32
Farm expense	5,671.76	6,558.88
Net farm income	1,252.64	2,276.44
Family living allowance		1,500.00
Project payment capacity per farm		776.44
Project payment capacity per acre-foot a/		11.45
Less 20% safety factor		2.29
Computed payment capacity per acre-foot at the farm headgate		$ 9.16

Table 8C.—Extensive agriculture, 160-acre farm with 150 acres irrigated—without and with project water

Item	Unit	PRODUCTION: Acres or number		Yield per unit		Amount		1939-44 prices ($)		Value ($)		DISPOSITION (VALUE): Farm ($)		Home ($)	Sales ($)	
		Without	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without and With	Without	With
Alfalfa	acre	74	74	2.5T	3.5T	185	259	11.86	11.86	2,194.10	3,071.74	168.41	180.75		2,025.69	2,890.99
Alfalfa pasture	"	1	1	3 T	4 T	3	4	11.86	11.86	35.58	47.44		47.44			
Corn	"	25	25	35 bu.	56 bu.	875	1,400	.94	.94	822.50	1,316.00	822.50	1,316.00			
Wheat	"	20	20	35 bu.	45 bu.	350	450	1.05	1.05	367.50	472.50	369.65	192.15		17.85	280.35
Barley	"	20	20	35 bu.	42 bu.	700	840	.61	.61	427.00	512.40	427.00	488.00			24.40
Beets	"	15	15	9 T	13 T	135	195	9.01	9.01	1,216.35	1,756.95				1,216.35	1,756.95
Onions	"	5	5	800 sa.	550 sa.	a/1,950	a/2,163	1.00	1.00	1,950.00	2,163.00				1,950.00	2,163.00
Aftermath	"	160	160	.5 A.U.M.	.5 A.U.M.	80 A.U.M.	80 A.U.M.	2.00	2.00	160.00	160.00	160.00	160.00			
Sheet tops						20 T	28 T	3.50	3.50	70.00	98.00	70.00	98.00			
Garden										b/ 175.00	b/ 175.00			b/175.00		
Subtotal										7,418.03	9,773.03	2,033.14	2,482.34	175.00	5,209.89	7,115.69
Milk cows	No.	1					1	100.00	100.00	100.00	100.00				100.00	100.00
S. M. calves	Lbs.				.20	1,911	2,548	.20	.20	191.10	254.80			63.70	127.40	191.10
Feeder cattle	Lbs.				.11	12,127	14,553	.11	.11	1,333.97	1,600.83				1,333.97	1,600.83
Feeder lambs	Lbs.				.129	8,928	10,714	.129	.129	1,151.71	1,382.11				1,151.71	1,382.11
Feeder pigs	Lbs.				.107	9,000	11,250	.107	.107	963.00	1,203.75			24.08	938.92	1,179.67
Breeding hogs	No.	3					3	25.00	25.00	75.00	75.00				75.00	75.00
Dairy products										219.89	286.37	37.21	52.23	87.20	95.48	146.94
Poultry products										863.40	926.40			122.10	741.30	804.30
Subtotal										4,898.07	5,829.26	37.21	52.23	297.08	4,563.78	5,479.95
Total										12,316.10	15,602.29	2,070.35	2,534.57	472.08	9,773.67	12,595.64

FARM INVESTMENT

	Without	With
Land and land improvements	$14,880.00	$14,880.00
Farm buildings	6,850.00	6,850.00
Farm machinery and equipment	6,365.00	6,365.00
Livestock inventory	803.52	1,004.64
Feed	488.33	502.19
Total investment	$29,386.85	$29,601.83

a/ The number of bags of onions equivalent to a value of approximately $175.00 have been deducted from the total yield to reflect the value of the family garden normally produced on a portion of this acreage. Total yield reduced 15 percent for loss in farm storage.

b/ Value of a family garden normally produced on farms of this type.

c/ Value of water delivered to the farm computed on the basis of farm headgate shortage of 1.08 acre-feet per acre or a main ditch headgate shortage of 1.67 acre-feet per acre.

CURRENT FARM EXPENSE

	Without	With
General:		
Interest cost	$1,012.56	$ 1,021.98
Taxes	474.69	489.82
Insurances	34.20	34.20
Improvements-depreciation and repair	560.00	560.00
Truck, gas and oil	48.90	63.09
Tractor, gas and oil	463.75	569.45
Utilities, etc.	100.00	100.00
Crop:		
Seed	274.40	274.40
Harvesting	572.50	707.50
Fertilizer	120.00	592.50
Spray and dust	50.00	50.00
Machinery-depreciation and repair	987.37	987.37
Irrigation water expense	240.00	240.00
Hired labor	1,379.16	1,876.86
Contract labor	0	0
Livestock expense	2,196.24	2,574.03
Total expense	$8,513.77	$10,144.20

FINANCIAL SUMMARY

Receipts	$9,773.67	$12,595.64
Farm privileges and rent	712.08	712.08
Gross farm income	10,485.75	13,307.72
Farm expense	8,513.77	10,144.20
Net farm income	1,971.98	3,163.52
Family living allowance		1,972.98
Project payment capacity per farm		1,191.54
Project payment capacity per acre-foot c/		7.35
Less 20% safety factor		1.47
Computed payment capacity per acre-foot at the farm headgate		$ 5.88

Table 82.—Intensive general agriculture, 120-acre farm with 114 acres irrigated—without and with project water

Item	Unit	PRODUCTION: Acres or number		Yield per unit		Amount		1939-44 prices ($)		Value ($)		DISPOSITION (VALUE): Farm ($)		Home ($)	Sales ($)	
		Without	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without and With	Without	With
Alfalfa	acre	23	23	3 T	5 T	69	115	11.86	11.86	818.34	1,363.90	195.10	265.66		623.24	1,098.24
Alfalfa pasture	acre	1	1	3 T	5 T	3	5	11.86	11.86	35.58	59.30	35.58	35.58			23.72
Corn	acre	20	20	55 bu.	75 bu.	1,100	1,500	.94	.94	1,034.00	1,410.00	955.04	1,410.00		78.96	
Barley	acre	20	20	40 bu.	50 bu.	800	1,000	.61	.61	488.00	610.00	340.00	204.35		147.01	405.65
Beets	acre	24	24	12 T	16 T	288	408	9.01	9.01	2,594.88	3,676.08				2,594.88	3,676.08
Beans	acre	8	8	900 cwt	1200 cwt	7,200	9,600	4.26	4.26	306.72	408.96				306.72	408.96
Onions	acre	8	8	450 bgs	500 bgs	a/3,354	a/3,757	.72	.72	2,417.00	2,705.00				2,417.00	2,705.00
Melons	acre	10	10	125 cts	140 cts	1,250	1,400	1.24	1.24	1,550.00	1,736.00				1,550.00	1,736.00
Aftermath	acre	120	120	.5 A.U.M.	.5 A.U.M.	60	60	2.00	2.00	120.00	120.00	120.00	120.00			
Beet tops						48 T	58 T	3.50	3.50	168.00	203.00	168.00	203.00			
Garden										b/175.00	b/175.00			175.00		
Subtotal										9,707.52	12,867.24	1,814.71	2,238.59	175.00	7,717.81	10,053.65
Milk cows	No.	1	1							20.00	20.00				20.00	20.00
S. M. calves	Lb.					200	200	.10	.10	20.00	20.00			20.00		
Feeder cattle	Lb.					20,212	24,255	.11	.11	2,223.32	2,668.05				2,223.32	2,668.05
Feeder lambs	Lb.					20,088	24,106	.129	.129	2,591.35	3,109.67				2,591.35	3,109.67
Feeder pigs	Lb.					4,500	4,500	.107	.107	481.50	481.50			24.08	457.42	457.42
Breeding cattle										100.00	125.00				100.00	125.00
Breeding hogs										16.00	16.00				16.00	16.00
Dairy products										79.39	79.39	9.52	9.52	69.87		
Poultry products										200.48	200.48			200.48		
Beef calves	Lb.					3,675	4,410	.11	.11	404.25	485.10			80.85	323.40	404.25
Subtotal										6,136.29	7,205.19	9.52	9.52	395.28	5,731.49	6,800.39
Total										15,843.81	19,672.43	1,824.23	2,248.11	570.28	13,449.30	16,854.04

FARM INVESTMENT

	Without	With
Land and land improvements	$18,960.00	$18,960.00
Farm buildings	6,300.00	6,300.00
Farm machinery and equipment	7,910.00	7,910.00
Livestock inventory	972.25	1,228.81
Feed	370.76	425.52
Total investment	$34,513.01	$34,824.33

a/ The number of bags of onions equivalent to a value of approximately $175.00 have been deducted from the total yield to reflect the value of the family garden normally produced on a portion of this acreage.

b/ Value of a family garden normally produced on farms of this type.

c/ Value of water delivered to the farm, computed on the basis of farm headgate shortage of .70 acre-feet per acre or a main ditch headgate shortage of 1.08 acre-feet per acre.

CURRENT FARM EXPENSE

	Without	With
General:		
Interest cost	$ 1,215.19	$ 1,235.10
Taxes	557.39	575.93
Insurances	42.00	42.00
Improvements-Depreciation and repair	530.00	530.00
Truck, gas and oil	53.22	66.69
Tractor, gas and oil	757.05	829.50
Utilities, etc.	100.00	100.00
Crops:		
Seed	269.20	269.20
Harvesting	1,301.60	1,495.80
Fertilizer	201.60	403.20
Spray and dust	134.00	234.00
Machinery-depreciation and repair	1,282.33	1,282.33
Irrigation water expense	252.00	252.00
Hired labor	2,490.30	2,978.10
Contract labor	0	0
Livestock expense	3,553.21	4,226.12
Total expense	$ 12,739.09	$ 14,519.87

FINANCIAL SUMMARY

Receipts	$ 13,449.30	$ 16,854.04
Farm privileges and rent	810.28	810.28
Gross farm income	14,259.58	17,664.32
Farm expense	12,739.09	14,519.87
Net farm income	1,520.49	3,144.45
Family living allowance		1,520.49
Project payment capacity per farm		1,623.96
Project payment capacity per acre-foot c/		11.97
Less 20% safety factor		2.39
Computed payment capacity per acre-foot at the farm headgate		$ 9.58

Table 8D.—Mountain valley agriculture, 160-acre farm with 125.5 acres irrigated without project water, and 155.5 acres irrigated with project water a/

Item	Unit	PRODUCTION: Acres or number		Yield per unit		Amount		1939-44 prices ($)		Value ($)		DISPOSITION (VALUE): Farm ($)		Home ($)	Sales ($)	
		Without	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without and With	Without	With
Alfalfa	acre	59	75	1.6 T	2.1 T	94.4 T	157.5 T	11.86	11.86	1,119.58	1,867.95	805.29	838.50		314.29	1,029.45
Alfalfa pasture	acre	1	1	1.6 T	2.1 T	1.6 T	2.1 T	11.86	11.86	18.98	24.91	18.98	24.91			
Wheat	acre	20	25	25 bu.	35 bu.	500 bu.	875 bu.	1.05	1.05	525.00	918.75	242.55	324.45		282.45	594.30
Barley	acre	25	32	40 bu.	55 bu.	1000 bu.	1760 bu.	.61	.61	610.00	1,073.60	610.00	1,010.16			63.44
Oats	acre	10	12	50 bu.	65 bu.	500 bu.	780 bu.	.50	.50	250.00	390.00	169.00	145.00		81.00	245.00
Aftermath	acre	130	160	.5 A.U.M.	.5 A.U.M.	65 A.U.M.	80	2.00	2.00	130.00	160.00	130.00	160.00			
Wild hay	acre	10	10	1.5 T	1.5 T	1.5 T	15	7.00	7.00	100.00	100.00	100.00	100.00			
Garden	acre	.5	.5							175.00	175.00			175.00		
Subtotal										2,928.56	4,710.21	2,075.82	2,603.02	175.00	677.74	1,932.19
Milk cows	No.	8	8							180.00	180.00				180.00	180.00
S. M. calves	Lb.					1,715	3,822	.875	.10	150.06	382.20				150.06	318.50
S. M. calves	Lb.					637		.10		63.70				63.70		
Dairy products										544.49	544.49	98.62	98.62	87.20	358.67	358.67
Poultry products										705.90	705.90			112.10	593.80	593.80
Feeder pigs	Lb.					7,763	7,763	.107	.107	830.64	830.64			24.08	806.56	806.56
Breeding hogs										61.00	61.00				61.00	61.00
Breeding cattle										550.00	550.00				550.00	550.00
Beef calves	Lb.					6,615	11,025	.09	.11	595.35	1,212.75				595.35	1,212.75
Subtotal										3,691.14	4,466.98	98.62	98.62	287.08	3,295.44	4,081.28
Total										6,609.70	9,177.19	2,174.44	2,701.64	462.08	3,973.18	6,013.47

FARM INVESTMENT

	Without	With
Land and land improvements	$ 6,400.00	$ 6,700.00
Farm buildings	4,200.00	4,200.00
Farm machinery and equipment	3,205.00	3,205.00
Livestock inventory	3,552.00	3,745.44
Feed	459.60	582.87
Total investment	$17,816.60	$18,436.31

a/ Includes 30 acres of land previously abandoned due to water shortage.

b/ Value of water delivered to the farm, computed on the basis of farm headgate shortage of .73 acre-feet per acre or a main ditch headgate shortage of 1.13 acre-feet per acre.

CURRENT FARM EXPENSE

	Without	With
General:		
Interest cost	$ 568.19	$ 585.93
Taxes	256.63	271.32
Insurance	20.40	20.40
Improvements-depreciation and repair	342.50	342.50
Truck, gas and oil	65.25	82.00
Tractor, gas and oil	308.25	428.75
Utilities	100.00	100.00
Crop:		
Seed	169.70	210.58
Harvesting	165.00	257.35
Fertilizer	0	0
Spray and dust	0	0
Machinery-depreciation and repair	640.51	640.51
Irrigation water expense	130.00	160.00
Hired labor	381.90	786.00
Contract labor	0	0
Livestock expense	717.48	836.51
Total expense	$ 3,865.81	$4,721.85

FINANCIAL SUMMARY

Receipts	$ 3,973.18	$6,013.47
Farm privileges and rent	702.08	702.08
Gross farm income	4,675.26	6,715.55
Farm expense	3,865.81	4,721.85
Net farm income	809.45	1,993.70
Family living allowance		1,500.00
Project payment capacity per farm		493.70
Project payment capacity per acre-foot b/		2.72
Less 20% safety factor		.54
Computed payment capacity per acre-foot at the farm headgate		$ 2.18

Irrigation benefits

For benefit analysis the water supply under the initial development was assumed to be distributed among 12 major ditches and 2 groups of minor ditches in proportion to their tentative requests for water. The budget that best represented farms on each ditch was used in estimating irrigation benefits.

The extensive agriculture-type farm was given the greatest weight in the analysis. Of the total, 631 farms, representing 83 percent of the acreage, were classified as extensive agriculture; 246 farms, representing 12 percent of the acreage, involved intensive agriculture with truck crops; 24 farms, representing 3 percent of the acreage, involved mountain valley agriculture; and 20 farms, representing 2 percent of the acreage, involved intensive agriculture.

The assumed distribution of the supplemental water available by the initial development is shown by type of agriculture in table 8E.

As a result of the increased water supply which would be made available by the initial development, the gross value of agricultural products in the project area could be increased by $2,368,200 annually. That total increase would consist of the following increments: $1,672,500 in gross crop value and $695,700 in value of livestock and livestock products.

Farm improvements over much of the area are fairly adequate. The more productive land under the better ditches have more extensive farm improvements than lands having junior water rights. As a result of project development, farm investments in land, farm buildings, farm machinery, livestock and feed would be increased by $682,000. Some of the presently irrigated lands need additional leveling, contouring, and minor drainage. Such construction would cost about $8 per acre over the entire area to receive supplemental water.

TABLE 8E.—*Estimated distribution of project water and payment capacity by type of farm.*

Type of farm	Number of farms	Distribution of acreage	Water shortage per farm (acre-feet)	Estimated distribution of project water used in the analysis (acre-foot)	Payment capacity per acre-foot at farm	Average river main ditch, and lateral loss
		Percent				*Percent*
Intensive general agriculture with truck crops	246	12	63	5,331	$9.16	27
Intensive general agriculture	20	2	129	908	9.58	34
Extensive general agriculture	631	83	267	48,987	5.88	41
Mountain valley agriculture	24	3	180	1,474	2.18	34
Total or weighted average	921	100	207	56,700	6.15	39

Irrigation of new land is not contemplated in the initial development. Consequently, opportunity for settlement of additional farm families is limited to the irrigated lands in farms of sufficient size and resources to support two or more farm families. The increase in farm families due to subdivision is not considered large enough to be significant, and the increase in farm population would therefore be limited to the additional farm laborers needed, estimated to be about

2,500 persons. The irrigable lands within the project area are held in private ownership except for some school land; therefore, none of the project lands would be subject to homesteading.

Measurable annual direct and indirect agricultural benefits resulting from the initial development of the Gunnison-Arkansas project are shown in the following tabulation:

Annual increase gross farm income	$2, 368, 200
Annual increase in farm costs:	
Farm investment cost	9, 800
Farm operation cost	1, 293, 600
Total costs	1, 303, 400
Annual direct benefit to farmers	1, 064, 800
Annual direct benefit to others (interest and wages)	436, 500
Total direct annual benefits	1, 501, 300
Indirect annual benefits:	
From farm expenditures	361, 300
From processing and marketing	1, 476, 200
Total indirect annual benefits	1, 837, 500
Total annual benefits	3, 338, 800

Irrigation payments

Payment capacity per acre-foot for water on the farm under the 4 types, ranges from $2.18 on mountain valley farms to $9.58 on farms in the vicinity of Pueblo, using intensive agricultural methods. The average is $6.15 per acre-foot (table 8E). It is anticipated, however, that the water would be sold by the proposed conservancy district at a uniform price to all potential water users. The value of water at the Pueblo Reservoir must take into account lateral losses, ditch losses, and river losses for each of the ditches making requests for water. The average loss in this study is 39 percent; that is, for each acre-foot of water delivered to the farm 1.64 acre-feet would have to be released from the Pueblo Reservoir. After allowances for these losses the overall value of water at Pueblo Reservoir is $3.75 ($6.15 divided by 1.64 acre-feet).

The major part of the water is expected to be used on farms practicing extensive irrigated-type agriculture. Approximately 83 percent of the land requiring supplemental water from the project will be represented by this budget. Farms of this type have a high proportion of class 1 land and produce feed grains and forage for livestock with only a limited acreage of beets, onions, and melons.

For this type of farming, payment capacity per acre-foot of water on the farm is $5.88 or $3.59 at Pueblo Reservoir ($5.88 divided by 1.64 acre-feet). This figure has been rounded to $3.60 per acre-foot. It is considered the most realistic and representative of the payment capacity of the major portion of the potential project water users, and is, therefore, used for the project financial analysis.

The same type of farm budget was used as being representative of farms under the Colorado Canal which is now owned and operated by the Twin Lakes Reservoir & Canal Co. Deducting $1.60 per acre-foot for the estimated cost of operation and maintenance of the company's transmountain collection and diversion works from the

above value gives $2 per acre-foot as the amount farmers under the Colorado Canal could afford to pay for water services at the Pueblo Reservoir. That amount is the charge for storage and regulation of the additional water that would be diverted to the Arkansas Valley by the Twin Lakes Reservoir & Canal Co. as a result of the storage facilities provided by the initial development.

Payment for the benefits that would accrue from the conversion of Arkansas River winter water to summer season water by the project has not been considered in the financial analysis. Evaluation of this service is planned and a return from this source will be used to increase payment of the cost allocated to irrigation.

No development period is recommended for lands to receive supplemental water inasmuch as the lands are already being farmed and the supplemental water would be utilized to increase present production.

Local participation and interest in the investigations and preparation of plans for the project have been excellent. The majority of people concerned are enthusiastically united and in favor of the development as evidenced by public meetings, general publicity, meetings of organizations in which project development is the principal topic of discussion, and the formation of organizations directly concerned with the development.

Chapter VI. Power

PRESENT DEVELOPMENT

In 1948 there were 15 private utilities, 25 municipal organizations 11 Rural Electrification Association cooperatives, and the Bureau of Reclamation serving the entire eastern Colorado power market area with electric power. The Bureau operates 1 plant in the area, the 21,600-kilowatt Green Mountain hydroelectric plant. On December 31, 1948, installed generating capacity of the utilities supplying power to the area totaled 347,105 kilowatts, of which 339,000 kilowatts were dependable capacity and 267,000 kilowatts were net assured capacity. The installed capacity was comprised of 70,280 kilowatts of hydroelectric capacity, 252,302 kilowatts of steam capacity, and 24,523 kilowatts of internal-combustion capacity. Installed capacity of industrial plants in the area totaled 85,020 kilowatts.

At present there is no high-voltage transmission system interconnecting all the important load centers. Ultimately, under the long-range plans of the Bureau of Reclamation, all existing and potential Federal power systems in the State would be interconnected. Ties with other utilities through these systems would enable an interchange of power among practically all power suppliers in the State and adjacent areas, thus assuring maximum efficiency of service, distribution, and utilization of power resources (exhibit 11).

In 1948 the noncoincident peak demand for utilities in the market area was approximately 300,000 kilowatts which was about 12 percent greater than the net assured capacity of 267,000 kilowatts, indicating the need for additional capacity to serve the area.

Potential hydroelectric power developments would not and could not supplant all existing or all potential powerplants supplying fuel-generated energy. The two types of plants are complementary and the potential hydroelectric developments are very limited. Operation of hydro and fuel plants should be coordinated by interconnected systems. From a conservation-of-fuel standpoint, however, the hydroelectric power possibilities of the area should be developed to their fullest extent so that the use of natural gas, oil, and coal reserves, now powering 89 percent of all electric generation in the project area, would be kept to a minimum.

POWER MARKET

The power market area to be partly served by the initial development of the Gunnison-Arkansas project is the State of Colorado east of the Continental Divide plus Grand and Summit Counties on the western slope. This is the combined power market area for the Colorado-Big Thompson project and the potential initial development of the Gunnison-Arkansas project—both Bureau of Reclamation developments. It is planned also to serve loads in the Gunnison

and Saguache areas because of their proximity to the project power system.

An examination of the marketing possibilities in the area indicate that an ample market would exist for the output of the powerplants of the two projects at their earliest possible completion date. The need for the 93,800 kilowatts of dependable capacity planned for the initial development of the Gunnison-Arkansas project is clearly shown on exhibit 12. During the early years of development, some power from the initial development may necessarily be absorbed in northern Colorado, but by 1960 it will all be required in the southern part of the State.

POTENTIAL DEVELOPMENT

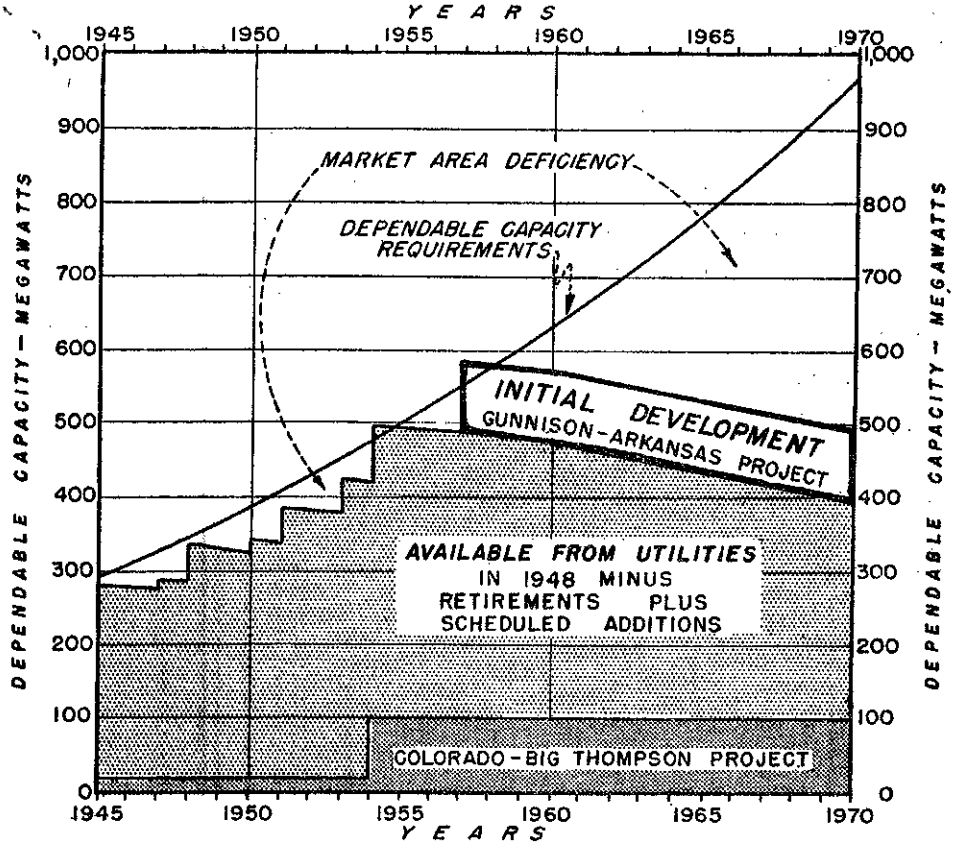
As discussed in chapter III, the project power system would include 60 miles of canals, 7 powerplants and switchyards, 9 substations, and an estimated 421 miles of transmission lines. Of the total installed generating capacity of 104,800 kilowatts, 93,800 would be dependable capacity. Total annual generation of the project powerplants would average 505 million kilowatt-hours—400 million kilowatt-hours firm energy and 105 million kilowatt-hours secondary energy. Annual salable energy would amount to 370 million kilowatt-hours of firm energy and an average of 97,125,000 kilowatt-hours of secondary energy. There is an adequate market for the above energy at rates of 5.5 mills for firm and 3.5 mills for secondary energy, as fuel costs alone for steam generation are over 4 mills per kilowatt-hour for the largest supplier in the project area. Contacts made with utilities and industry in the area substantiate this market.

The total annual power potentialities and the annual firm power potentialities are shown in table 9. The profile of features included in the initial development is shown on exhibit 6.

EXHIBIT 12

DEPENDABLE CAPACITY REQUIREMENTS AND SOURCE OF POWER SUPPLY a/

DEPENDABLE CAPACITY				
YEAR	ESTIMATED REQUIREMENTS	AVAILABLE FROM UTILITIES IN 1948 MINUS RETIREMENTS PLUS SCHEDULED ADDITIONS	MAXIMUM AVAILABLE FROM U.S.B.R. PROJECTS b/	MARKET AREA DEFICIENCY
1948	346,000 KW	319,000 KW	20,000 KW	7,000 KW
1950	393,000 KW	320,000 KW	20,000 KW	53,000 KW
1960	632,000 KW	380,000 KW	194,000 KW	58,000 KW
1970	966,000 KW	298,000 KW	194,000 KW	474,000 KW



a/ Combined Power Market Area (Portion of Colorado in Region 7)

b/ Colorado Big Thompson Project--Initial Development, Gunnison-Arkansas Project.

TABLE 9.—*Power potentialities: Initial development*

Powerplants	Total water available [1]	Canal, reservoir, and evaporation losses	Bypass for irrigation and fish	Water available for power generation	Generation energy	Energy losses 7½ percent	Salable energy
	(1,000 acre-feet)				(1,000,000 kilowatt-hours)		
TOTAL ANNUAL POWER POTENTIALITIES							
Elbert	117.4	13.3	11.2	92.9	39.0	2.9	36.1
Granite	307.6	6.7	14.6	286.3	66.8	5.0	61.8
Wapaco	310.2	0	0	310.2	125.9	9.4	116.5
Princeton	368.7	15.8	52.6	300.3	68.5	5.1	63.4
Johnson	349.1	10.5	23.4	315.2	69.4	5.2	64.2
Salida	315.2	6.4	0	308.8	102.4	7.7	94.7
Pueblo				[2] 600.0	33.0	2.5	30.5
Total					505.0	37.8	467.2
ANNUAL FIRM POWER POTENTIALITIES							
Elbert	86.3	11.7	12.3	62.3	26.3	2.0	24.3
Granite	228.8	6.7	15.1	207.0	48.8	3.7	45.1
Wapaco	247.2	0	0	247.2	100.4	7.5	92.9
Princeton	304.7	12.7	50.0	242.0	55.2	4.1	51.1
Johnson	277.0	7.8	19.3	249.9	55.0	4.1	50.9
Salida	249.9	5.3	0	244.6	81.3	6.1	75.2
Pueblo				[2] 600.0	33.0	2.5	30.5
Total					400.0	30.0	370.0

[1] After operational waste.
[2] Not all convertible to electric energy.

Preservation of fishery values on the upper Roaring Fork River could be accomplished by an extension of the collection system to provide water in exchange for that which could be diverted by the Twin Lakes system. The expected agreement for this exchange through the Fryingpan-Arkansas tunnel to the Sugar Loaf Reservoir would result in an average annual generation of about 2 million kilowatt-hours. This additional generation has not been utilized in the estimates contained herein for power generation but the added value would offset the added annual costs of the extension to the system.

BENEFITS

The total annual tangible power benefits from the power that would be produced in the initial development are estimated as follows:

Direct benefit: Gross revenue to Bureau (sale of power)	$2, 375, 000
Indirect benefits:	
Saving in production costs	327, 000
Share in benefits accruing to retailer	1, 199, 000
Share in increased value arising in final utilization	163, 000
Subtotal, indirect benefits	1, 689, 000
Total annual tangible benefits	4, 064, 000

POWER REVENUE

Table 16, financial study, presents an amortization study of the construction costs of $40,032,000 allocated to power. At average rates of 5.5 mills per kilowatt-hour of firm energy and 3.5 mills per kilowatt-hour of secondary energy, these costs could be retired with interest at 3 percent in a period of 50 years from the last powerplant investment. A surplus of about $243,264 would accrue in the final year. At these rates, the annual revenue from 370 million kilowatt-hours of salable firm energy would be $2,035,000 and from an average of 97,125,000 kilowatt-hours of salable secondary energy, $339,938, giving a combined annual gross revenue of $2,374,938. Reducing that figure by $854,050 for annual operation, maintenance, and replacement charges leaves a net operating revenue of $1,520,888 per year.

Chapter VII. Flood Control

HISTORICAL FLOODS

Floods of damaging proportions have not been recorded in the diversion area on the western slope and in the Arkansas Valley above Canon City. From Canon City eastward, however, damaging floods increase in frequency and volume to the John Martin Reservoir. Floods of varying magnitude and resultant damages have occurred in the area, principally on the eastern slope. The largest flood of record, caused by intense rains in the vicinity of Pueblo, occurred in June 1921. The flood reached an estimated peak discharge of 103,000 second-feet at Pueblo. Downstream tributaries contributed to the flow until at La Junta the peak reached an estimated 200,000 second-feet. From La Junta eastward the peak gradually decreased until it was about 120,000 second-feet at Holly. In the 1921 flood, loss of life was high, and property damage in the valley was estimated at more than $19 million, of which $10 million was in Pueblo.

EXISTING FLOOD-CONTROL STRUCTURES

At Pueblo the flood-protection works, built by the Pueblo Flood Conservancy District from 1924 to 1926, consist of a barrier dam across the Arkansas River about 6 miles west of the city, designed to decrease all high potential floods to 100,000 cubic feet per second or less, and an improved floodway channel through the city designed to discharge up to 125,000 second-feet. The Corps of Engineers has recently determined that with certain minor repairs, the floodway could convey a flood of 110,000 second-feet. Studies by the Bureau substantiate this figure. Without the Pueblo Dam and Reservoir, however, the city still sustains some risk from floods greater than the capacity of the floodway.

The John Martin Reservoir, primarily a flood-control development, is located 16 miles west of Lamar and below the mouth of the Purgatoire River. That reservoir, constructed by the Corps of Engineers, is designed to afford flood protection to the valley lands below by reducing all potential flood flows to 10,000 second-feet or less. The reservoir has a total capacity of 701,000 acre-feet, of which 281,000 acre-feet is reserved for flood control and the remainder allocated to water conservation for irrigation. The project was completed in 1948.

In the adjacent tributary areas flood-control works have been constructed on the Purgatoire River near Trinidad and on Monument Creek and the Fountain River and their tributaries in the vicinity of Colorado Springs.

PROPOSED REGULATION

Structures required for the collection of water in the diversion area would practically eliminate all local minor floods.

A small amount of flood control in the Arkansas Valley would be afforded by the Sugar Loaf and Twin Lakes Reservoirs in the head-

waters area. This measure of control would occur during flood periods when reservoir storage is below spillway crest, and the available storage would control all or part of the floodwater from snowmelt.

Of the 400,000 acre-feet of capacity in the potential Pueblo Reservoir, approximately 93,000 acre-feet would be allocated to flood control. With this flood storage capacity the 1921 flood could have been fully controlled at the dam site, leaving only the downstream inflow uncontrolled.

DAMAGES AND POTENTIAL BENEFITS

No flood-control benefits are claimed for the western slope diversion area or for the eastern slope headwaters area down to Pueblo.

The Corps of Engineers estimates that the total average flood damages amount to $890,000 annually in that reach of the river between the Pueblo Dam site and the John Martin Reservoir. Part of that damage is the result of flows from tributary streams.

Provision of 93,000 acre-feet of capacity for flood control in the Pueblo Reservoir would not only prevent damages to many existing structures and facilities, but would also eliminate the need for certain protective levees at Pueblo. The potential reduction of average flood damages between the Pueblo Dam site and the John Martin Reservoir attributable to the Pueblo Reservoir is estimated at $583,000 annually. That evaluation of preventable damages has been adopted as the flood-control benefit for the project.

Chapter VIII. Sediment Control

EXISTING SEDIMENT PROBLEMS

In the diversion area and on the eastern slope above Canon City sedimentation is negligible. The irrigated section of the Arkansas River between Pueblo and the John Martin Reservoir, however, has many sediment problems. Sediment that has been removed from canals now lines the canal banks and further disposal has become an expensive process. Aggradation of the river channel in the vicinity of diversion structures has either made those structures inoperative or necessitated their being raised. Various canal sand traps have been made inoperative. Reservoir capacities are being depleted and feeder canals supplying off-channel reservoirs have become clogged with sediment causing loss in canal capacities of as much as 50 percent in some instances. A considerable amount of sediment is being deposited in laterals and on the irrigated lands. Below the John Martin Reservoir very few sediment problems are evident.

POTENTIAL SEDIMENT CONTROL

In determining the average annual sediment yield that might be expected from the drainage area above the Pueblo Dam site, the flow-duration-sediment rating curve method of analysis was used. A rating curve of sediment discharge for given flows for the period of sediment data record and a flow duration curve of water discharges for the period of water record were developed. From these curves the average annual sediment load was determined. By preparing 2 flow duration curves, 1 for rain and 1 for snowmelt, and base flows, separate sediment load determinations were made. The computed sediment loads were then combined to give an estimated average total sediment load of 944 acre-feet per year at Pueblo Dam site with a suspended load of 834 acre-feet. Past diversions of the Bessemer ditch, which diverts above the damsite, averaged about 10 percent of the river flow at the damsite. As the new outlet for the ditch would be at the damsite, about 10 percent of the suspended load would be added to the 944 acre-feet of sediment contribution to the Pueblo Reservoir. Operation of the John Martin and other reservoirs by the Corps of Engineers, however, indicates that about 10 percent of the suspended sediment would be sluiced through the reservoir. Thus, the total annual sediment contribution to Pueblo Reservoir would remain 944 acre-feet and a total of 94,400 acre-feet of storage capacity would be required for the 100-year period.

Data from existing reservoirs in which sedimentation has occurred were used to estimate the manner in which sediment would be deposited in Pueblo Reservoir. At the end of 100 years sediment deposition at Pueblo Dam could be expected to be 15 feet above the original stream bed elevation. Based on a total capacity of 400,000 acre-feet,

the allocation of capacity at the end of 100 years of operation would be as follows:

Storage	*Acre-feet*
Flood control	93,000
Water conservation	210,600
Sediment	94,400
Dead storage [1]	2,000
Total	400,000

[1] 10,000 acre-feet less 8,000 acre-feet sediment in the dead-storage pool.

BENEFITS

Of the 944 acre-feet of sediment which would enter Pueblo Reservoir annually, it is estimated that below that reservoir 751 acre-feet would be prevented from being deposited in the existing reservoirs, canals, laterals, and on irrigated lands. No attempt is made to evaluate benefits for preventing deposition on irrigated lands. Total annual benefits are estimated to be $141,300 (table 10).

TABLE 10.—*Estimated annual sediment benefits, Pueblo Reservoir*

Point of deposition or pickup	Dollar benefits per acre-foot sediment stopped from depositing	Estimated annual sediment stopped from depositing (acre-feet)	Annual benefits
Bedload pickup	(1)	110	
Suspended load pickup	(1)	83	
John Martin Reservoir:			
Irrigation storage	$329	104	$34,200
Flood control	43	52	2,200
Off-channel reservoirs	329	60	19,700
Canals	160	89	14,200
Laterals	800	89	71,000
Irrigated land	(2)	357	
Total		944	141,300

[1] No benefits.
[2] Not evaluated.

Chapter IX. Municipal Water

PRESENT DEVELOPMENT

Municipal water supplies for cities and towns on the western slope are obtained from mountain streams, springs, or shallow wells. The quality of water varies from excellent to good, and supplies are adequate for present and anticipated needs.

The quantity of municipal water available on the eastern slope is barely adequate at present, and with anticipated future population increases, additional municipal water supplies will be needed, particularly by Pueblo and Colorado Springs. Generally, the quality of water in the Arkansas Valley is poor, and in many towns the water must be treated for industrial use. Canon City, Pueblo, and Rocky Ford are supplied municipal water from the Arkansas River; Colorado Springs obtains its water supply from the slopes of Pikes Peak; and the remaining towns are supplied from tributary streams, springs, and wells. Some artesian wells and springs supply soft water to a few towns along the Arkansas River, but at present practically all artesian wells are pumped, as their original artesian characteristics have been lost because the storage accumulated through the ages has been depleted.

ANTICIPATED NEEDS

With the exception of the drought period of the 1930's, the population of the Arkansas Valley has steadily increased since settlement first began. Continued population growth is anticipated. By the year 2000 it is estimated that 432,000 persons will be living in the Arkansas Valley.

Along with the increase in population will come an increased demand for municipal water. Approximately 17,000 acre-feet of water annually will be needed by cities and towns in the valley in addition to their present supplies. Pueblo, Colorado Springs, and the valley towns are already in urgent need of a supplemental municipal supply. All towns in the valley except Colorado Springs need an improved quality of municipal water. The following towns have expressed a desire to receive municipal water from the Gunnison-Arkansas project: Pueblo, Colorado Springs, Manzanola, Rocky Ford, La Junta, Las Animas, Lamar, Crowley, Wiley, and Eads. Although Salida, Canon City, and some other valley towns have not indicated a desire for municipal water, they could be supplied from the project should the need arise.

WATER REQUIREMENTS

Water requirements for the towns in the valley consist of irrigation, domestic, commercial, industrial, and public uses. Irrigation of lawns and gardens is the largest single factor affecting the water requirements. Thus, consumption during the summer months is much higher than at any other time of the year. Industrial usage is rela-

tively small. Most of the large industries in Pueblo have their own source of supply. Peak monthly demands in the city of Pueblo are exceeding the amount of water that can be supplied through direct diversion rights. The deficiencies are being met with the small amount of transmountain water in storage and with the purchase of water from other water users, which results in less water available for those other worthy purposes. Past and anticipated annual consumption of municipal water for the towns in the project area are summarized in table 11.

TABLE 11.—*Water requirements*

[Estimated future requirements based on population in the year 2000]

Town	Total past consumption		Total future consumption [1]		Additional needed [2]	
	Thousands of gallons per year	Acre-feet per year	Thousands of gallons per year	Acre-feet per year	Thousands of gallons per year	Acre-feet per year
Colorado Springs	2,668.6	8,211	4,380.0	13,442	1,711.4	5,231
Pueblo	6,814.0	20,966	8,322.0	25,540	1,508.0	4,574
Manzanola	38.7	119	45.1	139	45.1	139
Crowley	2.6	8	31.2	96	31.2	96
Rocky Ford	216.8	667	520.1	1,598	520.1	1,598
La Junta	526.8	1,621	797.5	2,450	797.5	2,450
Las Animas	217.8	669	305.2	937	305.2	937
Wiley	12.1	37	34.7	105	34.7	105
Eads	9.4	29	20.4	65	20.4	65
Lamar	405.7	1,248	700.4	2,150	700.4	2,150
Total	10,912.5	33,575	15,156.6	46,522	5,674.0	17,345

[1] Based on per capita consumption of 200 gallons per day for Colorado Springs and Pueblo, 70 gallons per day for Eads, and 190 gallons per day for the remaining towns.

[2] Data on additional needs can be derived mathematically from the other columns in the table only for Colorado Springs and Pueblo which require supplemental project water. Needs for the other valley towns are based upon complete project replacement of all existing municipal supplies.

SPECIAL WATER TREATMENT

The water which would be imported from the Fryingpan River Basin is of excellent quality. The addition of that water to the Arkansas River would tend to improve the present quality of the river water. Storage in the potential Pueblo Reservoir would practically eliminate present variations in dilution and consequent fluctuations in hardness of the water in the river at Pueblo.

The water which would be furnished to Pueblo and the valley towns below Pueblo would be purified in a potential treatment plant near the Pueblo Reservoir site. Capacity of the plant would be sufficient to treat 26,000 acre-feet annually for the city of Pueblo including the present supply, and 8,000 acre-feet for the valley towns below Pueblo. The central purification plant is included in the project to provide treated water for Pueblo and the Arkansas Valley towns at a reasonable cost. Of all the valley communities below Pueblo, only Rocky Ford has a purification plant and its capacity is barely adequate at present. Provision of individual plants by each municipality would increase the cost of water to consumers and difficulty in financing the cost of such ventures would be experienced in some of the smaller towns. Alternatives for the central project plant include construction of a similar plant: (*a*) by the communities as a cooperative enterprise, or (*b*) by a single community such as the

city of Pueblo which could charge the valley towns for the service rendered. The practicability of either of these alternatives would depend upon the ability of the communities or of some entity such as a conservancy district to make necessary financial arrangements.

POTENTIAL DEVELOPMENT

The initial development includes facilities for supplying communities with municipal water. Those facilities have been included because of the need for the water and the service, the interest shown by the communities, the obvious advantages and economies in construction and operation that would accrue from a comprehensive plan, and possible financial difficulties by the communities if they undertake construction themselves. The entire municipal water phase of the initial development is flexible and susceptible of elimination or adjustment, in whole or in part, without greatly affecting the economic feasibility of the remaining project. If the communities desire to finance and construct the facilities as planned—or according to another plan of their own devising—the Bureau of Reclamation will render all possible assistance.

Under the initial development, 15,000 acre-feet of project water would be allocated for municipal uses. An additional 2,000 acre-feet of transmountain water belonging to the city of Pueblo would be conserved by project facilities for municipal purposes. Of that total quantity of 17,000 acre-feet, 5,000 acre-feet would be available to Pueblo, 8,000 acre-feet to other towns in the valley (which includes a reserve of 500 acre-feet for possible future requests), and 4,000 acre-feet for the replacement of municipal water for Colorado Springs.

In the analysis contained herein future requirements of the various municipalities are based on conservative estimates of population and per capita consumption. Although these requirements do not agree with estimates by the individual cities and towns, it is generally agreed that the 17,000 acre-feet of water made available by the project for municipal purposes will meet the immediate needs with some allowance for future expansion. If in the actual negotiations with the municipalities following authorization of the project it should be determined that a greater quantity of water should be reserved for future municipal demands, such an allocation could be made without impairing the conclusions of this report regarding financial feasibility or payment.

Cities and industries

Colorado Springs.—Estimates indicate that Colorado Springs will require approximately 5,231 acre-feet of additional municipal water by the year 2000. The initial development could provide only a portion of that supplemental supply. A total of 4,000 acre-feet of project water has been allocated to Colorado Springs. The plan provides for pumping 2,700 acre-feet of water into the city system from Middle Beaver Creek. That water would be replaced for irrigation use by project water. Because of transportation and other losses involved in the irrigation replacement, 3,200 acre-feet of replacement water would be required. The remaining 800 acre-feet of project water reserved for Colorado Springs could be utilized as similar replacement in the event of future diversions from upper Beaver Creek or from other drainages.

The municipal water would be lifted approximately 140 feet into the existing Colorado Springs municipal supply system beginning with reservoirs located on the south slope of Pikes Peak. The pumped water, regulated with the present supply, would generate energy in the two municipally owned hydroelectric powerplants of the Colorado Springs system.

The annual diversion of 2,700 acre-feet from the Beaver Creek watershed would reduce the water supply for the downstream Skaguay Reservoir, causing an annual loss of about 2,500,000 kilowatt-hours of energy from the Skaguay hydroelectric plant, both facilities owned and operated by the Southern Colorado Power Co. Estimates of the annual gain and loss in hydroelectric power production as a result of the diversion are as follows:

	Annual kilowatt-hours
Gain at Ruxton and Manitou plants	7, 500, 000
Power required for pumping	—500, 000
Loss at Skaguay plant	—2, 500, 000
Net overall gain in production	4, 500, 000

It appears that the net overall annual gain of 4,500,000 kilowatt-hours to the city of Colorado Springs would be sufficient either (*a*) to finance the construction of a transmission line for the replacement of power lost at the Skaguay plant or, (*b*) if sold, would result in revenues sufficient for the city to reimburse the Southern Colorado Power Co. In either event, a transmission line to the pumping plant would be required. For the purpose of this study it has been assumed that the debits and credits involved in the power transaction would be about equal; therefore, neither the cost of the transmission line to the pumping plant nor its extension of the Skaguay plant has been included in arriving at the cost of the municipal water.

In addition to its hydroelectric use, water from Beaver Creek is also used by irrigators in the Penrose-Beaver area and in the Arkansas Valley. Coordination of the operation of Mount Pisgah Reservoir on Oil Creek is contemplated in the necessary exchange procedure for the replacement to the Penrose area. This plan for replacement involves the construction of a diversion dam on Oil Creek and a canal to the existing Brush Hollow Reservoir. A portion of the storage space in Skaguay Reservoir now used for power water regulation could be made available for irrigation supply for that part of the area not tributary to Brush Hollow Reservoir.

Pueblo.—As shown in table 11, the estimated additional water requirements for Pueblo by the year 2000 will be about 4,574 acre-feet. Much of that supplemental supply, and a better quality of the present supply, is needed immediately. In addition to providing treatment for Pueblo's present supply of 21,000 acre-feet which is diverted from the Arkansas River, the initial development would make available an additional supply of 5,000 acre-feet that would provide a reserve of 426 acre-feet above anticipated requirements.

The additional water would consist of 2,000 acre-feet from the existing Wurtz ditch transmountain diversion and 3,000 acre-feet from the potential Fryingpan-Arkansas diversion. Although the Wurtz ditch diversion is owned by the city of Pueblo, most of the yield is lost to the municipality because of lack of adequate storage capacity.

Storage facilities of the initial development would enable the conservation of that water for municipal use.

Pueblo's total supply of 26,000 acre-feet of water would be pumped from the Pueblo Reservoir directly into the potential purification plant where the water would be treated before being transferred by dual pipeline 7 miles to the city's distribution system. A reservoir would be constructed near the plant to provide the additional storage capacity required to supply the city's peak demand.

Valley towns.—The municipal water requirements for the eight valley towns is estimated at 7,540 acre-feet by the year 2000. In order to provide a reserve for those towns and possibly others, 8,000 acre-feet of project water has been allocated for the valley communities. The eight towns which have expressed a desire for project municipal water are: Manzanola, Rocky Ford, La Junta, Las Animas, Lamar, Crowley, Wiley, and Eads. The water for those towns would be pumped from the Pueblo Reservoir to the purification plant by the same pumping plant and penstock used to obtain the municipal water for Pueblo. After being treated in the purification plant the water would be carried down the valley by a main trunkline. Branch lines would be constructed from the trunk line to Crowley and Eads.

Colorado Fuel & Iron Corp.—At the request of the Colorado Fuel & Iron Corp., present owner of the existing Sugar Loaf Reservoir, 10,000 acre-feet of additional storage space would be furnished in the project system for storage of an average of 4,000 acre-feet of additional water from contemplated collection system on the upper Arkansas River.

Estimated charges

Specific and joint construction costs allocated to municipal water are amortized at 2 percent in 40 years. The proportionate share of the annual operation, maintenance, and replacement expenses is added to these amortization costs in order to determine total annual revenue requirements.

The estimated price that should be charged for municipal water in the project supply system is $22.60 per acre-foot. An estimated storage charge of $4.60 per acre-foot for the 2,000 acre-feet of Wurtz ditch water stored in project reservoirs and an estimated charge of $3.60 per acre-foot for improving the quality of the present 21,000 acre-foot supply should be paid by the city of Pueblo.

In addition to the supply system costs, the cost of municipal water to the city of Colorado Springs involves the following: (*a*) Construction costs of pumping plant, penstock, and substation, costs of power for pumping, and other operation, maintenance,and replacement expenses, (*b*) construction costs of diversion dam and the Oil Creek Canal, and the appropriate operation, maintenance, and replacement expenses, and (*c*) the Gunnison-Arkansas system cost for 3,200 acre-feet of municipal water.

The city of Pueblo and the valley towns should pay the estimated project system charge and their proportionate share of the construction cost and annual operation, maintenance, and replacement costs of the pumping plant, penstock, and purification plant and the total costs of the delivery facilities of those towns.

The estimated cost of municipal water to the various cities and towns to be served by the project are shown in table 12.

TABLE 12.—*Estimated costs of municipal water, initial development, Gunnison-Arkansas project*

Units	Water supplied (acre-feet)	Unit costs						Total annual revenue
		Supply system	Distribution system			Total per acre-feet	Total per 1,000 gallons	
			Pumping	Treatment	Delivery facilities			
							Cents	
Colorado Springs	2,700	[1] $26.80			$12.25	$39.05	12.0	$105,430
Pueblo:								
Wurtz ditch	2,000	[2] 4.60	[3] $4.95	$11.40	2.55	23.50	7.2	47,000
Present supply	21,000	[4] 3.60	[3] 4.95	11.40	2.55	22.50	6.9	472,500
Project water	3,000	22.60	[3] 4.95	11.40	2.55	41.50	12.7	124,500
Valley towns:								
Trunk line	7,274	22.60	4.95	11.40	49.15	88.10	27.0	640,840
Crowley branch line	96	22.60	4.95	11.40	108.55	147.50	45.3	14,160
Eads branch line	170	22.60	4.95	11.40	216.95	255.90	78.5	43,500
Colorado Fuel & Iron Corp	[5] 4,000	[2] 2.00				2.00		8,000
Water held for future demand	1,260	22.60				22.60	6.9	28,480
Total								1,484,410

[1] System price for 3,200 acre-feet replaced chargeable to the 2,700 acre-feet actually delivered.
[2] Storage charge.
[3] Includes assumption of present pumping costs.
[4] Charge for improvement of quality of water.
[5] 10,000 acre-feet of storage space required for additional water to be acquired by the Colorado Fuel & Iron Corp. from the Arkansas River.

NOTE. Costs of municipal features amortized at 2 percent in 40 years.

Final determination of an equitable charge for storing the 4,000 acre-feet of water annually for the Colorado Fuel & Iron Corp. would involve the summation of all factors involved in the acquisition of Sugar Loaf Dam and Reservoir from the Colorado Fuel & Iron Corp. without detriment to the corporation's present position. Inasmuch as solution of these problems would require additional studies and negotiations after authorization, the cost of storing an average of 4,000 acre-feet of water per year has been only tentatively estimated at $2 per acre-foot.

BENEFITS

Benefits that would arise from making available 17,000 acre-feet of additional municipal water to the cities of Colorado Springs, Pueblo, and the Arkansas Valley towns below Pueblo are evaluated from the cost of the cheapest alternative system that would provide equivalent supplies.

The most economical source for obtaining an equivalent municipal water supply is transmountain diversion. The alternative system would include facilities to collect and divert 15,000 acre-feet of water from the Fryingpan drainage and enlargement of the existing Sugar Loaf Reservoir to 79,000 acre-feet. In order to provide water equivalent in quality to that made available by the project, it would be necessary to bring the water by pipeline from the mouth of Grape Creek at Canon City to a purification plant near Pueblo. The purification plant and pipelines to Pueblo and the valley towns, as well as the additional facilities required for delivery and replacement of Colorado Springs additional municipal supply, would be the same as those included in the initial development. The cost of this alternative system is estimated at $33,575,000.

Amortization of this total construction cost at 2 percent interest over a 40-year period in accordance with established policy gives an annual capital cost of $1,227,000. Adding the annual operation, maintenance, and replacement expenses of $435,000 for the alternative system makes a total annual cost of $1,662,000. This annual cost of an alternative system is taken as the measure of municipal water supply benefits accruing from the project.

Chapter X. Fish and Wildlife

PRESENT AND POTENTIAL CONDITIONS

A preliminary statement by the Fish and Wildlife Service is included in chapter XVI as a part of this report.

The extension of the South Side collection system to intercept the south forks of Hunter Creek, as described in chapter III, would prevent loss to fishery values on the Roaring Fork River that might result from any increased diversions through the Twin Lakes (Independence Pass) transmountain diversion system now owned by the Twin Lakes Reservoir & Canal Co. by virtue of storage made possible to the project. Enough additional water would be diverted by the Hunter Creek extension to effectuate the exchange in the most adverse years. It is anticipated that the amount of water to be exchanged during the latter part of the summer of the minimum flow year would be about 3,000 acre-feet after allowance for losses has been made. The water obtained via extension of the collection system to the south forks of Hunter Creek would also help to preserve fishing in the Sugar Loaf and Twin Lakes Reservoirs.

The residual flows in the Fryingpan River and tributaries are those recommended by the Fish and Wildlife Service and appear in its statement included herein. These flows which were decided upon after several conferences among the Bureau of Reclamation, the State of Colorado, and the Fish and Wildlife Service, were used in determining the yield of the diversion system.

A part of the capacity of Aspen Reservoir in excess of replacement requirements would be available for future use in meeting demands in western Colorado. The water from the reservoir would eventually be delivered to the Roaring Fork River at the reservoir outlet. The pattern of delivery would be determined in such a manner as to best satisfy the purposes to which the reservoir is dedicated and to preserve the fishery values giving due weight to each use in accordance with the laws, regulations, and edicts of authority that exist or are to be constituted to administer the benefits from the storage in the projected Aspen Reservoir.

The elimination of pollution of Twin Lakes Reservoir due to the diversion of mine tailings into the reservoir from the Arkansas River via the Snowden Canal is being studied. If feasible, this alteration in plan would be incorporated in final design.

COSTS AND BENEFITS

The Fish and Wildlife Service has tentatively advised the Bureau of Reclamation that the preservation of fishery values on the Roaring Fork River would justify the estimated cost of $2,179,000 required to add the extensions to the project collection system. In consideration of possible damages to fish and wildlife on the eastern slope, however, no overall project benefit is included in the benefit-cost analysis.

Chapter XI. Recreation

LAND ACQUISITION

A report by the National Park Service is included in chapter XVI. Existing law does not permit the Bureau of Reclamation to purchase land specifically for recreational purposes. Therefore, recommendation by the National Park Service concerning land acquisition (see p. 150) cannot at present be put into effect. The merit of the National Park Service's proposal is recognized, however, as past experience on Bureau of Reclamation projects has revealed problems resulting from the inability to acquire lands for the protection of public use.

RECREATIONAL ADMINISTRATION

In chapter XVI, page 150, the National Park Service recommends that recreational administration be assumed by the Bureau of Reclamation or the governmental agency responsible for the adjoining or adjacent land. Existing law does not permit the Bureau to make expenditures for this purpose. Even if this authority were granted in the future, administration by a qualified local, State, or other Federal agency should be seriously considered.

Chapter XII. Stream-Pollution Abatement

Present conditions and stream-pollution problems

No acute stream-pollution problems exist in the diversion area, nor are they anticipated with the initial development.

Stream pollution in the Arkansas Valley as a whole is not serious, but its abatement is desirable, especially during periods of low river flow. In a few isolated reaches, pollution from mining operations and sewage disposal is a problem, but available information does not indicate that stream pollution as it now exists creates a hazard so far as agriculture is concerned.

Preliminary investigations indicate that all water diverted from the Arkansas River for irrigation is satisfactory. The quality of water on the lower reach of the river should be greatly improved as a result of storage and regulation of flood flows in the recently completed John Martin Reservoir.

The dumping of sewage and industrial wastes in the immediate vicinity of irrigation diversion works is rare in the Arkansas Valley. The two major cities in the valley, Pueblo on the main stem of the Arkansas River, and Colorado Springs on the Fountain River, have primary treatment of sewage. Colorado Springs also has facilities for chemical precipitation.

Untreated industrial wastes are important factors in the pollution of the upper Arkansas River and its tributaries in some instances. The most apparent effects of industrial waste pollution on the main stem of the river are observed below Leadville where tailings from the smelter and mine drainage can be observed for a considerable distance downstream. Most major industries, however, are located in towns where facilities are available for the treatment of industrial wastes.

The effect of stream pollution on municipal water supplies is not dangerous. Only Leadville, Canon City, Portland, Pueblo, and Rocky Ford obtain municipal water from the Arkansas River, and municipal water treatment facilities are provided at each of those towns.

Benefits

As the stream pollution abatement afforded by project development is only an incidental part of the project plan, no attempt has been made to evaluate the resultant benefits.

The initial development would import transmountain water derived from melting snow on a heavily forested and practically uninhabited watershed. The water would be of excellent quality from a bacteriological and chemical standpoint. Although some improvement of Arkansas River water would occur by dilution with the imported water, adequate treatment of wastes is considered desirable to provide a higher quality of water for irrigation, domestic, and industrial purposes.

Development of the project would provide Pueblo and municipalities below with a greatly improved water supply, as discussed in chapter IX.

Chapter XIII. Financial Analysis

BENEFITS

The multiple-purpose initial development would make a significant contribution to the economic life of the West and the Nation. Benefits would accrue locally because of flood control in the Arkansas Valley and municipal and industrial water supplies for several communities in the project area. Irrigated agriculture in the Arkansas Valley in Colorado would be more stabilized and the purchasing power and business activity of the area would be increased. Electric energy not only would fulfill a local need, but the increased supply would assist in meeting national requirements for industrial expansion to provide employment opportunities for a constantly expanding population.

BENEFIT-COST COMPARISON

Measurable project benefits that would accrue from the multiple purposes of the initial development are more than sufficient to support all project costs over the period of useful life of the works. For purposes of analysis this period is limited to 100 years although the principal project features would have a considerably longer life. Annual direct project benefits to irrigators, power users, municipal water users, fish and wildlife, owners of property in the Arkansas Valley flood plain below Pueblo, and facilities below Pueblo Reservoir protected from sediment plus indirect benefits arising from irrigation and power development, represent a total 1.76 times greater than all annual Federal project costs. As shown in table 13, it is significant that the sum of direct benefits alone is sufficient to support the annual project costs. Even though the item of $436,000 representing direct irrigation benefits to others in the form of wages and interest be deleted, the remaining direct project benefits would still support all annual project costs.

In this comparison, project costs consist of the annual equivalent of the net public investment in the project and the annual project operation, maintenance, and replacement costs required to keep the facilities in working order for the entire period of analysis. The net public investment is an economic cost to the Nation and represents the sum of the estimated construction costs plus an allowance for interest for the use of Federal funds during construction and minus the present worth of terminal salvage value of principal project works.

Numerous other benefits, which are intangible but nevertheless real, would also result from project development. Increased local purchases and sales in towns and communities in the project area would improve and stabilize the general economic conditions in the area. New industrial developments and increased production at existing manufacturing plants would be stimulated. Livestock output of the region would be greatly enhanced because of increased feed supplies stemming from project development. Increased returns to State and

local taxing institutions and enhancement of Federal income-tax receipts would arise from project benefits. The availability of a large block of hydroelectric power and high quality, adequate municipal and industrial water supplies would stimulate industry, and, like expanded irrigation, would result in the creation of new taxable values, new economic opportunities, and increased purchasing power. Hydroelectric power would conserve the West's supply of coal, oil, and gas reserves as a source of fuel and energy in homes, stores, and factories. Furthermore, it would stimulate the extraction of the vast mineral resources of the project area. The availability of a large block of power would stimulate the market for electrical appliances, provide increased comfort and convenience to residential users of electric energy, and contribute to expanded commercial and rural development. The power system planned would effectuate greater dependability and continuity of electric service through the integration and coordinated operation of powerplants and power systems.

In addition to the protection afforded by the potential Pueblo Reservoir, discussed in chapter VII, incidental flood control would be provided by the various multiple-purpose reservoirs in the project. Incidental flood control would be effected by controlling flood flows with the various multiple-purpose reservoirs when reservoirs level might be below spillway crest and the available storage capacity could hold all or part of the excess water.

TABLE 13.—*Summary of benefits and costs: Initial development*

AVERAGE ANNUAL BENEFITS

	Amount
Direct benefits:	
Irrigation:	
Direct benefits to farmers	$1,065,000
Direct benefits to others	436,000
Hydroelectric power	2,375,000
Municipal water	1,662,000
Flood control [1]	583,000
Sediment control	141,000
Total direct benefits	6,262,000
Indirect benefits:	
Irrigation	1,838,000
Hydroelectric power	1,689,000
Total indirect benefits	3,527,000
Total annual direct and indirect benefits	9,789,000

AVERAGE ANNUAL COSTS

Estimated construction cost	147,440,000
Interest during construction	8,405,000
Present worth of terminal salvage value	−3,332,000
Net public investment	152,513,000
Project investment, annual equivalent cost [2]	4,165,000
Adjusted operation, maintenance, and replacement	1,403,000
Total annual equivalent Federal costs	5,568,000

Benefit-cost ratio: 1.76:1.00.

[1] Flood-control benefits of $583,000 reflect 1948 prices. Direct and indirect crop losses due to floods ($426,000) adjusted to 1939–44 average prices would reduce total annual benefits to $393,500 and effect a decrease in the benefit-cost ratio from 1.76 to 1.00 to 1.72 to 1.00.

[2] Net public investment amortized at 2½ percent during 100 years.

The addition of imported water and streamflow control in the project area would provide a measure of stream pollution abatement. Benefits would be derived from alleviation of the polluted condition of streams in some areas. Although these benefits are not measurable in monetary terms, they are, nevertheless, real and important to the health and general welfare of the project area.

Project development would provide facilities for increasing the national strength with food and fiber, power, industry, and mineral development. More extensive agricultural and industrial development of the Rocky Mountain region is an important factor in the promotion of national security and the expansion of the national economy.

COST ALLOCATION

The total construction cost of the initial development of the Gunnison-Arkansas project is estimated at $147,440,000, based on October 1949 prices. Estimated annual operation, maintenance, and replacement costs for the period of repayment of reimbursable costs amount to $1,335,200.

Construction costs have been allocated to the functions of irrigation, power, municipal water supply, flood control, and fish and wildlife conservation. Flood control provides national benefits, and construction costs allocable to that purpose are a national responsibility under existing national policy. Likewise, existing law provides that costs incurred for fish and wildlife purposes are a national responsibility. Sediment control benefits also are considered to be of national value; however, existing law does not provide for an allocation of cost to that purpose. Allocations of costs to irrigation, municipal water supply, and power are returnable through revenues. All annual project costs for operation, maintenance, and replacement purposes are considered to be financed by the revenue producing functions.

As of July 1, 1949, a total of $336,000 has been spent on the investigation of the initial development of the Gunnison-Arkansas project, of which $200,000 has been general investigation funds and the remainder Colorado River development funds. The cost of investigations (expended from general investigation funds) is not specifically shown in the total estimated construction cost of the initial development. The percentages included in the estimate for investigations and engineering and administrative and general expense are considered adequate to cover the cost of those items including the investigations accomplished.

A number of methods of cost allocation were considered for application to the project. Among these were the equal apportionment method, the vendability method, the benefits method, the use of facilities method, and the alternative justifiable expenditure method. Analysis of those approaches indicates that all but the alternative justifiable expenditure method have serious limitations for application to the project.

The equal-apportionment method is essentially a rule of thumb since it divides joint costs equally among all of the project functions. The result, therefore, could not be supported by benefits or the costs of alternative single-purpose projects. The vendability method has wide application in private industry where commodities are priced in a

35002—53——9

competitive market. With the possible exception of power, however, the project purposes are not subjected to a competitive situation. Hence, this method is inappropriate. The benefits method is not defensible because the costs of alternative means of accomplishing the same benefits are not considered. The physical nature of the project is such that it would be difficult to apply the use-of-facilities method which is generally based on reservoir capacity or water release statistics.

The alternative justifiable expenditure method of cost allocation overcomes all of these objections and is the most appropriate for use. It is a version of the benefits method in that the costs of alternative single-purpose facilities or maximum justifiable investments, whichever are less, are taken as relative values of costs ascribable to the various project purposes. This method is based upon the estimated costs of the most economical substitute single-purpose facilities in the area which would provide benefits equivalent to those afforded in a multiple-purpose structure for each of the project purposes, such as power, irrigation, municipal water, and flood control. The joint costs of the multiple-purpose facilities are apportioned on the basis of the differences between the alternative justifiable expenditures for single-use facilities and the specific costs of facilities provided solely for each use in the multiple-purpose project. In the case of fish and wildlife conservation the allocation is limited to the cost of added and enlarged features specifically for this purpose in the western slope diversion area. The allocation of costs for the project are shown in the following table.

TABLE 14.—*Allocation of costs and apportionment of annual expenses*

Purpose	Alternative justifiable expenditure	Specific cost	Joint cost	Total allocation
Irrigation	$81,097,000	0	$59,930,000	$59,930,000
Municipal water	33,575,000	$18,050,000	11,472,000	29,522,000
Hydroelectric power	42,148,000	34,021,000	6,011,000	40,032,000
Flood control	21,347,000	0	15,777,000	[1] 15,777,000
Fish and wildlife [2]	2,179,000	2,179,000	0	2,179,000
Total	180,346,000	54,250,000	93,190,000	147,440,000
	Apportionment of annual operation, maintenance, and replacement expenses			
Irrigation		0	$76,080	$76,080
Municipal water		$391,580	13,490	405,070
Power		846,990	7,060	854,050
Total		1,238,570	96,630	1,335,200

[1] This amount is supportable also on the basis of Department of the Army policy which provides for capitalization of benefits (evaluated at current prices) at 3 percent interest for a 50-year period of analysis ($583,000 divided by annuity factor 0.0388655 equals $15,000,000).
[2] Allocation limited to added costs.

REVENUES

Of the total costs of $147,440,000 for the initial development, nonreimbursable construction costs of $17,956,000 allocated to flood control and fish and wildlife conservation represent only about 12 percent. The balance of $129,484,000 or approximately 88 percent of the total cost would be returned by revenues from power, municipal

water supply, and irrigation. Project finances are shown in detail in table 16.

The operating plan for the project irrigation and municipal water supply systems as envisioned in these studies involves the formation of a conservancy district in the benefited area. If the conservancy district should be limited to irrigation, the Government would deal with other entities for municipal water service. Project water would be delivered to the conservancy district or other entities at established basic rates per acre-foot within the payment capacity of the water users. The total annual revenues from irrigation and municipal water charges used in the financial studies are based on delivery of average quantities of water annually over the respective investment retirement periods. In the final analysis, however, annual revenues would depend upon the quantities of water actually delivered each year.

In addition to paying the charges for storage and delivery of project water, the conservancy district should levy an ad valorem tax on taxable property within its boundaries that would benefit from the initial development and pay the net proceeds of that tax to the Bureau. Revenues from the basic charges and the net proceeds from the ad valorem tax, together with power revenues assigned to irrigation costs, would be adequate to retire the construction costs allocated to irrigation and municipal water supplies and the annual operation, maintenance, and replacement charges associated therewith. It is estimated that the net proceeds from the conservancy district ad valorem tax would always be adequate to cover the annual operation, maintenance, and replacement expenses chargeable to irrigation.

The conservancy district would include all or parts of, but may not be limited to, the following counties: Lake, Chaffee, Fremont, Pueblo, Crowley, Otero, Bent, and Prowers. These counties contain most of the irrigated land along the Arkansas River in Colorado. The assessed valuation for those counties is shown on the following table:

TABLE 15.—*Assessed valuation, 1944*

County:	*Total county valuation*	County—Continued	*Total county valuation*
Bent	$10, 649, 000	Pueblo	$63, 921, 000
Crowley	5, 696, 000	Lake	25, 860, 000
Fremont	14, 047, 000	Chaffee	7, 247, 000
Otero	22, 918, 000		
Prowers	14, 973, 000	Total	165, 311, 000

NOTE.—Miscellaneous areas to receive general benefits may be added as experience dictates.

Although the total assessed valuation for the 8 counties is $165,311,000, parts of those counties may lie outside the boundary of the conservancy district. For that reason approximately 80 percent of the total or $132,249,000 has been used as representative of the valuation of those parts of the 8 counties and outlying areas which should be included within the district upon which a tax levy could be imposed. A 1-mill levy applied against the valuation of $132,249,000, less 10 percent for administrative costs of the conservancy district, would produce an annual revenue of approximately $119,000.

Of the total initial development construction cost allocated to irrigation, which amounts to $59,930,000, 82 percent, or $49,048,400, would be returned from project hydroelectric power and municipal water revenues and the balance of $10,881,600 would be returned by

the conservancy district during a period of 40 years. On the basis of average farm prices prevailing during the 6-year period, 1939 through 1944, it is estimated that the conservancy district would expect to collect, on the average, $229,120 annually as net irrigation revenues. Of this total, $204,120 would be obtained from the delivery of 56,700 acre-feet of supplemental irrigation water at $3.60 per acre-foot and $25,000 would come from a charge of $2 per acre-foot [1] on the net additional imported Twin Lakes water. In 40 years that annual return would retire a non-interest-bearing debt of $9,164,800. The ad valorem tax levy by the conservancy district would return an estimated $119,000 annually, but annual irrigation operation, maintenance, and replacement expenses of $76,080 would leave a balance in ad valorem tax receipts of $42,920. In 40 years that amount would retire a non-interest-bearing debt of $1,716,800. An additional charge will be collected from the water users who would receive the benefit of having winter water stored in project reservoirs and released to them during the irrigation season if an equitable value, determined after further study, could be agreed upon. This possible charge has not been considered in the analysis.

No development period for irrigation is deemed necessary as only supplemental water would be supplied in the initial development.

Gross annual municipal water supply revenues would total $1,484,410. This includes $405,070 for annual operation, maintenance, and replacement charges leaving net annual revenues of $1,079,340. A total net revenue of $43,173,600 would be obtained during a 40-year period which would retire the investment of $29,522,000 with interest at 2 percent and leave a surplus of $8,531 at the end of the 40th year. The annual operation, maintenance, and replacement costs of $405,070 consist of $13,490 attributable to the project water supply facilities and $391,580 associated with specific facilities of the municipal water distribution system.

Hydroelectric power revenues would retire a major part of all construction costs of the initial development. The annual sale of 370 million kilowatt-hours of firm energy and 97,125,000 kilowatt-hours of secondary energy at anticipated average rates of 5.5 mills and 3.5 mills, respectively, would provide a gross revenue of $2,374,938 each year after the last powerplant investment. Deductions for power operation, maintenance, and replacement expenses would leave an annual net revenue of $1,520,888, which would retire the $40,032,000 of project cost allocated to power with interest at 3 percent during a 50-year period and leave a surplus of $243,264 in the final year.

Application of municipal and industrial water and power interest components to that portion of irrigation costs which is beyond the ability of the irrigators to pay would retire in 38 years the $49,048,400 irrigation costs to be met by those revenues. Of that total, power revenues would pay $35,478,000 and municipal and industrial water revenues would pay $13,570,400.

At the end of the final year the earned cumulative surplus would amount to $251,795.

[1] $3.60 less operation, maintenance, and replacement costs on the diversion system now owned and operated by the Twin Lakes Reservoir & Canal Co.

EFFECTS OF POSSIBLE MODIFICATIONS

In the project plan every effort has been made to consider the optimum balance among project functions, maximum benefits over costs, and the best fulfillment of the needs of the project area. However, some changes in the project plan, prior to construction, involving functions not now authorized, modifications of the plans for municipal water supply, increased power production, or increased irrigation revenues are possible as they might be indicated by the emerging needs of the people to be served or because of changes in Federal and State laws and regulations.

Future authorization of an allocation to sediment control would amount to about $3½ million based upon the benefits accruing to that purpose. This allocation would effect decreases in the allocations of joint costs to other purposes. The decrease, however, while lowering the total amounts allocated to each of the other functions would be insufficient to have an appreciable effect on power or water-service rates or on the length of retirement periods.

If future recreation studies and investigations show a need for development of recreational facilities appurtenant to any of the project features, the addition of such facilities and an allocation of costs to this function would have only a slight effect upon project finances. Should any amount of joint costs be allocated to recreation, the retirement period would be shortened correspondingly.

Any reduction in scope in the plans for municipal water supply would tend to increase the allocations of water to other functions and result in a net loss in project revenues. However, additional irrigation revenues would be realized because of the change in use of water from municipal to irrigation purposes. The investment retirement periods for irrigation and power would be increased in proportion to the extent of any reduction in the scope of the plans for municipal water supply. Such modification would not have serious effects on project finances. To illustrate this point, the elimination of all municipal water supply from the project would lengthen irrigation and power retirement periods to only 60 years.

Nonparticipation in the project municipal water functions by the city of Colorado Springs would either increase the municipal water rates to other cities and communities or lengthen the retirement period for municipal water. Additional revenues would be realized from irrigation as a result of converting to irrigation use the municipal water intended for Colorado Springs but would not adversely affect the retirement periods for irrigation and power.

Elimination of branch pipelines to the communities of Crowley and Eads would have little effect upon project finances. The small amount of water allotted to those towns could be absorbed by other towns along the valley trunkline or its use converted to irrigation.

Should the cities of Colorado Springs and the Arkansas Valley towns choose to finance and construct the municipal water distribution system, consisting of the added facilities to deliver water into the Colorado Springs system, the filtration plant, and valley pipelines, either in whole or in part, the financial plan would not be seriously affected. If the entire distribution system were constructed by the local communities, it is probable that the retirement period for

irrigation would be lengthened to somewhat over 50 years because the assistance provided by municipal water revenues in the liquidation of irrigation costs would be reduced. Construction of only the purification plant by the local communities would not affect the retirement period. However, the interest component of municipal water revenues would be less and the use of more hydroelectric power revenues for liquidation of irrigation costs would be required.

The possibility of increased power revenues arising through the exchange of water via the Fryingpan diversion, Sugar Loaf and Twin Lakes Reservoirs in the interest of preserving fishery values, the provision of additional head at the Pueblo powerplant, and an exchange of energy with the Colorado Fuel & Iron Corp., as discussed in chapters III and VI, would reduce the retirement period for power and provide greater overall project revenues.

In the event the State laws are revised to permit charges for the use of return flows and to provide a basis for such charges, increased revenues from irrigation would be possible which would reduce the balance of irrigation costs to be retired by the interest components of municipal water and hydroelectric power revenues. The length of the irrigation retirement period, however, would not be affected.

If a service charge for the conservation of winter water should be agreed upon, it would increase irrigation revenues but would not shorten the retirement period.

Chapter XIV. Related Investigations

ACKNOWLEDGMENT

Various Federal agencies, each having an interest in the development of resources in the project area, have collaborated in the preparation of this report. The agencies have cooperated to the extent of available funds and personnel, and their comments or findings are either specifically included or reflected in this report.

Grateful acknowledgment is made of the cooperative assistance and contributions in time and effort rendered during the investigations and preparation of this report by the following: Corps of Engineers, Department of the Army; Geological Survey, National Park Service, Fish and Wildlife Service, and Bureau of Mines, Department of the Interior; Soil Conservation Service, Forest Service, Bureau of Agricultural Economics, Extension Service, and land-use coordinator, Department of Agriculture; Bureau of the Census and Weather Bureau, Department of Commerce; Federal Power Commission; Federal Land Bank of Wichita; Public Works Administration; Works Progress Administration; Civil Works Administration; Federal Emergency Relief Administration; Colorado Agricultural and Mechanical College; Rural Electrification Association; Isaac Walton League; Colorado Water Conservation Board; Colorado State Planning Commission; Colorado State Engineer's Office, including division irrigation engineers and district water commissioners; Colorado Game and Fish Commission; Colorado State Highway Department; Arkansas Valley Ditch Association; Water Development Association of Southeastern Colorado; Colorado River Water Conservation District; Uncompahgre Water Users' Association; several other Government, State, county, and civic organizations; and various railroads, corporations, municipalities, canal and irrigation companies, chambers of commerce, business establishments, farmers, ranchers, and individuals interested in project development.

GEOLOGICAL SURVEY

The Geological Survey has provided important information on streamflow and mapping throughout the area included in the project plan. Additional data on surface and groundwater and sedimentation which could be obtained by the Geological Survey would be useful in the operation of the potential Gunnison-Arkansas project. Maps, planometric and topographic, are urgently needed for further project investigations by the Bureau of Reclamation in the area. A comprehensive mapping program should be initiated by the Geological Survey in order that complete coverage of the area may be made. Investigations should be initiated to determine the nature and extent of the natural resources within the project area. Included in these studies should also be a determination of the location, character, and value of mineral properties.

NATIONAL PARK SERVICE

The National Park Service has made a preliminary investigation of the recreational aspects of the project. A condensation of its reconnaissance report is included in this substantiating report. It is important that these studies be continued to develop basic data necessary to keep this phase of the planning and development abreast of other activities.

FISH AND WILDLIFE SERVICE

The Fish and Wildlife Service has also carried out preliminary investigations of the project. Its preliminary statement and general recommendations are included in this report. A more detailed report is being prepared by the Fish and Wildlife Service.

Further study is required to determine the net effect on fish and wildlife of construction of the Aspen Reservoir and enlargement of the Sugar Loaf and Twin Lakes Reservoirs. Additional studies are also required to determine the effects of depleting the Arkansas River above Salida and increasing and regulating flows between Salida and Pueblo. The development of a small constant-level lake in the borrow-pit area below the potential Pueblo Dam and improvement of the old river channel through the city are further recreational possibilities that should be investigated before the overall effect of the project on fish and wildlife can be fully evaluated.

BUREAU OF MINES

The Bureau of Mines has reviewed earlier drafts of the report and has expressed the need for comprehensive studies to determine the potentiality of the mining industry in the project area which has produced roughly a billion dollars in gold, silver, lead, zinc, copper, and molybdenum, and is still considered one of the more important sources of minerals in the West. This Bureau has stated that the availability of ample low-cost electric energy would no doubt materially contribute to maintaining a thriving mining industry. A study and a report on the potentiality of the mining industry in the area should be completed for use in additional planning.

BUREAU OF LAND MANAGEMENT

The Bureau of Land Management and its predecessors, namely the Grazing Service and the General Land Office, have been participating in the process of collection of information on land patterns, classification of lands, and the performance of cadastral surveys on public lands. As the development of the project progresses, certain additional work by the Bureau of Land Management will be required. Classification of public lands affected by the project should be completed. Withdrawals in some cases will be necessary. Surveys by the Bureau of Land Management to establish the validity of mining claims will be important in the areas where rights-of-way are to be purchased for the construction of project features. This work should be done well in advance of the need for rights-of-way. The study factors affecting water production on adjacent public lands or in catchment areas contributing to project reservoirs are important.

DEPARTMENT OF AGRICULTURE

Department of Agriculture investigations of the project area were conducted by the Soil Conservation Service and by the Forest Service. The Soil Conservation Service has a major interest and responsibility in the project area through its watershed improvement program which would complement major flood-control works along the main streams to give the most complete protection that can be justified for the entire basin. It is also responsible for technical assistance to the soil conservation districts organized on the project lands. Snow surveys made by the Soil Conservation Service provide essential data for use in estimating streamflows. Many of the facilities and features of the potential Gunnison-Arkansas project will be located in the national forests and on withdrawn lands within the exterior boundaries of the national forests. Many of the various uses already authorized on those and adjacent lands may require adjustment. Watershed management on these forest lands is of great importance and will influence the useful life of the project. Full cooperation between the Forest Service and the Bureau of Reclamation is essential through all the stages of planning, development, and operation.

Experiences of these agencies reveal the vital importance of watershed development for conservation and the need for beneficial range management practices so that soil erosion will be retarded and vegetative cover will be improved. The accomplishment of these aims would, the Bureau believes, reduce sedimentation of streams and reservoirs, aid in regulation of runoff, reduce floods, and make available a more reliable and possibly increased water supply for irrigated agriculture. Further investigations in this field and development of this type of a conservation program are urgently needed in connection with the project plan.

FEDERAL POWER COMMISSION

The Federal Power Commission has been kept advised of power developments of the initial development during the investigations thereof and has been cooperative in reviewing earlier drafts of the report.

In order to determine the type and time schedule of power development best adapted to the needs of the area, the power potentialities, markets, and transmission system should be restudied concurrently with the progressive development of the project in conjunction with the Federal Power Commission.

CORPS OF ENGINEERS

The Corps of Engineers and the Bureau of Reclamation have cooperated closely in determining the relationship between flood and conservation regulation and in determining flood control and sediment-control benefits. The Corps of Engineers is one of the principal participants in the cooperative stream-gaging program which has been carried on in the project area. The work of the Corps of Engineers in that regard should be continued to provide an inventory of water resources for planning future development and for use in connection with current investigations. Further investigation of these

important elements must be continued and the results carefully considered in order that maximum benefits may be obtained from the project plan.

PUBLIC HEALTH SERVICE

The Public Health Service has made a reconnaissance survey and report on pollution conditions of the upper Arkansas River which has been made an appendix to this report. These studies supply the present needs of the Bureau of Reclamation; however, the additional stream-pollution studies proposed by the Public Health Service and the Colorado State Health Department under Public Law 845, 80th Congress, will be important in pointing out situations that should be corrected in order that those situations attributable to present practices and natural causes may not be eventually cataloged as the end products of reclamation development.

COSTS

The estimated costs for all of the foregoing investigations are included in the project estimate.

Chapter XV. The Comprehensive Plan

POSSIBLE FUTURE IMPORTATIONS

Possible ultimate plans for the full development of the upper Arkansas River Basin would call for the diversion of additional transmountain water to the Arkansas Valley. If current and future studies of within-basin project potentialities show that there is additional water in the Colorado River Basin available for export to the eastern slope, there are excellent opportunities for the use of such water within the Arkansas Basin in Colorado. The initial development could be expanded by diverting additional water from other tributaries of the Roaring Fork River and from the Gunnison River to the Arkansas River Basin.

In any plan for possible expansion the original features of the initial development would be retained. Those features, together with additional facilities for diversion and storage, could satisfy the supplemental needs of irrigated lands, provide water for the initial irrigation of thousands of acres of new land, fulfill the demands for municipal water, and generate large blocks of hydroelectric power. Orderly stage construction could be carried on in order to provide additional water and facilities progressively as justified by economic conditions.

GUNNISON DIVERSION

Potential reservoirs and powerplants on the Gunnison River, with appurtenant transmission lines and substations, are possible western-slope developments that could be integrated with other facilities of the plan for expansion of the initial development. Replacement storage, long-term or cyclic storage, power possibilities, and recreational considerations are among the many potent factors that should be investigated more fully.

Water could be diverted from Anthracite Creek and Crystal River and combined with the natural flows of the Slate and East Rivers to be carried by canal to a potential Almont Reservoir on Taylor River for regulation and diversion to the eastern slope. Hydroelectric power could be generated at the dam by uniform releases of water for downstream fish culture.

Diversions could also be made from Maroon, Castle, and Difficult Creeks and the water carried to the Taylor River where it could be regulated in the potentially enlarged Taylor Park Reservoir for transmountain diversion. Power could be developed from water released through a hydroelectric plant located at the bottom of a vertical shaft leading from that reservoir to a transmountain Gunnison-Arkansas tunnel.

A potential Gunnison-Arkansas tunnel, beginning at the Almont Reservoir, could transport water to a point near, but at an elevation about 800 feet below, the enlarged Taylor Park Reservoir. At that

location, water released through the Taylor Park powerplant and the combined flows could be carried through the Continental Divide to the eastern slope.

The diverted Gunnison Basin water could enter the then-existing Arkansas power canal constructed in the initial development. The power canal and other features could be enlarged as required to handle the additional water. A new water conduit system could be constructed from the Salida power plant to a potential Wellsville powerplant and possibly to potential powerplant sites on Texas Creek, at Webster Park, and the Canon City from whence the water could be returned to the Arkansas River.

Additional eastern-slope developments under an expanded plan might include enlargement of the Pueblo Reservoir, enlargement of the Horse Creek Reservoir north of Las Animas, construction of additional power-transmission facilities, and construction of additional main canals for the irrigation of new lands. Enlargement of the Skaguay Reservoir and construction of a pipeline could be undertaken for the purpose of obtaining additional municipal water for the city of Colorado Springs by exchange procedures. In order to provide additional municipal water to the Arkansas Valley towns below Pueblo, the capacity of the valley pipelines could be increased by installation of booster pumps.

Chapter XVI. Reports by Cooperating Agencies

Department of the Interior,
Fish and Wildlife Service,
Office of the Regional Director,
Albuquerque, N. Mex., January 25, 1950.

Mr. Avery A. Batson,
Regional Director, Region 7,
Bureau of Reclamation,
Denver 2, Colo.

Dear Mr. Batson: Pursuant to the verbal request of Mr. T. R. Swem of your staff, there is furnished herein a preliminary statement of our findings to date covering the fish and wildlife aspects of the potential Gunnison-Arkansas project, initial phase. This statement, according to Mr. Swem, is needed for inclusion in a project report now being prepared by your Pueblo, Colo., area office.

It has been agreed that this statement would be considered of a purely temporary nature, pending completion of a standard Fish and Wildlife Service report, and would not include monetary values. It would merely discuss the probable effects of the project on fish and wildlife resources in much the same manner as had already been presented to the State of Colorado policy and review committee, Gunnison-Arkansas project. Accordingly, the following paragraphs contain a discussion and summary of the findings of this Service with regard to the initial phase of the Gunnison-Arkansas project, but it should be emphasized that pending approval of a Service report by the Director, Fish and Wildlife Service, this statement must be considered as preliminary and subject to change at some later date.

1. From the Special Report, Initial Development, Gunnison-Arkansas Project, Colorado, dated September 1949, it is understood that the project would be comprised of the following major features:

(*a*) A replacement and storage reservoir on the western slope (Colorado Basin) to be known as Aspen Reservoir, located on Roaring Fork River about 1 mile above the town of Aspen, Colo.

(*b*) A system of tunnels and cut and cover conduits, extending from the Fryingpan River to Lime Creek on the north and to the headwaters of Hunter Creek (Roaring Fork watershed) on the south, to intercept the runoff of the upper Fryingpan River and its tributaries and Hunter Creek for diversion to the eastern slope (Arkansas Basin).

(*c*) A transmountain diversion tunnel through the Continental Divide about 6 miles in length, extending from a point on Fryingpan River at elevation 10,000 feet to elevation 9,908 feet on the Lake Fork of the Arkansas River about 3½ miles above existing Sugar Loaf Reservoir (Turquoise Lake).

(*d*) A storage reservoir on Lake Fork of the Arkansas River to be known as Sugar Loaf Reservoir, to be formed by enlargement of existing Turquoise Lake, a reservoir controlled by the Colorado Fuel & Iron Corp.

(*e*) A diversion dam on the Arkansas River at Snowden about 5 miles southwest of Leadville to divert water by means of a canal, 10 miles in length, to Twin Lakes.

(*f*) Twin Lakes Reservoir (now controlled by Twin Lakes Reservoir & Canal Co.) to be enlarged to a capacity sufficient to store the water diverted from the Fryingpan and Roaring Fork watersheds on the western slope as well as excess water available in the Arkansas River at Snowden. The reservoir would also be used to aid in balancing the demands for power and irrigation.

(*g*) A terminal storage and distribution reservoir to be known as the Pueblo Reservoir located on the Arkansas River 6 miles west of Pueblo, Colo.

(*h*) A power system, to be known as the upper Arkansas Valley power system, consisting of 60 miles of power canals along the west side of the Arkansas Valley between Turquoise Lake and Salida, diversion structures, 7 hydroelectric powerplants, 8 substations, and 347 miles of transmission lines.

2. Aspen Reservoir would have a storage capacity of 28,000 acre-feet of water and would inundate approximately 3½ miles of the Roaring Fork River at normal high pool. We have no knowledge of the proposed operation of Aspen Reservoir as yet, except that it would store water for replacement of demands at Aspen and other future downstream demands as they may develop.

3. Aspen Reservoir would appear to have sufficient capacity over and above present needs to assure a relatively high and constant pool elevation, but it cannot be evaluated until an operation plan is available. This plan would need to be correlated with maintenance of adequate streamflows to protect fish and wildlife in Roaring Fork River downstream from Aspen Reservoir.

4. It has been recommended by this Service, at regional level, that the following schedule of minimum streamflows be preserved at the head of Aspen Reservoir:

Month	Average second-feet flow	Acre-feet (1,000)	Month	Average second-feet flow	Acre-feet (1,000)
October	44	2.7	May	100	6.2
November	35	2.1	June	120	7.1
December	29	1.8	July	100	6.2
January	26	1.6	August	63	3.5
February	25	1.4	September	44	2.6
March	24	1.5			
April	64	3.5	Total		40.9

5. These minimum flows represent quantities below which, at particular seasons of the year specified, damage would accrue to the fish and wildlife values of the streams involved. Therefore, whenever the inflow at the points of diversion by the Twin Lakes Reservoir & Canal Co. from Roaring Fork River and its tributaries shall be equal to or less than that needed to maintain the recommended minimum flows at the head of Aspen Reservoir, no diversions to the eastern slope from the Roaring Fork or its tributaries should be made.

6. These minimum flows should also be allowed to flow below Aspen Reservoir. According to Bureau of Reclamation studies, the average annual runoff at Aspen was 95,700 acre-feet during the years 1931–44,

a period of less than normal streamflow. Present Bureau plans would deplete the Roaring Fork at Aspen by an average 44,000 acre-feet annually. Our recommended streamflows below Aspen would require an average of less than 40,900 acre-feet, since recommended minimums would not be maintained in years of less than average natural runoff. But assuming a demand of 40,900 acre-feet for fish and wildlife below Aspen Reservoir there would still remain an average of 10,800 acre-feet annually available for storage in that reservoir.

7. In order that recommended flows at the head of Aspen Reservoir may be maintained to the extent that they would naturally occur in the normal runoff of Roaring Fork River and its tributaries above Aspen Reservoir, it would be necessary that the Twin Lakes Canal & Reservoir Co. agree to refrain from diverting water through its collection system at such times as the natural flow of the Roaring Fork River and its tributaries may be insufficient to maintain more than the stipulated minimum flows at the head of the reservoir.

8. It is recognized that the company has a legal right to divert up to 504 (tentatively, 621) second-feet without regard to time or total quantity other than to protect existing rights on the western slope. Should the company agree to forego diversions at such time as the result would be detrimental to fish and wildlife resources on the Roaring Fork River and its tributaries, it appears that the amount of water which they might have diverted under such conditions could be made available to them in exchange by means of added diversions through the Fryingpan collection system.

9. The Fryingpan collection system would permit the average annual diversion of 69,200 acre-feet from the headwater streams of the Fryingpan watershed and from Hunter Creek. The system would be extended to include Last Chance Creek and Lime Creek, tributaries of Fryingpan River. Diversions from Lime Creek would be limited to the flood months of May and June. The divertable flow indicated above would be in excess of these recommended by this Service for fish and wildlife preservation, which are as follows:

[Second-feet]

Month	At points of diversion	Near Norrie, below junction with North Fork
October–March, inclusive	15	30
April	30	100
May	30	150
June	30	200
July	30	100
August	30	75
September	30	65

10. It will be noted that the above flows deviate from the recommendations presented in a letter to Area Engineer Powell from Acting Regional Director K. C. Kartchner, dated September 9, 1949, in which the Fish and Wildlife Service recommended a flow of 125 second-feet in Fryingpan River below the North Fork in July and 100 second-feet in August. This matter was resolved in conference at Glenwood Springs, October 31, 1949, upon Mr. Powell's statement suggesting flow of 100 and 75 second-feet, respectively, and advising

representatives of this Service that it appeared physically impossible for the project to secure the amount of water required and still maintain flows in Fryingpan River of 125 second-feet in July and 100 second-feet in August.

11. The Service agreed to the change on the basis that the flows suggested by Mr. Powell give reasonable assurance of preserving fishery values and are acceptable at this stage of project planning. It should be understood, however, that the Service regards all such recommendations as preliminary in nature, as they would naturally be considering the type of report being prepared. Such matters should be investigated in detail by the Fish and Wildlife Service and the Colorado Game and Fish Commission at such time as it may become necessary for your office to prepare a definite plan report.

12. To provide a supply of water which might be exchanged with the Twin Lakes Canal & Reservoir Co., as explained in paragraph 8 above, the Bureau of Reclamation has planned to extend the collection conduit from Hunter Creek to the South Fork of Hunter Creek and to enlarge the Fryingpan-Arkansas tunnel at an estimated increase in the total cost amounting to $2,179,000. We feel that this cost could be properly allocated to fish and wildlife preservation, since it would be introduced solely to prevent loss of and damage to fish and wildlife resources on the Roaring Fork River and its tributaries.

13. Unless preconstruction planning, drafting of plans and specifications, and supervision during construction all reflect a mindfulness of the value of natural resources, much of the good resulting from maintenance of the recommended streamflows may be nullified. Consequently, this Service and the Colorado Game and Fish Commission would like to be consulted regarding construction details insofar as these might affect fish and wildlife resources, which would include the number and location of access roads, alternative methods where cut and cover conduit might do irreparable damage, location and treatment of borrow pits and spoil-disposal areas, location of construction camps, and other matters of similar nature.

14. The enlargement of Turquoise Lake, Twin Lakes, and the proposed operation of Clear Creek Reservoir would result in lowered fishery values at all three sites. All three are open to public use for fishing, although they are privately owned. Turquoise Lake could be a much better fish producer under proper biological management. It is little used by fishermen due to the fact that it is overrun with suckers. The other two reservoirs, however, sustain an important recreational fishery. Historically, fluctuations of Twin Lakes and Turquoise Lake have averaged about 11 feet, annually. Under the proposed plan of operation, Sugar Loaf (Turquoise Lake, enlarged) and the enlarged Twin Lakes Reservoir would have had an average annual fluctuation of 56 feet and 36 feet, respectively, during a period such as from 1930 to 1941. The results of more recent studies show an average annual fluctuation of 65 feet for Sugar Loaf and 21 feet for Twin Lakes in the period from 1921 to 1944. Clear Creek Reservoir would fluctuate about 20 feet weekly in connection with its use as an afterbay for Granite powerplant. There would be a further detrimental effect upon Twin Lakes Reservoir through the operation of Snowden Canal if that canal should divert below California Gulch, source of mine-tailing pollution in the Leadville area. It is recom-

mended that the heading for the Snowden Canal be made above the confluence of California Gulch and the Arkansas River.

15. Pueblo Reservoir would be located on the Arkansas River about 6 miles west of Pueblo, Colo. The location is in arid short-grass prairie. Tree growth consists of a good stand of large cottonwoods along the main river bottom and scattered patches of pinion-juniper woodland on the hills. The reservoir basin is deeply incised by tributary gullies entering the main stream. Weather bluffs of shale and limestone form the sides of the main valley and its tributaries. The reservoir would have an average annual fluctuation of 75 feet, based upon water supply studies from 1921 to 1944. This, together with the general unattractiveness of the site and the barren nature of the soils, does not indicate much possibility for development of an important fishery. It is possible that a small borrow-pit pond, as at John Martin Reservoir, would have far more value for fishing than the main reservoir. Wildlife values at this site would probably be small, because of location and operating conditions.

16. Of particular importance in connection with project reservoirs and to varying degrees in connection with other project features, is the assurance of full public access to all areas where recreational use may develop, excepting locations where special considerations regarding operation of the project would not permit. Since the program of land acquisition in connection with a project such as this and future policy in regard to use of lands acquired but not permanently inundated are so closely connected with assurance of public access and derivation of maximum fish and wildlife values, it is further recommended that provision be made for the Colorado Game and Fish Commission and the Fish and Wildlife Service to cooperate in the formulation of plans for land acquisition prior to the initiation of such a program in connection with any of the project features.

17. Flows of the Arkansas River would be drastically modified in the reach between Snowden diversion and the Salida powerplant. A comparison of natural versus proposed flows is presented in the following tabulation:

Location	Flow in second-feet					
	Average winter flow			Average August flow		
	Natural flow	Proposed flow	Percent residual	Natural flow	Proposed flow	Percent residual
Between Salida and Lake Creek	39	29	75	104	29	28
Between Lake Creek and Granite gage	70	65	92	400	65	16
Between Granite gage and Wapaco	108	70	64	476	70	15
Between Wapaco and Cottonwood Creek	108	65	60	476	65	14
Between Cottonwood Creek and Chalk Creek	130	82	63	519	106	20
Between Chalk Creek and Salida powerplant	144	95	65	522	151	29

18. The value of the river above Salida would be reduced through decrease in aquatic habitat. At the same time, the fishing pressure on the smaller stream remaining might be expected to increase for a time, at least, but at the expense of the residual population of game and fish. Thus, the State Game and Fish Commission and very likely

the Fish and Wildlife Service would find themselves burdened with the difficult job of trying to maintain good fishing through artificial stocking. Growing fish in hatcheries is expensive.

19. The river below Salida powerplant would present a condition in which winter flows would be more than double average natural winter flows, or 544 compared to 212 second-feet. This does not necessarily represent an unfavorable condition. But during the summer, when average flows normally decrease in volume from 970 second-feet in July, 673 in August, 351 in September, and 304 in October, flows with the project would be as follows: July, 735; August, 670; September, 628; and October, 616 second-feet. This is significant when it is understood that most fishing use now occurs when streamflows begin to decrease after the middle of August. It is believed that the attractiveness of this reach of the river would decline under the proposed with-the-project conditions.

20. The project would supply about two-thirds of the supplemental water requirements for 322,000 acres of inadequately irrigated land in the Arkansas Valley. At present these lands provide habitat for waterfowl, fur animals, and upland game birds. Whether the net effect of this project would be favorable or unfavorable in this area is difficult to predict on the basis of present investigations. It appears that benefits and losses might be so nearly balanced in the irrigated area as to be negligible. It is possible that means of increasing benefits through proper management measures in connection with the project might be possible, however, and this matter is being made the subject of further investigations.

This is, we repeat, a preliminary statement, but we trust it will meet your present needs. There are many matters of lesser importance which have not been discussed herein. They will be included in our forthcoming report. There are also further possible, although less probable, means of preventing loss, particularly in connection with the Arkansas Basin developments. These will also be further investigated.

We appreciate the cooperation that you and your staff continue to show in these matters of mutual interest, and it is our hope that the progress made will, in the final analysis, prove to be no less real than apparent.

Very truly yours,

JOHN C. GATLIN,
Regional Director.

SUMMARY OF REVISED RECREATIONAL RECONNAISSANCE REPORT GUNNISON-ARKANSAS TRANSMOUNTAIN DIVERSION PROJECT COLORADO DECEMBER 1949 COVERING INITIAL DEVELOPMENT ONLY

Prepared by
NATIONAL PARK SERVICE
REGION 2
DEPARTMENT OF THE INTERIOR
FOR
BUREAU OF RECLAMATION
REGION 7
DENVER, COLO.
JANUARY 1950

SUMMARY OF REVISED RECREATIONAL RECONNAISSANCE REPORT, GUNNISON-ARKANSAS TRANSMOUNTAIN DIVERSION PROJECT, COVERING INITIAL DEVELOPMENT ONLY, COLORADO, JANUARY 1950

A memorandum of understanding between the Bureau of Reclamation and the National Park Service with reference to recreational surveys on the proposed Gunnison-Arkansas project was entered into December 12, 1946.

The Reconnaissance Report, Recreational Use and Development, Gunnison-Arkansas Transmountain Diversion project, Colorado, was distributed under date of May 1948. A revision of this report was required because of subsequent changes made in Bureau of Reclamation project proposals. This revision entitled "Revised Recreational Reconnaissance Report, Gunnison-Arkansas Transmountain Diversion Project" was completed and distributed in December 1949. The following analysis summarizes the broader aspects of the revised report.

The Gunnison-Arkansas project, as now planned by the Bureau of Reclamation, consists of the initial development and other possible additional expansions. The Bureau of Reclamation is seeking authorization of this first phase of development only at this time since it is reported to have had sufficient study to support its economic feasibility from the standpoint of irrigation and power. Consequently, this summary covers only the initial development proposal.

The next possible phase, maximum gravity diversion, is being investigated further by the Bureau of Reclamation and is discussed briefly in the revised recreational reconnaissance report.

It is the intent of the revised recreational reconnaissance report to present the findings, formulate conclusions, and to offer suggestions for the protection and preservation of important natural, scenic, historic, and scientific features in the project area.

The initial development proposal is placed under two headings to facilitate the recreational analysis: (1) the western slope covering that portion of the project which is located west of the Continental Divide, and (2) the eastern slope, covering that portion which is located east of the Continental Divide.

I. WESTERN SLOPE

The project area is located in the southern portion of Colorado within the boundary of the White River National Forest. The proposed diversion works are situated entirely within the high mountains and plateau region, adjacent to the divide, at elevations averaging 10,000 feet. They involve the collection of water in the upper reaches of the watersheds of Fryingpan River and Hunter Creek, tributaries of the Roaring Fork River, and diversion to the Arkansas River Valley through the Continental Divide for the production of power and for irrigation.

The Fryingpan region is distinguished by a series of high forested ridges, intervening tributary canyons, typical mountain meadows, and rushing streams. Although the area is attractive scenically, it does not possess any noteworthy, outstanding, or unique features in this respect. However, the combination of such qualities as scenic attractiveness, wilderness character, remoteness, and the excellence of its waters for fishing makes it an important natural recreational area. Access into this region is provided by State Road No. 104 which follows the main stem of the Fryingpan River to the upper reaches of its watershed. Along this road are located several guest ranches, cabin camps, and lodges which depend on attractions of the Fryingpan area for support. Two Forest Service campgrounds and a colony of summer homes are also situated along the stream adjacent to the road. However, the greater part of the upper Fryingpan region is accessible only by trails. This is apparently a reason that the upper drainage area has remained in its present natural state.

Residents of Colorado rely on the excellence of the fishing and hunting resources of the Fryingpan area for vacation and weekend activities, and indications are that an increasing number of vacationists are being attracted to this area. It is estimated by the Fish and Wildlife Service that approximately 18,500 fisherman-days are spent annually along the 62 miles of the Fryingpan River below the proposed diversion system and that big-game hunting in the project area on the western slope involves 10,000 hunter-days. It appears that the region of the upper tributaries of the Fryingpan and Roaring Fork River watersheds is one of the few remaining natural areas in the Colorado Rockies, except those incorporated in the wilderness areas or national parks, which has not been invaded by the development of roads, mines, or other installations to the extent of impairing its natural character. Although the actual size of the potential diversion area is only about 50,000 acres, it is of sufficient importance recreationally and scenically to warrant protection of these resources.

The installation and operation of project facilities such as tunnels, conduits, construction roads, work camps, utilities, etc., as now planned for the diversion of western-slope waters to the Arkansas River Valley would impair the natural qualities of this region by marring the scenic and esthetic character of the landscape and by depleting streamflows.

The site of the other project feature on the western slope is Aspen Reservoir located on the lower Roaring Fork River about 1 mile above the town of Aspen, a highly developed recreational and resort center. No important or unique recreational opportunities or scenic qualities exist within the impoundment area.

The value of this proposed reservoir for recreation is questionable and cannot be appraised fully until the final operational schedule is available. In any event, it appears that recreational development would be costly. However, the expenditure of funds for development may be justified by demand because of the location of the reservoir in relation to the town of Aspen.

Although it is realized that the demands of our expanding economy are complex and that needs for irrigation, hydroelectric power, and municipal water supplies may be great, it is also essential to preserve the recreational and scenic qualities of the project area while still utilizing its resources commercially.

Accordingly, it is recommended if the project is authorized that such authorization provide the necessary safeguards to these recreational and scenic resources in that final planning and execution of construction work be undertaken in cooperation with the National Park Service and with the Forest Service in the areas in which the latter, as administering agency, is concerned.

In order to preserve noteworthy scenic values, tunnels should be substituted for cut and cover conduits wherever economically feasible in the potential diversion areas since the installation of this latter facility requires considerable surface excavating and grading that would be detrimental to the natural character of the terrain.

The location of spoil material from tunnels should be determined as accurately as possible prior to construction operations so as to effect the least possible damage to the existing landscape.

Wherever new roads are necessary for access into the construction areas for installation of diversion facilities, such routes should be held to minimum number, and the standard road section should be held to minimum width to reduce construction scars. Consideration should be given to one-way routes with occasional turnouts.

The project plan should outline the length and locations of new roads required for construction purposes. Prior to installation of diversion facilities in the Fryingpan River-Hunter Creek areas, a review should be made on the number of such access routes that will be necessary for postproject operations and maintenance. All such roads not needed further should be closed or obliterated upon termination of construction activities.

Fish and Wildlife Service requirements for minimum flows of the Fryingpan River and Hunter Creek should be sustained in order to preserve fishery values and protect the natural scenic aspects of the streams.

There should be close cooperation with the National Park Service and the Forest Service in planning and locating access roads, construction campsites, permanent buildings, borrow pits, canals, and powerlines, and the disposition of spoil material from tunnels, conduits, etc., since they have a definite bearing on existing recreational and scenic values.

No important historic features were found within the immediate areas of the proposed diversion in the Fryingpan-Hunter Creek area nor within the proposed Aspen Reservoir site. Also, although extensive studies have not been made, it is not anticipated that any important archeological, paleontological, and geological features lie in the western slope project area.

However, the Bureau of Reclamation should notify the National Park Service of any historic, archeologic, or other scientific features worthy of preservation which it may discover within the proposed construction sites in this area.

II. EASTERN SLOPE

The upper Arkansas Valley, in the project area from Leadville to Salida, possesses outstanding scenic values, mainly because of the backdrop provided by the rugged peaks and ranges of the Continental Divide on its western flank. The valley itself would not be particularly important scenically without this spectacular background.

The upper Arkansas River is not particularly attractive as it is laden with mine-tailings sediment. Part of the land is within the boundaries of the San Isabel National Forest and is generally devoted to ranching and mining activities.

Recreational opportunities are present at a few artificial lakes in the upper valley region between Leadville and Buena Vista, but the greatest attractions lie in the mountain lakes, streams, and forests above the valley. Existing reservoirs at Twin Lakes and Turquoise Lake, both scheduled for enlargement in the initial development, provide recreation advantages for the immediate region. The water surface of each lake is fairly stable, as fluctuations average not more than 10 to 12 feet annually. Twin Lakes is developed as a small fishing resort. It is estimated that approximately 8,000 to 9,000 visitor-days annually are spent there. Of this number 6,600 are fisherman-days. Turquoise Lake is used mostly by summer-home occupants. Of its total use, about 600 visitor-days annually are devoted to fishing.

Clear Creek Reservoir just north of Buena Vista in the Arkansas River Valley is scheduled for use as a powerplant afterbay. The water content of the pool has been quite unstable in the past. Recreationally, it is used chiefly for fishing, an estimated 2,600 fisherman-days being spent here annually.

The lower portion of the Arkansas Valley, which stretches over the Great Plains from Pueblo to the Colorado-Kansas State line, is devoted chiefly to agriculture. Steel plants, iron foundries, and agricultural processing plants are located in some of the principal cities. This section of the valley has no particular value when analyzed from a scenic and recreational standpoint. There are several existing reservoirs in this region, but in general they are not suitable for recreational purposes because of wide fluctuations of pool contents and salinity of the waters.

There appears to be a need for developed recreational areas associated with water bodies in the plains region, particularly from Pueblo eastward, as such opportunities are limited at the present time. Residents of this area now have to travel to the mountains for suitable recreation. The proposed Pueblo Reservoir, located about 8 miles west of the city of Pueblo, offers a site in desirable relationship to a concentrated portion of valley population.

In general, project construction involving canals, tunnels, and powerplants would not materially affect the scenic qualities of the upper Arkansas River Valley. However, in a few instances, the proposed power canal in the vicinity of Wapaco and on the ridge above Brown's Canyon, together with the diversion canal between Snowden and Twin Lakes in the locations now planned, would create severe construction disturbances as viewed from the heavily traveled valley routes, highways U. S. 285 and 24.

The proposed enlargements of existing Twin Lakes and Turquoise Lake (Sugarloaf Reservoir) to larger reservoirs would serve no added purpose recreationally. Exchanging two existing lakes, both with small annual fluctuations of water surfaces averaging about 11 feet annually for larger bodies of water with greater fluctuations yearly (Sugarloaf 56 feet and Twin Lakes 36 feet) and with wide variations of water levels from year to year, will add no recreational advantages. Trading two lake areas, on which recreational uses and developments have been established and which are still capable of further expansion,

for larger reservoirs with less potential fishery values and on which facilities would have to be developed does not appear warranted from the recreational standpoint. Consequently, no recreational benefits would be gained by enlarging the present reservoirs.

Clear Creek Reservoir is to be utilized at its present capacity as an afterbay for a potential powerplant. Although future operations of the reservoir may provide a rather unstable pool, its value recreationally may not be materially impaired since the present irregular operational pattern has not been conducive to recreational use other than fishing. No recreational development exists, and none appears to be warranted in the future.

From data now available on the proposed Pueblo Reservoir, it appears that the vertical fluctuation of the pool annually and the anticipated wide variance of water levels from year to year will not be favorable to recreational use or the establishment of planned facilities.

The installation of the potential power-transmission system extending from Pueblo through the upper Arkansas River Valley and over the Continental Divide to Dillon may cause considerable damage to the scenic resources of the region, and studies should be made to determine its best location in relation to these values.

Further study should be made by the Bureau of Reclamation of the proposed operations of the potential Pueblo Reservoir and of reservoir enlargement at Twin Lakes and Turquoise Lake in order to effect a more stable pool in each case during the recreational season. Operations showing less annual fluctuation would reflect more favorably on potential recreational values.

In the interests of preserving scenic values in the upper Arkansas River Valley, the Bureau of Reclamation should exercise extreme care in planning the locations of the following proposed canals so that unsightly construction scars may be minimized.

(1) Johnson to Salida powerplant sites
(2) Wapaco powerplant site to Clear Creek Reservoir
(3) Wapaco powerplant site to a point approximately 2 miles south
(4) Snowden diversion canal

Locations of the potential power-transmission system extending from Dillon through the Arkansas River Valley to Pueblo should be studied in the field with the National Park Service prior to preparation of final construction plans.

Noteworthy historic features in the project area include the townsites of Dayton and Interlaken and the existing town of Twin Lakes at the Twin Lakes Reservoir site; the abandoned Colorado & Midland Railroad grade and appurtenances within the Sugarloaf Reservoir site; and the Goodnight Ranch and various ghost towns and railroad stations relating to the historic Santa Fe and the Denver & Rio Grande Railroads at the Pueblo Reservoir site. In addition, the whole project area is lined by vital historic associations with the early eras of exploration, fur trading, gold mining, and the railroad boom.

All of the reservoir sites indicated have sufficient historic interest to warrant recognition of final development plans, perhaps in the form of historical markers. Excavation of historic sites or relocation of historic structures in no case appears to be sufficiently justifiable to warrant the expenditure of funds. However, it is desirable that a

complete pictorial record of the historic sites and settings be obtained through photography.

Prehistoric and historic Indian sites are numerous through the lower Arkansas Valley, but, with the exception of one small campsite in the Pueblo Reservoir site, none are known to occur in the proposed reservoirs or other project areas. However, the entire Pueblo Reservoir has not as yet been adequately surveyed, and future work may reveal additional sites that might require further attention.

The proposed areas along the upper Arkansas River from Leadville to Salida, including Sugarloaf, Twin Lakes, and Clear Lake, have not as yet been surveyed. However, it is not anticipated that there will be any important sites located here that will be affected by project construction. Some additional survey and possible limited testing will be done in Pueblo Reservoir by the department of anthropology of the University of Denver.

Although no known fossil exposures exist in any of the proposed project areas, it is possible that such might be uncovered during certain of the construction activities, and it is suggested that a close watch be kept during construction and that the Smithsonian Institution or National Park Service be notified if any fossil remains are discovered.

The following are National Park Service recommendations that apply to the entire initial development proposal.

> Sufficient land should be acquired by the Bureau of Reclamation at each reservoir to allow for any recreational activities that may develop. In addition, adequate land should be obtained for proper control of the shoreline at full pool and for a reasonable distance back from the shoreline to allow for passage of the public around the pool except in areas not open to the public for reasons pertaining to operations or other project functions.
>
> Any recreational activities that may develop at the reservoirs should be administered by the Bureau of Reclamation or the governmental agency responsible for the adjoining or adjacent lands.
>
> In clearing of trees at reservoir, care should be taken to hold the clearingline as near the normal waterline as possible and consistent with the operation of the reservoirs.

More detailed discussions of the recreational aspects of the project proposals are set forth in the revised recreational reconnaissance report.

III. GENERAL

The project area in its present state is more valuable recreationally and scenically than it would be if the project were completed. It possesses certain intangible values that are far greater than those that can be estimated in monetary terms. Therefore, it is considered highly conjectural and impractical under the circumstances to present a monetary estimate covering losses and gains that would accrue from project construction. However, some of the losses might be minimized by application of certain protective measures described above.

RUSSELL L. MCKNOWN,
Acting Chief Recreation Planner.

COMMENTS, GOVERNOR OF ARIZONA

OFFICE OF THE GOVERNOR,
STATEHOUSE,
Phoenix, Ariz., August 28, 1951.

Mr. MICHAEL STRAUS,
Commissioner of Reclamation,
Department of the Interior,
Washington 25, D. C.

DEAR MR. STRAUS: At my request the Arizona Interstate Stream Commission examined your project planning report No. 7–8a.49–1 on the initial development of the Gunnison-Arkansas project, Roaring Fork diversion, Colorado.

I have received their comments, which I hereby adopt as the official comments of the State of Arizona, and enclose herewith copy of their letter.

Sincerely yours,

HOWARD PYLE, *Governor.*

ARIZONA INTERSTATE STREAM COMMISSION,
Phoenix, Ariz., August 28, 1951.

Hon. HOWARD PYLE,
Governor of Arizona,
Statehouse, Phoenix, Ariz.

DEAR GOVERNOR PYLE: We have examined project planning report No. 7–8a.49–1 of the Department of the Interior, Bureau of Reclamation, region 7, on the initial development of the Gunnison-Arkansas project, Roaring Fork diversion in Colorado.

We have not attempted any detailed analysis of engineering features or financial studies, but have concerned ourselves solely with the question of the diversion of 69,000 acre-feet of water from the headwaters of the Roaring Fork River to the Arkansas River Basin.

That quantity of water falls clearly within the right of the State of Colorado to the use of Colorado River water as agreed in the upper Colorado River Basin compact.

The State of Arizona, of course, is not concerned where water is used within the State of Colorado so long as it is within the share of that State. Accordingly, we have no objection to the subject report or the diversion of the quantity of water indicated above.

Respectfully yours,

WAYNE M. AKIN, *Chairman.*
RAY KILLIAN, *Secretary.*

COMMENTS, CALIFORNIA DEPARTMENT OF PUBLIC WORKS

STATE OF CALIFORNIA,
DEPARTMENT OF PUBLIC WORKS,
Sacramento, August 27, 1951.

Hon. OSCAR L. CHAPMAN,
Secretary of the Interior,
Washington, D. C.

MY DEAR MR. SECRETARY: Your proposed report on the initial development (Roaring Fork diversion), of the potential Gunnison-Arkansas project, Colorado, dated May 4, 1951, was received on May 15, 1951, and on May 16 was transmitted to the division of water resources of this department for review and report thereon. On May 17, the State engineer, chief of the division of water resources, forwarded copies of the report to the Colorado River Board of California for consideration by that board.

The report of the State engineer has been received and is transmitted herewith in accordance with the provisions of Public Law 534, 78th Congress, 2d session. Also transmitted herewith for your consideration are the comments of the Colorado River Board of California.

I concur in the comments of the State engineer and request that they be considered as expressing the views and recommendations of the State of California on your proposed report on initial development (Roaring Fork diversion) Gunnison-Arkansas project, Colorado. It is further respectfully requested that the report of the State engineer, dated August 27, 1951, and the comments of the Colorado River Board of California on this subject be transmitted to the President of the United States and to the Congress along with the other material that may be so transmitted.

Very truly yours,

FRANK B. DURKEE,
Director of Public Works.

STATEMENT OF THE STATE OF CALIFORNIA ON PROPOSED REPORT OF THE SECRETARY OF THE INTERIOR ENTITLED INITIAL DEVELOPMENT, ROARING FORK DIVERSION, GUNNISON-ARKANSAS PROJECT, COLORADO

INTRODUCTION

The Commissioner of Reclamation by letter, dated May 8, 1951, transmitted to the director of public works, for the views and recommendations of the State of California the proposed report of the Secretary of the Interior on the initial development (Roaring Fork diversion), Gunnison-Arkansas project, Colorado (project planning report No. 7–8a.49–1), approved and adopted by the Secretary on May 4, 1951.

The report was received in the office of the director of public works on May 15, 1951, and referred on May 16, 1951, to the State engineer, who is the chief of the division of water resources, for review and report. On May 17, 1951, two copies of the report of the Secretary of the Interior were transmitted by the State engineer to the Colorado River Board of California for comment.

The proposed report of the Secretary of the Interior comprises (*a*) a letter, dated April 16, 1951, from the Commissioner of Recla-

mation to the Secretary of the Interior, approved and adopted by the Secretary of the Interior on May 4, 1951; (*b*) report of the regional director, region 7, United States Bureau of Reclamation, dated July 5, 1950, and revised February 23, 1951; and (*c*) a substantiating report, including reports by cooperating agencies.

The proposed initial development (Roaring Fork diversion) is a feature of the potential Gunnison-Arkansas project, a major unit in the comprehensive plan of development of the water resources of the upper Arkansas River Basin. The initial development is a multipurpose project involving the diversion of water at elevation 8,100 feet from the Roaring Fork, a tributary of the Colorado, to the Arkansas River, a tributary of the Mississippi River.

The features of the project of the initial development as set forth in the proposed report of the Secretary of the Interior, comprise the following:

(*a*) A system of about 50 miles of canals and tunnels on the western slope of the Continental Divide for the collection of water from Hunter Creek and Fryingpan River, tributaries of the Roaring Fork River.

(*b*) Aspen Reservoir, with an active capacity of 28,000 acre-feet near the town of Aspen on the western slope to provide replacement water and water for future use in meeting the demands in western Colorado.

(*c*) The Fryingpan-Arkansas tunnel, about 6 miles in length, for diverting water collected on the western slope to the eastern slope.

(*d*) The Sugar Loaf Reservoir on the eastern slope of the upper Arkansas Basin, enlarged from its present capacity of 17,000 acre-feet to 117,000 acre-feet for storage and regulation of water imported from the western slope.

(*e*) The Snowden diversion dam on the Arkansas River above Snowden, Colo., and the Snowden diversion canal which would convey water from the Arkansas River to the enlarged Twin Lakes Reservoir.

(*f*) The Twin Lakes Reservoir in the upper Arkansas Basin, a few miles south of Snowden, Colo., enlarged from its present active capacity of 56,000-acre feet to 260,000 acre-feet, for storage and regulation of water imported from the western slope by the Fryingpan-Arkansas diversion, water imported by existing Twin Lakes diversion, and water diverted from the Arkansas River by the Snowden Canal.

(*g*) The Pueblo Reservoir on the Arkansas River west of Pueblo, Colo., with a capacity of 400,000 acre-feet to store water for irrigation and municipal use and for flood control.

(*h*) A project power system comprising 60 miles of canals, 7 powerplants having an installed capacity of 104,800 kilowatts, 7 switchyards, 9 substations, and about 400 miles of transmission lines.

(*i*) Specific municipal water supply facilities for furnishing additional municipal water to Colorado Springs, Pueblo, and several Arkansas Valley towns, which supply facilities would be constructed by the United States only after construction by the communities themselves proves infeasible.

The total capital cost of the project is given in the report under review as $147,440,000 on the basis of October 1949 prices.

The capital cost of the Roaring Fork diversion features alone, taken from exhibit 7 of the substantiating report, are as follows:

Replacement Reservoir, Aspen, 28,000 acre-feet	$6, 746, 000
Hunter Creek-Aspen Canal, 200 second-feet	190, 000
Hunter Creek extension canal	280, 000
Fryingpan collection system	20, 427, 000
Fryingpan-Arkansas divide tunnel	8, 839, 000
Total	36, 482, 000

The annual water supply diverted is given in the report under review as 69,200 acre-feet.

The annual cost of operation and maintenance including reserves for replacement, and the net annual revenues are given in the report

as $1,335,200 and $2,872,300, respectively. The nonreimbursable costs are allocated in the report at $17,956,000 and the reimbursable costs at $129,484,000. Of the latter figure, $59,930,000 is allocated to irrigation but the probable repayment by irrigation is reduced to $10,881,600 through the application of interest ($49,048,400) on the power and municipal water investments. The latter figure $49,048,400 represents about 38 percent of the total reimbursable cost.

In the report, the capital cost allocated to power is $40,032,000, comprising a direct cost of $34,021,000 and a joint cost of $6,011,000. The average annual energy output and revenue anticipated from the project are estimated in the report at 370 million kilowatt-hours at 5.5 mills, amounting to $2,035,000, and 97,125,000 kilowatt-hours at 3.5 mills, amounting to $340,000, or a total of $2,375,000. The annual cost estimated on the bases of interest at 3 percent, repayment in 50 years on a 3 percent sinking-fund basis, and operation and maintenance and replacement, as shown in the report under review at $854,000, is $2,410,000, which is slightly larger than the estimated annual revenue.

The proposed report of the Secretary of the Interior finds the initial development of the Gunnison-Arkansas project has engineering feasibility, is economically justified and financially feasible, and concurs in and adopts the recommendations of the regional director.

COMMENTS

The proposed report of the Secretary of the Interior, including the report of the regional director and the substantiating report thereof, has been reviewed and carefully considered within the time limitations permitted by the Flood Control Act of 1944 (Public Law 534, 78th Cong., 2d sess.).

As result of this review and study, the following comments are respectfully submitted:

1. It is the policy of the State of California to favor full development of the waters of the Colorado River system which have been apportioned to the upper basin under the Colorado River compact and beneficial utilization thereof in accord with the provisions of that compact and related documents and laws.

2. The primary interest of the State of California in the initial development (Roaring Fork diversion) of the potential Gunnison-Arkansas project is that in its construction and operation, California will receive its due apportionment of the waters of the Colorado River system as provided for in the Colorado River compact and related documents and laws.

3. The State of California favors congressional authorization of the initial development (Roaring Fork diversion) of the Gunnison-Arkansas project and the construction with Federal funds consistent with the national welfare (*a*) if the project qualifies under criteria, policies and procedures established by the Congress, and (*b*) if the diversion and utilization of the waters of the Colorado River system by and through the project works will not impair the rights of the State of California or any of its agencies to the waters of that system as defined and set forth in the Colorado River compact and related documents and

laws, or will not adversely affect the quality of such waters to which California has rights.

4. If the project is authorized by the Congress, the State of California concurs in the recommendation of the regional director that suitable language be included in the authorizing document clearly stating that authorization or appropriation of funds for the project or for the continued investigations shall not in any way constitute a commitment, real or implied, to further importations from the Colorado River system to the Mississippi River Basin.

Appended for your consideration are the comments of the Colorado River Board of California.

Submitted by:

A. D. EDMONSTON,
State Engineer.

SACRAMENTO, CALIF., *August 27, 1951.*

LOS ANGELES, CALIF., *August 2, 1951.*

INTERDEPARTMENTAL COMMUNICATION

To: Mr. A. D. Edmonston, State Engineer, Division of Water Resources, Public Works Building, Post Office Box 1079, Sacramento 5, Calif.

From: Colorado River Board of California, 315 South Broadway.

Subject: Review of Federal report; Gunnison-Arkansas project, Roaring Fork diversion.

Reference is made to letter, dated May 8, 1951, from the Commissioner of Reclamation to the Hon. Charles H. Purcell, director of public works, State of California, transmitting in accordance with the requirements of the Flood Control Act of 1944, copies of the proposed report of the Department of the Interior on the initial development (Roaring Fork diversion), Gunnison-Arkansas project, Colorado, Project Planning Report No. 7–8a.49–1, for information and such comments as the State might wish to make.

By interdepartmental communication, dated May 17, 1951, you transmitted copies of that report to this office with the request that comments be furnished for incorporation in a report to be submitted by the director of public works. In response thereto, the Colorado River Board of California presents the following comments, which were approved at its regular meeting on August 1, 1951, with the request that they be incorporated in or transmitted with the report of the director of public works.

COMMENTS OF COLORADO RIVER BOARD OF CALIFORNIA

1. The report under review contemplates diversions from tributaries of Roaring Fork Branch of the Colorado River through a transmountain tunnel to the Arkansas River Basin. It proposes an average consumptive use of 90,100 acre-feet a year. This quantity is apparently within the entitlement of the State of Colorado under the upper basin compact, and would be unlikely to have an important physical effect on the water supply of the lower basin. It is indicated, however, by the title of the report, and otherwise, that the Roaring

Fork diversion is only an initial stage of the potential Gunnison-Arkansas project which would involve exportation of a relatively large quantity of Colorado River water, possibly as much as 900,000 acre-feet a year, or more (H. Doc. 419, 80th Cong., 1st sess.) and appropriation of funds for continued investigation of such extended project is recommenced by the regional director. Exportation of large quantities of pure snow water from the headwaters of the Colorado River would likely have serious adverse effect upon the quality of Colorado River water available to the lower basin under the Colorado River compact. The compact intends that the lower basin receive water which is usable. It is believed that before the project is authorized, adequate studies should be made to determine the effect of all anticipated transmountain diversions from the Colorado River upon the quality of water thereafter available to the lower basin.

Should the project be authorized by the Congress, the legislation should, as recommended by the regional director, include suitable language stating that the authorization constitutes no commitment, real or implied, to further exportation of water from the Colorado River system.

2. The Colorado River compact limits use of Colorado River water to the seven Colorado River Basin States. With exportation of any large quantity of Colorado River water to the Arkansas River, substantial return flows to the Arkansas may be experienced. Any authorization of the project should require adequate assurances from the State of Colorado that the water exported to the Arkansas will be consumptively used in Colorado, i. e., that it will not permit the flow of the Arkansas River at the Colorado-Kansas State line to be augmented by return flows from the Colorado River water.

3. The report assumes or implies the correctness of certain interpretations of the Colorado River compact with which California does not agree. If Congress approves the construction of the project it should make it clear that it does not approve nor disapprove any such interpretations of the Colorado River compact.

4. The financial plan of the project depends upon the use of the interest component of power and municipal revenues to pay a major portion of the irrigation construction costs. Such use of the interest component is based upon an opinion of the Solicitor of the Department of the Interior in 1944, which has not been approved by the Congress and is believed to be contrary to law. It is also in conflict with the report of the President's Water Resources Policy Commission submitted to the President in December 1950. The report of the Commission is likely to receive consideration during the current Congress.

As respects the use of the interest component, term of repayment, and other matters of general policy, Congress should first reach its conclusions upon the report of the President's Commission, and then apply them in the authorization of such a project as the one under review. For a statement of California's position on this subject, reference is made to the views of the State of California on elements of a national water resources policy submitted to the President's Water Resources Policy Commission dated June 1950.

COLORADO RIVER BOARD OF CALIFORNIA,
By RAYMOND MATTHEW, *Chief Engineer.*

COMMENTS, COLORADO WATER CONSERVATION BOARD

OFFICIAL COMMENTS AND RECOMMENDATIONS OF THE STATE OF COLORADO ON THE INITIAL DEVELOPMENT, GUNNISON-ARKANSAS PROJECT, ROARING FORK DIVERSION, COLORADO

(Project Planning Report No. 7–8a.49–1, Bureau of Reclamation, Department of the Interior, dated January 1950)

AUGUST 7, 1951.

The SECRETARY OF THE INTERIOR.

SIR: On behalf of the State of Colorado and pursuant to section 1 of the act of December 17, 1944 (58 Stat. 887), there are herewith transmitted the comments, views, and recommendations of the State of Colorado concerning the initial development of the Gunnison-Arkansas project, Roaring Fork diversion, being Project Planning Report No. 7–8a.49–1, Bureau of Reclamation, Department of the Interior, dated January 1950.

These comments, views and recommendations are submitted under the authority of chapter 265, Session Laws of Colorado, 1937, creating the Colorado Water Conservation Board, and defining its functions in accordance with the designation of such board by the Governor of the State of Colorado pursuant to section 1 of the act of December 17, 1944 (58 Stat. 887), as the official State agency to act in such matters.

The comments, views, and recommendations of Colorado submitted herewith are as follows:

1. Colorado recognizes that the waters of the Arkansas River in the Colorado portion of the upper Arkansas River Basin are overappropriated and that serious loss in crop production on presently irrigated farmland results. Stabilized agricultural economy in the area requires supplemental water supplies. Additional quantity and better quality of domestic and municipal water are critically needed in the Arkansas Valley, Colo., for the cities of Colorado Springs, Pueblo and various valley towns. New sources must be found if necessary and dependable water supplies for a growing population are to be provided. The best economy and the most efficient use of limited sources of water require multiple-use project development which will serve the needs of agriculture, requirements for domestic and municipal water supplies, flood control, the preservation of recreational and fish and wildlife values and the production of hydroelectric power. Neither further retirement of presently irrigated land to meet necessary and pressing municipal requirements for water nor project development designed to serve a single purpose would be consonant with the most desirable economic advancement of Colorado, or with the highest utilization of its limited water supplies.

2. Colorado concurs in the findings of the project report that the project described therein is engineeringly feasible, economically justified, and financially feasible, and that the proposed plan for the payment of reimbursable capital costs is in accordance with the Federal reclamation law.

3. The allocation of capital costs as between the various project features, including a nonreimbursable allocation to flood control and fish and wildlife preservation, is considered reasonable.

35002—53——11

4. It is recognized that the allocation to the various project purposes of annual operation, maintenance and replacement costs has been made to correspond to the allocation of capital costs. Colorado recommends that an authorization of the project shall not preclude a readjustment of operation, maintenance, and replacement charges as between municipal and domestic users and power and irrigation users which might more accurately reflect the actual use of water by said users.

5. It is also recommended that the authorization of the project include the valley pipeline as referred to in said report for the use and benefit of the various valley towns.

6. Colorado calls attention to the fact that the project, its operation, maintenance and the use of Colorado River water thereunder, must be subject to the provisions of the Colorado River compact of November 24, 1922 (H. Doc. 605, 67th Cong., 4th sess.), the upper Colorado River Basin compact of October 11, 1948 (Public Law 37, 81st Cong., 1st sess.), and the Boulder Canyon Project Act of December 21, 1928 (45 Stat. 1057–1064). Further reference to this matter appears in these comments in connection with the subject of operating principles. The features of the project and their operation for the storage and reregulation of the native waters of the Arkansas River are subject to the provisions of the Arkansas River compact of December 14, 1948 (Public Law 82, 81st Cong., 1st sess.) between Colorado and Kansas. On July 24, 1951, the Arkansas River Compact Administration, an agency created by the compact for its administration, after a review of the project report and consideration of the effect of the operation of the proposed project on the administration of the provisions of the compact, adopted the following resolution:

Whereas there has been submitted to the States of Colorado and Kansas by the Secretary of the Interior, in accordance with provisions of section 1 of the 1944 Flood Control Act, a report of the Bureau of Reclamation on the proposed initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado (Project Planning Report No. 7–8a.49–1), and such States are required to transmit to the Secretary of the Interior their respective official comments and recommendations on the report and proposed development; and

Whereas the Arkansas River Compact Administration, an official interstate body created by the Arkansas River compact and charged with the administration of such compact, is interested in the proposed development to the extent that its construction and operation shall not interfere with the rights, interests, and obligations of Colorado and Kansas under the compact: Now be it

Resolved by the Arkansas River Compact Administration, That the following comments and recommendations relating to said report of the Secretary of the Interior, to wit:

The Arkansas River Compact Administration submits these comments and recommendations to the Governors of Colorado and Kansas respecting the proposed initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado, namely:

1. The administration understands that the project plan proposes:

(*a*) The importation by appropriate project works of approximately 70,000 acre-feet of water a year from the Colorado River Basin to the Arkansas River Basin for supplemental irrigation and domestic water supplies in Colorado and for the production of hydroelectric energy.

(*b*) In connection with such importation of water and its regulation in the Arkansas River Valley by project works, the reregulation of native waters of the Arkansas River (the term "native water," as herein used, being those waters covered and defined by art. III–B of the Arkansas River compact).

2. The interstate water relations of Colorado and Kansas with respect to the Arkansas River do not justify any objection to the proposed project

development for the importation of Colorado River water (described in subpar. (*a*) above).

3. The reregulation of native waters of the Arkansas River (native waters being as above mentioned) concerns the Arkansas River Compact Administration and both Colorado and Kansas in complying with the provisions of the Arkansas River compact and maintaining the benefits and obligations of the two States under that compact. To that end, it is recommended to the Governors of Colorado and Kansas, and expressed as a policy of the Arkansas River Compact Administration, that the initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado, as set forth in Project Planning Report No. 7–8a.49–1 of the Bureau of Reclamation, be approved: *Provided, however,* That there shall be no reregulation of native waters of the Arkansas River as proposed in such report until a plan of operation, rules, regulations, procedures, and agreements in furtherance thereof, including any pertinent agreements between the Corps of Engineers and the Bureau of Reclamation, shall have been submitted to, and approved by, the Arkansas River Compact Administration and the affected water users.

4. It is the purpose and intent of these recommendations that the proposed project development shall not interfere with or defeat the rights, interests, and obligations of Colorado and Kansas under the Arkansas River compact.

be transmitted to the Governors of the States of Colorado and Kansas and such Governors be and are hereby requested to submit the same to the Secretary of Interior with their official State comments and recommendations upon said proposed project and development.

Colorado interprets and understands that paragraph 3 of the resolution of the Arkansas River Compact Administration is controlled by paragraph 4 thereof: and that the words "affected water users" in said paragraph 3 mean only water users in the State of Colorado so long as Colorado complies with the terms of said compact.

7. Paragraph 74, pages 36 to 39, both inclusive, under the heading "Operating Principles," contains the operating principles which the report explains were recommended by a policy and review committee set up by the Colorado Water Conservation Board to study and review plans and reports on the first stage of the Gunnison-Arkansas project. This committee was composed of representatives of the board, the Colorado Game and Fish Commission, western Colorado, the Arkansas Valley, and the city of Colorado Springs. The report fails to explain that such committee was required to report to the Colorado Water Conservation Board and its recommendations would not be effective until approved by that board. The report on the project does not disclose what action was taken by the board nor does it contain all of the recommendations of the policy and review committee. Some of the matters contained in the report of the committee are not strictly concerned with project operation, but are related to, and constitute a material part of, such operating principles.

The recommendations of the policy and review committee were revised and approved by the Colorado Water Conservation Board on February 22, 1951. (See letter with attachments of the director of the Colorado Water Conservation Board, dated February 27, 1951, and addressed to the director of region 7, Bureau of Reclamation.) Paragraph 74, pages 36 to 39, both inclusive, of the report correctly sets forth that part of the report of the policy and review committee designated "Article II: Operating Principles," as revised and approved by the Colorado Water Conservation Board, but it omits other material portions of the committee's report as revised and approved by the board, namely:

The action of the policy and review committee will be presented to the Colorado Water Conservation Board for such action as the board deems proper.

The action of the Colorado Water Conservation Board will be incorporated in the official comments of the State of Colorado, made pursuant to section 1 of the 1944 Flood Control Act.

The authorization of the project will recognize the operating principles approved by the Colorado Water Conservation Board.

Prior to commencement of project construction, the following conditions precedent must be satisfied.

(*a*) There will be executed a payment contract between the Eastern Colorado Conservancy District and the United States in which will be incorporated the approved operating principles.

(*b*) There will be executed such contract with the Twin Lakes Reservoir & Canal Co. as is necessary to make effective the approved operating principles.

(*c*) The Eastern Colorado Conservancy District will firmly bind itself to the operation of the project in accordance with the approved operating principles.

It is recommended that this project shall hereafter be referred to as the Fryingpan-Arkansas project. Approval of this provision by eastern Colorado representatives shall not be implied as an abandonment of their expressed intention to obtain approval of a project from the Gunnison River nor shall approval of this provision by western Colorado representatives be construed as any consent on their part to the authorization of a project for the exportation of water from the Gunnison River to eastern Colorado.

The committee recognizes that the approval of this report is not to serve as a precedent or example for the approval of any other transmountain diversion of major proportions not heretofore authorized.

The policy of the State of Colorado as initiated in statewide meetings held under the auspices of the State planning commission at Denver and Grand Junction, and as evidenced by resolutions, dated June 15, 1935, and February 28, 1936, was not adhered to because surveys of the character mentioned in said resolutions were not available to the committee. Nothing herein contained shall be deemed or construed as a precedent for Federal projects not heretofore authorized until adequate surveys have been made and the necessary data are available so that a general allocation or apportionment of the waters of the Colorado River, allocated for consumptive use in the State of Colorado, under the upper Colorado River Basin compact, may be made between eastern Colorado and western Colorado, as distinguished from an attempt to execute such State policy by a piecemeal or series of partial allocations, any of which may seriously interfere with a complete, overall State program.

Paragraph 88 of the report under the heading "Recommendations," states:

E. The project be operated under the direction of the Secretary of the Interior in accordance with the operating principles set forth in this report or as principles may be modified in the future by agreement between the Secretary and the commission established by the State of Colorado.

It is understood that the operating principles, mentioned in this quotation from the report, are those set forth in paragraph 74, pages 36 to 39, both inclusive, and that the "commission" mentioned therein is the commission which may be created in the manner and for the purpose set forth in paragraph 17 of the operating principles. (See p. 39 of the report.)

Colorado's approval of the plans set out in the report and of the authorization of the project is conditioned upon compliance with the operating principles set forth in the report (see par. 74, pp. 36 to 39, both inclusive) and also full recognition and compliance with those portions of the policy and review committee's report, as revised and approved by the Colorado Water Conservation Board, which are omitted from the report and which are hereinabove set out; except that as to the name of the project, it is recommended and urged that in an appropriate manner the project should hereafter be known and

referred to as the "Fryingpan-Arkansas project." It is noted from the letter of the Commissioner of Reclamation to the Secretary of the Interior, contained in the report, that it is stated:

> This development is designed as a self-contained unit, and its construction would not imply a commitment for developing future water supplies in the Gunnison River Basin for diversion to the Arkansas River Basin.

Colorado approves this statement but such a statement lends weight to the reason for changing the name of the project as herein recommended. Diversion from the Fryingpan River to the Arkansas has no relation to the Gunnison River. It is not proposed under this "self contained" project to divert water to the Arkansas Basin from the Gunnison River. The identification of the project on the cover of the report and used throughout the report—"Initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado"—is a misnomer and misleading, and in the future may, in some manner, lead to unwarranted implications. In addition to the recommended change in project identification, Colorado requests that the project be authorized as the "Fryingpan-Arkansas project."

8. The Colorado River Water Conservation District is an agency created by State statute (ch. 20, p. 997, Session Laws of Colorado, 1937) for the conservation, use, and development of the water resources of the Colorado River and its principal tributaries. The area comprised within the district includes 7 counties and a part of an eighth county within the natural drainage of the Colorado River in western Colorado. The Southwestern Water Conservation District is an agency created by State statute (ch. 231, p. 866, Session Laws of Colorado, 1941) for the conservation, use, and development of the water resources of the San Juan and Dolores Rivers and their principal tributaries. The district comprises 7 counties and a part of an eighth county within the natural basin of the Colorado River in western Colorado. When the board of directors of each of the two districts passed upon the report and recommendations of the policy and review committee, including the operating principles, as revised, their separate resolutions, among other things, contained the following language:

COLORADO RIVER WATER CONSERVATION DISTRICT BOARD

> *Be it further resolved*, That in the opinion of the board of directors of the Colorado River Water Conservation District, the Colorado Water Conservation Board should adopt a resolution that no further federally financed transmountain diversions from the natural Colorado River Basin should be approved for authorization until the surveys described in said section IV above are completed and the need for the use of water in western Colorado has been determined.

(Sec. IV, to which reference is made, is shown by the two paragraphs contained in the report of the policy and review committee, quoted on page 160 of these comments, and commencing with the words "The committee recognizes" and "The policy of the State," respectively.)

SOUTHWESTERN WATER CONSERVATION DISTRICT BOARD

> * * * this board feels it should interpose no objection to the proposed diversion, but with the clear and distinct understanding this consent shall not be considered as waiver of objections to any other federally financed transmountain diversion of the waters of the Colorado River; and with the further understanding that the State Water Conservation Board of the State of Colorado shall not approve of any other such federally financed diversion project until the studies

of the needs of the western slope be fully completed so that an intelligent decision relative to such needs may be given. We feel that after the many and long delays in making such studies and the promises made by some high in authority in the Reclamation Service, the western slope is entitled to have such studies completed in the very near future, and that no further federally financed transmountain diversions should be made without the completion of such investigations.

At the meeting of the Colorado Water Conservation Board on February 22, 1951, when the revised report of the policy and review committee, including revised operating principles for this project, was approved by the Colorado Water Conservation Board, the board unanimously approved two motions which provided that the resolutions, above mentioned and partially quoted, submitted by the Colorado River Water Conservation District and the Southwestern Water Conservation District be accepted and approved as a policy of the Colorado Water Conservation Board.

9. Paragraph 68 commencing on page 33 states:

The proposed basic rate of $3.60 per acre-foot at the Pueblo Reservoir has been determined to be within the payment capacity of the water users.

It is respectfully requested that such proposed charge should not constitute either a maximum or a minimum charge nor should it indicate a uniform charge or indicate where water will be used or whether or not consideration in fixing charges can be given to return flows from such use. The figure is purely an estimated average charge per acre-foot and the district in allocating such water should be allowed complete latitude in connection therewith.

10. Paragraph 68 as contained on page 33 has the following sentence:

The district would assume responsibility for delivery of irrigation water.

This responsibility is certainly not that of the United States, but neither should the district be responsible for patrolling every ditch. If water is turned out from the reservoir, it is immediately subject to the control of the State water officials, who should be advised of such rights in water and who are charged with the responsibility of delivering the same to the correct ditch. It is contemplated that each ditch will do its own policing.

11. Attention is directed to paragraph 68 on page 33 and the sentence reading:

This district or possibly another entity would contract with the Government for Federal construction of the specific municipal water system * * *.

It is contemplated that a proper repayment entity under Colorado laws such as a metropolitan water district may be created for this particular purpose or that a joint contract executed between the various municipalities utilizing this feature will be executed and the project's authorization should be sufficiently broad to authorize any such contract deemed desirable.

12. Page 34 in the tabulation on function and source of revenue contains the following:

District tax ($132 million at 1 mill minus 10 percent)	$119,000

Attention is directed to the fact that under Colorado law, 3 possible rates are in existence; one-half of 1 mill, being the rate prior to delivery of project water; 1 mill, being the rate after such project water becomes available, and prior to the time of any deficiency or default;

and 1½ mills in the event of default or deficiency; levies in any of these 3 categories may be less but cannot exceed these figures.

13. Attention is directed to page 34, the item captioned "Municipal and Industrial Water, Municipal Supplies (38,000 Acre-Feet at Various Rates)." It is respectfully pointed out that it may be some years before this amount of water is utilized and that the quantity indicated is but an estimate which may be exceeded ultimately. The authorization of the project should not preclude the possibility of charging municipalities lower rates during the period of time that such water is not actually required for the municipal needs. Pueblo might ultimately require 10,000 acre-feet and desire at the outset to commit herself for the immediate purchase of 5,000 acre-feet. Until such time as she actually requires 10,000 acre-feet of water, she should not be charged therewith at the proposed rates. The project authorization should permit charging lower rates until the water is used for municipal purposes.

14. Attention is directed to paragraph 70 on page 35. It is respectfully suggested that the report makes no reference to potential evaporation savings by moving shallow plains storage reservoirs upstream and storing the same quantities of water at higher altitudes.

15. Attention is directed to a statement at the top of page 42, reading:

> Such contracts should include provisions for the right or renewal thereof once or more than once under stated terms and conditions mutually agreeable to the parties and subject to increase or decrease in rates corresponding to increase or decrease of cost of construction and of operation, maintenance, or improvement or deterioration in the payment ability of the water users.

This sentence must be reconciled with the existing Colorado law which is set forth in chapter 266 of the Session Laws of Colorado 1937, being section 19 thereof, which requires the petition for allocation of water filed by the water user and addressed to the conservancy district to contain therein the charge to be imposed for each acre-foot of water. The statute requires the petition to contain the following: (1) Name of applicant, (2) quantity of water to be purchased or otherwise acquired, (3) descriptions of lands upon which the water will be used and attached, (4) price per acre-foot to be paid, (5) whether payments will be made in cash or annual installments, (6) agreement that the annual installments and the charges for maintenance and operating shall become a tax lien upon the lands for which such water is petitioned and allotted and to be bound by the provisions of this act and the rules and regulations of the board. While it was contemplated initially that the price per acre-foot would be fixed, such as, in the case of the Colorado-Big Thompson project, $1.50 per acre-foot, it is believed that this statutory provision can be complied with by stating the price per acre-foot shall be not less than $ nor more than $.

Respectfully submitted,

DAN THORNTON,
Governor, State of Colorado and Ex Officio Chairman of the Colorado Water Conservation Board.

CLIFFORD H. STONE,
Director, Colorado Water Conservation Board.

COMMENTS, GOVERNOR OF KANSAS

STATE OF KANSAS,
OFFICE OF THE GOVERNOR,
Topeka, August 2, 1951.

Hon. OSCAR L. CHAPMAN,
Secretary of the Interior,
Department of the Interior,
Washington, D. C.

DEAR MR. SECRETARY: Enclosed herewith is a resolution adopted by the Colorado-Kansas Arkansas River Compact Administration. As attorney general of Kansas, I served on the compact commission of these two States which drafted a workable compact now being successfully administered by the present compact administration composed of representatives of both States and Gen. Hans Kramer as a representative of the United States.

That administrative agency, by the enclosed resolution, presents its recommendations. As Governor of Kansas I have also received the recommendations of my special advisory committee, and they are in accord with the enclosed resolution, as are my personal convictions resulting from my own knowledge of and experience with the overall Arkansas River project.

Kansas has no objection to the development of the proposed Gunnison-Arkansas project as set forth in Project Planning Report No. 7–8a.49–1 of the Bureau of Reclamation. However, we in Kansas would oppose any attempt for this development to interfere with the rights, interests and obligations of Colorado or Kansas under their Arkansas River compact.

That is to say, we in Kansas would object only to any reregulation of native waters of the Arkansas River Basin until such time as it could be definitely determined that reregulation of native waters would not be detrimental to Kansas or to interstate water relations between Kansas and Colorado.

We assume, of course, that no such attempt at reregulation would be made or desired without a meeting of the two States and the United States after the completion of the project.

Sincerely,

EDWARD F. ARN, *Governor.*

RESOLUTION

Whereas there has been submitted to the States of Colorado and Kansas by the Secretary of the Interior, in accordance with the provisions of section 1 of the 1944 Flood Control Act, a report of the Bureau of Reclamation on the proposed initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado (Project Planning Report No. 7–8a.49–1), and such States are required to transmit to the Secretary of the Interior their respective official comments and recommendations on the report and proposed development; and

Whereas the Arkansas River Compact Administration, an official interstate body created by the Arkansas River compact charged with the administration of such compact, is interested in the proposed development to the extent that its construction and operations shall not interfere with the rights, interests, and obligations of Colorado and Kansas under the compact: Now be it

Resolved by the Arkansas River Compact Administration, That the following comments and recommendations relating to said report of the Secretary of the Interior, to wit:

The Arkansas River Compact Administration submits these comments and recommendations to the Governors of Colorado and Kansas respecting the

proposed initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado, namely:

1. The administration understands that the project plan proposes:

(*a*) The importation by appropriate project works of approximately 70,000 acre-feet of water a year from the Colorado River Basin to the Arkansas River Basin for supplemental irrigation and domestic water supplies in Colorado and for the production of hydroelectric energy.

(*b*) In connection with such importation of water and its regulation in the Arkansas River Valley by project works, the reregulation of native waters of the Arkansas River (the term "native waters," as herein used, being those waters covered and defined by art. 111–B of the Arkansas River compact).

2. The interstate water relations of Colorado and Kansas with respect to the Arkansas River do not justify any objection to the proposed project development for the importation of Colorado River water (described in subpar. (*a*) above).

3. The reregulation of native waters of the Arkansas River (native waters being as above mentioned) concerns the Arkansas River Compact Administration and both Colorado and Kansas in complying with the provisions of the Arkansas River compact and maintaining the benefits and obligations of the two States under that compact. To that end, it is recommended to the Governors of Colorado and Kansas, and expressed as a policy of the Arkansas River Compact Administration, that the initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado, as set forth in Project Planning Report No. 7–8a.49–1 of the Bureau of Reclamation, be approved: *Provided, however,* That there shall be no reregulation of native waters of the Arkansas River as proposed in such report until a plan of operation, rules, regulations, procedures, and agreements in furtherance thereof, including any pertinent agreements between the Corps of Engineers and the Bureau of Reclamation, shall have been submitted to, and approved by, the Arkansas River Compact Administration and the affected water users.

4. It is the purpose and intent of these recommendations that the proposed project development shall not interfere with or defeat the rights, interests, and obligations of Colorado and Kansas under the Arkansas River compact.

be transmitted to the Governors of the States of Colorado and Kansas and such Governors be and are hereby requested to submit the same to the Secretary of the Interior with their official State comments and recommendations upon said proposed project and development.

The foregoing is a true and correct copy of the resolution adopted by the Arkansas River Compact Administration at its meeting of July 24, 1951, at Lamar, Colo.

HARRY C. NEVIUS,
Secretary.

COMMENTS, UTAH STATE ENGINEER

THE STATE OF UTAH,
OFFICE OF STATE ENGINEER,
Salt Lake City, June 5, 1951.

Re Gunnison-Arkansas Project, Project Planning Report No. 7–8a.49–1, January 1950.

SECRETARY OF THE INTERIOR,
Department of the Interior, Bureau of Reclamation,
Washington, D. C.
(Attention: Michael Straus, Commissioner.)

DEAR SIR: This will acknowledge receipt of your letter dated May 8, 1951, and two copies of the Department of the Interior's proposed report on the initial development (Roaring Fork diversion), Gunnison-Arkansas project, identified as Project Planning Report No. 7–8a.49–1, January 1950.

35002—53——12

Pursuant to your request for views and recommendations, will state that Utah makes no adverse recommendations or comments with respect to the approval, authorization, or construction of this project.

Sincerely yours,

JOSEPH M. TRACY,
State Engineer.

COMMENTS, WYOMING NATURAL RESOURCES BOARD

STATE OF WYOMING,
WYOMING NATURAL RESOURCE BOARD,
Cheyenne, June 11, 1951.

Mr. MICHAEL W. STRAUS,
Commissioner, United States Bureau of Reclamation,
Washington, D. C.

DEAR MR. STRAUS: This will acknowledge receipt of your letter of May 8, 1951, and accompanying report of the Bureau of Reclamation on the Gunnison-Arkansas project, Roaring Fork diversion, Colorado.

Agreeable to your request I have reviewed the above-captioned report and offer comments thereon as follows:

1. The project appears to be feasible inasmuch as it is estimated to provide benefits of approximately 1¾ times the cost.

2. That the water proposed to be diverted from the Colorado River watershed is well within the allocation of Colorado under the terms of the upper Colorado River compact.

In view of the foregoing I can see no reason why Wyoming should oppose construction of the Gunnison-Arkansas project as proposed in the report of the Bureau of Reclamation dated January 1950.

Respectfully submitted.

L. C. BISHOP,
Director, Wyoming Natural Resource Board.
J. ELMER BROCK,
President, Wyoming Natural Resource Board.

COMMENTS, CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, September 26, 1951.

Hon. MICHAEL W. STRAUS,
Commissioner of Reclamation, Bureau of Reclamation,
Department of the Interior, Washington, D. C.

DEAR MR. STRAUS: Reference is made to your letters of May 8, 1951, to the Secretary of the Army and to the Chief of Engineers, enclosing copies of your report dated January 1950 on the initial development, Gunnison-Arkansas project, Roaring Fork diversion, Colorado, for the information and comments of the Department of the Army, in accordance with section 1 of the Flood Control Act of 1944. I have been directed by the Secretary of the Army to furnish you the views of the Department of the Army on your report. You state in your letter to the Secretary of the Army that your report will

be sent to the President and to the Congress under provisions of section 9 (a) of the Reclamation Project Act of 1939.

Your report recommends approval of a multiple-purpose initial-development plan, based on transmountain diversion of water from the Colorado River Basin eastward to the Arkansas River Basin for irrigation, hydroelectric power, municipal water supply, flood and sediment control, stream-pollution abatement, and fish and wildlife conservation. The plan, estimated for a 10-year construction period and a total cost of $147,440,000 based on 1949 prices, comprises about 50 miles of canals and tunnels and a water-replacement reservoir on the western slope of the Continental Divide; 6 miles of transmountain diversion tunnel; and on the eastern slope 3 earth-fill dams, 60 miles of power canal, 10 miles of diversion tunnel, 7 hydroelectric power-plants with a total installed capacity of 104,800 kilowatts, 400 miles of transmission line, and a municipal water-supply system. Water imported to the Arkansas River Basin from the Colorado River Basin is to come out of Colorado's apportionment under the upper Colorado River compact of October 11, 1948.

Of the $147,440,000 total estimated cost (based on 1949 prices) of the recommended plan, $59,930,000 is allocated to irrigation, $40,032,000 to power, $29,522,000 to municipal water supply, $15,777,000 to flood control, and $2,179,000 to fish and wildlife conservation. The annual charges over a 100-year period with interest at 2.5 percent are estimated at $5,568,000. Your report estimates the annual benefits at $9,789,000 consisting of $3,339,000 from irrigation, $4,064,000 from power, $1,662,000 from municipal water supply, $583,000 from flood control, and $141,000 from sediment control. The benefit-cost ratio is estimated at 1.76 to 1. It is further estimated that the costs allocated to irrigation, power, and municipal water supply ($129,484,000) probably can be returned to the United States as follows: Irrigation, 40 years without interest by payment of $10,881,600 by the irrigators and application of $49,084,000 (82 percent) interest on power and municipal water investments; power, 50 years with interest at 3 percent, $40,032,000; and municipal water supply, 40 years with interest at 2 percent, $29,522,000. The use of an interest component on power investments and also on investments for municipal water supply to repay irrigation costs is a matter which should receive the most careful consideration by Congress. In this connection, your attention is invited to the letter of February 1, 1950, from the Director of the Bureau of the Budget to the Secretary of the Interior, commenting on your Columbia River Basin report (printed in H. Doc. No. 473, 81st Cong., 2d sess.), in which it is stated:

> * * * in setting rates for the sale of power, the Secretary may consider the application of interest on the power investment, from the various projects covered by the account, to the return of nonpower costs, only to the extent that he can do so under reclamation law—existing or as hereafter amended. As you know, this is one of the matters on which recommendations are expected from the President's Water Resources Policy Commission.

Your report states that the designs and estimates are based on preliminary information and cites the necessity for additional studies and detailed surveys for preparation of the definitive plan. Owing to the effect of Pueblo Dam on the downstream Corps of Engineers John Martin Dam and Reservoir, it is requested that this office be

afforded the privilege of further review of certain features of the project upon completion of definite plans.

You state in your report that the initial development (Roaring Fork diversion) is designed as a self-contained unit, and that its construction would not imply a commitment for developing future water supplies in the Gunnison River Basin for diversion to the Arkansas River Basin.

It is noted with respect to the economic justification of the project that the sum of the direct irrigation benefits to farmers, direct power benefits, and benefits to municipal water, flood control, and sediment control (totaling $5,826,000) is sufficient to justify the annual project cost of $5,568,000. Since the project is justified on the basis of direct benefits, the question of the use of secondary benefits does not arise with respect to the matter of economic justification.

Although the report does not specifically state a policy for operation of the 93,000 acre-feet of storage capacity in Pueblo Reservoir that is allocated to flood-control purposes, it is assumed that the operation will be in accordance with regulations to be concurred in by the Secretary of the Army as specified under section 7 of the Flood Control Act of December 22, 1944, and that such regulations will be formulated to assure optimum flood-control benefits from the flood-control-storage allocation. With respect to the nonreimbursable flood-control allocation of $15,777,000 which was obtained by capitalizing the annual flood-control benefits of $583,000, it is noted that according to page 126 of the appendix containing the substantiating material, this amount is stated to be arrived at on the basis of Department of the Army policy which provides for capitalization of benefits at 3 percent interest for a 50-year period of analysis. This is not correct. Although this method has been used in some cases, particularly where the overall project justification is close to unity, its use in a project with a relatively high benefit-cost ratio means that flood control is bearing more than its proper share of the cost of the project. It is our belief that all project purposes should share in the savings due to multiple-purpose development.

It is considered essential that this study, and any future studies that propose importation of additional water into the drainage basin of the Arkansas River, be thoroughly coordinated with the authorized study of the Arkansas-White-Red River Basins. Region 7 of the Bureau of Reclamation is to be commended for its program of coordination of planning with other Federal and State agencies in the early phases of investigation for this report.

The proposed project does not appear to conflict functionally with any project or plans of the Corps of Engineers, but the privilege of further review of certain features of the project upon completion of definite plans is requested.

The opportunity to review your report on the initial development, Gunnison-Arkansas project, Roaring Fork Diversion, is appreciated.

Sincerely yours,

LEWIS A. PICK,
Lieutenant General, Chief of Engineers.

COMMENTS, DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, May 23, 1952.

The honorable the SECRETARY OF THE INTERIOR.

DEAR MR. SECRETARY: In his letter of May 8, 1951, the Commissioner of Reclamation, acting in your behalf, requested comments upon a proposed report entitled "Initial Development, Gunnison-Arkansas Project."

It appears that the irrigation segment of the proposed multiple-purpose undertaking consists of two distinct phases. One of these is aimed at making more effective use of the water supply already available in the upper Arkansas Basin. The other is designed to increase this supply by importation of water from the Colorado River Basin. It is noted that the costs and benefits of these two phases are combined for purposes of economic evaluation. This is not in accord with the basic principles of evaluation set out in the May 1950 report of the Subcommittee on Benefits and Costs of the Federal Interagency River Basin Committee. We believe that to bring your report into line with these principles it should present the benefits and costs of all separable increments of the proposed project, and should show that each such increment is more economical than any feasible alternative. It seems particularly important, in view of the obviously high cost of importing water from the Colorado River Basin, that a separate evaluation be made of the use of such water for irrigation.

We assume that provisions will be made for replacement of any national-forest facilities that may be impaired by the proposed project.

The opportunity afforded us to review this report is appreciated.

Sincerely,

CHARLES F. BRANNAN,
Secretary.

COMMENTS, DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, October 10, 1951.

The honorable the SECRETARY OF THE INTERIOR.

DEAR MR. SECRETARY: In his letter of May 8, 1951, the Commissioner of Reclamation, acting in your behalf, requested comments upon a proposed report entitled "Initial Development, Gunnison-Arkansas Project." This report was referred to all of the interested agencies of this Department and has been reviewed by experts in soils, agricultural economics, engineering, soil and water conservation, agronomics, and irrigation practices. The following comments are based upon this technical review.

It appears from our analysis that the irrigation segment of the proposed multiple-purpose undertaking actually consists of two distinct phases. One of these is aimed at making more effective use of the water supply already available in the upper Arkansas Basin. The other is designed to increase this supply by importation of water from the Colorado River Basin.

In our opinion the former is more important than the latter. According to the report, less than half of the water now passing the headgates of the irrigation works is actually applied to farm fields. Moreover, some of the floodwaters are lost and winter diversions are excessive. Clearly there is a need for a full-scale program designed to reduce water wastage, to improve irrigation systems and practices and to capture more Arkansas River floodwater. Parts of such a program are proposed in the report. But there is little indication of how some of the contemplated measures would be put into effect. It seems to us that this phase of the irrigation plan should be considerably expanded. This could easily be accomplished through the interagency planning effort now underway in the Arkansas-White-Red River Basins. This leads us to suggest that the proposed project be made an integral part of the comprehensive plan which will result from that effort, and that in the process the provisions for making more effective use of the available water be extended and strengthened. We are calling this to the attention of our representative on the interagency committee for the region and are asking him to cooperate to the fullest possible extent in all efforts to more fully meet the needs of the irrigation enterprises of the upper Arkansas River Basin.

It is also suggested that this phase of the irrigation plan be evaluated separately. It should, we believe, be considered the basic irrigation program for the area. The proposal to import water should be considered as an additional increment and evaluated as such.

All segments of the proposed multiple-purpose program are combined for purposes of economic evaluation. Hence it is not possible to determine, from the data given in the report, the possible effects of the separate evaluations suggested. We note, however, that the cost of the combined irrigation program would exceed $65,000 per farm (if the additional water made available is applied to 921 farms, as assumed in the calculation of benefits), or roughly $500 per irrigated acre. This high cost is, we assume, largely due to the importation feature of the combination. When such costly measures are required every possible alternative solution should be given thorough consideration.

All other separable segments of the multiple-purpose program should, of course, also be separately evaluated. We would suggest that in making these evaluations the Bureau of Reclamation utilize the procedures recommended by the Subcommittee on Benefits and Costs of the Federal Interagency River Basin Committee. As the priniciples proposed by the subcommittee have been adopted by this Department their use would make it possible for us to concur in your conclusions as to the economic feasibility of the various segments of the plan.

If it should be considered necessary to proceed with the project in advance of completion of the comprehensive plan for the Arkansas-White-Red region, we would suggest:

1. That the means by which it is intended to bring about more effective use of water now available be more fully explained and provided for, and that, at the very least, the contemplated conversion of winter flow be made a condition of Federal participation.

2. That definite provisions be made for the replacement of any national-forest facilities or services that may be impaired by

the project, and for protection of the Maroon-Snowmass primitive area against invasion. As it would be impossible to replace this primitive area, or to repair any damage that it might suffer, the only way to preserve its unique public value is to make certain that it is not affected by the project.

3. That provisions be made for the protection of any potentialities that may exist for economically justified small-scale irrigation at higher altitudes on both sides of the Continental Divide; in particular for the irrigation of pastures and meadows where needed to insure a balanced grazing program.

We greatly appreciate the opportunity afforded us to review this report.

Sincerely,

CHARLES F. BRANNAN,
Secretary.

COMMENTS, DEPARTMENT OF COMMERCE

DEPARTMENT OF COMMERCE,
BUREAU OF FOREIGN AND DOMESTIC COMMERCE,
Washington, D. C., July 30, 1951.

Mr. MICHAEL E. STRAUS,
Commissioner, Bureau of Reclamation,
Department of the Interior, Washington 25, D. C.

DEAR MR. STRAUS: We have several comments on the proposed report of the Department of the Interior on the initial development (Roaring Fork diversion), Gunnison-Arkansas project.

INTEREST ON RETURN PAYMENTS FROM POWER

We have a question concerning paragraph 69 of page 34 of the report of the regional director, which reads: "Parts of the interest on return payments from power (3 percent) and municipal water (2 percent) would be applied to the irrigation investment."

Two important questions of policy are raised by this proposal. Ordinarily, return payments from power and municipal water would be returned to the National Treasury, from where they would be eligible for appropriation to any region and any purpose the Congress saw fit. The report's proposal would automatically appropriate these funds to this area and to the particular purpose of irrigation.

In our view such an important point of policy should be considered independently of a project.

HIGHWAY RELOCATION

The information in the report as to highway inundation and relocation is brief and very little factual data are presented. While more study would be necessary before final estimates of cost of highway relocation could be given, it appears that the Bureau of Reclamation estimates for land and rights may be adequate for highway relocations in the vicinity of the Aspen Reservoir, the Sugar Loaf Reservoir enlargement, and the Pueblo Reservoir enlargement. The cost of highway relocations at these 3 projects is estimated to represent

approximately 15 percent, 65 percent, and 50 percent, respectively, of the cost of land and rights.

However, in the case of the Twin Lakes Reservoir enlargement project, the cost of highway relocation would appear to be several times the Bureau's estimated cost of land and rights.

HYDROLOGIC DATA

In 1948 the FIARBC Subcommittee on Hydrology recommended that additional evaporation, precipitation, and other meteorological stations be established in the vicinity of the project area. Perhaps it would be well for the Bureau of Reclamation to acknowledge the need for additional data of the above type in the present report.

CONTROL SURVEYS

In the substantiating report section of this study the planners make certain recommendations regarding needed surveys and maps. In this connection, the Coast and Geodetic Survey is now extending the basic (first and second order) horizontal and vertical control in that area. This control is used by the Geological Survey and other mapping and engineering agencies as the basic framework for detailed topographic mapping and other engineering surveys.

Sincerely yours,

H. B. McCoy, *Director.*

COMMENTS, FEDERAL POWER COMMISSION

Federal Power Commission,
Washington, D. C., August 22, 1951.

Subject: Initial development, Roaring Fork diversion, Gunnison-Arkansas project, Colorado.

Mr. Michael W. Straus,
Commissioner, Bureau of Reclamation,
Department of the Interior, Washington 25, D. C.

Dear Mr. Straus: The comments herein with respect to the proposed report of the Department of the Interior on the initial development, Roaring Fork diversion, of the Gunnison-Arkansas project, Colorado, are transmitted in response to your letter of May 8, 1951. The transmittal of these comments by the Commission is in accordance with the established procedures of the Federal Interagency River Basin Committee.

The plan of development recommended in the proposed report provides for the importation of water from the Roaring Fork Basin of the Colorado River watershed into the upper Arkansas River Valley, and the regulation and use of both imported and native flows for supplemental irrigation, water supply, flood control, power development, and other purposes. The report states that although the proposed plan is designed as a self-contained unit, it could constitute the initial stage of a much larger project involving the future diversion of water supplies from the Gunnison River in the Colorado Basin to the Arkansas River Basin.

As described in the report, the recommended development would consist of a system of canals and tunnels on the western slope to

collect water for diversion, and the proposed Aspen Reservoir on the Roaring Fork River to provide replacement water; a tunnel under the Continental Divide to convey water to the Sugar Loaf Reservoir which would be enlarged; a canal extending from the Sugar Loaf Reservoir to the Albert powerplant to be constructed at the head of the enlarged Twin Lakes Reservoir, and also a canal diverting water from the Arkansas River into the larger Twin Lakes Reservoir; a canal extending from the Twin Lakes Reservoir to Salida, Colo., to provide for the development of power at plants to be constructed at power drops at the Granite, Wapaco, Princeton, Johnson, and Salida sites; a reservoir and powerplant located on the Arkansas River immediately upstream from Pueblo, Colo.; a power transmission network; and facilities for furnishing additional municipal water supply for certain cities and towns in the Arkansas River Basin.

The report shows that by diverting 69,200 acre-feet of water annually from the Colorado River Basin and through regulation and conservation of native flows, the plan would provide a total of about 185,000 acre-feet of supplemental irrigation water per year for use on the 322,000 acres of irrigated land in the Arkansas Valley. This would reduce the average annual water shortage on these lands from the 35 percent now experienced to about 15 percent. The 7 powerplants in the plan would have a total installed capacity of 104,800 kilowatts, of which 93,800 kilowatts would be considered dependable. The estimated average annual generation at the plants is shown as 505 million kilowatt-hours, including 400 million kilowatt-hours of primary energy. The plan would provide about 17,000 acre-feet of water annually for municipal supply to Colorado Springs, Pueblo, and several Arkansas Valley towns. It was estimated that operation of the reservoirs would eliminate two-thirds of the annual flood damages in the reach of river between the proposed Pueblo Reservoir and the existing John Martin Reservoir. Other benefits would include sediment control, pollution abatement, and fish and wildlife conservation.

The cost of the proposed development is estimated at $147,440,000 on the basis of October 1949 prices. Under the tentative cost allocation proposed, $59,930,000 would be charged to irrigation; $40,032,000 to power; $29,522,000 to municipal and industrial water supply; $15,777,000 to flood control; and $2,179,000 to fish and wildlife. The last two items named would be considered as nonreimbursable. Of the amount allocated to irrigation, $10,881,600 would be repaid by the irrigators, $35,478,000 would be returned through use of the interest component on power revenues, and $13,570,400 returned through use of the interest component of municipal and industrial water supply revenues. A payout period of 50 years is contemplated in the report.

In the benefit-cost analysis given in the report, the annual cost of the development is estimated at $5,568,000 on the basis of 2.5 percent interest rate and 100-year amortization period. The total average annual benefits are estimated at $9,789,000, indicating a benefit-cost ratio of 1.76 to 1.00. It is stated in the report that the direct benefits, estimated at $6,262,000 annually, would be sufficient to justify the annual project costs.

It is noted that the annual power benefits are estimated in the report at $4,064,000. This includes $2,375,000 estimated revenues from the sale of energy at 5.5 mills per kilowatt-hour of firm energy and

3.5 mills per kilowatt-hour of secondary energy; $327,000 in savings in production costs to utilities purchasing project power for resale (assumed to be passed on to the consumers); $1,199,000 as a proportionate share of the retailing utilities' benefits arising from resale of project power; and $163,000 as a proportionate share of the increased value of goods and services produced by final utilization of the power. The report considers the first item as the direct power benefit and the three remaining items as indirect benefits.

The Commission believes that the inclusion of at least some of the indirect benefits listed above in the project justification is questionable. On the basis that the power has a value equal to the cost of production by alternative steam-electric plants, the Commission staff estimates the annual power benefits of the development at approximately $3,400,000. The staff reports, however, that the project power benefits, both as estimated in the report and as computed by the staff, are substantially in excess of the annual power costs, assuming adoption of the proposed cost allocation and also using a 2.5 percent interest rate and a 50-year amortization period.

Using the power benefits as computed by the Commission staff and the direct benefits for other functions as given in the report, the staff finds that the total of these benefits would exceed the annual costs, computed on the basis of 2.5 percent interest rate and 50-year amortization period. It appears, therefore, that as stated in the report the overall development would be justified by the direct benefits.

As indicated above, 82 percent of the cost of the development chargeable to irrigation would be repaid through use of the interest component of the revenues from the sale of power and municipal water supplies. The Commission is familiar with the interpretations under which such procedures have been adopted by your Department. It believes, however, that the interest portion of power revenues represents a power cost that should be paid into the Federal Treasury rather than diverted for use as irrigation subsidy.

The Commission staff has made studies of the proposed development both during the time of project formulation and in review of the subject report of your Department. The staff reports that its estimates of the power available at the project are in substantial agreement with the estimates of your office. The staff also advises that its studies confirm the conclusion of the report that there would be a market for the project power by about 1960.

Consideration has been given by the staff to certain modifications of the plan, all of relatively minor nature, which may prove desirable from the standpoint of power development. The report also recognizes that further investigations may show the desirability of altering some of the project details. For example, it is stated in the report that further study may show that it is more economical to develop the Elbert power head in two steps, each utilizing about one-half of the 515 feet of available head. A second alternative plan for this project studied by the staff would provide a pond on Corske Creek to serve as an afterbay for an upper plant utilizing about 125 feet of head, and to act as a forebay for a power plant at the Elbert site

developing the remainder of the head. Such a plan would not only provide for greater flexibility of operation but also would permit a larger power installation at the Elbert plant for low load factor operation.

The staff points out that it would be desirable also to provide forebays for the Granite and Wapaco power plants if topographic conditions are suitable for the construction of such facilities. It is noted that the plans include forebays for the three lower plants on the Arkansas power canals, namely, the Princeton, Johnson, and Salida plants. In view of the large storage capacity to be provided above and below the Granite plant, the staff believes that it would be desirable to increase the ultimate installation at that plant from the 19,200 kilowatts proposed to approximately 40,000 kilowatts for peaking purposes.

The staff studies indicate that it may be desirable to develop a small amount of power at the Aspen Dam for project operation and for possible use on a small local load. On the basis of the proposed operation of the reservoir, it appears that an installation of approximately 500 kilowatts might be warranted.

It is noted that the report considers that the power capacity at the Pueblo Dam would not be dependable because of the possible lack of sufficient head and flow for power development during winter peak load months. The staff suggests that a part of the capacity might be made dependable by maintaining a dependable power head at maximum drawdown through tailrace excavation or otherwise, and by effecting agreements whereby winter releases could be stored in downstream reservoirs such as John Martin.

The proposed plans do not provide for the development for power of the 2,400 feet of fall in the 70-mile reach of the Arkansas River between Salida and the Pueblo Reservoir. Studies by the staff indicate that on the basis of the water available under the recommended plans, a dependable capacity of about 89,000 kilowatts and an average annual generation of approximately 470,000,000 kilowatt-hours could be developed in this section of the river. The staff advises that such development would not be economically feasible at the present time but that the proposed plans for initial development as outlined in your report would not interfere with the future development of this power.

The Commission appreciates the opportunity of reviewing and commenting upon the report of your Department.

Sincerely yours,

MON C. WALLGREN, *Chairman.*

COMMENTS, PUBLIC HEALTH SERVICE, FEDERAL SECURITY AGENCY

FEDERAL SECURITY AGENCY,
PUBLIC HEALTH SERVICE,
Washington, D. C., August 16, 1951.

The Honorable OSCAR L. CHAPMAN.
The Secretary of the Interior,
Washington, D. C.

DEAR MR. SECRETARY: Pursuant to the policies and procedures established by the Federal Interagency River Basin Committee, we have reviewed the preliminary report furnished by your Department entitled "Initial Development (Roaring Fork Diversion) Gunnison-Arkansas Project, Colorado," dated January 1950.

Our comments, for the most part, consist of suggested revisions of statements concerning water pollution in the Arkansas River Valley. These revisions are based on more up-to-date data compiled in recent joint studies by the Public Health Service and the State of Colorado.

The following comments are made with page identification as carried in your report:

A. REPORT OF THE REGIONAL DIRECTOR

(1) Page 26, paragraph 36

Suggest this paragraph be replaced in its entirety by the following:

36. Stream pollution in the mountainous and primitive western slope diversion area presents no problem at the present time. However stream pollution is of real significance in the eastern slope area. Diversion water from the western slope will alleviate this pollution somewhat, but the construction of adequate sewage and waste treatment plants will be necessary to make the pollution abatement complete.

B. SUBSTANTIATING REPORTS

(1) Page 122, chapter XII

Suggest this chapter be replaced in its entirety by the following:

PRESENT CONDITIONS AND STREAM POLLUTION PROBLEMS

No stream-pollution problems exist on the western slope diversion area, where transmountain water is to be obtained. However, the eastern area, which extends from the headwaters of the Arkansas River, near Leadville, to the Colorado-Kansas boundary, has a very definite stream-pollution problem.

Almost at its inception, the Arkansas River is defiled by the uncontrolled discharge of municipal and industrial wastes at Leadville. Progressive deterioration of the river waters then continues to the Kansas line; serious pollution problems exist in a number of local areas.

The sanitary requirements of water used for irrigation purposes have not been established; however, from available data, the need for pollution abatement of waters to be used for irrigation is apparent below Leadville, Pueblo, Rocky Ford, and other areas.

Stream pollution is always a potential hazard to public water supplies. That this hazard exists for users of the Arkansas River water is exemplified by the problem of public water supply treatment at Pueblo. Its supply has only provisional approval as an interstate carrier watering point.

BENEFITS

The initial development would import transmountain water derived from melting snow on a heavily forested and practically uninhabited watershed. The water would be of excellent quality from a chemical and bacteriological standpoint. Its effect on the Arkansas River should prove beneficial from the standpoint of both quality and quantity, particularly during periods of low flow. Dilution of the highly mineralized river water and the stabilization of flow will be a boon to many uses, especially municipal and industrial water supplies.

The beneficial effects of the diversion water on pollution in the Arkansas River, however great, should not be considered a panacea for its entire water-pollution problem. Water-pollution abatement can only be accomplished by the concurrent installation of adequate sewage and waste treatment facilities at all significant sources of pollution.

(2) *Page 134, section titled "Public Health Service"*

Suggest the last three lines of this paragraph which read:

* * * in order that those situations attributable to present practices and natural causes may not be eventually cataloged as the end products of reclamation development.

be changed to read:

* * * and will furnish criteria by which the benefits of the diversion project may be measured in the future.

Sincerely yours,

M. D. HOLLIS,
Chief, Sanitary Engineering Officer, PHS,
FSA Member, Federal Interagency River Basin Committee.

O