An Evalution of the Poudre River Projects in North-Central Colorado

by

David Blaney

4/30/84
Environmental Studies 302
Professor Bolton

Introduction

Water, considered a more or less unlimited resource twenty years ago, has become a very important consideration in planning issues. The problem of water resource allocation and management is becoming an issue full of conflicts, and nowhere are these conflicts felt more than in the West, where an extremely limited water supply must provide not only for dramatically increasing populations, but also for increasing irrigation requirements for the extensive agriculture of the Midwest. One area where these conflicts have surfaced, and are being resolved, is in the Cache La Poudre River basin of Colorado.

The Cache La Poudre basin is presently an area of both intensive agricultural use and high growth - from 1970 to 1976, Fort Collins, which lies at the mouth of the Poudre Canyon, had the fourth highest growth rate among the nation's Standard Metropolitan Statistical Areas (50,000 population or greater) according the the U.S. Census Bureau (1). In addition, the climate of the area is semi-arid, with an average yearly precipitation ranging from 14.4 to 17 inches in the area near Fort Collins to over 20 inches in the mountains.. The combination of high growth rate and low amount of native water available make this area a prime region likely to experience water shortages in the future.

In the past four years, several major studies have been carried out studying the feasibility of damming various sections of the Poudre. Such projects would provide additional water and electricity (through associated hydroelectric plants) which are expected to be needed as growth continues over the next fifty years. However, the projects also result in varying amounts of inundation and destruction of private and public property, with associated economic and environmental costs.

The issue is complicated by the fact that the Cache La Poudre River is currently under study by the U.S.D.A. for Wild and Scenic designation under the Wild and Scenic Rivers Act of 1968. Although twelve rivers in Colorado are currently under study, the Poudre is one of the only two rivers in the northeastern quarter of Colorado under study, and is the only one not extensively developed throughout its canyon.(1) Thus, a great pressure exists from people who use it for recreation, pushing to designate the area for preservation under this act.

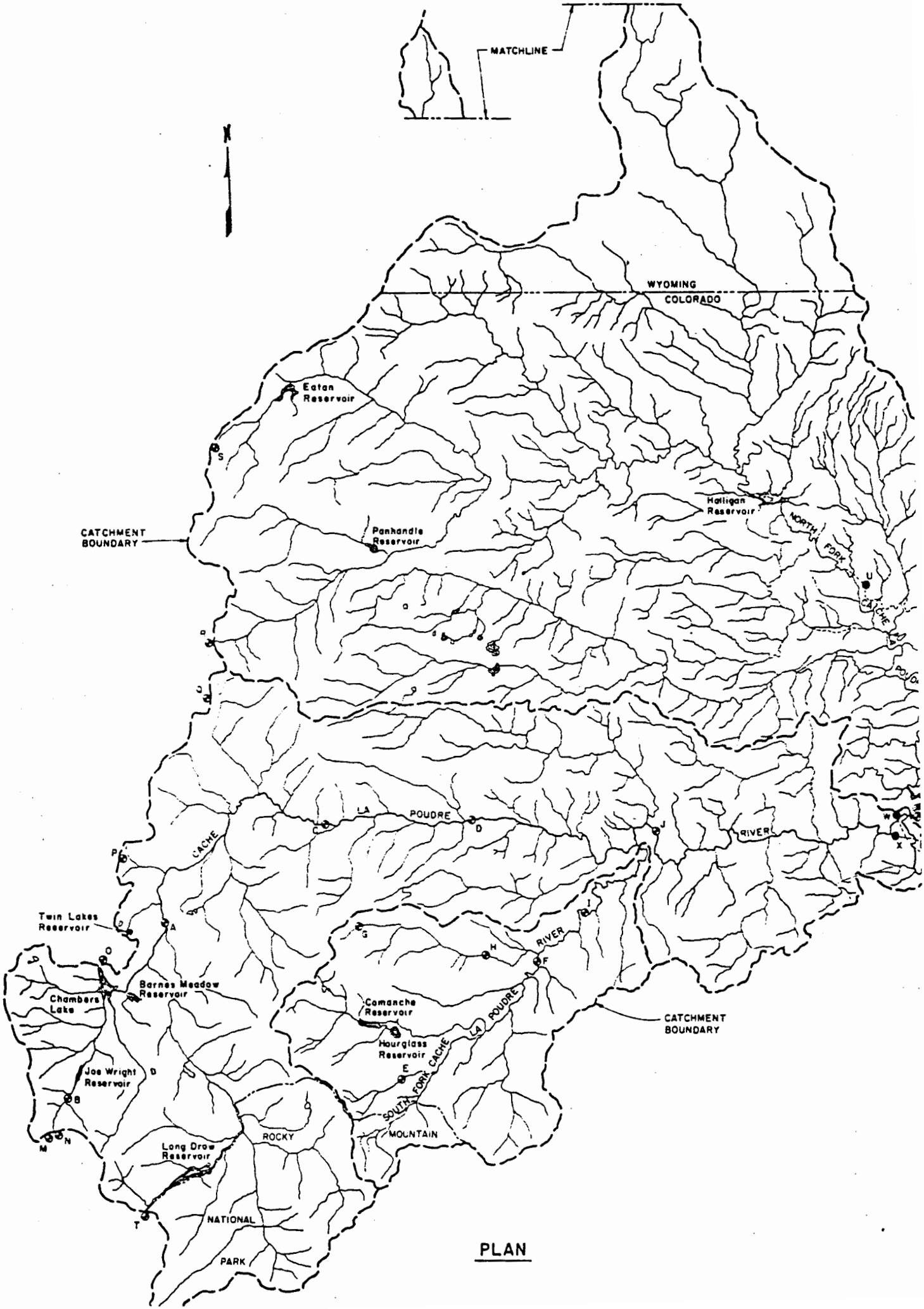
In this paper I will attempt to address some of the issues involved in the proposals to dam the Poudre, as well as look at the costs and benefits of such projects. In order to do this I first present a bit more background on the Poudre River basin and current water uses, as well as projected demands for the future. This will be followed by a description of the various projects which have been considered and a brief description of the residuals and other effects on the

environment. Next, I will evaluate the effects of these projects, both in the context of direct effects upon the immediate basin area, and the broader effects upon the wildlife and the people living in the Fort Collins - Poudre Canyon area. Finally, I will work on a valuation of the costs and effects of the projects as well as an evaluation of the Wild and Scenic designations. From these I will draw conclusions, including a recommendation that one of the projects be integrated into the preservation plans provided by the Wild and Scenic Rivers Act. This integration seems to provide the best balance between complete preservation of the Poudre River basin and the extensive plans for development of the area, and preserves many of the values of people living in the affected area.

Background

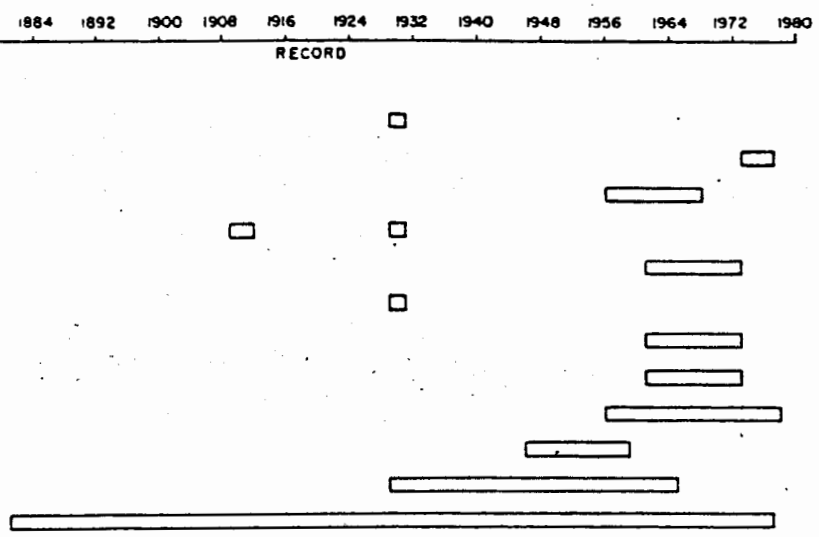
The Cache La Poudre River basin lies in north-central Colorado on the eastern slope of the Rocky Mountains (see Figure 1). Elevations in the basin vary from just over 4000 feet at the confluence with the South Platte River near Greeley, Colorado, to well over 13,000 feet in Rocky Mountain National Park (1). The annual water supply is supplied by snowmelt from snowfields in the high mountains, and, to a lesser extent, from rainfall. The bulk of this flow occurs in the main stem and South Fork, originating in Rocky Mountain National Park, with a smaller contribution coming from the North Fork, which originates in the northern part of the basin.

The total average annual water supply currently amounts


MATCHLINE
N
WYOMING
COLORADO
Eaton Reservoir
CATCHMENT BOUNDARY
Panhandle Reservoir
Halligan Reservoir
NORTH FORK
CACHE
LA POUDRE
RIVER
CACHE
Twin Lakes Reservoir
Barnes Meadow Reservoir
Chambers Lake
Joe Wright Reservoir
Comanche Reservoir
Hourglass Reservoir
SOUTH FORK CACHE LA POUDRE
RIVER
CATCHMENT BOUNDARY
ROCKY
MOUNTAIN
Long Draw Reservoir
NATIONAL
PARK
PLAN

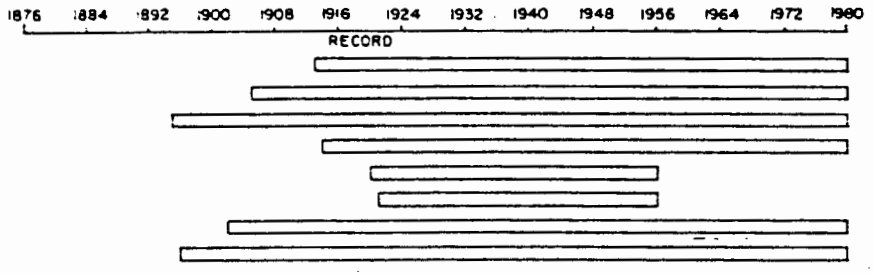
STREAMFLOW GAGING STATIONS UPSTREAM FROM MOUTH OF THE CANYON

STATION LETTER	STATION NO.	STATION	DRAINAGE AREA, mi^2
		CACHE LA POUDRE BASIN	
A	674500	CACHE LA POUDRE RIVER ABOVE CHAMBERS LAKE OUTLET	89.2
B	674610	JOE WRIGHT CREEK NEAR CAMERON PASS	5.05
C	674750	CACHE LA POUDRE RIVER NEAR RUSTIC	199.
D	674800	CACHE LA POUDRE RIVER NEAR LOG CABIN	230.
E	674820	FALL CREEK NEAR RUSTIC	3.64
F	674850	SOUTH FORK CACHE LA POUDRE NEAR EGGERS	69.8
G	674851	LITTLE BEAVER CREEK NEAR IDYLWILDE	0.89
H	674853	LITTLE BEAVER CREEK NEAR RUSTIC	12.3
I	674860	SOUTH FORK CACHE LA POUDRE NEAR RUSTIC	90.3
J	674900	CACHE LA POUDRE RIVER BELOW ELKHORN CREEK	404.
K	675150	NORTH FORK CACHE LA POUDRE NEAR LIVERMORE	568.
L	675200	CACHE LA POUDRE RIVER NEAR MOUTH OF CANYON	1055.



TRANSMOUNTAIN DIVERSIONS INTO CATCHMENT UPSTREAM FROM MOUTH OF THE CANYON

STATION LETTER	STATION NO.	STATION
M	674550	CAMERON PASS DITCH
N	674600	MICHIGAN DITCH [1]
O	674650	SKYLINE DITCH
P	674700	LARAMIE-POUDRE TUNNEL
Q	674720	BOB CREEK DITCH
R	675000	COLUMBINE DITCH
S	675050	WILSON SUPPLY DITCH
T	901000	GRAND RIVER DITCH

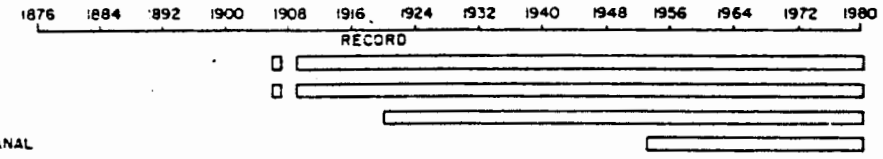


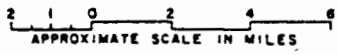
[1] PUBLISHED AS RISK AND McNAB DITCH 1904 - 1912

Milton Seaman Reservoir

DIVERSIONS FROM CATCHMENT UPSTREAM FROM MOUTH OF THE CANYON

STATION LETTER	STATION
U	NORTH POUDRE CANAL
V	POUDRE VALLEY CANAL
W	FT. COLLINS PIPELINE
X	NORTH POUDRE SUPPLY CANAL





COLORADO WATER CONSERVATION BOARD

CACHE LA POUDRE PROJECT
RECONNAISSANCE STUDY

CACHE LA POUDRE RIVER CATCHMENT UPSTREAM FROM MOUTH OF THE CANYON

Figure 1

to about 400,000 acre-feet per year. Currently, municipal and industrial water uses of the Poudre amount to approximately 40,000 acre-feet per year. However, the major water demand is not for municipal or industrial use, but rather for agricultural use. Approximately 270,000 acre-feet per year are presently used for irrigation purposes, bringing the total water usage to 310,000 acre-feet per year (2).

At this time excess water demand does not present a serious problem; only minimal water rationing measures were needed during the summer of 1976, following a fairly severe drought which had occurred during the previous eighteen months. However, growth projections for the area show that over the next 50 years, demand for water could quite easily overtake the available water supply, especially in drought years. Three population scenarios were developed by Tudor Engineering (2). For a high estimate of growth, the recent growth of four percent was assumed to continue through the year 2000, and then assumed to gradually drop to two percent by 2030, the terminal year for all projections in their study. For low growth rates, the State Demographer's low projections for the Larimer - Weld County area (in which the Poudre River basin is contained) were used. They are a three percent growth rate through 1990, dropping to two percent by 2020. The medium projection used the midpoints between these two projections. Final population figures for 2030 were 473,400, 594,500, and 715,700 for low, medium, and high projections respectively, All of these projections show a very significant population increase from the current 87,900 people in the Poudre water service area.

For purposes of calculating water demand increases, the medium growth projection rate was used. Water use per capita was assumed to drop from the current 240 gallons per day (includes uses for parks, golf courses, etc.) to 190 gallons per day, and industrial use was assumed to triple, by 2030. Based on this projection, it is estimated that the municipal and industrial water demand will increase from the current 40,000 acre-feet to over 146,000 acre-feet per year.

These increases will be partially offset by encroachment of urban growth into agricultural areas, reducing agricultural land from the current 225,000 acres to approximately 197,000 acres in 2030 (2). This would result in a reduction of demand of 34,000 acre-feet for agriculture. An additional 24,000 acre-feet of supply are expected to be provided by the Windy Gap water project (which will divert water from the West Slope Colorado River to the Poudre River basin) which is to be completed by 1990 (5). All of these calculations imply a net yearly surplus of 42,000 acre-feet. However, because of the monthly variability of water flow in the Cache La Poudre, the drop from the current 90,000 acre-feet surplus to 42,000 acre-feet per year would lead to significant water shortages in the late summer and early fall, when demand is at its peak and water flow is low.

Another aspect to consider is the growth in utility demand. Estimates project electrical peak load demands to increase from the current 3160 megawatts to 7420 megawatts in 2000. As of 1980, approximately 3700 megawatts are avail-

able. Thus, a great need for additional sources of electricity exists, demonstrating the need for the construction of additional power sources over the next two decades.

Summary of the Poudre Projects

A total of eight alternative projects were considered for construction on the Poudre River by Tudor Engineering in their study. Four of these were cut out in the preliminary study because of a lack of economic feasibility. I will proceed to detail the other four alternatives.

In designing alternatives, several objectives had to be met. First of all, all projects were to be located upstream from Fort Collins and situated to control as much of the total flow of the river basin as possible. Also, all projects were to include terminal reservoirs near the mouth of the canyon to be used for storage and conservation purposes, and could include additional storage reservoirs in the upper portion of the basin for the purpose of regulating flows for hydroelectric peaking power production, as well as for additional conservation storage.

The four alternatives feature various combinations of four different reservoir sites (Figures 2, 3). These sites are:

Grey Mountain Reservoir, on the main stem
New Seaman Reservoir, on the North Fork
Elkhorn Reservoir, on the main stem
Idylwilde Reservoir, on the main stem.

Grey Mountain and New Seaman Reservoirs are representative of conservation storage sites which would be located at or near

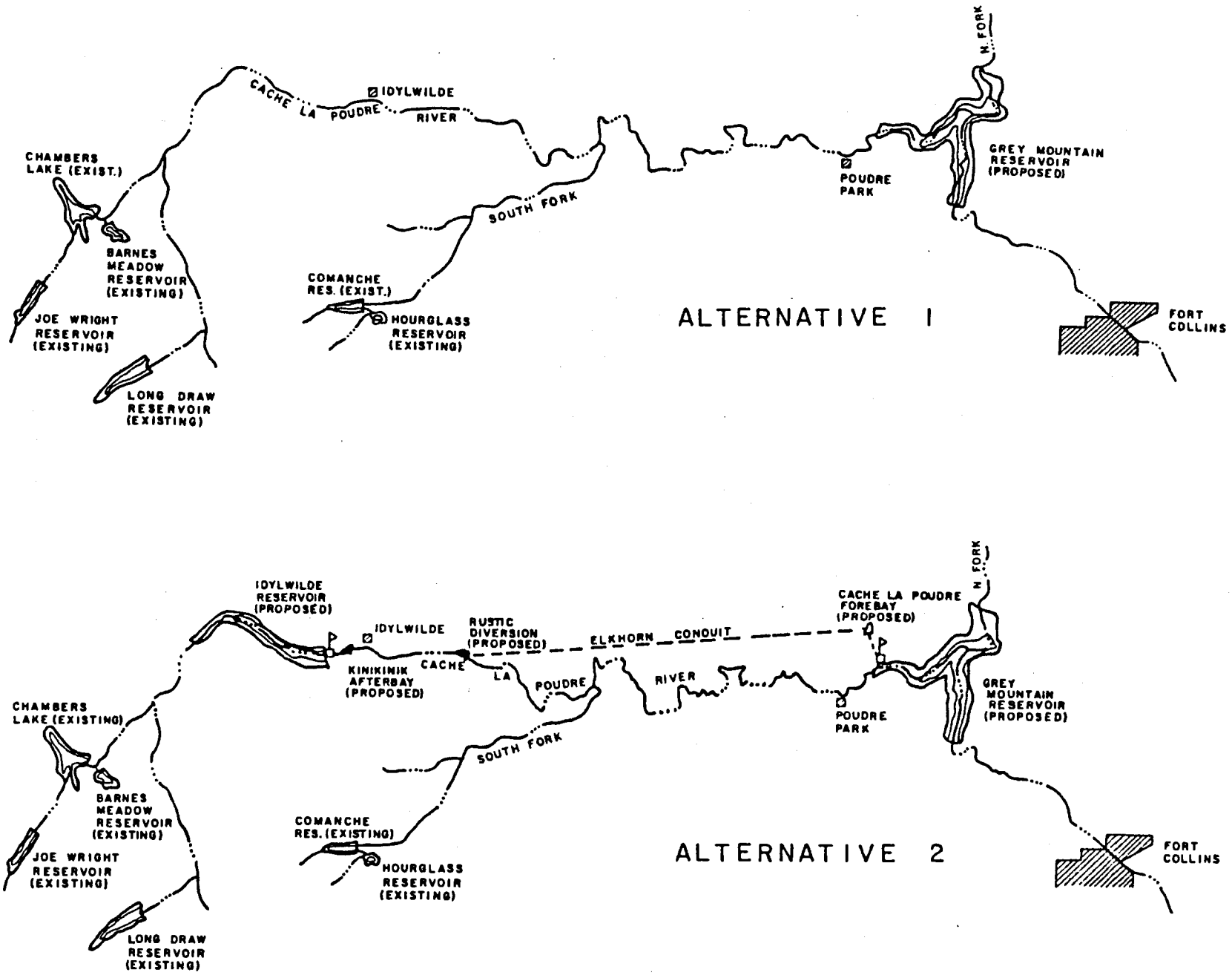
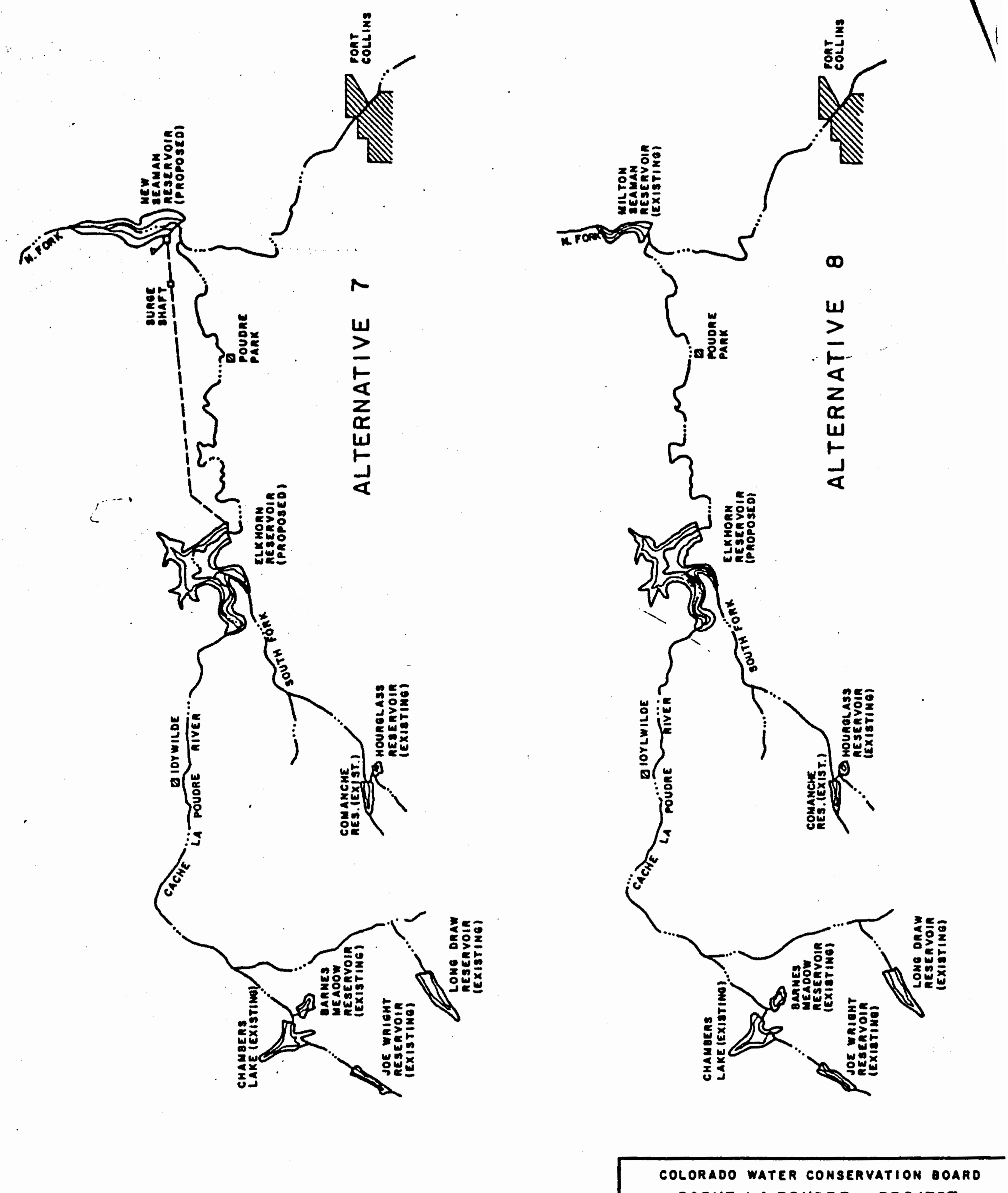

CACHE LA POUDRE RIVER
IDYLWILDE
CHAMBERS LAKE (EXIST.)
BARNES MEADOW RESERVOIR (EXISTING)
JOE WRIGHT RESERVOIR (EXISTING)
LONG DRAW RESERVOIR (EXISTING)
COMANCHE RES. (EXIST.)
HOURGLASS RESERVOIR (EXISTING)
SOUTH FORK
N. FORK
POUDRE PARK
GREY MOUNTAIN RESERVOIR (PROPOSED)
FORT COLLINS
ALTERNATIVE 1
IDYLWILDE RESERVOIR (PROPOSED)
IDYLWILDE
KINIKINIK AFTERBAY (PROPOSED)
RUSTIC DIVERSION (PROPOSED)
ELKHORN CONDUIT
CACHE LA POUDRE FOREBAY (PROPOSED)
CACHE LA POUDRE RIVER
CHAMBERS LAKE (EXISTING)
BARNES MEADOW RESERVOIR (EXISTING)
JOE WRIGHT RESERVOIR (EXISTING)
LONG DRAW RESERVOIR (EXISTING)
COMANCHE RES. (EXISTING)
HOURGLASS RESERVOIR (EXISTING)
SOUTH FORK
N. FORK
POUDRE PARK
GREY MOUNTAIN RESERVOIR (PROPOSED)
FORT COLLINS
ALTERNATIVE 2

Figure 2



COLORADO WATER CONSERVATION BOARD

CACHE LA POUDRE PROJECT
RECONNAISSANCE STUDY

PRELIMINARY ALTERNATIVE
PROJECT CONFIGURATIONS

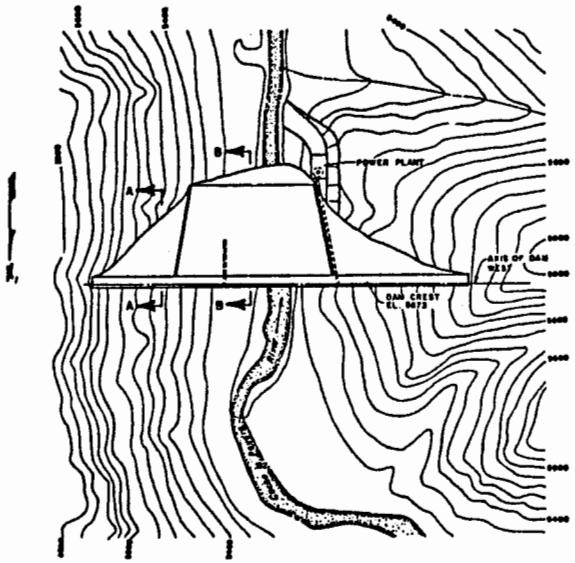
Figure 3

the mouth of the canyon where upper basin flows could be stored and regulated. Idylwilde would be used primarily for large scale hydroelectric development. Elkhorn, depending upon its configuration, could be used for either purpose.

The first alternative (Alternative 1), involves only Grey Mountain Reservoir. The site is advantageous because of its location at the mouth of the Poudre Canyon. It would be capable of capturing, storing, and releasing all flows from the upper basin, to meet the demands of agricultural, municipal, and industrial uses. Grey Mountain Dam would be a 390 foot high roller-compacted concrete structure with spillway, and would provide a total of 200,000 acre-feet of storage capacity, and 12 megawatts of run-of-the-river (natural base water flow) hydroelectric capacity (see Figure 4). It is estimated that this alternative would yield a total of 16,300 acre-feet of new water per year (2). This yield of new water, which occurs in all of the alternatives, is due to decreases in evaporation and transpiration losses; those losses are less if water is stored in one or two large, deep reservoirs rather than several small, shallow reservoirs on the plains area around Fort Collins and Greeley.

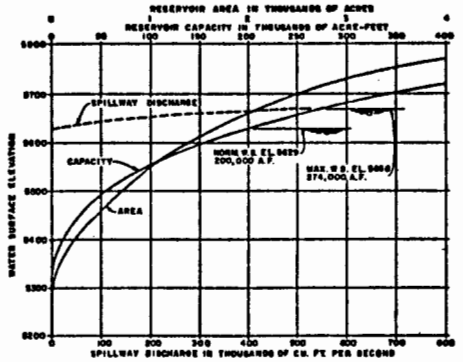
The second alternative, Alternative 2, is a multiple reservoir system with conservation storage and peaking power. It includes Grey Mountain Reservoir with 200,000 acre-feet of storage capacity and Idylwilde Reservoir with 200,000 acre-feet of storage. Its dam would be 310 feet high, with the same structure and composition as the Grey Mountain Dam. In addition, it would require a 90 foot rockfill saddle dam

Figure 4

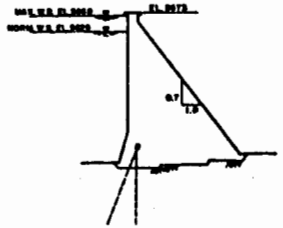


PLAN

SCALE IN FEET



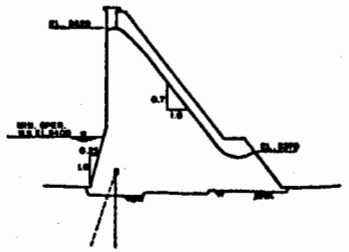
AREA-CAPACITY-DISCHARGE CURVES



SECTION A-A

TYPICAL NON-FLOW SECTION

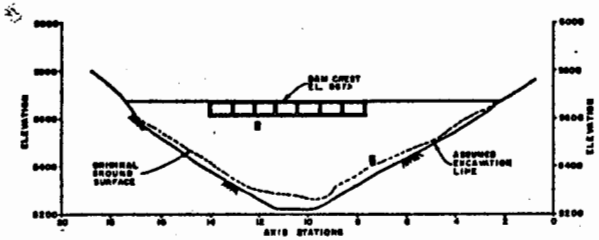
SCALE IN FEET



SECTION B-B

TYPICAL SPILLWAY SECTION

SCALE IN FEET



PROFILE ALONG AXIS OF DAM

COLORADO WATER CONSERVATION BOARD

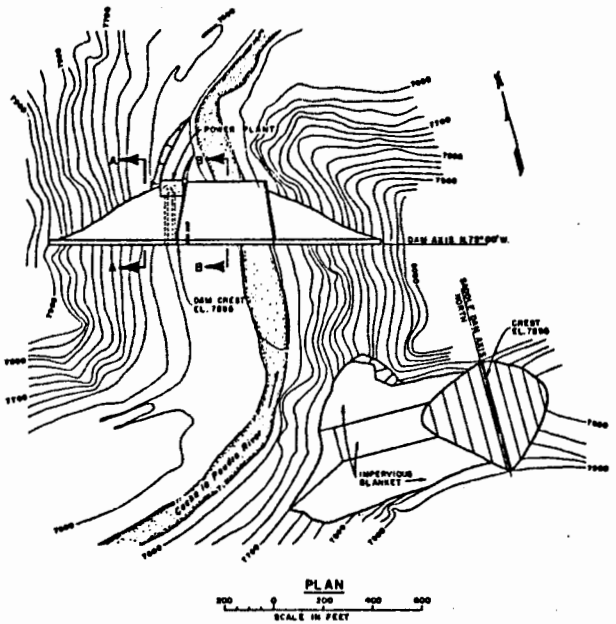
CACHE LA POUDRE PROJECT
RECONNAISSANCE STUDY

GREY MOUNTAIN DAM

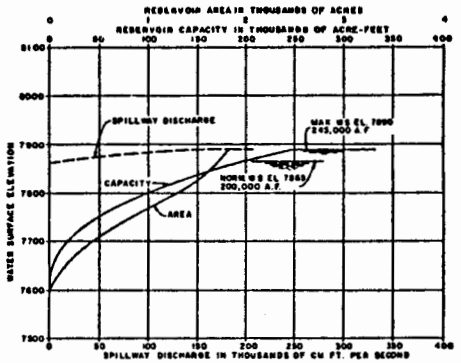
TUDOR ENGINEERING COMPANY

FIGURE VII-1

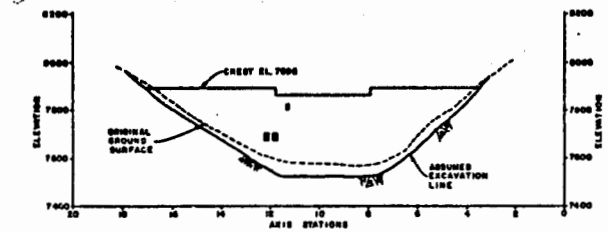
Figure 5



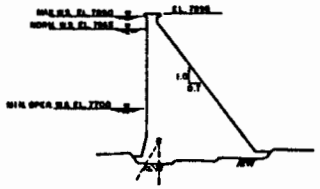
PLAN



AREA-CAPACITY-DISCHARGE CURVES



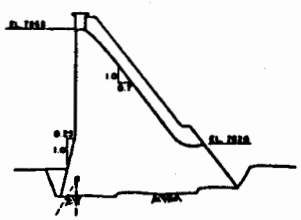
PROFILE ALONG AXIS OF DAM



SECTION A-A

TYPICAL NON-FLOW SECTION

SCALE IN FEET



SECTION B-B

TYPICAL SPILLWAY SECTION

SCALE IN FEET

COLORADO WATER CONSERVATION BOARD

CACHE LA POUDRE PROJECT
RECONNAISSANCE STUDY

IDYLWILDE DAM

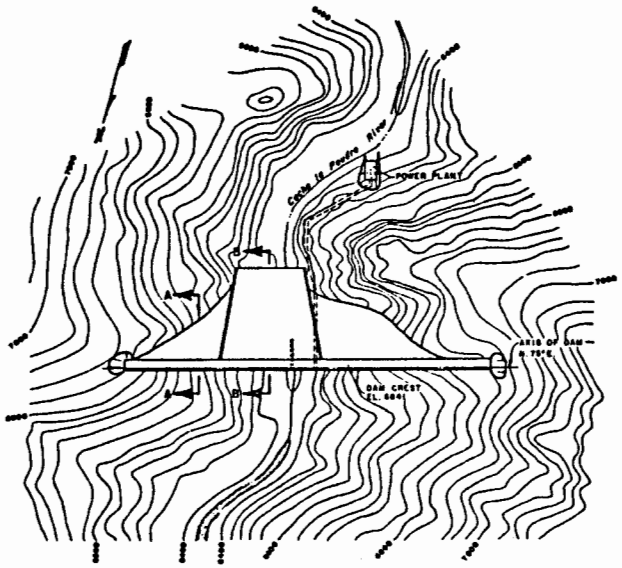
TUDOR ENGINEERING COMPANY FIGURE - VII - 4

(Figure 5). A 24 megawatt peaking power plant (operating only during the hours of highest power demand) at Idylwilde Reservoir and an 81.5 megawatt peaking power plant at Grey Mountain would also be included, as well as a plant providing 12.5 megawatts run-of-river capacity. This alternative would provide an additional 14,300 acre-feet of water (2).

The third alternative to be considered is Alternative 7, a multiple reservoir system comprised of Elkhorn Reservoir, with 196,000 acre-feet of storage capacity, and New Seaman Reservoir, with 200,000 acre-feet of storage capacity. A 79 megawatt peaking power plant would be built at New Seaman Reservoir, and run-of-river plants would provide 9.3 megawatts of capacity. In addition, 8.4 miles of tunnel and 1.5 miles of pipeline would be required to divert water from the main stem to New Seaman Reservoir. This system would provide 13,600 acre-feet of new water.(5). Elkhorn dam would be 455 feet tall (Figure 6); New Seaman would be 390 feet tall (Figure 7). Both would be roller-compacted concrete structures.

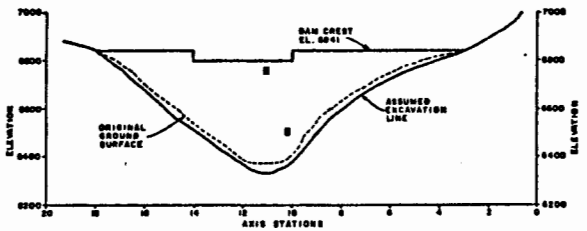
The final alternative, number 8, would consist of only the 196,000 acre-foot capacity of Elkhorn Reservoir, and would provide 14 megawatts of run-of-the-river hydroelectric capacity. It would provide a yield of 14,400 acre-feet of new water (5).

In addition, Alternatives 2 and 7 would require several diversions, conduits, forebays, and afterbays in order to direct water to the power plant and to control flow from the plant.

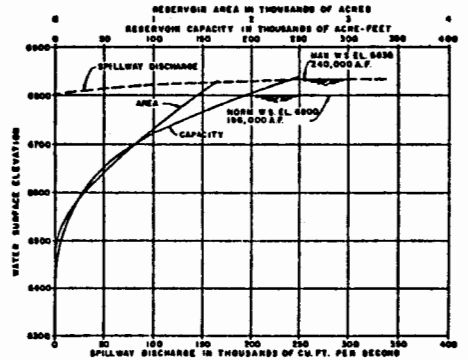


PLAN

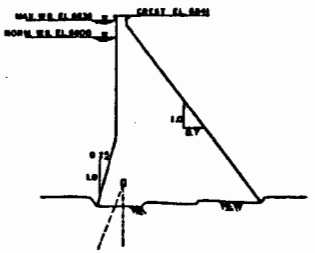
SCALE IN FEET



PROFILE ALONG AXIS OF DAM



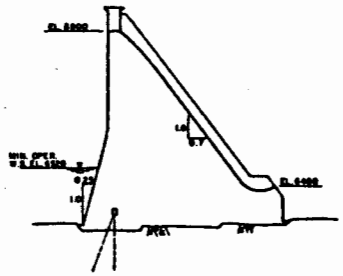
AREA CAPACITY DISCHARGE CURVES



SECTION A-A

TYPICAL NON-OVERFLOW SECTION

SCALE IN FEET



SECTION B-B

TYPICAL SPILLWAY SECTION

SCALE IN FEET

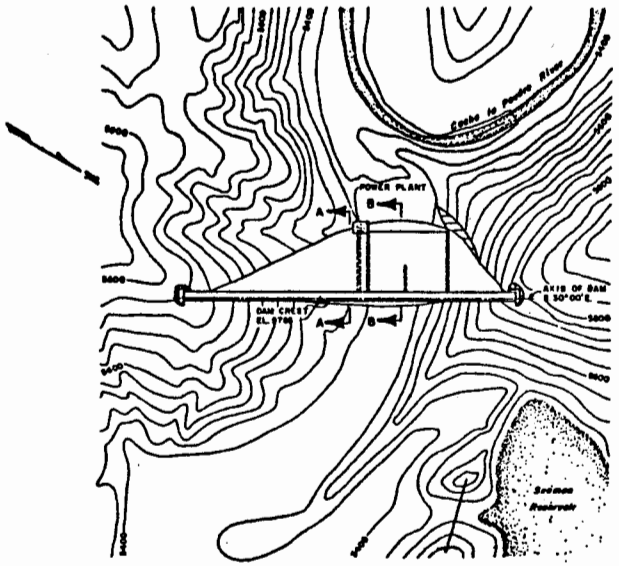
COLORADO WATER CONSERVATION BOARD

CACHE LA POUDRE PROJECT
RECONNAISSANCE STUDY

ELKHORN DAM

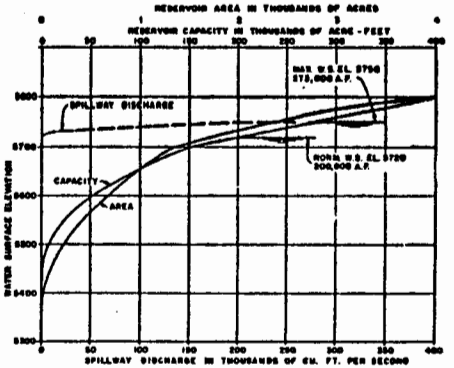
TUDOR ENGINEERING COMPANY FIGURE: VII-3

Figure 6

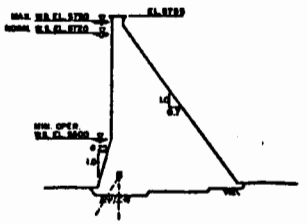


PLAN

SCALE IN FEET



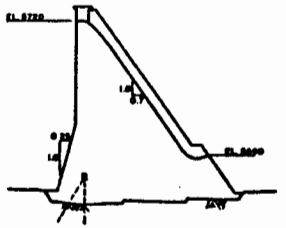
AREA - CAPACITY - DISCHARGE CURVES



SECTION A-A

TYPICAL NON-OVERFLOW SECTION

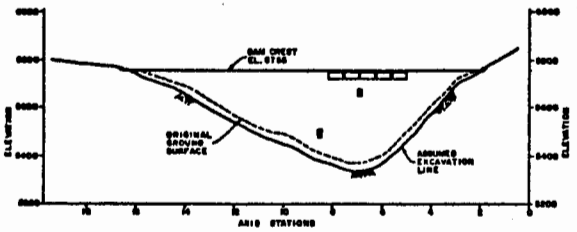
SCALE IN FEET



SECTION B-B

TYPICAL SPILLWAY SECTION

SCALE IN FEET



PROFILE ALONG AXIS OF DAM

COLORADO WATER CONSERVATION BOARD

CACHE LA POUDRE PROJECT
RECONNAISSANCE STUDY

NEW SEAMAN DAM

TUDOR ENGINEERING COMPANY FIGURE VII-2

Figure 7

Residuals and Effects of the Projects

These dam projects would not provide residuals to any extent; a certain amount of rock would need to be disposed of as a result of excavations at the dam sites, but this would provide no problem. The hydroelectric power, being a "clean" energy source, would provide no residuals.

The only effect which at first glance would appear to be of any importance would be the "silting up" which might occur in the reservoirs upon completion of the project, and the resultant erosion downstream from the dams. However, most of the water in the river is from snowmelt runoff, and the runoff areas are for the most part well vegetated or rocky. Thus, the amount of suspended material is fairly low. Sedimentation has been estimated a 0.1 acre-feet per year per square mile of contributing area for the South Fork and main stem, and 0.2 acre-feet per year per square mile of contributing area for the North Fork (2). Sediment deposit thus does not pose a significant problem - a small storage space allocation could easily be made in each project to provide for sediment accumulation (see Figure 1 for drainage areas). The rocky river bed would allow only minimal erosion below the dam sites. Thus, no residuals of any importance seem to be connected with any of the projects.

The main impact of each of the alternatives is instead upon the environment. In terms of inundation, a large variation in effects can be seen.

Alternative 1 would inundate a total of 1,670 acres. Most

of this land is privately owned. Fifty five buildings, including the current Fort Collins Water Treatment Plant, and six miles of major highway would be in the impacted area. Costs for relocation of all buildings and highways have been estimated at 32.8 million dollars. Alternative 2 would inundate an additional 1700 acres, two-thirds of it privately owned, and would include seven additional miles of highway, five recreation facilities (campgrounds, picnic grounds), and seventy four buildings, including a state fish hatchery. Total costs of relocations are estimated a 58.2 million dollars (2).

Alternative 8 would inundate 1420 acres, most of it publically owned land. Seven miles of highway lie in the affected area, as well as nine buildings and seven recreational facility sites. Relocation costs are estimated at 20.8 million dollars. Alternative 7 would inundate 1640 additional acres (half privately owned). Four and one half additional miles of highway would need to be moved, as well as four more buildings, for an additional 12.6 million dollars.

However, additional, non-monetary costs would also be incurred as a result of each of the projects. Each project involves complete loss of vegetation and wildlife in the affected area. Also, the river will be impacted outside of the area of inundation - 2 miles, 30 miles, 14 miles, and 14 miles of additional river would be impacted for Alternatives 1, 2, 7, and 8, respectively. It is difficult to tell whether these impacts would be adverse or not, but it is definite that these additional lengths of river would be affected by the modifica-

tions of historic flows brought about by the dams.

Finally, two endangered species reside in the Poudre Canyon area, the Green Cutthroat Trout, and the Peregrin Falcon. Of these, only the Peregrin Falcon might be affected (the Green Cutthroat lives in only the remote upper sections of the Poudre) (1). Though it is difficult to estimate the effects upon the falcon, nesting sites have been identified in all of the affected areas (5), so a certain amount of impact is expected. However, it would not be difficult for the falcons to change nesting sites within the canyon - suitable sites with abundant food lie throughout the canyon.

In studying the effects upon the environment, Tudor looked mainly at the costs of relocations for a comparison of the various sites. Since, in terms of endangered species, all of the projects only have a small impact, this is a reasonable way of looking at each project. The Poudre Canyon area is unsuitable for wood harvest or mining, so effects upon theses two areas can be ignored. In terms of looking at loss of forest and wildlife, it is difficult to put a monetary value on the loss. Instead, acreages of lost land must be looked at in order to provide a basis for comparison. Overall, Tudor did about as complete an estimate of environmental effects as is possible.

Effects on Receptors

The effects on receptors were also studied to an adequate extent by Tudor. In terms of effect upon remaining wildlife,

both positive and negative effects exist. The reservoirs would provide excellent habitats for trout living in the area, and would be advantageous to many animal species living nearby, both in terms of food and water. Currently most of the river is followed by major highway (1), making it difficult for animals to use the river as a source of food and water, due to the disturbances caused by people and cars. Much of the reservoirs, on the other hand, would be bordered by forest. This would provide a beneficial habitat for species living in the surrounding areas.

The negative effects lie simply in the change of habitat. The ecosystems of the Poudre River basin will be disturbed, with a resulting change in the population composition of the region. In addition, human interference would be increased in some areas as a result of the increased recreational opportunities which the reservoirs would provide.

However, it is impossible to tell whether the beneficial or detrimental effects would be greater. The only thing that can be accurately said is that the effects will increase with increased project size. Thus, Alternative 8 would have the least impact, and Alternative 2 the most. Beyond this, no conclusions can be drawn.

The effects upon people in the area are a bit easier to study. In terms of direct impact upon residences, other buildings, and private land, Alternatives 1 and 2 have a much greater impact than 7 and 8. This is due to the fact that the lower ten miles of the Poudre Canyon are presently fairly

extensively developed by private land owners, and this is the section of the canyon which would be inundated by Grey Mountain Reservoir. Idylwilde Reservoir, in Alternative 2, would also inundate an extensively developed area in the upper canyon, including the town of Kinikinik.

In terms of recreation, effects are a bit harder to estimate. Currently, the Poudre Canyon provides about 200,000 visitor days (12 hour days) per year of land-based recreation, about 80% of which is camping. The Poudre River is also one of the most extensively fished rivers in Colorado. Studies indicate that fishing on the main stem averages 279 man-days per year, or a total of 112,000 visitor days per year. Increases have varied from 11 to 33 percent per year over the past ten years for various stretches of the river.(1).

Another direct effect would be upon the boating in the Poudre. During the period from 1967 to 1976, boating on the Poudre increased 2000 percent, to well over 5000 visitor days per year. This includes canoeing, kayaking, and, to a limited extent, rafting. All of these are limited pretty much to the period of runoff, usually starting in early May and extending to middle or late July.

The effect upon boating of any of the alternatives would be, for the most part, beneficial. Though short stretches of river would be lost due to inundation, alterations to stream flow resulting from the upstream projects would generally have a positive effect on recreational boating activities as a result of making stream flows more predictable, extending high and

moderate flow periods, and reducing the peak flow times, when water levels are too high for most water based activities (1). These benefits would be felt to a much greater extent with the multiple reservoir systems, due to the greater length of river in which stream flows would be altered..

In addition, the reservoirs would provide a much wider range of possibilities for recreational boating than presently exists. With any of the systems both sailing and motorboating/water skiing opportunities would arise. At this point, only two reservoirs in the Fort Collins area are large enough to provide extensive opportunities for these activities, and one of the two is closed to power boats. Both are currently over-used, especially Horsetooth Reservoir (open to power boats). Any of these alternatives would provide a much desired, and, considering the current overcrowding of Horsetooth, a needed additional large facility for water recreation for the Fort Collins area.

As far as non-water related recreational effects, the effects are harder to estimate. Though all but one of the projects (number 1) will inundate a significant number of developed recreational sites, each would in turn provide many new sites for development. Thus, it is difficult to estimate the final impact of each of the alternatives for this issue.

Finally, in order to estimate the general opinions of people in the Fort Collins area, a study was carried out by Professor David Freedman of the Department of Sociology at Colorado State University. In this study (4) he looked at

the ranking of issues by thirty groups in the Fort Collins area. A total of thirteen issues were identified as being important by test groups. Groups included water users (general), businesses, farmers and ranchers, environmentalists, homeowners, and outdoor recreation users, just to name a few. In summary, the study showed a general conflict between the interest groups regarding any water development projects. The conflicts were greatest for the proposed Grey Mountain Dam, and almost as great for the Idylwilde project. Conflicts were much lower for off-main stem storage sites such as the New Seaman Dam project. Thus, in terms of general impact, people seem to prefer Alternative 8 over the others, followed by Alternative 7, with Alternatives 1 and 2 causing much disquiet.

Values

When comparing the alternatives in order to decide which is the most feasible and reasonable project, many things must be considered. One must consider the whole picture - the monetary costs and benefits of the projects, as well as the non-monetary effects upon the environment and receptors. Also, the necessity of building any project must be considered in the first place.

The whole question of development of the Poudre River has been met with criticism and conflict from many of the residents of Fort Collins. Many look at the projects as being destructive in nature, threatening to ruin the pristine beauty of the Poudre Canyon. In general, there is an attitude that any major

change or development in the canyon will be bad.

However, one must also consider the future. Fort Collins is growing very rapidly, and it will continue to grow. Resources are quickly becoming strained, and something has to be done in order to provide additional sources of water and electricity. Growth will not be discouraged by limited water supplies, but needs will instead be met at the expense of agricultural water (6). All of these projects would provide these two resources, water to a similar degree for all four projects, and electricity to a varying extent. None of them can be considered, in the end, as bad, since they will provide resources necessary for maintaining a good quality of life in Fort Collins over the next fifty years. Though similar resources could be provided through many additional reservoirs around Fort Collins, and an additional coal fired power plant in the area, the feasibility of such projects is far below that of the Poudre projects, due both to a much lower cost effectiveness involved in building many small scattered reservoirs, and the greater impacts caused by an additional power plant and additional reservoirs in the Fort Collins area.

Thus, it can be fairly safely assumed that one of these projects, or a variation of one of these, will be built sometime in the future. The question is, which one?

In order to make a comparison, a benefit-cost analysis of each must be looked at. After all, if a project will cause a large annual loss to the investor, it must be most seriously questioned before construction begins. In addition, the re-

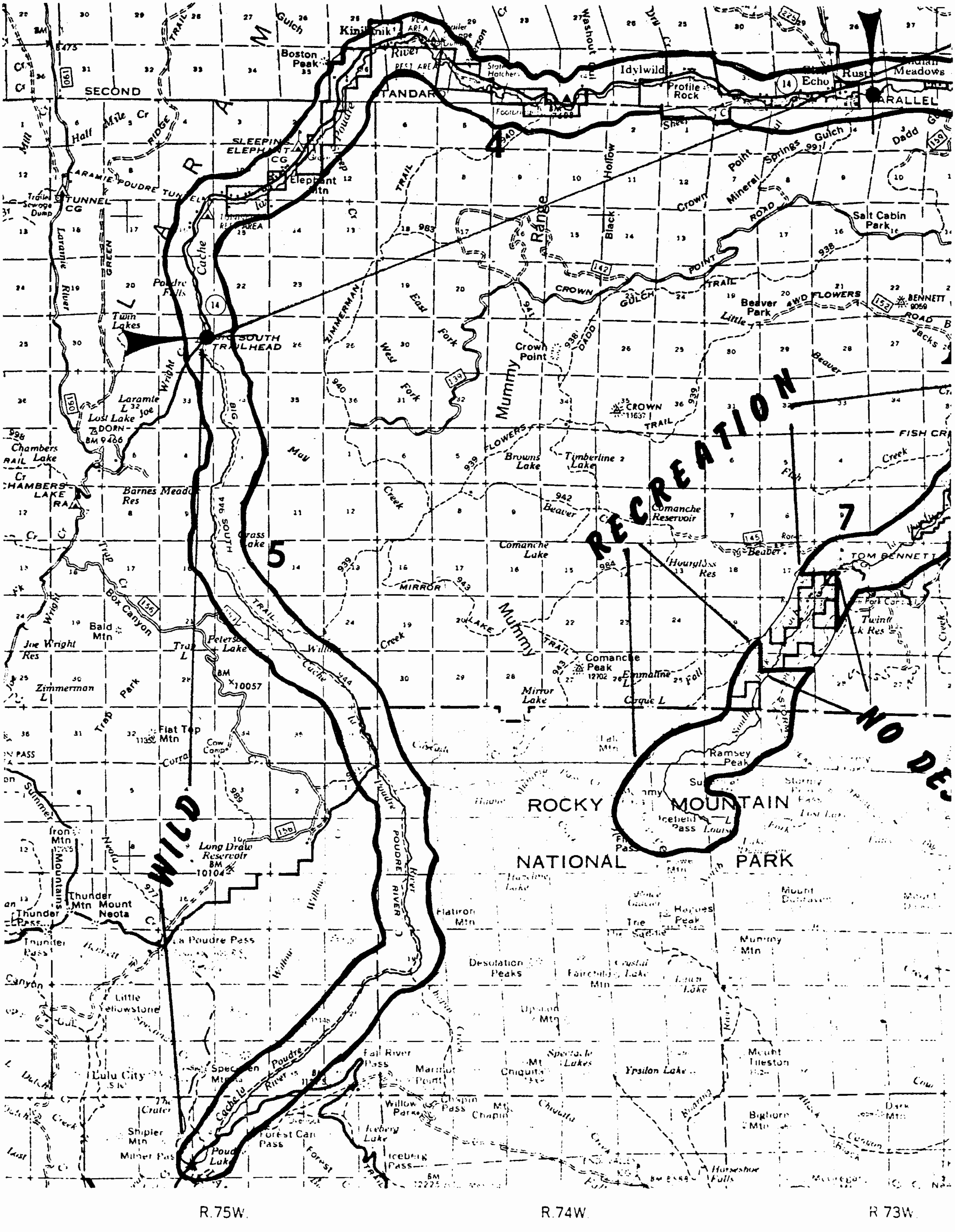
commendations for designations of the Poudre River under the Wild and Scenic Rivers Act must be considered. Considering the rapid, uncontrolled growth of activity recently occurring in the canyon, an designation such as what has been recommended by the U.S.D.A. in the 1980 draft E.I.S. is most definitely in the best interest of all Fort Collins residents interested in enjoying the use of a relatively unspoiled region of the eastern Rockies.

The purpose of the Act is to preserve rivers, which, "with their immediate environments, posess outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural, or other similar values..." Three categories exist within the Act:

1) Wild - unpolluted, undammed, with primitive surroundings, accessible only by trails
2) Scenic - undammed, with shoreline largely undeveloped, accessible by road
3) Recreational - readily accessible, with some development and preexisting dams allowed

In the draft study by th U.S.D.A., the Poudre was divided into seven sections, determined by geography and preexising development. After consideration of several different alternatives, and the social, economic, environmental, and recreational impacts of each, a recommendation which designated sections 2, 3, 4, and 7 as recreational, sections 5 and 6 as wild, and section 1 as undesignated, due to extensive preexisting development. One section of section 7 was left undesignated, to allow for the construction of a previously proposed Rockwell Reservoir. (See Figure 8).

In their formulation of Alternatives, Tudor took these



Kinikinik
Boston Peak
SECOND
STANDARD
PARALLEL
Idylwild
Profile Rock
Echo
Rustic
Indian Meadows
State Hatchery
REST AREA
Half Mile Cr
RIDGE
TRAIL
SLEEPING ELEPHANT CG
Elephant Mtn
LARAMIE POUDRE TUNNEL
TUNNEL CG
Laramie River
GREEN
Cache
Poudre Falls
BIG SOUTH TRAILHEAD
Twin Lakes
Laramie L
Joe Wright Cr
Lost Lake
DORN
Chambers Lake
CHAMBERS LAKE
Barnes Meadow Res
ZIMMERMAN
East Fork
West Fork
May Creek
Mummy Range
CROWN POINT
Crown Point
CROWN
Black Hollow
Crown Point Road
Mineral Springs Gulch
Salt Cabin Park
Dadd Gulch
Beaver Park
4WD FLOWERS ROAD
BENNETT
Little Beaver
Jacks
FLOWERS
Browns Lake
Timberline Lake
Comanche Reservoir
Comanche Lake
Beaver
Hourglass Res
TOM BENNETT
Twin Lk Res
Fish Cr
FISH CR
RECREATION
NO DES
MIRROR LAKE
Mummy
Comanche Peak 12702
Emmaline L
Cirque L
Mirror Lake
Grass Lake
BIG SOUTH TRAIL
Box Canyon
Bald Mtn
Joe Wright Res
Trap L
Peterson Lake
Zimmerman L
Trap Park
Flat Top Mtn
Cow Camp
Long Draw Reservoir
WILD
Iron Mtn
Never Summer Mountains
Thunder Mtn
Mount Neota
Thunder Pass
La Poudre Pass
Little Yellowstone
Lulu City
Specimen Mtn
Shipler Mtn
Milner Pass
Poudre Lake
Cache la Poudre River
POUDRE RIVER
Willow
Flatiron Mtn
ROCKY MOUNTAIN
NATIONAL PARK
Ramsey Peak
Iceberg Pass
Fall River Pass
Forest Can Pass
Iceberg Lake
Iceberg Pass
Willow Park
Chapin Pass
Mt Chapin
Mt Chiquita
Marmot Point
Desolation Peaks
Fairchild Mtn
Ypsilon Lake
Spectacle Lakes
Hagues Peak
Mummy Mtn
Mount Dunraven
Mount Tileston
Bighorn Mtn
Dark Mtn
Horseshoe Falls
Lawn Lake
The Saddle
Stormy Peaks
Lost Lake
Mount Dickinson
4
5
7
R.75W.
R.74W.
R 73W.

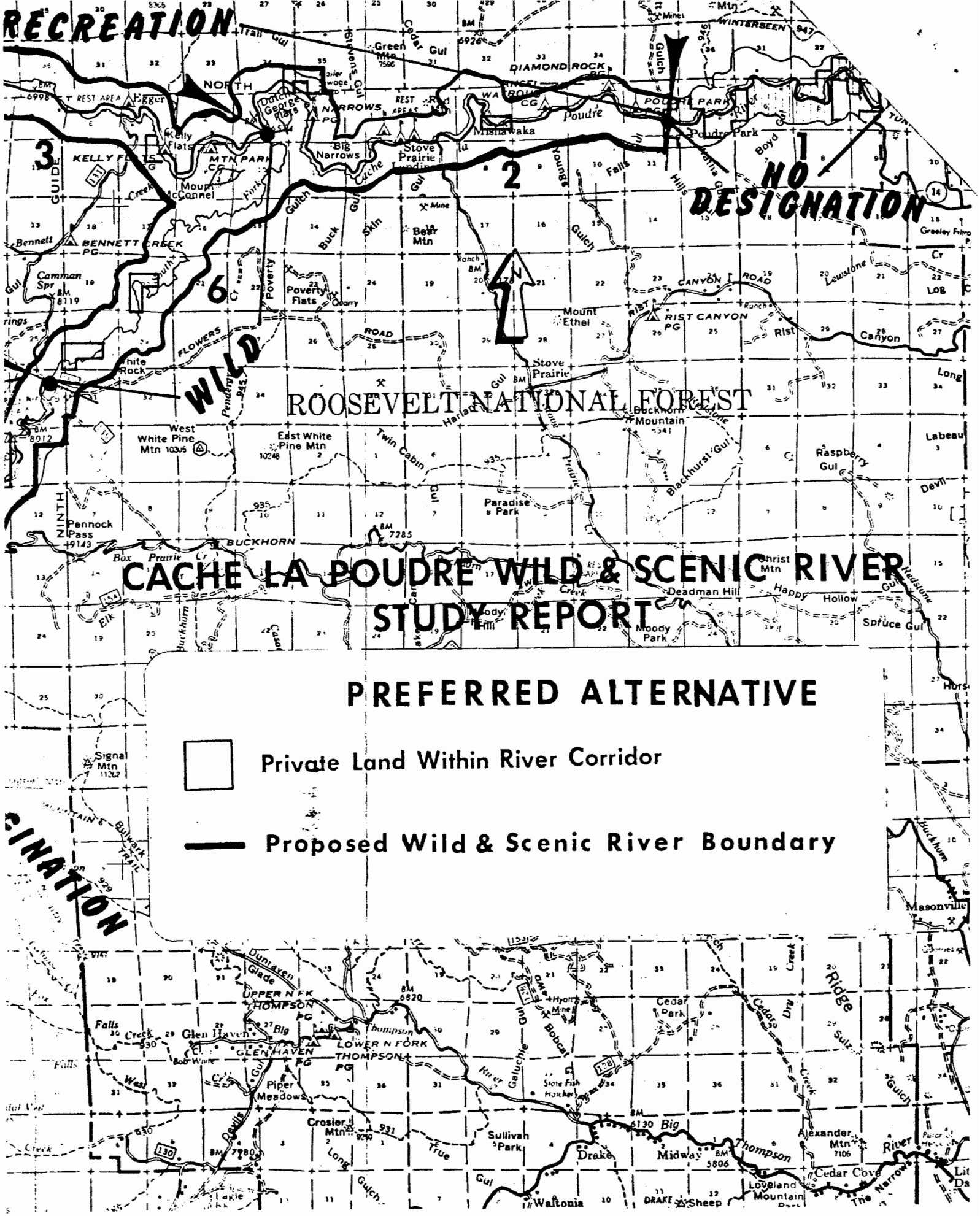

RECREATION
NO DESIGNATION
WILD
ROOSEVELT NATIONAL FOREST
CACHE LA POUDRE WILD & SCENIC RIVER STUDY REPORT
PREFERRED ALTERNATIVE
Private Land Within River Corridor
Proposed Wild & Scenic River Boundary
R 72W
R.71W
R.70W.

Figure 8

recommendations into account, thus showing a strong concern for the environment. However, even more attention should be paid to these recommended designations when deciding on the best project.

Lastly, the values and opinions of the people of Fort Collins must be considered when deciding upon a project. Interests, desires, and conflicts have been raised by the public, and these cannot be ignored. A final project will blend these desires and concerns with the economic and environmental values involved in that project.

Valuation of Projects

A detailed benefit-cost analysis of the four alternatives was conducted by Tudor Engineering in their study (Figure 9). A discount rate of 7.5% over a 100 year period was assumed. Total project cost, including construction, building relocations, and interest payments was calculated, and this was separated into run-of-river hydro costs, costs of peaking power, and conservation storage costs. Annual benefits of conservation and run-of-the river hydroelectric power were then calculated. The following benefit-cost ratios were then obtained:

Benefit-Cost Ratio	Alt.1	Alt.2	Alt.7	Alt.8
Conservation	0.36	0.36	0.43	0.44
Run-of-River Hydro	3.89	3.39	3.87	3.65
Combined	0.59	0.60	0.69	0.73

Net annual benefits ranged from -2.5 million dollars per year for Alternative 8 to well over 4.5 million dollars per year for Alternative 1. Thus, at a first glance, all projects

TABLE VIII-1
CACHE LA POUDRE PROJECT
SUMMARY OF ECONOMIC EVALUATION AT 7.5 PERCENT DISCOUNT RATE
(100 YEAR PERIOD - 1982 PRICES)
(IN THOUSANDS OF DOLLARS)

	ALTERNATIVE 1 GREY MOUNTAIN ONLY	ALTERNATIVE 8 ELKHORN ONLY	ALTERNATIVE 2 IDYLWILDE-GREY MOUNTAIN	ALTERNATIVE 7 ELKHORN-NEW SEAMAN
COSTS				
TOTAL PROJECT COST				
TOTAL CAPITAL COST	130,800	109,600	400,800	354,300
INTEREST DURING CONSTRUCTION	14,715	12,330	60,120	53,145
TOTAL ECONOMIC INVESTMENT COST	145,515	121,930	460,920	407,445
ANNUALIZED ECONOMIC INVESTMENT COST	10,920	9,150	34,590	30,580
ANNUAL O,M,&R COST	200	235	1,690	1,160
TOTAL ANNUAL ECONOMIC COST	11,120	9,385	36,280	31,740
SEPARABLE COST OF RUN-OF-RIVER HYDRO				
CAPITAL COST	6,860	8,040	8,420	6,310
INTEREST DURING CONSTRUCTION	515	605	630	475
TOTAL ECONOMIC INVESTMENT COST	7,375	8,645	9,050	6,785
ANNUALIZED ECONOMIC INVESTMENT COST	555	650	680	510
ANNUAL O,M,&R COST	155	190	220	175
ANNUAL ECONOMIC COST	710	840	900	685
BASE CONSERVATION STORAGE COST				
CAPITAL COST	123,940	101,560	123,940	101,560
INTEREST DURING CONSTRUCTION	13,945	11,425	13,945	11,425
TOTAL ECONOMIC INVESTMENT COST	137,885	112,985	137,885	112,985
ANNUALIZED ECONOMIC INVESTMENT COST	10,350	8,480	10,350	8,480
ANNUAL O,M,&R COST	45	45	45	45
ANNUAL ECONOMIC COST	10,395	8,525	10,395 1/	8,525 2/
SEPARABLE COST OF PEAKING POWER				
CAPITAL COST	N/A	N/A	268,440	246,430
INTEREST DURING CONSTRUCTION	N/A	N/A	40,265	36,965
TOTAL ECONOMIC INVESTMENT COST	N/A	N/A	308,705	283,395
ANNUALIZED ECONOMIC INVESTMENT COST	N/A	N/A	23,170	21,270
ANNUAL O,M,&R COST	N/A	N/A	1,425	940
ANNUAL ECONOMIC COST	N/A	N/A	24,595	22,210
BENEFITS-ANNUAL				
CONSERVATION PURPOSES				
MUNICIPAL AND INDUSTRIAL WATER SUPPLY	3,060	3,060	3,060	3,060
IMPROVED SYSTEM MANAGEMENT	250	250	250	250
SUPPLEMENTAL IRRIGATION WATER SUPPLY	480	430	420	390
SUBTOTAL (CONSERVATION PURPOSES)	3,790	3,740	3,730	3,700
RUN-OF-RIVER HYDRO	2,760	3,070	3,050	2,650
ECONOMIC ANALYSES				
BENEFIT-COST RATIO FOR CONSERVATION PURPOSES ONLY	0.36	0.44	0.36	0.43
INCREMENTAL BENEFIT-COST RATIO FOR RUN-OF-RIVER	3.89	3.65	3.39	3.87
BENEFIT-COST RATIO - CONSERVATION PLUS RUN-OF-RIVER	0.59 3/	0.73 3/	0.60	0.69
NET ANNUAL BENEFITS FOR CONSERVATION PURPOSES ONLY	-6,605	-4,785	-6,665	-4,825
NET ANNUAL BENEFITS - CONSERVATION PLUS RUN-OF-RIVER	-4,555 3/	-2,555 3/	-4,515	-2,860
BREAKEVEN VALUE OF PEAKING POWER (ANNUAL)	N/A	N/A	24,595	22,210
DOLLARS PER KILOWATT-YEAR	N/A	N/A	238	281
MILLS PER KILOWATT-HOUR	N/A	N/A	135	135

1/ EQUIVALENT TO ALTERNATIVE 1.

2/ EQUIVALENT TO ALTERNATIVE 8.

3/ REPRESENTS TOTAL PROJECT

Figure 9

seem economically unfeasible.

However, Alternatives 2 and 7 provide additional revenue from peaking power production. In order to calculate the cost effectiveness of each, a breakeven value was calculated for them, which is equal to the dollars per kilowatt-year which would have to be charged in order for the project to just meet its power production costs. For Alternative 2 this worked out to 238 dollars; for Alternative 7 it is 281 dollars per kilowatt-year. Both of these are significantly below the 325 dollars per kilowatt-year which would need to be charged by an alternative coal-fired plant of comparable peaking power capacity. Thus, both projects appear to be nearly equally feasible, as well as desirable over alternate sources of power such as a coal-fired plant.

This is about the extent to which the comparison between projects was carried by Tudor - no commitment was made regarding the relative values of Alternatives 2 and 7. However, when several other factors are considered, a decision of one project over the other can be made, dependent to a certain extent upon the values of that individual.

First of all, the public has expressed strong disagreement with the development of two of the sites, Grey Mountain and Idylwilde Reservoirs, as stated previously. Though it is hard to judge whether the dislike of the projects would remain as strong after their construction, it is a factor which must be considered. In addition, Alternative 2 involves the relocation or loss of many more residences and other buildings than Alter-

native 7. Though the direct costs of this were accounted for in Tudor's study, the additional, non-monetary costs incurred by residents and store owners was not figured in.

Alternative 7, on the other hand, conflicts more strongly with the Wild and Scenic Rivers proposal. Though the lower dams in both projects would have no effect, the upper reservoir for number 7 would encroach upon area recommended to be set aside as wild (area 6), unlike number 2, which falls entirely in an area recommended for recreation. Though the designations are not yet official, the construcion of Elkhorn Reservoir would require that the designation of area 6 be changed to recreational, with the resulting decrease in effective preservation of the area. It would allow development of one of the relatively few areas of currently untouched stretches of river.

In terms of recreation, both alternatives have benefits and drawbacks. Alternative 7 would provide recreational facilities closer to Fort Collins, thus requiring less traffic in the upper part of the canyon by visitors, and thus placing less stress on the upper canyon. However, it would also inundate the three most popular present campgrounds, Mountain Park, The Narrows, and Kelly Flats, and because of its proximity to Fort Collins(less than half the distance up the canyon), Elkhorn would probably cause a greater total use of the canyon, with most of the stresses of use concentrated in the lower canyon. For the purposes of boating (canoeing and kayaking), Alternative 2 would supply three times the length of controlled

stream flow over that provided by Alternative 7, making it the better project when looking at canoeing and kayaking.

Finally, there is one other factor which has not been considered earlier - that of historical values. Several state historical sites lie in the area of Kinikinik, including the Keystone Hotel, the Kinikinik Ranch, and the Home Moraine Geologic Area exhibit (also on the National Registry of Historic Places) (1). The construction of Idylwilde Reservoir would result in the loss of all of these sites. Though the magnitude of the historical value of these sites is far from overwhelming, their value must still be considered in comparing the projects.

Conclusions

So, in the end, Alternative 2 seems to provide for greater preservation of environment and provides a greater length of controlled river for recreation, as well as requiring a slightly lower breakeven charge for peaking power. Alternative 7, on the other hand, sacrifices these to a certain extent, thereby preserving several historical sites, providing more accessible recreation, and, more significantly, cause much less disturbance of current canyon residences.

The decision between these two hinges on a question of one's values. In my opinion, the small gains of slightly greater environmental preservation and slightly lower power charges are far outweighed by the inconveniences and costs which would be forced upon canyon residents in Alternative 2. In addition, readily accessible recreation is of great

value, in my opinion. Alternative 7 would most definitely provide this to a greater extent than Alternative 2. Finally, I'm not really sure how much additional strain would be put on the lower canyon. It is already extensively developed, and thus can accomodate more visitors with less strain and damage than can the upper Poudre. Much of the upper Poudre's beauty lies in the low level of current impact, due to a much lower usage by visitors than the lower Poudre. Alternative 7 would not provide for any development in this area, thus allowing it to maintain the more "untouched" atmosphere which it now maintains.

Thus, in my opinion, there is little question as to which alternative is more desirable - number 7. Though other people with different values may disagree, I feel that this alternative provides a much better balance between environmental, social, and economic values.

REFERENCES

Cache La Poudre Wild and Scenic River: Draft Environmental Impact Statement and Study Report. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, 1980. This provides the details of several alternative designations of sections of the Poudre River regarding wild and scenic classification.

Colorado Water Conservation Board Project Studies: Cache la Poudre. Denver, CO: Colorado Water Conservation Board, Department of Natural Resources, 1982. Six alternative projects dealing with the feasibility of damming various sections of the Cache la Poudre River are evaluated. The study was carried out by Tudor Engineering Company (Denver), and appears to be a very reliable source of information.

Doyle, Robert E. "Rivers Wild and Pure: A Priceless Legacy." National Geographic, July, 1977, pp. 2-11.

Freeman, David M. "Water and Public Policy Conflict in the Cache la Poudre River Basin." Colorado State University, 1982.

Interim Report on the Cache la Poudre Project Study. Denver, CO: Colorado Water Conservation Board, Department of Natural Resources, 1983. This report summerizes and gives additional information regarding the four most acceptable alternatives presented in the "Interim Report" prepared by Tudor Engineering Company. This study was carried out by the Colorado Water Conservation Board as a follow-up to the Tudor study.

Waternews. Northern Colorado Water Conservancy District, Loveland, CO, March 15, 1984.