Merced Integrated Regional Water Management Implementation Grant Proposal

Appendix 3-2

Merced County Streams California, General Design Memorandum Phase 1 Plan Formulation

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DESIGN MEMORANDUM NO. 2 MARCH 1980

MERCED COUNTY STREAMS
CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

PLAN FORMULATION

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

MERCED COUNTY STREAMS

CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

PLAN FORMULATION

MARCH 1980

Department of the Army
Sacramento District
Corps of Engineers
Sacramento, California

MERCED COUNTY STREAMS
CALIFORNIA

DESIGN MEMORANDUMS (DM)

	No.	Date	Item	Title	Approval Date
	1	Mar 75	DM	Hydrology	11 Sep 75
	2	Mar 80	DM	Phase I GDM/EIS	
*	4	Jun 81	DM	Real Estate - Castle & Bear Dams and Reservoirs	
	2	Sep 81	DM	Phase II GDM	
	5	Oct 81	DM	Feature DM - Castle Dam and Reservoir	
	6	Dec 81	DM	Feature DM - Bear Dam and Reservoir	
	7	Oct 81	DM	Site Geology - Castle Dam	
	3	Nov 81	DM	Concrete Materials (entire project)	
	8	Nov 81	DM	Site Geology - Bear Dam	
	4A	Unscheduled	DM	Real Estate - Burns and Haystack Mountain Dams and Reservoirs	
	9	Unscheduled	DM	Feature DM - Haystack Mountain Dam and Reservoir	
	10	Unscheduled	DM	Feature DM - Burns Dam and Reservoir	
	11	Unscheduled	DM	Site Geology - Haystack Dam	
	12	Unscheduled	DM	Site Geology - Burns Dam	
	13	Unscheduled	DM	Feature DM - Channel Improvements	*

Rev. Jan 1981

MERCED COUNTY STREAMS
CALIFORNIA

GENERAL DESIGN MEMORANDUM
PHASE I

PLAN FORMULATION
MARCH 1980

REVISIONS

DATE	Revised Pages or Drawings
Jan 1981	XXV, 16, 82, 83, 87, 88, 89, 90, 95, 98, IV, V, VI, VII, VIII

MERCED COUNTY STREAMS, CALIFORNIA
GENERAL DESIGN MEMORANDUM

PHASE I

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GENERAL DESIGN MEMORANDUM - PHASE I

PLAN FORMULATION

Pertinent Data for
Recommended Plan

GENERAL DATA

Name	Merced County Streams, California
Authorization	Flood Control Act of 31 December 1970 Public Law 91-611 Sec 201, 84 Stat 1824
Streams	Bear Creek Burns Creek Black Rascal Creek Canal Creek Black Rascal Slough Fahrens Creek Cottonwood Creek El Capitan Canal
Counties and State	Merced and Mariposa; California
Purpose	Flood control, and recreation.

DRAINAGE AREAS

Bear Reservoir	72.1 sq. mi.
Burns Reservoir	72.2 sq. mi.
Haystack Reservoir	18.3 sq. mi.

Drainage areas (Cont'd)

Castle Reservoir	28.2 sq. mi.
Lower Bear Cr. Channel	254.0 sq. mi.
Bear Creek above W. 16th St.	204.0 sq. mi.
Fahrens Creek and tributaries	40.4 sq. mi.

RESERVOIR DATA:

CASTLE RESERVOIR

Dam

Type - Impervious core with random fill upstream and downstream, with transition zones between core and random fill.

Top of dam (crest) elevation	220.5	feet 1/
Freeboard above spillway flood pool	3.5	feet
Crest width	20	feet
Crest length	2,250	feet
Side slopes		
Upstream	1 V on 3.0 H 2/	
Downstream	1 V on 2.5 H	
Maximum height (bottom of core trench to crest)	52.5	feet
Total excavation (incl. borrows)	41,100	C.Y.
Total volume of embankment	150,000	C.Y.

Dikes

Type - Homogeneous earthfill		
Crest width	20	feet
Crest length	4,090	feet
Side slopes		
Upstream	1 V on 3.0 H	
Downstream	1 V on 2.5 H	
Total excavation (incl. borrows)	32,900	C.Y.
Total volume of embankment	37,700	C.Y.

Spillway

Type - Perched spillway with an unlined approach and discharge channel.		
Spillway (ungated) - Concrete control sill		
Crest length	8.5	feet
Crest width	300	feet

1/ All elevations mean sea level
2/ 1 vertical (v) on 3.0 horizontal (H)

Spillway data (Cont'd)

Crest elevation	212.5	feet
Spillway length		
Discharge channel	860	feet
Approach channel	800	feet
Spillway side slopes		
Discharge channel	1 V on 2 H	
Approach channel	1 V on 2 H	
Total excavation	175,000	C.Y.

Outlet works

Type - Ungated riser intake (drop inlet structure), gated irrigation bypass, cut-and-cover conduit, exit structure (impact basin) and exit channel.

Location - Foot of left abutment		
Riser - Rectangular cross section		
Height from conduit invert to riser crest elevation	21.5	feet
1 - side drop inlet		
Crest Elevation	202.5	feet
Length	5	feet
1 - 2' wide by 1.5' high port invert elevation	183.0	feet
1 - 7.0' diameter reinforced concrete cut-and-cover conduit		
Intake elevation		
Riser crest	202.5	feet
Low level port	183.0	feet
Irrigation bypass	181.0	feet
Conduit invert	181.0	feet
Impact basin		
Width	22	feet
Total length	30	feet
Exit channel		
Side slope	1 V on 1 H	
Length	30	feet
Width	22	feet

Outlet works (Cont'd)

Reservoir pool data

Reservoir pool elevations		
Gross pool	211.0	feet
Spillway design flood pool	217.0	feet
Reservoir areas		
At gross pool	780	acres
At spillway design flood pool	1,310	acres
Reservoir storage		
At gross pool	7,100	acre-feet
At spillway design flood pool	13,100	acre-feet
Perimeter at gross pool	19.5	miles
Length of reservoir	6.9	miles

Hydrology

Runoff, average annual (estimated unimpaired)	3,830	acre-feet
Flow		
Mean annual at damsite	5	cfs
Standard project flood peak inflow	4,100	cfs
Standard project flood peak outflow	570	cfs
Spillway design flood peak inflow	9,050	cfs
Spillway design flood peak outflow	1,900	cfs

HAYSTACK MOUNTAIN RESERVOIR

Dam

Type - Impervious core with random fill shells upstream and downstream with transition zones between core and random fill.		
Top of dam (crest) elevation	313.0	feet
Freeboard above spillway flood pool	3.0	feet
Crest width	20	feet
Crest length	2,245	feet
Side slopes		
Upstream	1 V on 2.5 H	
Downstream	1 V on 2.5 H	
Maximum height (bottom of core trench to crest)	78	feet
Total excavation (incl. borrows)	514,000	C.Y.
Total volume of embankment	545,000	C.Y.

Spillway data

Type - Perched spillway with an unlined approach and discharge channel.		
Spillway (ungated) - Concrete control sill		
Crest length	20	feet
Crest width	210	feet
Crest elevation	305.0	feet
Spillway length		
Discharge channel	570	feet
Approach channel	400	feet
Slope of discharge channel	2.0%	
Spillway side slopes		
Discharge channel	1 V on 2 H	
Approach channel	1 V on 2 H	
Total excavation	189,000	C.Y.

Outlet works

Type - Ungated riser intake (drop inlet structure), cut-and-cover conduit, exit structure (impact basin) and exit channel.		
Riser - Rectangular cross section, ungated Height from conduit invert to crest elevation	37.5	feet

c. Outlet works (Cont'd)

2 - side drop inlets		
Crest elevation	296.5	feet
Length	17.25	feet
1 - 3.9' wide by 1.0' high port		
invert elevation	265.0	feet
Conduit - number and size		
1 - 5.75-foot-diameter cut-and-cover conduit - 245 feet long		
Intake elevation		
Riser crest	296.5	feet
Low level port	265.0	feet
Conduit invert	259.0	feet
Impact basin		
Width	29	feet
Total length	39	feet
Exit channel		
Side slope	1 V on 2 H	
Width	29	feet
Length	68.5	feet

Reservoir pool data

Reservoir pool elevations		
Gross pool	299.0	feet
Spillway design flood pool	310.0	feet
Reservoir areas		
At gross pool	425	acres
At spillway design flood pool	785	acres
Reservoir storage		
At gross pool	5,800	acre-feet
At spillway design flood pool	12,600	acre-feet
Perimeter at gross pool	6.4	miles
Length of reservoir	2.3	miles

Hydrology

Runoff, average annual (estimated)	2,080	acre-feet
Flow		
Mean annual at damsite (estimated)	3	cfs
Standard project flood peak inflow	3,800	cfs

Hydrology (Cont'd)

Standard project flood peak outflow	450	cfs
Spillway design flood peak inflow	10,250	cfs
Spillway design flood peak outflow	1,300	cfs

BURNS RESERVOIR

Dam

Type - Extension and expansion of existing impervious earthfill dam by use of random fill.		
Top of dam (crest) elevation	334.5	feet
Freeboard above spillway flood pool	4.0	feet
Crest width	20	feet
Crest length	4,800	feet
Side slopes		
Upstream	1 V on 3 H	
Downstream	1 V on 3 H	
Maximum height (bottom of core trench to crest)	68	feet
Total excavation (incl. borrow)	1,160,000	C.Y.
Total volume of embankment	972,000	C.Y.

Dikes

Type - Existing impervious earthfill enlarged with random fill.		
Crest width		
Sta 168+16.40 to Sta 201+56.40	20.0	feet
Sta 0+27.00 to Sta 98+74.00 and Sta 0+00.00 to Sta 16+80.00	12.0	feet
Crest length	14,870	feet
Side slopes		
Upstream	1.0 V on 3.0 H	
Downstream	1.0 V on 3.0 H	
Total excavation (incl. borrows)	included in dam quantity	
Total volume of embankment	included in dam quantity	

Spillway data

Type - Existing spillway would be removed and replaced by a 40-foot-wide ungated ogee section with stilling basin.		
Crest width	53	feet
Crest elevation	315.0	feet
Spillway length		
Discharge channel	130	feet

Spillway data (Cont'd)

Approach channel	130	feet
Slope of discharge channel	33.3%	
Stilling basin		
Width	53	feet
Apron elevation	253.1	feet
Total length	77	feet
Exit channel		
Side slope	1 V on 2 H	
Length (approximately)	380	feet
Total excavation	44,700	C.Y.

Outlet works

Type - Existing conduit would be removed and replaced by 3.75' diameter modified circular conduit at existing location. Exit structure (impact basin) and exit channel.

Conduit - number and size
1 - 3.75-foot-diameter modified circular conduit - 395 feet long

Intake elevation		
Conduit invert	266.0	feet
Impact basin		
Width	24	feet
Total length	32	feet
Exit channel		
Side slope	1 V on 2 H	
Width	24	feet

Reservoir pool data

Reservoir pool elevations		
Gross pool	315.0	feet
Spillway design flood pool	330.5	feet
Reservoir areas		
At gross pool	1,540	acres
At spillway design flood pool	2,700	acres
Reservoir storage		
At gross pool	22,600	acre-feet
At spillway design flood pool	54,000	acre-feet
Perimeter at gross pool	18.3	miles

Reservoir pool data (Cont'd)

Length of reservoir	3.8	miles

Hydrology

Runoff, average annual (1922-48 estimated, 1949-72 recorded)	13,330	acre-feet
Flow		
Mean annual at damsite	18	cfs
Standard project flood peak inflow	15,000	cfs
Standard project flood peak outflow	1,800	cfs
Spillway design flood peak inflow	29,000	cfs
Spillway design flood peak outflow	8,500	cfs

BEAR RESERVOIR

Dam

Type - Extension and expansion of existing earthfill dam. New section at the right abutment will be earthfill with impervious core and a random fill upstream and downstream with transition zones between core and random fill.

Top of dam (crest elevation)	480.5	feet
Freeboard above spillway flood pool	5.0	feet
Crest width	20	feet
Crest length	3,165	feet
Side slopes (new section)		
Upstream	1.0 V on 2.75 H	
Downstream	1.0 V on 2.0 H	
Side slopes (modified existing section)		
Upstream	1 V on 2 H	
Downstream	1 V on 2 H	
Maximum height (bottom of core trench to crest)	138	feet
Total excavation (incl. borrows and existing dike)	1,600,000	C.Y.
Total volume of embankment	1,540,000	C.Y.

Spillway data

Type - Existing spillway would be abandoned and replaced with 90-foot-wide ungated ogee spillway with stilling basin.

Spillway data

Crest length	90	feet
Crest elevation	455	feet
Approach channel		
Type - unlined trapezoidal		
Bottom width	90	feet
Side Slopes	1 V on 2 H	
Total length	1,400	feet
Slope	0.4%	adverse
Discharge chute		
Total length	96	feet
Slope	33%	constant
Stilling basin		
Width	90	feet
Apron elevation	388	feet
Total length	110	feet
Exit channel		
Side Slope	1 V on 2 H	
Width	100	feet
Length	550	feet
Total excavation	530,000	C.Y.

Outlet works

Type - Conduit would be gated in a dual passage gate section. Major portion of existing 7-foot diameter cut-and-cover conduit would be used. Exit structure (stilling basin) and exit channel.

Conduit - number and size

- 2 - 7.0' H x 3.5' W rectangular conduit - 37 feet long
- 1 - Transition from 2 - 7.0' H x 3.5' W rectangular conduit to 7.0' diam. circular conduit. - 46.0 feet long
- 1 - 7.0' diameter circular conduit - 460 feet long
- 1 - Transition from 7.0' diameter circular conduit to 7.0' H x 5.25' W rectangular conduit - 20.0 feet long
- 1 - 7.0' H x 5.25' W rectangular conduit - 5.0 feet long

Intake elevation

Conduit invert	344.0	feet

Outlet works (Cont'd)

Gates	
Bulkhead	1-3'-6" wide by 9'-4" high
Service	1 - slide gate 3'-6" x 7'-0"
Emergency	1 - slide gate 3'-6" x 7'-0"
Stilling basin	
Width	20 feet
Apron elevation	326.7 feet
Total length (including parabolic drop)	142 feet
Exit channel	
Slope	1 V on 10 H adverse
Width	40 feet

Reservoir pool data

Reservoir pool elevations	
Gross pool	455.0 feet
Spillway design flood pool	475.5 feet
Reservoir areas	
At gross pool	545 acres
At spillway design flood pool	650 acres
Reservoir storage	
At gross pool	24,000 acre-feet
At spillway design flood pool	36,300 acre-feet
Perimeter at gross pool	18.8 miles
Length of reservoir	4.4 miles

Hydrology

Runoff, average annual (1956-1972 recorded)	19,020 acre-feet
Flow	
Mean annual at damsite	26 cfs
Standard project flood peak inflow	20,900 cfs
Standard project flood peak outflow	4,200 cfs
Spillway design flood peak inflow	38,850 cfs
Spillway design flood peak outflow	27,000 cfs

LEVEE AND CHANNEL MODIFICATION

	LOWER BEAR CREEK				UPPER BEAR CREEK
	Drain Channel	Bear Creek Bypass	Bear Creek	Black Rascal Slough	Bear Creek
	E.S. Bypass to E.S. Canal	E. S. Canal to Crane Road	Crane Rd. to Crocker Dam		Above Crocker Dam
Length (miles)	3.7	4.0	9.4	7.4	1.1
Levee improvements					
Length (stream miles)	3.7	4.0	2.4	5.4	0.6
Avg. height of levees (feet)	9	7	6.5	6	4.5
Crown width of levees (feet)	12	12	12	12	12
Landside slope	IV on 2H	1V on 2H	1V on 2H	1V on 2 H	1V on 2H
Waterside slope	IV on 3H	1V on 3H	1V on 3H	1V on 3 H	1V on 3H
Riprap length (feet)	150	-	600	2,400	-
Road resurfacing on existing levees					
Length (stream miles)	-	-	7	2	0.5 1/
New Channel excavation					
Length (stream miles)	3.7	4.0	4.8	5.4	0.6
Avg. bottom width feet	140	150	60	40	120
Avg. depth (feet)	6	5	9	8	12
Project design flows (cfs)	9,000	6,500	2,000	4,500	7,000

1/ Raise road to act as levee

LEVEE AND CHANNEL MODIFICATION

FAHRENS CREEK

STREAM / REACH	Fahrens Crk. Bear Crk. to Cottonwood Crk.	Fahrens Crk. Above Cottonwood Crk.	Black Rascal Crk. Fahrens Crk. to G. Street	Cottonwood Crk.	El Capitan Canal
Length (miles)	3.4	0.8	1.6	1.1	0.9
Levee Improvements					
Length (stream miles)	3.4	0.8	1.2	1.1	0.9
Avg. height of levees (feet)	7	5	4	4.5	9 Crown
Width of levees (feet)	12	12	12	12	12
Landside slope	1V on 2H	1V on 2H	1V on 2H	1V on 2H	1V on 2H
Waterside slope	1V on 3H	1V on 3H	1V on 3H	1V on 3H	1V on 3H
Riprap length (feet)	2,300	-	150	-	-
New Channel excavation					
Length (stream miles)	2.2	0.8	1.6 1/	0.8	-
Avg. botton width (feet)	100	60	30	40	-
Avg. depth (feet)	10	7	9	7	-
Project design flows (cfs)	7,000	6,300	1,800	1,900	negligible

1/ Includes 0.4 miles of concrete box channel

RELOCATIONS AND MODIFICATIONS

Item	Castle Reservoir	Haystack Mt. Reservoir	Burns Reservoir	Bear Reservoir	Fahrens & Tributaries	Bear Creek	Drain Channel
State highway bridges replaced	-	-	-	-	1	-	-
Local road bridges replaced	-	-	-	-	9	-	-
New local road bridges	-	-	-	-	-	1	-
New private road bridges	-	-	-	-	-	2	1
Private road bridges modified	-	-	-	-	1	-	-
Railway bridges replaced	-	-	-	-	3	-	-
Abandoned railway bridge removed	-	-	-	-	1	-	-
Residential homes	2	-	-	-	-	-	-
Barns & associated structures	-	1	1	1	-	-	-
Powerline (mi)	0.5	-	0.6	-	0.8	0.8	-
Telephone lines (mi)	-	-	-	-	0.9	0.6	-
Television cable (ft)	-	-	-	-	400	350	-
R.R. Tel & Tel Signal Line (feet)	-	-	-	-	500	-	-
Waterlines (mi)	-	-	-	-	.5	-	-
Sewerlines (mi)	-	-	-	-	.4	-	-
Gaslines (mi)	-	-	-	-	.5	-	-
Irrigation lines and canals (mi)	-	-	-	-	1.2	6.3	-
Fencing (mi)	-	-	-	-	4.7	39.4	-
Roads (mi)	0.3	-	1.5	-	-	0.5	-
Storm Drain (mi)	-	-	-	-	0.9	-	-
30" x 30" Concrete Drain Strs (ea)	-	-	-	-	5	6	-
Concrete spillways (ea)	-	-	-	-	-	9	-
Drag gates (Barbed wire) (ea)	-	-	-	-	-	74	-
Wire mesh gates (ea)	-	-	-	-	-	15	-
42" Irrigation siphons (ea)	-	-	-	-	2	-	-
Inverted siphons (ea)	-	-	-	-	-	3	1
Drainage pump modification (Job)	-	-	-	-	1	-	-
Relocate pump structure (Job)	-	-	-	-	-	1	3

RECREATION FACILITIES

Biketrails		
10-foot-wide blacktop bikeway	6	mi
Location - on top of the levees along those sections of Black Rascal and Fahrens Creeks north of State Highway 99.		
Staging areas		
Quantity	2	
Location - one at each end of Fahrens Creek		
Facilities		
Graveled parking area for 10 cars		
4 picnic tables		
Potable water supply		
Chemical restrooms		
Access ramps		
Quantity	3	
Location - strategic locations along the levee		
Bridge - would link the Fahrens and Black Rascal portions of the trail.		
Activity mix		
Bicycling	60%	
Pedestrian activities	35%	
Equestrian activities	5%	

FISH AND WILDLIFE PROJECT IMPACTS

Unavoidable detrimental impact		
Cultivated agriculture removed	316	acres
Grassland removed	905	acres
Riparian habitat removed	45	acres
Marshland	25	acres
Beneficial impacts		
Habitat preserved		
Freshwater marshland	2800	acres
Grassland	111	acres
Riparian	14	acres
Habitat created		
Freshwater marshland	25	acres
Riparian	45	acres

ECONOMICS

Cost (7-1/8 interest rate, 1 Oct 1979 price level)

* Total Federal first cost 1/	$67,100,000
Total non-Federal first cost	14,000,000
Total first cost	$81,100,000
Total Federal annual cost 2/	$ 4,966,500
Total non-Federal annual cost	1,127,000
Total annual cost	$ 6,093,500

Justification (7-1/8% interest rate, 1 Oct 1979 price level)

Average annual benefits	
Flood control	$ 6,380,000
Recreation	62,000
Employment	500,000
Total average annual benefits	6,942,000
Net benefits	$ 848,500
Benefit-cost ratio	1.14 to 1

1/Of the $67,100,000 first cost, Non-Federal interests will reimburse the Federal government $130,000 for their share of the recreation facilities and $111,000 for their share of the mitigation facilities.

2/Cost includes an adjustment for recreation and mitigation reimbursements. *

Rev. Jan 1981

Merced County Streams, California
General Design Memorandum - Phase I
Plan Formulation

CHAPTER I - INTRODUCTION

1. GENERAL.

a. Authorization. - The project for Merced County Streams, California, was authorized by Section 201 of the Flood Control Act of 31 December 1970 (Public Law 91-611 Sec 201, 84 Stat. 1824). The project, as shown on Plate I, is authorized for flood control, irrigation, recreation, and fish and wildlife enhancement, and is comprised of: (1) three new detention dams (Castle, Haystack Mountain, and Marguerite): (2) enlargement and modification of four existing detention dams (Burns, Bear, Owens, and Mariposa); and (3) about 52 miles of levee and channel modifications. Plate I shows the authorized plan of improvement.

b. PURPOSE AND SCOPE OF STUDY. - The purpose of the Phase I GDM studies is to determine what changes, if any, should be made in the authorized project plan before proceeding to construction. A decade has passed since the authorization. Significant physical, economic, and social changes have occurred in the areas affected by the project. In addition, public attitudes and agency evaluation criteria regarding water resources development have changed. Therefore, the studies include a reassessment of flood control and water-related needs and opportunities in the study area; reexamination of possible alternatives to the authorized plan; reevaluation of project impacts and mitigative and enhancement measures; and coordination with agencies, interest groups, and the general public. The Phase I GDM is primarily a planning document; studies are of feasibility scope. Project designs have been refined only to the level of detail necessary to make realistic cost estimates and adequately define significant project impacts. Detailed disigns and cost estimates, cost allocations, final land requirements, etc. will be determined during the Phase II GDM studies. Included in the feasibility-scope cost estimates is a contingency item to cover modifications that may be found necessary as a result of more detailed designs. The Phase I GDM has been prepared in accordance with Engineer Regulations 1105-2-920 and 1110-2-1150. Although not specifically required, planning and formulation of the project has been essentially in conformance with the Water Resources Council's Principles and Standards.

2. Requirements of local cooperation. - The requirements of local cooperation, as recommended by the Chief of Engineers in his report dated 25 November 1970, are presented below. The project was authorized substantially in accordance with that report; the report

has not been printed as a Congressional document. Prior to construction, assurances shall be furnished to the satisfaction of the Secretary of the Army that for:

a. All projects. -

Local interests will:

(1) Provide guidance and leadership in preventing unwise future development of the flood plain by use of appropriate flood plain management techniques to reduce flood losses; and

(2) At least annually, inform affected interests of the degree of protection provided by the project.

b. Castle Dam and Reservoir. -

The Merced Irrigation District will:

(1) Continue to divert up to 1,000 cubic feet per second of the floodflows of Fahrens Creek at the Merced Irrigation District main canal into Yosemite Lake;

Local interests will:

(1) Repay an appropriate part of the initial construction costs allocated to recreation and fish and wildlife, such repayment presently estimated at $1,695,000;

(2) Finance, when needed, one-half of the cost of required facilities for future recreation, an amount presently estimated at $745,000;

(3) Assume responsibility for maintenance and operation of recreation facilities; and

(4) Settle all claims for water rights pertaining to establishment and use of a permanent pool for recreation purposes.

c. Burns Reservoir -

Local interests will:

(1) Repay an appropriate part of the initial construction costs allocated to recreation and fish and wildlife, such repayment presently estimated at $2,265,000;

(2) Finance, when needed, one-half of the cost of required facilities for future recreation, presently estimated at $590,000;

(3) Assume responsibility for maintenance and operation of

recreation and fish and wildlife facilities; and

(4) Settle all claims for water rights pertaining to establishment and use of a permanent pool for recreation purposes.

d. Mariposa Reservoir -

Local interests will:

(1) Repay an appropriate part of the initial construction cost allocated to recreation and fish and wildlife, such repayment presently estimated at $655,000;

(2) Finance, when needed, at least one-half of the cost of required facilities for future recreation, presently estimated at $550,000;

(3) Assume responsibility for maintenance and operation of recreation and fish and wildlife facilities; and

(4) Settle all claims for water rights pertaining to establishment and use of a permanent pool for recreation purposes.

e. Supplemental levee and channel improvements -

Local interests will:

(1) Furnish without cost to the United States all lands, easements, and rights-of-way necessary for construction;

(2) Make all necessary relocations and alterations to existing improvements, including highway facilities, which may be required for construction of the project;

(3) Hold and save the United States free from damages due to the construction works:

(4) Maintain and operate after completion the levee and channel improvements as well as existing project channels in accordance with regulations prescribed by the Secretary of the Army;

(5) Prevent encroachment of any type that would impair flood control effectiveness of the project works; and

(6) Preserve, or restore and thereafter maintain, at the capacities prevailing in 1968 (ref. pg 19), the other flood channels of Merced County streams which are within proposed project limits but are not to be improved by the proposed project.

3. Existing improvements. - The existing flood control improvements in the Merced area are described below. A more detailed description

can be obtained in the Merced County Streams Review Report, dated June 1969 and in the Hydrology DM, dated March 1975.

a. Federal. - The currently authorized project is a modification of the Merced County Stream Group, California, project authorized by the 1944 Flood Control Act (Public Law 78-534, 78th Congress, 2nd Session). The plan for the existing project was presented in House Document No. 473, 78th Congress, 2nd Session, "Merced County Streams, California," published in 1944. Construction of the project was initiated in 1948, completed in Fiscal Year 1957 and the requirements of local cooperation are being complied with. The completed project includes four flood detention reservoirs generally east of the city of Merced, as tabulated below.

EXISTING RESERVOIRS

Name	Capacity (acre-feet)
Burns	7,000
Bear	7,700
Owens	3,600
Mariposa	15,000

The project also includes downstream channel restoration and enlargement and two diversion channels. Except for emergency flood control repair work, there are no other significant Federal flood control works in the stream group. The Corps of Engineers has been operating and maintaining the existing project reservoirs since their completion. Operation and maintenance of the existing project channel works has been the responsibility of local interests.

b. State. - The State of California has constructed the Eastside Bypass, a unit of the San Joaquin River Flood Control Project. This bypass carries excess San Joaquin River flow from a point below Fresno to a point just upstream from the Merced River. As a part of this project the channels of Bear and Owens Creek were improved below the Eastside Canal.

c. Local. - The Merced Irrigation District has constructed an extensive irrigation system within the project area. The major features of this system are the Snelling Diversion Dam located on the Merced River; Yosemite Lake, an offstream storage and regulation reservoir; Main Canal located between the diversion dam and Yosemite Lake; and Fairfield and LeGrand Canals which distribute water from Yosemite Lake. These facilities provide some flood protection to Castle Air Force Base and the agricultural lands north of Merced.

4. Current studies have shown that enlargement of Mariposa and Owens Reservoirs, construction of Marquerite Reservoir, and modifications of channels in the Mariposa and Deadman-Dutchman Stream groups are not economically justified at this time. These features of the authorized

project are therefore being deferred for future consideration. These studies also show that enlargement of Bear and Burns Reservoirs, construction of the new reservoirs, (Castle on Canal Creek and Haystack Mountain Reservoir on Black Rascal Creek), and levee and channel improvements on Fahrens, Black Rascal, and Bear Creek are economically justified. In addition local interests have strongly objected to recreation at the reservoirs but support bicycle and hiking trails along the downstream channels. Therefore, the project proposed in this design memorandum consists of only those economical and desireable features for flood control and recreation for the Bear Creek Stream Group.

CHAPTER II - AUTHORIZED PROJECT

5. Highlights of authorized plan. - As previously stated, the authorized project consists of: (1) three new detention dams, (2) enlargement and modification of the four existing detention dams, and (3) about 52 miles of levee and channel modifications. Streams within the study area can be divided into three main groups; (1) Bear - consisting of Bear, Burns, Black Rascal, Fahrens, and Canal Creeks; (2) Mariposa - consisting of Mariposa, Ownes, and Miles Creeks; and (3) Deadman-Dutchman - consisting of Deadman and Dutchman Creeks. The authorized plan contemplated providing about 100-year flood protection (1 percent chance of occurrence in any one year) to most of the urban areas in the City of Merced and nearly 50-year protection to surrounding agricultural lands. Tabulated below are data on costs and benefits as well as the physical features for the authorized project. Plate I shows the authorized project features. Additional detailed information is available in the feasibility report, "Review Report for Flood Control on Merced County Streams, California," Sacramento District, Corps of Engineers, June 1969.

ECONOMIC JUSTIFICATION
AUTHORIZED RESERVOIRS AND CHANNELS
(Discount Rate 4-5/8%, 1969 Price Level)

Item/Stream Group	Bear	Mariposa	Deadman-Dutchman	Total
First cost, ($1,000)	18,560	11,070	6,310	35,940
Annual costs, ($1,000)	1,207	670	335	2,212
Annual benefits,($1,000)	2,504	1,024	665	4,193 1/
Benefit-cost Ratio	2.1 to 1	1.5 to 1	2.0 to 1	1.9 to 1/

1/ Includes area redevelopment (employment) benefits of $355,000.

PERTINENT DATA
AUTHORIZED STORAGE FACILITIES

Item/Reservoir	Bear Group				Mariposa Group		Deadman-Dutchman Group
	Castle	Haystack Mtn.	Burns	Bear	Owens	Mariposa	Marguerite
Use 1/	F,R	F	F,R	F	F	F,I,R	F,I
Drainage area, sq mi	27.3	18.3	73.8	72.1	25.6	108.0	64.1
Gross storage cap., acre-ft	11,500	3,000	30,000	14,400	4,800	50,000	13,000
Inactive capacity, acre-ft	1,500	300	2,300	400	300	3,000	2,000
Max. flood space, acre-ft	2,700	2,700	14,000	14,000	4,500	25,000	7,000
Gross pool area, acres	1,100	260	1,840	380	210	1,260	1,490
Gross pool elev., feet	202.5	290.5	319	434	414	481	296.6
Dams - earthfill							
Maximum height, feet	44	59	72	109	81	130	44
Total length, feet	15,800	2,300	17,000	2,700	13,000	5,600	20,700
Crest elevation, feet	214	313	337	452.5	428	499.5	306.5
Spillways - concrete							
Gates	No	No	No	No	No	No	No
Crest elevation, feet	202.5	290.5	319	434	414	481	296.6
Crest length, feet	97	15	40	141	95	260	425
Spillway design flow, cfs	10,400	20,000	26,800	30,400	11,400	43,400	22,400
Spillway des. flow elev., ft	209	308	332	448	423	494	301
Outlets - gated, concrete							
Number	1	1	3	1	1	1	2
Capacity, cfs	800	1,500	2,000	800	110	1,100	1,100
Cost - 4-5/8%, 1969 Prices							
First cost ($ x 1,000)	5,700	2,520	6,130	2,200	860	6,630	5,740
Annual cost ($ x 1,000)	358	138	364	116	44	376	300

1/ F - Flood control, I - Irrigation, R - Recreation plus fish and wildlife enhancement.

PERTINENT DATA
AUTHORIZED CHANNELS
(Discount Rate 4-5/8%, 1969 Price Level)

Item/Stream Group	Bear Creek	Mariposa Creek	Deadman Creek
Channel length, (miles)	20.6	24.1	7.4
Capacity, (cfs)	5,500	3,800	1,300
First cost, ($ 1,000)	1,990	3,580	570
Annual costs, ($ 1,000)	112	210	35

CHAPTER III - PROBLEMS AND NEEDS

6. General. - The Merced County Streams group area lies in the San Joaquin Valley in Merced and Mariposa Counties, California. The stream groups lie easterly of and drain into the San Joaquin River (via the Eastside Bypass) between the Chowchilla River on the south and the Merced River on the north, generally as shown on Plate I. These streams drain about 450 square miles of watershed area within the foothills of the Sierra Nevada and about 330 square miles of valley area entirely within Merced County. The Merced County streams are naturally intermittent; most of their channels are used in the valley to convey water from the Merced River for local irrigation. Because of the relatively low elevations of the drainage basins, floods originate almost entirely from rainfall without being significantly affected by snowmelt. Rainfall occurs mostly in the winter and early spring, with only scattered showers, generally occurring during the rest of the year.

7. The city of Merced, the communities of Le Grand and Planada, Castle Air Force Base, and several other small communities are the main urban- type development in the flood plain. However, the flood plain and adjacent areas are primarily agricultural with diversified, irrigated crop farming predominating. The flood plain encompasses the large Merced Irrigation District, the smaller Le Grand - Athlone Water District, and El Nido Irrigation District. Industry and manufacturing are confined mainly to Merced County and are generally limited to the processing of agricultural products. The area is adequately served by several transportation facilities including main lines of the Atcheson, Topeka, and Santa Fe, and Southern Pacific railroads, and Federal, State, and county highways. The populations of Merced County and the city of Merced have increased rapidly since 1930. Much of the development has been due to Castle Air Force Base and to expansion of irrigation throughout the county. Populations of Merced County and the city of Merced in 1978 were estimated at about 123,600 and 32,800, respectively. Population in Merced County is currently increasing at a rate of about 3 percent per year. A more intensive agricultural use is also developing in flood plain areas.

8. Flood control. -

a. Basis of authorized project. - Flood problems within the study area are caused by heavy rainstorms that can occur during the period from October through April. Rainstorms can either be general storms, producing widespread, heavy precipitation throughout the basin or local storms, producing extremely heavy, short-term precipitation over small areas within the basin. Although other water resource problems and needs have been identified in the study area, the flood problems are of primary importance and the reason local agencies requested a review of the existing flood control project. Floods or threats of floods occur almost every year. Plate II shows the extent of the flood problem under existing conditions.

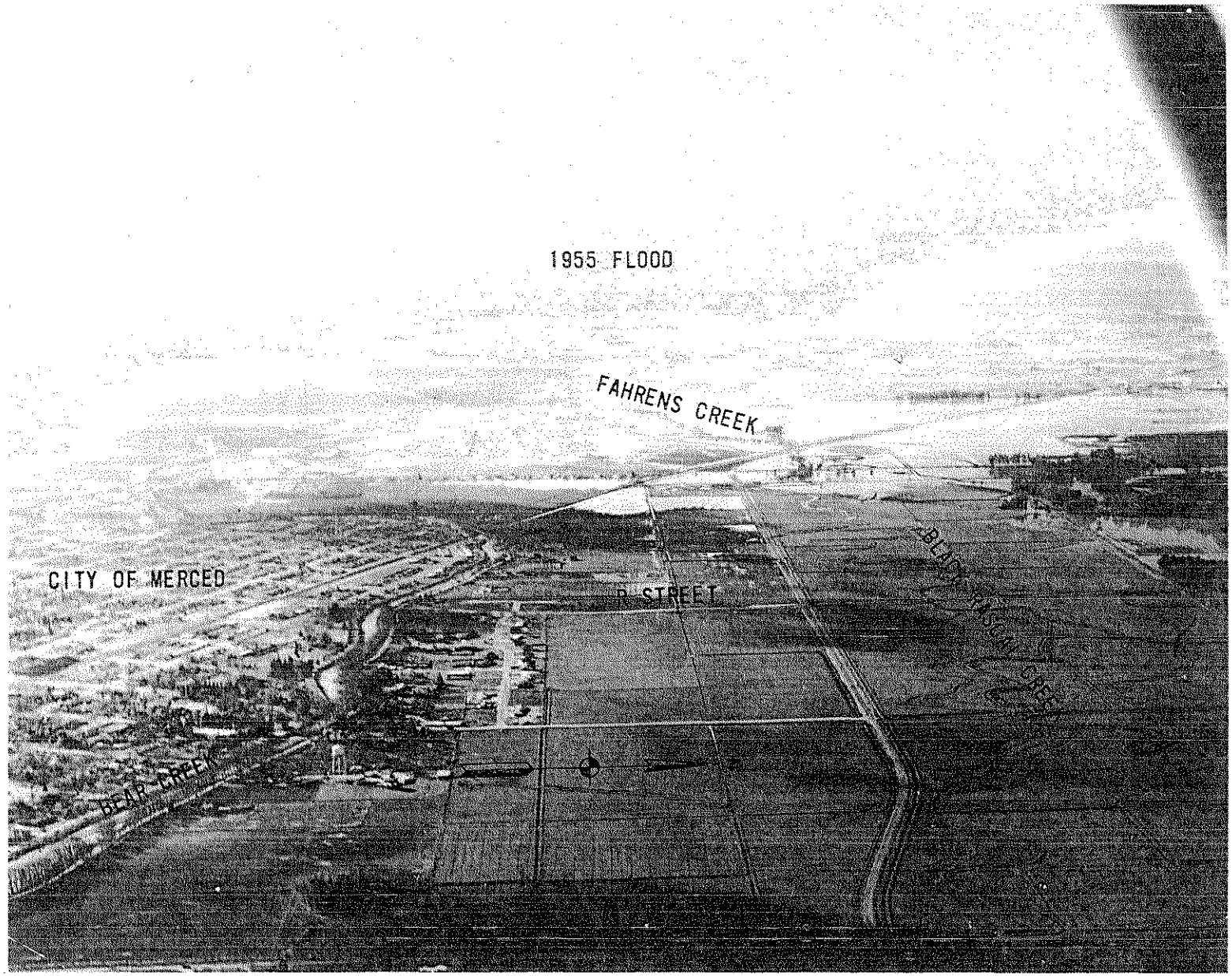
b. The existing flood control project, consisting of four detention dams, two diversion channels, and channel works, does not provide an adequate degree of protection to the developing flood plain area. Also, long duration releases from detention reservoirs prolong to some degree the flooding in the lower reaches. Due to a more intense type of agricultural development in the area in the last 20 years, flooding that caused little damage to the undeveloped pastureland in the past creates serious problems with the present development. There are no flood protection facilities for the Deadman-Dutchman Creeks flood plain, and none for flood plains downstream of project channels and upstream of the Eastside Bypass channels. Locally-constructed levees, ditch and canal banks, and limited flood control operation of the Merced Irrigation District's irrigation system provide some degree of flood protection for Canal Creek in the vicinity of Castle Air Force Base and for lower Fahrens Creek, but larger floods are essentially uncontrolled. Detailed treatment of the flood problem and other water resource problems and needs is presented in the review report of 1969 previously referenced.

c. A public meeting to determine the desires and views of local interests prior to formulating the authorized plan was held in March 1961. At the meeting, local interests expressed a desire for flood protection along streams that were not included in the existing project and along streams between the downstream limits of the project and the Eastside Bypass. Local interests also indicated the need for an increased degree of protection at some locations within the existing project area. A final public meeting to present the now authorized plan was held in October 1966; the plan was generally supported by local interests.

d. Current evaluation. - Current flood problems remain essentially as described above with one exception; the flood plains of Fahrens Creek and its Black Rascal Creek tributary have now become an area of intense urban growth in the city of Merced. Such development, including shopping centers, schools, and many private residences, was not foreseen at the time of the feasibility report and is being located in the area without adequate flood protection (see photographs 1 & 2). Local interests, comprising the Reclamation Board of the State of California, Merced County, the city of Merced, Merced Irrigation District, and others continue to support flood control works in the area, including Fahrens Creek and Black Rascal Creek. Detailed evaluation of present and future flood damages is discussed in Chapter IV of this report and presented in more detail in Appendix E.

9. Recreation.

a. Basis of authorized project. - Merced County lies in a semiarid section of California which has limited water-based recreation areas within 20 miles or less, and the existing water



City Merced, 1955 flood

Photograph 1

City Merced, 1977 development

Photograph 2

oriented recreation needs have greatly exceeded the presently available recreation facilities. Any type of water-oriented recreation facility provided has been readily used after development, and there continues to be a demand for recreation facilities. It is not expected that other distant reservoirs would satisfy the needs of the project area. The need for water-oriented recreation facilities, including measures for fish and wildlife, was recognized and supported by local interests in development of the authorized plan.

b. Current evaluation. - Water-oriented recreation needs in the area continue, and as the population increases, the gap between needs and available facilities will increase in the absence of new facilities. However, at a public meeting held in May 1976 local interests were generally strongly opposed to any recreation development at the authorized reservoirs and, further, requested public access not be provided to any lands which might be acquired for project reservoirs. There is continuing local support for recreation trails (hiking and biking) to be included with levee and channel works in and adjacent to the city of Merced. Detailed evaluation of present and future recreation and fish and wildlife problems and requirements is discussed in Chapter IV and in Appendix C, Recreation Resources.

10. Irrigation water supply. -

a. Basis of authorized project. - A large part of the Merced County Streams flood plain is served with irrigation water from the Merced River through the systems of the Merced and El Nido Irrigation Districts. The Le Grand - Athlone Water and El Nido Districts in the Deadman Creek area desire to develop, if possible, new irrigation water supplies locally or through the Water and Power Resource Service's East Side and Mid Valley Canals. The existing East Side Canal, a local irrigation project located about 10 miles west of Merced, has no connection with the Bureau's project of the same name. Ground water levels are receding rapidly due to pumping as more land is utilized for irrigated crops. Merced Irrigation District developments on Merced River currently meet the immediate demands for irrigation water in Merced County, except in most of the El Nido and Le Grand - Athlone service areas. Agua Fria Reservoir on upper Mariposa Creek was also being considered for construction by the State of California and could have provided additional water supply in the ara. Local interests, including El Nido Irrigation District and Le Grand - Athlone Water District supported works including irrigation as developed in the authorized plan.

b. Current evaluation. - The Water and Power Resource Service's Mid Valley Canal is currently in the advanced planning stages. However, the Mid Valley Canal will only supply about 70 percent of the current overdraft. The Service's East Side Canal, which would have a much larger capacity, is being held in abeyance due to lack of State interest. The East Side Canal would divert water from the Folsom South Canal, but construction of this facility is not foreseen at this

time. The State has also dropped consideration for the Agua Fria Reservoir. Local interests, including El Nido Irrigation District and Le Grand - Athlone Water District, continue to support development of irrigation water supply in the Corp's project. Detailed evaluation of present and future irrigation water supply is discussed in Chapter V of this report.

11. Other considerations. - Other than drainage problems caused by high water table in the lower flood plain area, no other significant water resource problems or needs have been identified. The Merced County Streams, due to their limited seasonal runoff, provided no potential for navigation or hydoelectric power generation. There are no existing or anticipated municipal water supply problems, and water pollution and erosion are not presently a problem within the basin. Watershed protection and management measures in the flood plain are being actively pursued by local interests.

CHAPTER IV - INVESTIGATIONS

12. Hydrology. - Subsequent to project authorization, detailed hydrologic studies were made of streams in the Merced County Stream Group. Information developed in these studies is contained in Design Memorandum No. 1, "Hydrology," Sacramento District, Corps of Engineers, dated March 1975. The report was approved by the Office, Chief of Engineers on 11 September 1975.

13. The hydrology design memorandum presents hydrologic data and criteria pertinent to the Merced County Streams. It contains a description of the hydrologic characteristics of the watershed area, discusses flood characteristics, and describes the development of the standard project floods and probable maximum floods. It also presents an analysis of streamflow frequencies, channel capacities, water supply, reservoir sedimentation, water quality, and freeboard requirements. Typical flood events to be expected, under current conditions, and channel capacities are compared in the following tabulation. Floodflows designated 50-year and 100-year are defined as flows having a 2 percent and 1 percent chance of being equaled or exceeded in any given year respectively. The standard project flood (SPF) is a hypothetical event which might be expected from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographical area involved, excluding extremely rare combinations.

Channel Capacities and Floodflows

Stream	Reach	Peak Flow (cfs) at Index Pt. 50-year	100-year	SPF	Channel Cap. (cfs)
Canal Creek	Black Rascal Sl. to Livingston Canal	-	-	-	400 (1)
Canal Creek	Livingston Canal to Castle damsite	2,800	3,500	4,500	800
Fahrens Creek	Black Rascal Creek to Main Canal	-	-	-	500
Fahrens Creek	Bear Creek to Black Rascal Creek	5,400	6,600	8,900	600
Black Rascal Cr.	Fahrens Creek to Black Rascal Div.	-	-	-	100 (2)
Black Rascal Div.		-	-	-	3,000 (3)
Black Rascal Cr.	Black Rascal Div to Haystack Mtn damsite	4,500	5,400	7,200	3,000
Bear Creek	Fahrens Creek to Black Rascal Div.	10,200	14,000	21,200	7,000
Bear Creek	Black Rascal Div to Burns Creek	10,300	14,500	21,700	6,500
Bear Creek	Burns Creek to Bear Reservoir	-	-	-	5,000
Burns Creek	Bear Creek to Burns Reservoir	-	-	-	2,000
Miles Creek	Owens Creek to Merced County Line	4,200	5,300	7,800	1,000
Owens Creek	Miles Creek to Owens Diversion	2,100	3,300	5,700	100 (2)
Owens Creek	Owens Diversion to Owens Reservoir	2,600	3,700	6,100	500
Owens Div		-	-	-	400 (3)
Mariposa Cr	Owens Div to Mariposa Reservoir	11,200	16,000	23,000	2,000
Deadman Creek	Dutchman Creek to Marguerite damsite	3,000	3,600	4,400	500
Dutchman Creek	Deadman Creek to Marguerite damsite	4,400	5,600	7,600	600

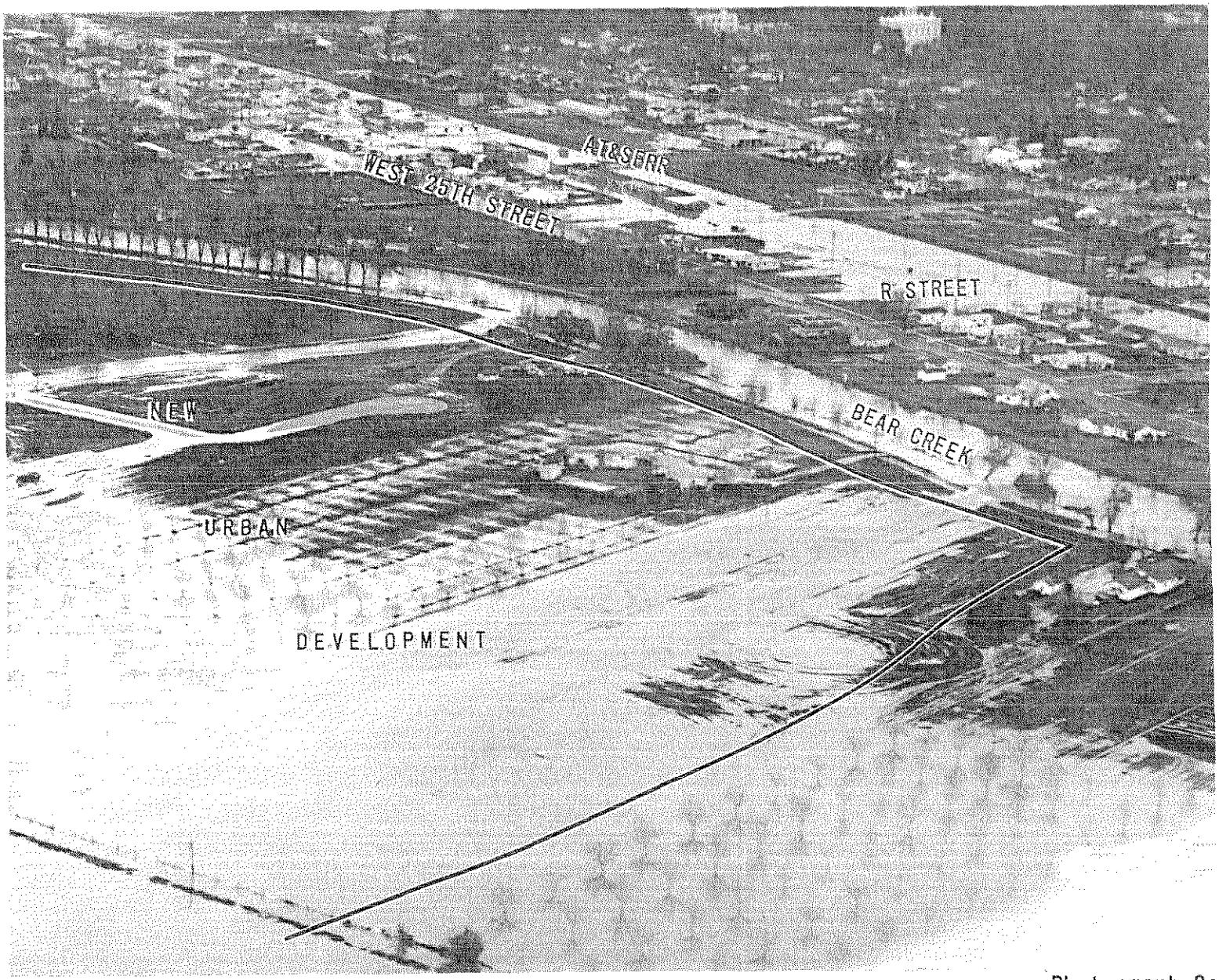
(1) The Livingston Canal diverts up to 600 cfs from Canal Creek, increasing the effective capacity of this reach to 1,000 cfs.
(2) Limited by culverts at road crossings.
(3) Existing project design flow; higher flows have been carried historically.

14. Flood producing storms in the Merced County Strams basin occur as rain during October through April. Flooding results from two distinct types of storms: general storms that produce widespread precipitation; and local storms that produce heavy, short-term precipitation over small areas. Very little snowmelt runoff occurs in the basin.

15. Sedimentation. -

* The proposed reservoirs are flood detention structures with no permanent pools. Detention periods are short and low flows would pass directly through the reservoirs. The existing Merced County Streams Group reservoirs have had very little sediment deposition and this has not created any operational problems. Studies made as part of the Hydrology Design Memorandum dated March 1975 indicate that the 100-year sedimentation would amount to about 4-1/2 perent of the gross capacity of the proposed reservoirs. This small amount of sediment deposition would not affect the operation or effectiveness of the proposed reservoirs. *

16. Nature of flooding. - Major floods originate in the foothills and are contained in the narrow valleys, but as they emerge onto the San Joaquin Valley floor, the channel capacities are generally insufficient to contain flows larger than the 10-year flood. (See photographs 2a and 2b.) As the streams continue on the valley floor downstream to the San Joaquin River, their capacities diminish until they are only able to carry very low flows upon reaching the vicinity of Crane Road and Highway 59. Consequently, the floodwaters overflow the stream banks, spread out over the flatlands, and comingle. Downstream overland floodflows stop at the East Side Canal, which crosses the flood plain, forming a large pond in excess of 4,000 acres. Construction of the San Joaquin River levees and the Eastside Bypass, which diverts floodwaters from the Merced area to the San Joaquin River, included enlargement of the downstream levee of the East Side Canal. It was built by the State to receive up to 7,000 cfs from Bear Creek, 2,000 cfs from Owens Creek, and 5,000 cfs from the combined Deadman-Dutchman Creeks. Because of the limited capacities of the bypass entrances at Owens and Bear Creeks and the drainage structure at Mariposa Creek, the floodwaters do not completely drain into the Bypass and flood stages as high as 10 feet occur. With these stages, floodflows continue north past Bear Creek to the San Joaquin River further downstream. Photograph 3 shows typical flooding along the Eastside Bypass.

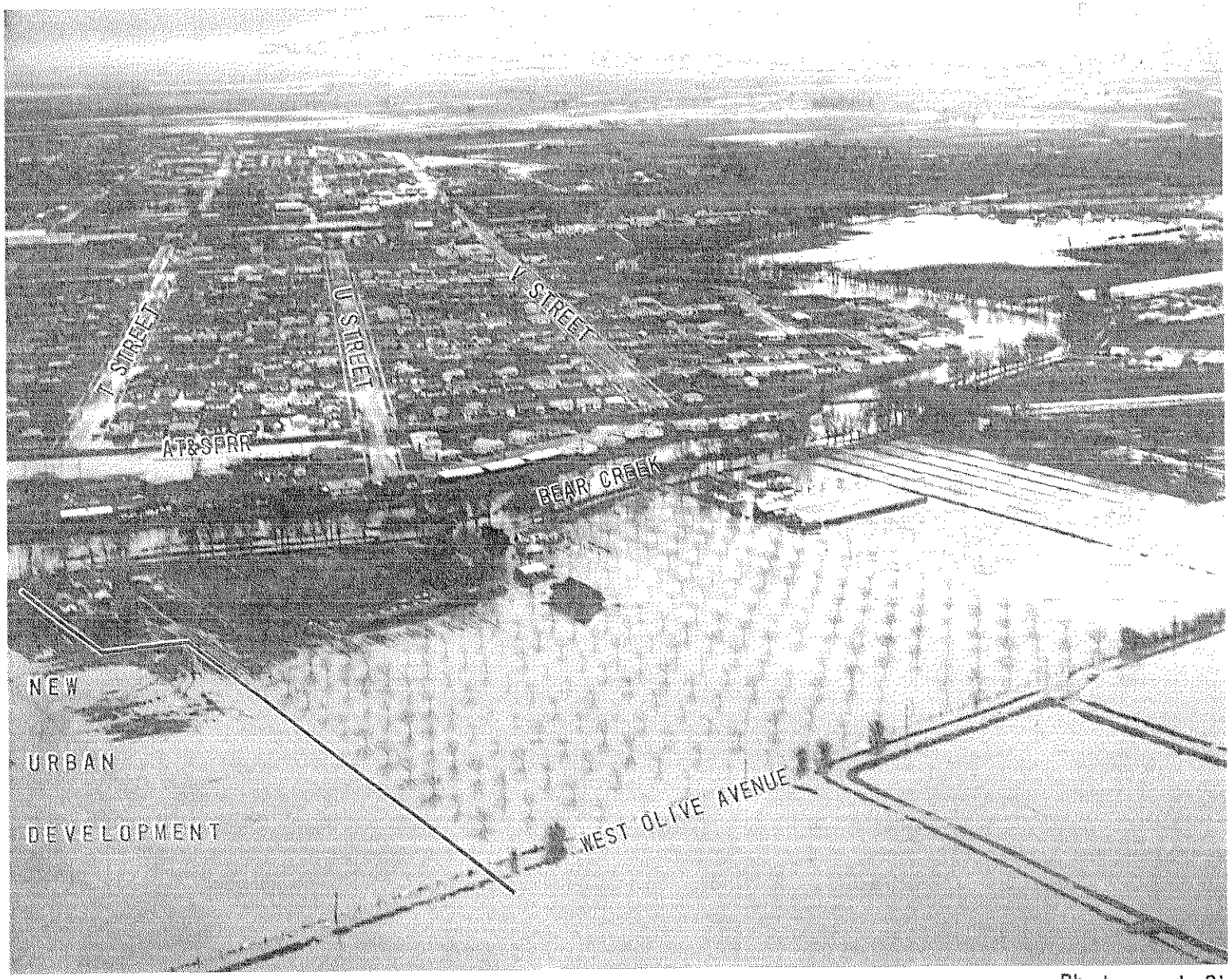


City Merced, 1955 Flood

Photograph 2a

1969 flood at Eastside Bypass

Photograph 3



City Merced, 1955 Flood

Photograph 2b

17. Additional hydrologic studies. - Hydrologic studies were made for the Black Rascal, Fahrens, and Cottonwood Creek areas to define project condition channel design flows since no analysis had been done on these streams during the survey report phase. These studies consisted of a smaller drainage area delineation to adequately define flows. The studies were made using the basic procedures and criteria established in the Hydrology DM.

18. A mathematical model of the basin was developed using the HEC5C computer program. This model was used to analyze project effects. Floods of various frequencies, determined using percentages of the SPF, as discussed in the Hydrology DM, were routed using this model to develop project condition flow-frequency curves. Project condition routings used in this model are discussed in the following paragraph. Frequency curves are presented in Appendix E. Hydrographs showing project effects are presented on Plates, V, VI, VII, VIII, and IX.

19. Channel and overbank flow routings (Preproject). - Preproject routings are described in the Hydrology DM. As indicated in the DM, reservoir routings were used at all major stream obstructions. These consist of the four existing reservoirs, all the stream crossings of the ATSFRR, Highway 99 - Southern Pacific Railroad, and the East Side Canal and Eastside Bypass. Routings between these points were accomplished using Tatum's procedures except along Bear Creek as noted below. Substantial overbank flows occur along most of the streamswhen channel capacities are exceeded. Bear Creek overbank flows along the south bank follow a separate path to the ponding area at the East Side Canal. These overbank flows were routed using the Modified-Puls technique. Some volume loss was assumed in this reach due to ponding behind major canal embankments. In all the other routing reaches (where Tatum's procedures were followed) it was assumed that all depression storage was filled from antecedent rain and runoff prior to the onset of the main flood wave. In addition, it was assumed that precipitation on the valley agricultural areas during the main flood wave was lost to seepage and ponding and did not contribute to peak streamflows. Velocities for use in determining Tatum steps (see plates X and XI) were obtained from a plot of flow velocity versus stream slope prepared from past miscellaneous stream flow measurements throughout the area. Outflow ratings at the various bridge openings were prepared from bridge data furnished by the railroad companies and the State of California. Division of flow assumptions for each of the stream crossings on the Main Canal, for Livingston Canal below Castle Air Force Base, and for Yosemite Lake diversions to Fairfield Canal and LeGrand Canal were prepared from data furnished by the Merced Irrigation District. No encroachment into the design freeboard was allowed in determining diversion capacities for the existing project diversion channel on Black Rascal Creek. The routing methods were verified by historical flood reconstitutions at the stream gages on Bear Creek at McKee Road and in the Black Rascal Creek Diversion (refer to Hydrology DM). There are no gages further downstream that could be used to verify the routing techniques.

20. Channel and overbank flow routings (Project). - Project routings were made using the same techniques as used for preproject conditions except that allowances were made for the enlarged reservoirs on Bear and Burns Creeks and the new reservoirs on Black Rascal and Canal Creek. In addition, it was assumed that all Canal Creek and Edendale Creek flows above the Merced Irrigation District's main canal would not be diverted by the main canal but would be allowed to flow across the canal into Castle Reservoir on Canal Creek. The reservoir routing on Fahrens Creek at the ATSFRR was eliminated for project conditions because the channel upstream on Fahrens Creek will be improved, thus eliminating the ponding area at this point.

21. Sensitivity analysis. - In order to test the validity of the routing assumptions, especially in reaches where substantial overbank flows occur, a sensitivity analysis was made to illustrate the effects of changes in routing coefficients on resultant peak flows. The two reaches selected for this sensitivity analysis are reaches where overbank flows occur but were not routed separately from main stream flows. The results of this analysis are shown on Plate X and XI. As indicated, a wide variation in routing coefficients, some of which are unrealistic, does not change resultant peak flows significantly.

22. Flood Plains. - The mapping, to determine the extent and depth of flooding, was based on a 5-foot contour map. Experience in similar areas in the San Joaquin Valley indicate that the use of 1- and 2-foot contours does not significantly alter the delineation of the flooded area or the depth of flooding.

23. Socio-economic assessment. - An analysis of public health, safety, and well-being, including the possibility of loss of life, was conducted. General public exposure to possible plans was carried out by coordination with interested Federal and non-Federal agencies, groups, and individuals by means of public meetings, field trips, meetings with small groups, correspondence, and other public involvement procedures. Environmental effects were assessed for "without project" conditions and "with project" conditions. These studies aided in avoiding detrimental environmental effects where possible or compensating for adverse effects. The socio-economic assessment provided help in using a systematic interdisciplinary approach to selection of a plan, based on an integrated use of natural and social sciences and environmental design arts. Appendix D, "Socio-Economics," contains in detail the information developed from these studies.

24. Flood damages analysis. - Studies were conducted to determine the frequency of flooding and area inundated, to evaluate the protection afforded by existing storage and levee projects, and to formulate andevaluate alternative measures to provide a higher degree of flood protection for the Merced County Stream group. Included in the analysis was the assumption that all new and replacement structures would be flood proofed to the 100-year flood level, which is according

to present FIA guidelines. A designated 100-year floodway was not delineated due to the relatively flat terrain which produces extensive sheet flow type flooding. Flood frequency data were developed for with- and without-project conditions. Studies confirmed the need to provide a higher degree of flood protection than that provided by the existing project. Flood control alternatives are described in Chapter VI. Design Memorandum No. 1, "Hydrology," which is an approved analysis of the changed hydrological conditions, contains a description of flood frequency and reservoir regulation studies performed. Average annual flood damages expected to occur without the project are estimated at about $6,750,000. The city of Merced has had a long history of flooding. Newspaper articles, accounts from local residents, and recent official records indicate that flooding occurred in 1935, 1936, 1937, 1938, 1950, 1955, 1958, 1969, and 1973.

25. The largest floods of recent record occurred December 1955, February 1958, and January-February 1969. Flood damages by major classification have been updated to 1979 price levels and are shown in the following tabulation:

HISTORIC FLOOD DAMAGES
(1979 Prices)

Damage Classification	1955	1958	1969
Residential	$224,000	$ 0	$ 1,000
Commercial	52,000	143,000	0
Indusrial	73,000	4,000	3,000
Public Facilities	527,000	9,000	134,000
Agricultural	604,000	841,000	1,717,000
8 Total Damage	$1,480,000	$997,000	$1,855,000
Total Acres Flooded	15,300	19,800	24,030

The flood damages tabulated above represent damages resulting from floods having a frequency of occurrence of 8 to 45 years in the Merced area based on hydrology under current conditions. The flooded areas were in the urban fringe and rural reaches in the lower end of the study area near the East Side Canal. Due to the lack of detailed information on the specific type and location of damages, the historic flood damage can only be used to establish estimates for agricultural clean-up costs and as a guide in determining crop damage and rural public facility damage. Because the flooding characteristics are similar for all frequencies of flooding, the data can also be used as a damage base for rural agricultural and public facility damages for less frequent floods (e.g., the 100-year event).

26. Measurement and projection of physical flood damages are based on relationships between present and future land use characteristics andvulnerability to damages. Essentially, three steps are used in measuring damages for future years; (1) estimating the number and size of the physical units; (2) estimating the existing and future values of units; (3) and determining the damage susceptibility of those units. The number and size of existing physical units in the flood plain were determined from field surveys and analyzing available data such as aerial photographs, zoning maps, assessor rolls, and land use maps. Projections of future growth were based on city and county general plans, zoning maps, and ordinances. These data were modified, where necessary, by local and regional projections for population, employment, income, and agricultural productivity. For each flood hazard zone (25, 50, 100-year, and SPF events), land was separated into five specific categories: residential, commercial, industrial, public and semi-public facilities, and agriculture. Then, further distinctions were made for each category in order to accommodate the difference in flood damage susceptibility. Agricultural lands were analyzed on the basis of itemized damage sustained rather than in terms of damages as a percent of total value. The final step in the measurement and projection of physical flood losses involved the determination of the damage susceptibility of units in the flood plain. Flood damages were computed by determining the relationship between vulnerability of land uses to damages based on depths, flows, and frequencies of flooding. Depth-damage relationships describe probable damages that would occur under different depths of flooding and are expressed either as a percentage of that total value of damageable property or as the amount of probable loss which could be expected. The depth-damage relationships were developed on a reach-by-reach basis. See Appendix E para. 11 a(3) for a detailed discussion of depth-damage relationships. Other factors considered in the flood damage analysis were velocity, duration, and debris content of floodwaters. The damage computations were based on the assumption that new and replacement units in the 100-year flood plain are flood proofed. Agricultural damage occurring from floods of different frequencies is directly proportional to the acreage and crop types included in the flood plains. Details concerning determination and computation of flood damages are contained in Appendix E, "Flood Control Benefits". Damages by stream groups, rounded to the nearest ten thousand, are summarized in the following tabulation:

Damages ($1,000)

	Average Annual Current	: Equivalent Annual
Bear Creek	4,400	5,670
Mariposa Creek	480	620
Deadman-Dutchman Creek	380	460
Total	5,260	6,750

27. Irrigation water supply. - Irrigation needs in the Merced County Stream group area were evaluated. These studies, conducted in coordination with the Water and Power Resource Service, concluded that there is an estimated current need for an additional 37,000 acre-feet of water per year. This deficiency is ultimately estimated to reach 53,000 acre-feet annually. As the mountainous valleys of Mariposa County are developed, there will be increasing demands for irrigation and domestic water for small, suburban-type tracts, especially in the vicinity of Mariposa. However, these current studies further revealed that development of irrigation water supplies by storage in the authorized reservoirs is not economically justified at this time; consequently, consideration of additional irrigation water supply has been deferred for future evaluation.

28. Water quality. - Water quality studies were made to determine the existing water quality and related conditions in the project area and its surroundings. These studies included a literature search, a field- laboratory sampling program for a 2-year period, and mathematical modeling of alternatives to determine the effects on downstream water quality. The field and laboratory testing were carried out under contract with the California Department of Water Resources and were conducted by the San Joaquin District of the Department. Water quality requirements of area agriculture, stock, fish and wildlife, and recreation were determined. Areas of existing quality or drainage problems were noted, as were areas of ecological significance. A water quality monitoring program was developed to aid in assuring that State and Federal criteria are met during construction and operation of the project.

29. These streams are intermittent, with flows normally occurring from December through April. As the streams traverse the valley floor their qualities can be expected to vary considerably, reflecting the drainage conditions of an extensive irrigated agricultural area. Some of the more important parameters from the foothill data are shown below, and generally applies to all the streams except for Canal creek.

Parameter	Range	Parameter	Range
Water temp. °F	52-76	Tot P, mg/L	0.02-0.22
pH (field)	7.4-8.5	TDS, mg/L	90-230
CO_3, mg/L	0	TSS, mg/L	5-40
NCO_3, mg/L	50-230	VSS, mg/L	0-16
Na, mg/L	5-30	BOD(5), mg/L	1.0-4.4
B, mg/L	0-0.2	T.H. ($CaCO_3$), mg/L	50-180
Org. N, mg/L	0.1-1.4	SAR	0.2-1.2
NH_3-N, mg/L	00.14	Class.	C1, S1 to C2, S1
NO_3-N, mg/L	0-0.79	EC, unhos/cm at 25°C	100-440

30. The waters range from soft to hard, depending upon how much runoff is occurring, and can be classed as calcium bicarbonate waters.

31. The streams are all suitable for irrigation of crop types currently grown in the area. The salinity hazard (as represented by EC) ranges from low to medium, and the sodium hazard (as represented by SAR) is low. The low salinity indicates the applied water will be easily available for uptake by the plant roots (low osmotic pressure), and the low sodium indicates the clays will not disperse to close the interstices and cause drainage problems. Boron concentrations encountered will not be injurious to the crops.

32. Canal Creek has higher organic load (BOD, VSS) than the values in the tabulation above, indicating a pollutional input of oxygen-demanding material. This pollutional load does not affect current uses of the waters, because thay are shallow and not impounded. Also the salt concentrations and water temperatures in Canal Creek are less than those shown above, indicating the dilutional effects of the MID Canal water from the Merced River.

33. The higher range nutrient data above was normally found in Deadman and Dutchmen Creeks, indicating more algae growth will occur there. Algae growth potential (AGP) studies conducted by DWR in March and April of 1974 support this. The waters of Deadman and Dutchmen Creeks grow three to four times as much algae as the other streams tested. The AGP studies also show that nitrogen is currently limiting to algae growth, but phosphorus is in excess, therefore it is not limiting to growth. These results show that additional nitrogen must be kept out of the streams if algal growth is to be curtailed. Algae identification and qualitative enumeration were done on samples collected for the AGP study and shows that diatoms dominate the crop.

34. During 1974, Mariposa and Burns Creeks were sampled for the heavy metals copper, lead, mercury, and zinc. During 1975, Mariposa, Burns

and Canal Creeks were sampled for cadmium, lead, mercury, and chromium. All the heavy metal concentrations were low. The watershed of Dutchman Creek has a cooper mine which hints that low pH water and copper contamination may be expected on occasion. There is no evidence that this has occurred in the past to cause problems in the Merced National Wildlife Refuge.

35. The discharge of municipal effluent from Mariposa's treatment facilities is not now noticed in the data collected from Mariposa Creek. It is assumed that the National Pollutant Disposal Elimination System (NPDES) requirements imposed will prevent undesirable input qualities to Mariposa Reservoir, although some nutrient input may occur (a post-construction monitoring program will monitor this).

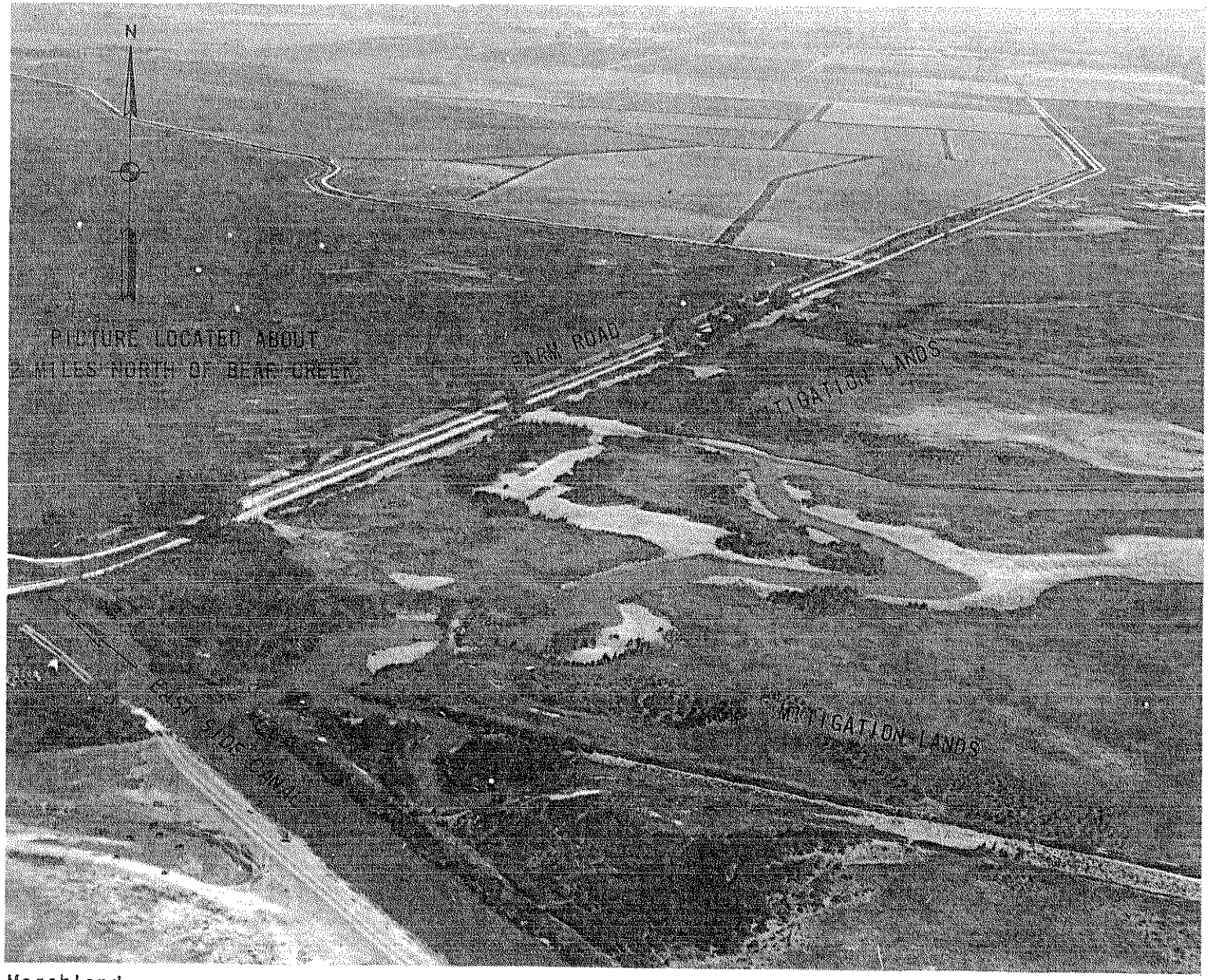
36. The Merced County Streams have been channelized in the most downsteam portion of the basin by the Eastside Bypass.

37. Bear Creek runs through the urban area of Merced, and can be expected to carry the multitude of pollutants typical of an urban area (organics, fertilizers, heavy metals, pesticides) to the San Joaquin River.

38. There will be no measurable changes to the water quality of the streams since all reservoirs are detention type which impound water for only a short period of time.

39. Marshland assessment. - Marshland areas currently exist in the downstream reaches of the project. Studies were conducted in cooperation with the Fish and Wildlife Service to assess the value of these areas and determine impacts to the marshlands (photograph 4) which would be caused by construction of the project. The assessment included identification of vegetation and wildlife endemic to the area. The study was used to determine wildlife mitigation features required for the project. These features are described in paragraph 95, Fish and Wildlife Provisions.

40. General recreation. - The needs for outdoor recreation development in the study area were evaluated early in Phase I Advanced Engineering and Design (AE&D) studies. Recreation measures were formulated for alternative reservoir plans and the downstream channel improvements. Studies of the potential market area and expected attendance were accomplished, and then, at the request of local interests, the potential for recreation development was confined to the downstream reaches of streams in conjunction with channel improvements. The results of the recreation studies and recreation land requirements are presented in Appendix C, "Recreation Resources."



Marshland

Photograph 4

41. Fish and wildlife. - There has been extensive coordination with the Fish and Wildlife Service (USFWS) and the California Department of Fish and Game to identify project impacts and mitigation needs. Studies by USFWS identified land requirements for mitigating adverse impacts caused by the project. Mitigation measures are described in paragraph 95. A list of endangered species for the project area has been acquired from the U.S. Fish and Wildlife Endangered Species office. A biological assessment of project impacts on the endangered species in the area is presently being conducted.

42. Cultural resources. - A cultural resources reconnaissance survey was conducted by professional archeologists under contract to the Corps in June 1976. Bear, Burns, Owens and Mariposa Reservoirs were the only areas where archeological or historical sites were found in the authorized project sites by the reconnaissance team during this first investigation. At Bear Reservoir 13 archeological and 3 historical sites were located within the reservoir and downstream areas. The historical sites are probably related to mining camps of the mid-1800's. At Burns Reservoir, six archeological sites were previously identified in 1951 but not found during the recent survey, leading the archeologist to conclude that the sites may have been destroyed. However, Corps archeologists have identified 2 additional archeological sites within the Burns Reservoir area, for a total of 15 archeological and 3 historical sites in the Bear Creek group. At Owens Reservoir, 6 archeological and 1 historic site were found within the reservoir. At Mariposa Reservoir, 9 archeological and 7 historic sites were found. However, because of deferral from current plans, these latter two reservoirs will not be affected. Fahrens, Black Rascal and Canal Creeks were surveyed in March 1978. No historic or prehistoric sites were located during the field-work phase of the archeological investigtion, but during the pre-field research phase, it was discovered that two prehistoric sites exist or existed along Fahrens Creek. Copies of the correspondence with Federal and State Agencies are included in Appendix A, Pertinent Correspondence. Those agencies with which the Corps coordinates to deal with the cultural resources concerns are listed in paragraphs 139 and 141 of this report.

43. During Phase II, an intensive cultural resource survey will be accomplished. Based on the findings and recommendations contained in this report, proposals for mitigation and preservation of cultural resources will be identified. By Congressional authority, cultural resources mitigation is limited to a maximum of 1 percent of Federal project costs. Additional information can be found in Appendix F, "Basis of Design and Cost Estimates."

44. Future studies. - Future studies and reports to be accomplished during Phase II design work are shown at the front of this GDM.

CHAPTER V - REANALYSIS OF AUTHORIZED PLAN

45. General. - The authorized plan, as described in Chapter II, was reanalyzed based on current predicted economic and hydrologic conditions to determine if the plan now meets the established economic and other criteria presented in Chapters VI and VII. As noted previously, the authorized plan as originally envisioned would provide about 100-year flood protection to most of the urban areas in Merced and nearly 50-year protection to surrounding agricultural lands. Based on changed hydrologic conditions reported in the Hydrology Design Memorandum, the authorized plan would now provide 80-year protection to the urban areas. The plan would also provide storage for irrigation water at Mariposa and Marguerite Reservoirs. Reanalysis of the authorized plan included evaluating damages and benefits based on implementation of the Flood Disaster Protection Act of 1973 (Public Law 93-234, 87, Stat 975) and projecting future damageable property considering affluence factors to be related only to contents of residential structures. Recreation was reevaluated in accordance with guidance contained in Principles and Standards and in view of conditions currently existing. Irrigation accomplishments and benefits were also reexamined by the Bureau of Reclamation, and the results of its investigation are included in the following paragraphs. The potential of the streams within the project area for production of hydroelectric power was reviewed and the findings indicate that due to their limited seasonal runoff, they provide no hydroelectric potential. Further analysis was made by stream group to determine if these functionally independent units were economically feasible.

46. Analysis. - First and annual costs and annual benefits for each purpose of the authorized plan are displayed by stream group in the following tabulation. Costs and benefits were computed at 1 October 1977 price level and a 6-5/8 percent interest rate.

Stream Group	First Cost ($1,000)	Annual Cost ($1,000)	Annual benefits ($1,000) Flood control	Irrigation	Recreation	Total	B/C
Bear Creek	35,240	2,731	3,290	-	994	4,284	1.6
Mariposa Creek	20,010	1,524	337	345	126	808	0.5
Deadman-Dutchman Creeks	13,350	955	321	233	-	554	0.6
Total	68,600	5,210	3,948	578	1,120	5,646	1.1

Since the Bear Creek Group was clearly economically feasible, a detailed reassessment was conducted and is shown in Chapter VI. However, it can be seen from the above tabulation, the authorized

works on Mariposa and Deadman-Dutchman Creeks are not economically justified, considering current prices and economic conditions. To insure that other possible solutions to solving the water resources problems on these two stream groups were not overlooked, several alternatives were evaluated and are described in the following paragraphs.

47. Flood control. - The following alternatives were examined on a single purpose flood control basis.

a. Reservoirs only. - An alternative flood control plan that was evaluated among an array of alternatives was one comprising reservoirs only and included a 28,750 acre-feet gated Mariposa Reservoir in the Mariposa Stream group and a 6,300 acre-feet ungated Marguerite Reservoir in the Deadman-Dutchman Stream group. These sizes represent a 50-year storage level at the reservoir sites. The following tabulation summarizes the economics for this plan:

Reservoirs Only Alternative

Stream Group	First Cost ($1,000)	Annual Cost ($1,000)	Annual Benefits($1,000): Flood Control	B/C
Mariposa Creek	6,384	455	133	0.3
Deadman-Dutchman Creeks	8,058	575	205	0.4

The level of protection provided in the Mariposa group was about 10 years for the rural area above Highway 99 and about 1 year for the rural area below the highway. For the Deadman-Dutchman group, the level of protection for the rural area was about 1 year throughout. The levels of protection do not increase relative to current conditions because the channel capacities below the reservoirs, which were not enlarged in this plan, are inadequate to accommodate either the local runoff below the reservoirs or flood control releases. Although the frequency of flooding is the same with this plan, the reservoirs do decrease the peak floodflows and depth of flooding. As an example, in the Mariposa group, for a 20-year flood the peak floodflows are reduced by about 50 percent while for a 50-year flood the peak flows are reduced by about 70 percent. In the Deadman-Dutchman group, the corresponding peak flows are reduced by about 80 and 85 percent, respectively. The reduced peak flows result in decreased flood depths and, hence, an appreciable reduction in damages. However, the benefits are not sufficient to equal the costs. Because of inadequacy of the downstream channel capacity below the reservoirs, changing the storage levels will not make a reservoirs only alternative economically feasible.

b. Channels only. - Modification to the downstream channels of Mariposa and Deadman-Dutchman Stream groups, without new or enlarged upstream reservoirs, was investigated. Most of the area traversed by these streams is agricultural, with no urban growth predicted in the foreseeable future. Three degrees of flood protection were evaluated to determine which would be the best solution to alleviate the downstream flood problem. The improvements considered included about 15 miles of channel on Mariposa Creek and 9 miles of channels on Deadman-Dutchman Creeks. A summary of the economic analysis is shown in the following tabulations:

Mariposa Creek

Degree of protection	5-year	10-year	25-year
Design flow (cfs)	2,500	3,100	8,100
Annual benefits ($1,000)	121	139	234
Annual costs ($1,000)	216	248	373
Excess benefits ($1,000)	-95	-109	-139
Benefit-cost ratio	0.6	0.6	0.6

Deadman-Dutchman Creeks

Degree of protection	5-year	10-year	25-year
Design flow (cfs)	2,000	3,000	4,900
Annual benefits ($1,000)	107	122	151
Annual costs ($1,000)	293	388	519
Excess benefits ($1,000)	-186	-266	-368
Benefit-cost ratio	0.4	0.3	0.3

It should be noted that the benefits shown for the 25 year degree of protection approach the maximum that could be possibly realized. Any alternative involving a higher degree of protection would resfult in increased costs, lower excess benefits, and a lower benefit cost ratio.. It is apparent that channel improvement for flood protection on these two stream groups is also not economically justified at this time.

c. Reservoirs and channels. - The following alternative was found to be the best plan among an array of alternatives providing various levels of protection that has both reservoir storage to reduce the peak floodflows and enlarged channels below the reservoirs to contain local runoff and flood control releases. The Mariposa Stream group would include a 28,750 acre-foot gated Mariposa Reservoir with a 5,600 cfs channel enlargement while the Deadman-Dutchman Stream group would include a 6,300 acre-foot ungated Marguerite Reservoir with a 2,100 cfs channel enlargement. The following tabulation summarizes the economics for this plan:

Reservoirs and Channels

Stream Group	First Cost ($1,000)	Annual Cost ($1,000)	Annual Benefits ($1,000): Flood Control	B/C
Mariposa Creek	13,374	1,015	412	0.4
Deadman-Dutchman Creeks	10,578	809	271	0.3

The channel enlargements substantially improve the level of protection relative to the "reservoirs only" alternative: the Mariposa group would have about 33-year protection for the rural area east of Highway 99 and about 100-year protection for the rural area west of that highway, while the Deadman-Dutchman group would have about 50-year protection throughout. As with the other alternative plans for the lower stream groups, this plan provides substantial flood control benefits, although not sufficient to justify the costs incurred at this time.

48. Irrigation. - Preliminary studies were made of multipurpose alternative plans including irrigation. Selected alternatives were identified for more detailed evaluation by the U.S. Bureau of Reclamation for Mariposa and Marguerite Reservoirs.

a. The economic practicality of developing water supply from streams of the Merced County Stream group is constrained by limited runoff. Yearly streamflow, less than 100,000 acre-feet, is dispersed among the numerous streams in the area. Yearly variations of runoff range from nearly zero to as much as four times the average annual figure. Other factors further reduce economic feasibility of irrigation storage. Large amounts of evaporation at the reservoirs prevent practical savings of stored water from year to year. Relative facility costs are large, mainly due to size in relation to yield. These factors make alternative sources for water supply viable from outside the study area.

b. Water supply needs within the study area of Merced County were evaluated. The city of Merced and urban areas have adequate domestic supply from ground water. The Merced Irrigation District (MID) imports agricultural water supply from developments on the Merced River and obtains additional water from wells within the area. MID supplies most of the needs for the northeast sector of the county. The lower Mariposa and Deadman-Dutchman group areas seriously need an additional supply of water. Two districts, El Nido and Le Grand-Athlone Irrigation Districts, serve this area. These two districts receive most of their water from local wells and small amounts of imported water from MID. Ground water in the latter district is dropping about 1 foot per year from overpumping.

c. Mariposa, Deadman, and Dutchman Creeks are upstream from the service districts in the water-short area. Mariposa Creek and Deadman-Dutchman Creeks have been considered as the best local storage supply for surface water development. Mariposa Creek contains 35 percent of the upland runoff from the study area. Also, Mariposa Dam would be physically suitable for a large storage reservoir. Marguerite Reservoir, while not having the same advantages, does lend itself to multipurpose flood control and development and is located in the service area. The economics of multipurpose development of Marguerite Reservoir and Mariposa Reservoir are presented in the following description of alternatives. The information presented was obtained from the Water and Power Resource Service, which has indicated that the data are applicable to 1977 conditions and prices.

d. Mariposa Multipurpose Reservoir. - This alternative would consist of enlarging Mariposa Reservoir from the existing 15,000 acre-foot capacity to the authorized capacity of 50,000 acre-feet. The reservoir would then be used for flood control, irrigation, general recreation and fish and wildlife. The latter two functions would be served by maintenance of a minimum pool of 5,000 acre-feet. Water conserved at the reservoir would be used by El Nido Irrigation District, which contains about 9,200 irrigable acres.

e. Mariposa Reservoir yield studies were accomplished recognizing a downstream water rights release of 178 cfs or an average of 10,700 acre-feet per year. The reservoir capacity was assigned to the following purposes: irrigation, 20,000 acre-feet; flood control, 25,000 acre-feet, which would gradually be made available for conservation use in spring and summer months; general recreation and fish and wildlife, 5,000 acre-feet. The total annual regulated water supply for Mariposa Reservoir, based on a 41-year (1921-1962) study period, is estimated to be 10,600 acre-feet at the dam. The on-farm amount, considering distribution losses, is 6,900 acre-feet annually.

f. Water requirements were determined from a ground water study developed in the 1960's. Ultimate average annual water supply, both surface and ground water, was estimated at 20,000 acre-feet. The ultimate annual water requirements were estimated to be 28,500 acre-feet, giving a needed supplemental import supply of 8,500 acre-feet. This imported requirement would be partially met from the Mariposa Reservoir project.

g. Benefits resulting from a supplemental water supply from Mariposa Reservoir for El Nido Irrigation District were based on a crop projection generally paralleling the 1974 cropping pattern. The weighted per-acre net farm incomes were used to compute the direct benefits. These direct benefits amount to $150 per acre. With an average water requirement of 2.97 acre-feet per acre, the direct benefits at the farm would be $50 per acre-foot. Using the on-farm delivery of 6,900 acre- feet from Mariposa Reservoir, the total direct annual irrigation benefits from the conservation storage are

$345,000. Since the Irrigation District already has conveyance and distribution facilities, there are no additional direct irrigation costs.

h. Following the public meeting held in May 1976, local interests requested that the economic feasibility of Mariposa and Marguerite Reservoirs be reevaluated and that their lack of economic justification be reaffirmed. Therefore, the costs in the following tabulations differ from the current updated estimate from the feasibility report because of design change and refinements included in the reevaluation.

Mariposa Reservoir

Costs ($1,000)		Annual Benefits ($1,000)			
First	Annual	Flood Control	Irrigation	Recreation	B/C
17,900	1,266	337	345	167	0.7

i. Marguerite Multipurpose Reserovir. - This alternative would consist of the authorized 13,000 acre-foot capacity reservoir located on Deadman-Dutchman Creeks. The functions and allocations of capacities are as follows: 7,000 acre-feet, flood control; 2,000 acre-feet, inactive storage; and 4,000 acre-feet irrigation. The flood control storage would be available for conservation uses on the same schedule as Mariposa Reservoir. Water Supply yield was determined by correlation of local hydrologic data made available. Included in the yield study was a downstream water right of 2,400 acre-feet. Marguerite Reservoir would be used to store winter and spring flows from Deadman and Dutchman Creeks without encroachment of flood control space. The annual yield, based on the same study period as Mariposa Reservoir, was estimated to be 3,900 acre-feet at the dam with an on-farm delivery of 3,700 acre-feet.

j. Benefits from the water supply of Marguerite Reservoir would be realized in the Le Grand-Athlone Irrigation District, which contains approximately 15,000 acres of irrigated land. Benefits were determined by farm budget analysis, based on the existing cropping pattern. Direct benefits, represented by weighted per acre net farm incomes, average $190 per acre. Using an average water requirement of 3.04 acre-feet per acre, the direct benefits at the farm would be $63 per acre-foot less $6.59 per acre-foot for delivery. With an on-farm delivery of 3,700 acre-feet from Marguerite Reservoir, the net annual irrigation benefits at Marguerite Reservoir from the conservation storage are $209,000.

k. The following table shows the economic feasibility of conservation storage and the most effective flood control plan using current design and cost procedures.

Marguerite Reservoir

Costs ($1,000)		Annual Benefits ($1,000)				
First	Annual	Flood Control	Irrigation	Recreation	Total	B/C
16,140	1,134	321	209	-	530	0.5

49. Recreation. - A multipurpose alternative was analyzed which included Mariposa Reservoir as the only recreation site. Recreation benefits for Mariposa Reservoir were evaluated in prior studies along with water oriented recreation at Castle and Burns Reservoirs. If recreation facilities are not included at the latter two reservoirs, more use would be made of the Mariposa facilities. The following analysis reviews the recreation opportunities based on this condition, using the most liberal unit benefit assumptions. Recreation was not considered practical at Marguerite Reservoir because the pool is shallow and would be depleted early in the irrigation season to reduce evaporation loses and to conserve other existing irrigation sources until later in the season. The best flood control and irrigation storages described in accompanying paragraphs were included with recreation, resulting in a 52,000 acre-foot gated reservoir. The following tabulation summarized the economics of the plan.

Recreation Mariposa Reservoir Only

			Annual Benefits ($1,000)				
Stream Group	First Cost ($1,000)	Annual Cost ($1,000)	Flood Control	Irrigation	Recreation	Total	B/C
Mariposa Creek	18,912	1,342	412	345	140	897	0.7

By eliminating recreation facilities in the Bear Group and the competition for water-related recreation activity, the recreation use and benefits increase at Mariposa Reservoir by about 10 percent. Greater use would be possible if the reservoir were closer to the city of Merced. Only limited boating activity was considered practicable because of the lowered reservoir pool during the irrigation season. The reevaluation improves the economic feasibility of works on Mariposa Creek Stream group, but the plan still lacks economic justification.

50. Nonstructural measures. - In view of the fact that no structural measures appeared justified for the Mariposa and Deadman-Dutchman Stream groups, consideration was given to providing nonstructural measures in these areas to solve the flood problems. Both of these areas are in agricultural use at the present time. This use is in conformance with the County General Plan, and no change in land use is projected within the near future. Implementation of nonstructural measures is generally applicable to non-agricultural uses, such

as residential or commercial. The major flood damage is agricultural related, making traditional nonstructural measures ineffective in solving the flood problem. Any future construction would be flood proofed in accordance with the requirements of the Flood Disaster Prevention Act of 1973. Therefore, a nonstructural alternative is not viable for these areas.

51. Summary. - No features of the authorized plan for Mariposa and Deadman-Dutchman Creeks are economically justified at this time. Furthermore, the variations to the authorized plan and other alternative plans for these two stream groups which have been analyzed are not economically justified at this time. It is recognized that a need exists for flood control and the development of irrigation supplies, and local interests continue to express strong support and need for developing flood control and irrigation storage in the areas of these two stream groups. In view of the current findings, the best solution at this time would be deferral of these two stream groups for future consideration.

CHAPTER VI - ALTERNATIVES

52. Planning objectives. - The purposes of preconstruction planning studies are to reassess features of the authorized project under present conditions, ensure the project will provide an economical and acceptable solution to problems and needs, and evaluate alternatives, prior to initiating design. As indicated in Chapter V, the authorized plan was not economically justified nor are any viable alternatives. Accordingly, the remaining studies are limited to the Bear Creek Stream group. Although the existing project has reduced flood damages from Merced County Streams, it does not provide an adequate degree of protection to the affected area, and flood protection is also needed in other areas which are not affected by the existing project. Because of the frequent flooding of agricultural areas in the flood plain and the high potential for extensive damage and possible loss of life in the City of Merced and adjacent uran areas, the need for flood control works is considered of paramount importance. The demand for water-oriented recreation in the study area is high, and, therefore, consideration has been given to full development of recreation opportunities, although local interests support only limited recreation facilities associated with levee and channel works. Consideration has also been given to enhancement of fish and wildlife resources in the area. There is also a significant demand for additional irrigation water supply in southern Merced County. These, then, are the primary planning objectives to be satisfied, if possible, in plan formulation: flood control, recreation, fish and wildlife, and irrigation water supply. Achieving these objectives is based on satisfying certain technical, economic, environmental, and social criteria. These criteria are discussed below. The Phase I GDM has been prepared in accordance with Engineer Regulations 1105-2-920 and 1110-2-1150. Although not specifically required, planning and formulation of the project has been essentially in conformance with the Water Resources Council's Principles and Standards. October 1977 price levels and an interest rate of 6-5/8 percent are used in the following formulation procedure. The formulation results would not be altered by using 1979 price levels. The recommended plan described in Chapters VIII through XV have costs and benefits calculated at October 1979 levels and an interest rate of 7-1/8 percent.

a. Technical criteria. -

(1) The plan should be consistent with the California Water Plan and the Merced County General Plan.

(2) Streamflows should be based on runoff with projected future land use.

(3) Existing flood control features should be preserved and utilized to the maximum extent, consistent with economic criteria.

(4) Dam and levee and channel design requirements, such as freeboard and cross section, should be established on the basis of existing site conditions, available materials, and type of structure selected.

(5) Spillway width and surcharge depth required for any contemplated reservoir should be determined assuming the spillway design flood (Probable Maximum Flood).

(6) A high degree of flood protection, such as SPF protection, should be provided to present and future urban areas, consistent with economic criteria.

b. National Economic Development criteria. -

(1) Each separable unit of improvement or purpose must provide benefits at least equal to costs unless otherwise justified on an intangible basis.

(2) Each alternative considered in detail must be "justified" in the sense that total beneficial effects (monetary and nonmonetary) associated with the objectives are equal to or exceed the total adverse effects (monetary and nonmonetary) associated with the objectives.

(3) The selected plan must have net national economic benefits unless the deficiency in net benefits incurred is associated with attaining environmental quality objectives.

(4) The scope of development is such as to provide the maximum net benefits; however, environmental quality and intangible considerations could dictate a project which foregoes some of the net tangible benefits.

(5) The period of analysis was set at 100 years based on the period over which the plan is expected to serve a useful purpose.

(6) Benefits and costs were expressed in comparable terms. Annual cost includes maintenance, operation, and major replacements.

(7) Project benefits were based on analysis of conditions without and with a project, utilizing methodology described in the Water Resources Council's Principles and Standards and Corps of Engineer's regulations.

c. Environmental Quality Criteria. -

(1) Plans were formulated to the extent practicable so as to preserve and enhance the quality of the natural environment, including fish and wildlife, vegetation, land, air, water, open space, and scenic and esthetic values.

(2) Where feasible, adverse environmental effects of potential actions would be avoided.

(3) Mitigation for unavoidable adverse environmental effects would be seriously considered and implemented when justified.

d. Social well-being and regional development considerations. -

(1) Consideration should be given to preservation of historical, archeological, and other cultural resources.

(2) Consideration should be given to safety, health, community cohesion, and social well-being.

(3) Displacement of people should be minimized to the extent practicable.

(4) Improvement of leisure activities and public facilities should be evaluated.

(5) Effects of a project on regional development including income, employment, business and industrial activity, population distribution, and desirable community growth should be considered.

e. A number of plans for the Bear Creek group, including the authorized plan, were considered to solve the area's flood and related water resource problems and needs. These alternatives may be grouped into four categories: (1) no action, (2) nonstructural measures, (3) structural measures, and (4) combinations of structural and nonstructural measures, as described below.

53. No action. - "No action" essentially comprises no structural or nonstructural measures undertaken by the Federal Government to control or reduce damages from future flooding in the area. In the future the population of the area will increase, business will expand, and the demand for services will grow; likewise, the flood hazard will also increase. There will be greater damage to residential and commercial property; and business activity, transportation, and communication will be disrupted. Public services such as education, health care, and police and fire protection will be disturbed. Since Merced County has been designated as a flood hazard area, flood plain management measures must be implemented for the area to be eligible for Federal flood insurance and Federally assisted financing such as FHA and VA loands. Specifically, land use regulations must be adopted requiring all new structures in the 100-year flood plain to be either elevated above the flood plain or be flood proofed. Both the city and county of Merced have applied for participation in the National Flood Insurance Program under the Flood Disaster Prevention Act of 1973 (Public Law 93-234). Under this Act, communities are required to adopt land use regulations, certified by the Flood Insurance Administration, that would require that all new and replacement residential structures in the 100-year flood plain have their first flood elevated to or above the 100-year flood elevation and all new or replacement nonresidential structures be flood proofed up to the level of the 100-year flood. The economic losses noted in paragraph 25 and the threat to community safety and well-being generally make "no action" an undesirable alternative by the Corps.

54. Nonstructural measures. - Nonstructural measures considered for Merced County include zoning and building code regulations, flood proofing, flood forecasting, and evacuation. As described in paragraph 53 above, to be eligible for Federally assisted financing, Merced County must adopt land use regulations to reduce future flood plain, but there is a practical limit to what can be excluded as the areas north and east of Bear Creek are designated for urban development by the city and county master plans. For the same

reason, evacuation of the flood plain or abandonment of existing buildings and reconstruction elsewhere is not an economical solution. Advance warning by flood forecasting could help prevent injury, but there would not be sufficient time to prevent damages to property. Finally, all existing structures could be flood proofed by raising them or building protective dikes, but the costs would be prohibitive. Since the city and county of Merced are participating in the Flood Insurance Program, actions to prevent damage to future development under this program would be considered a preproject condition. Project related nonstructural measures would apply only to existing development. Studies showed that nonstructural measures to provide a degree of protection greater than 100 years to future development would not be economically justified.

55. Flood Proofing or Relocating Existing Structures. - Flood proofing existing structures would involve implementation of building codes and subdivision regulations which would require raising structures above the flood plane or providing dikes and levees to prevent flood damage. Raising the lowest floor of a building to a desired elevation to provide a higher degree of flood protection is accomplished by using fill material or columns and footings. Dikes and levees could also be used, especially for large existing developments such as shopping centers, industrial parks, and schools. Costs and benefits in the tabulations below result from raising structures to provide the desired level of protection and thus prevent damages which would otherwise have occurred. Relocation is accomplished by purchase, condemnation, and removal of existing structures. Provision would need to be made for alternative location of structures for urban development outside of the flood plain. Relocation costs are those costs incurred for removing existing development and purchasing and constructing new facilities in safe areas. Relocation benefits result from reduced flood damages because of less intensive uses, such as agriculture and parks, of the evacuated flood prone area. Structural development in the SPF flood plain for the base year of 1985 for the project is listed in the following tabulation:

Number of Structures in the SPF Flood Plain
Bear Creek Group

Residential	17,570
Commercial	2,435
Industrial	115
Public & Semipublic	105
Agricultural	-
Total	20,225

Specific flood proofing methods depend upon the type of structure involved. Cost estimates for flood proofing residential structures were based on three types of measures: (a) flood proofing to preclude floodwaters from entering the building's interior; (b) provision of a waterproof concrete utility cell to house the electric switch box,

furnace, and water heater located in basements which could be flooded; and (c) raising the building above the flood level. In residences which had basements, the alternative consisted of permanently sealing off basement openings, waterproofing the interior and exposed exterior basement walls, and installation of sump pumps and providing automatic check valves in sewage lines. The second method, consisting of a utility cell, protects the utilities but does not prevent additional damage; therefore, this method was not extensively used. The third measure consisted of raising buildings on columns or footings above the flood level. Commercial and public service structures were treated differently from residential structures because costs of raising these buildings would be prohibitive. Flood proofing measures considered consisted of providing check valves for sewer lines; blocking basement openings, first floor doors, and windows; and waterproofing sump pumps and wells. Industrial structures would be protected by providing a ring levee or floodwall complete with closures and pumps for interior drainage. Costs and benefits of flood proofing and relocating structures within the Bear Creek flood plain are shown in the following tabulation:

Floodproofing Existing Development

Degree of Protection	Costs in ($1,000) First	Costs in ($1,000) Annual	Benefits ($1,000)	B/C
10 yr	10,255	655	215	0.3
25 yr	25,360	1,620	650	0.4
50 yr	61,440	3,925	1,090	0.3
100 yr	128,675	8,220	1,665	0.2
SPF	186,360	11,905	2,560	0.2

Relocating Existing Development

Degree of Protection	Costs in ($1,000) First	Costs in ($1,000) Annual	Benefits ($1,000)	B/C
10 yr	40,855	2,610	565	0.2
25 yr	82,965	5,300	1,620	0.3
50 yr	207,335	13,245	2,625	0.2
100 yr	472,980	30,215	3,870	0.1
SPF	600,715	38,375	5,005	0.1

It can be seen that neither of these measures are economically feasible for existing development. Because of the high costs, economic infeasibility, and the support of local interests for other plans, nonstructural measures were eliminated from further consideration.

56. Structural measures. - Structural measures considered include channel modifications, reservoirs, and combinations of reservoirs and channels. During preliminary evaluation of these measures under present conditions of development, the costs of construction of only channels, of relocation of structures adjacent to the channels, and of

modification of bridges were generally found to be far in excess of flood control benefits; therefore, these measures were not economically feasible. However, it was found that the existing channel capacities below any reservoir sites would not be sufficient to contain the local runoff or flood control releases from reservoirs; thus, construction of reservoirs only would not solve the flood problem either. Accordingly, a combination of reservoirs and channels was considered. A detailed discussion of structural alternatives considered is contained in the following paragraphs. For identification purposes the flood control accomplishments of the various structural alternatives were divided into four major areas. The four areas were Merced central, which is the area south of Bear Creek; Merced north, which is essentially the area protected by improvements on Fahrens Creek; Merced airport, which is the area south and west of State Highway 99 and which is primarily rural with some urbanization in the eastern portion; and lower Bear Creek.

57. Levees and channels only. - As noted in paragraph 13, as the streams in the study area proceed across the San Joaquin Valley floor, their channel capacities and ability to carry floodflows diminish substantially. As a means of providing flood protection to the Bear Creek area, the following levee and channel alternatives were analyzed: the enlargement of existing channel capacities and the addition of levees to convey floodflows that the natural channels cannot carry through the damage areas to the Eastside Bypass; and the construction of diversion channels to carry floodflows around the damage centers. The following paragraphs describe these alternatives based upon division of the channel works into three reaches: the Eastside Bypass to Highway 99, comprising the Merced airport and lower Bear Creek damage areas; reaches upstream from Highway 99, comprising the Merced central damage area; and Fahrens Creek, comprising the Merced north damage area.

58. Eastside Bypass to Highway 99. - In the lower reach the levee and channel modifications would begin at the Eastside Bypass entrances with backwater levees and extend upstream with leveed channels. The construction of levees to the East Side Bypass has the beneficial effect of transporting Bear Creek floodflows out of the flood plain and into the San Joaquin River. At the same time, these levees could prolong and slightly increase the ponding to the south of Bear Creek by restricting the flows of Mariposa and Deadman-Dutchman Stream groups from draining north (see photograph 5). Currently, drains are provided at Mariposa Creek (Duck Slough) by a double 4 foot by 8 foot gated box culvert and at the Owens Creek leveed entrance to partially relieve the ponding.

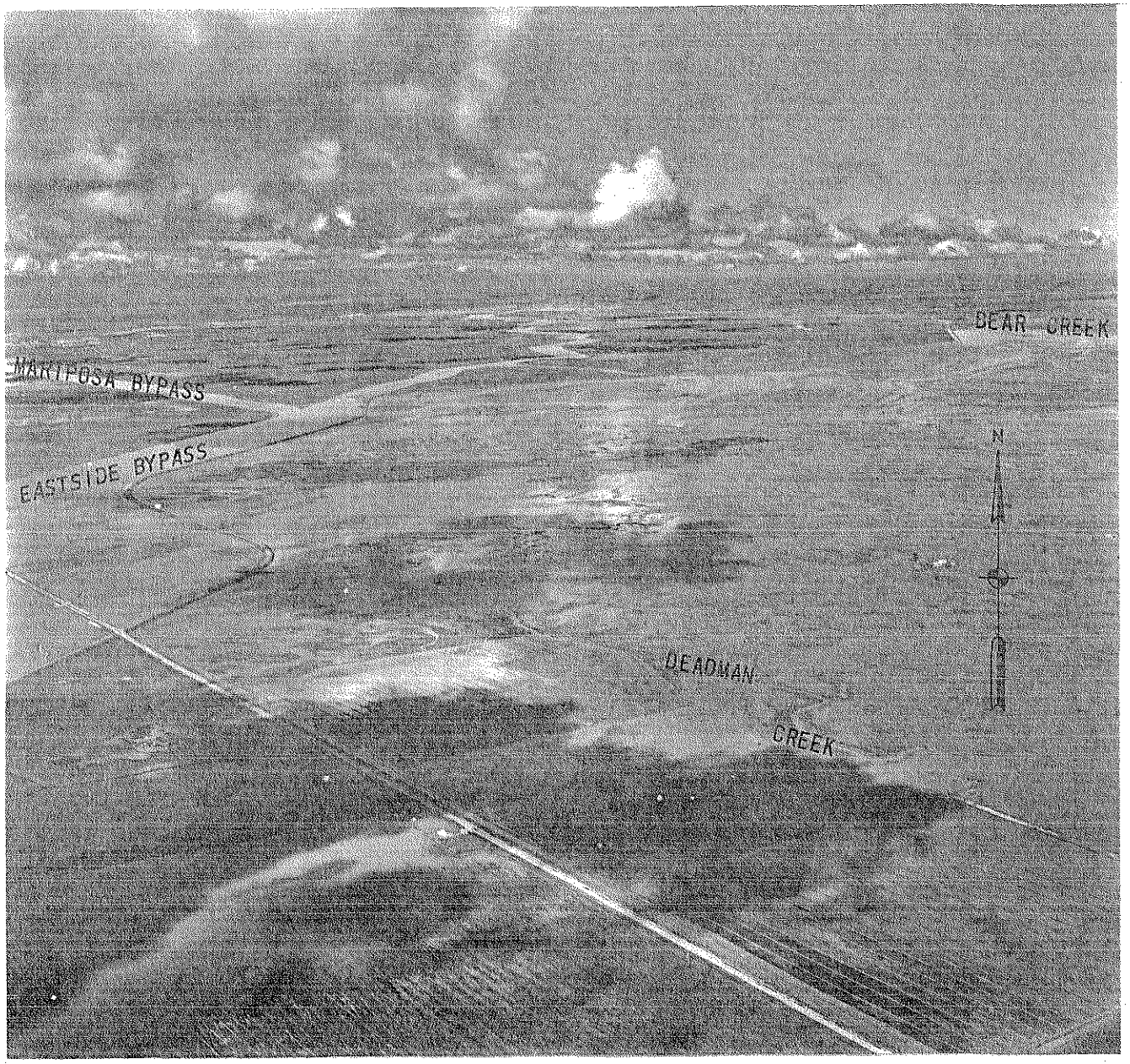
59. Hydrologic studies made of historic floods and the 50-year flood indicate that it is possible to drain ponded water into the Eastside Bypass before flows from the upstream areas of the San Joaquin River arrive. This same condition is true for more infrequent floods. By constructing a drainage channel adjacent to and south of Bear Creek

between the East Side Canal and the Eastside Bypass the water that previously flowed north over Bear Creek will flow into the Eastside Bypass before the main San Joaquin River flows enter the Eastside Bypass. This will keep the depth of ponded water at or below the existing conditions.

60. The following tabulation contains a summary of the design flows, length of possible channel works, and annual benefits and costs for various degrees of protection in the lower bear Creek and Merced airport damage areas.

Alternative Degrees of Protection for Bear Creek

	LEVEE & CHANNEL IMPROVEMENTS			
	Degree of Protection			
Stream Group	2-1/2 yr	5 yr	10 yr	25 yr
Bear Creek				
Design Flow (cfs)	5,000	6,600	7,700	10,000
Length of Channel(miles)	21	21	21	21
Benefits ($1,000)	158	342	384	-
Costs ($1,000)	276	396	576	-
Excess Benefits ($1,000)	-118	-54	-192	-
B/C	0.6	0.9	0.7	-



1969 ponding south of Bear Creek

Photograph 5

None of the plans in this reach are economically justified; however, a channel capacity of about 6,600 cfs is the best alternative.

61. Upstream of Highway 99. - The greatest amount of flood damages occur in the Merced central damage area from Bear Creek, Fahrens Creek, and their tributaries within the Bear Creek Stream group. Levee and channel works on Bear Creek through the city would require enlargement of the channel, which would necessitate relocation of a city street that parallels the creek, and removal of a row of homes throughout its length. A concrete lined channel could be considered as an alternative. Both of these alternatives are environmentally and economically undesirable. A less costly alternative would consist of a bypass originating upstream from the city which would extend around its southern limits. At the terminus of the bypass southeast of the airport, a flowage easement would be required where floodflows would be dissipated overland. As provision of 100-year protection would be a relatively small increase over present conditions, a high degree of protection of 200 years for the urban area was considered. Specifications for the bypass plan around the central city follow:

BEAR CREEK BYPASS LEVEE AND CHANNEL IMPROVEMENTS

Degree of Protection	200-year
Design Flow (cfs)	18,000
Length (miles)	10
Benefits ($1,000)	2,967
Costs ($1,000)	4,164
Excess Benefits ($1,000)	-1,197
B/C	0.7

This plan would provide flood protection to a portion of the urban area in Merced adjacent to Bear Creek but does not solve the total flood problem for the area and is not economically justified. Higher levels of protection were considered, but they were not economically justified.

62. Fahrens Creek. - Flood protection for Fahrens Creek was not specifically provided for in the authorized project. The flood plain of Fahrens Creek and the tributary of Black Rascal Creek are located in the center of Merced. Extensive urban development, including shopping centers and schools, has taken place in the area without adequate flood protection. The economic analysis, in applying hydraulics and hydrologic variables, is complex since the area is subject to flooding from both Bear Creek and Fahrens Creek, as well as from upper Black Rascal Creek. The authorized project would reducethe damages significantly but would not provide an adequate level of protection for the entire existing urban area. The feasibility of providing levee and channel improvements for the Merced north area is shown below:

FAHRENS CREEK
LEVEE AND CHANNEL IMPROVEMENTS

	Degree of Protection				
	50-Yr	100-Yr	150-Yr	200-Yr	SPF
Design Flow (cfs)	4,300	5,400	6,000	6,400	7,000
Length (miles)	6	6	6	6	6
Annual Benefits ($1000)	1,232	1,661	1,696	1,717	1,731
Annual Costs ($1000)	301	311	336	353	383
Excess Benefits ($1000)	931	1,350	1,360	1,364	1,348
B/C	4.1	5.3	5.0	4.9	4.5

Based on the need for flood protection for this area and the results of the above analysis, flood control works on Fahrens Creek have been added to the alternative plans for further study.

63. Combined channel improvement plan for Bear Creek. - None of the channel improvement plans for the separate reaches of Bear Creek satisfactorily solves the flood problems below the existing reservoirs. To determine if channel improvements only would be a viable alternative, the different reaches were combined to form an integral project, consistent with providing flood protection to most of the urban area of Merced. The best plans for the three reaches previously described were utilized in evaluating this alternative. This plan would provide SPF protection to the Merced central and north areas, about 100-year flood protection to the airport area, and somewhat less than 50-year protection to the lower Bear Creek area. The first cost of this plan is estimated at $88,885,000 with annual costs and flood control benefits estimated at $6,364,000 and $5,121,000, respectively. The benefit-cost ratio of this plan is 0.8 to 1.

64. Reservoirs only. - Flood control reservoirs would operate by intercepting and storing floodwater originating in upstream watersheds and then releasing flows to downstream channels at a rate within the capacity of the channel. Reservoirs without downstream channel modification are not practicable since floodflows entering the existing channels below the reservoirs would frequently exceed the channel capacities. There would be no protection to downstream areas from flooding by the localized runoff, particularly below Highway 99 where there is virtually no channel capacity in most of the streams. Additionally, the water released from the reservoirs as part of their operation would increase the duration of the flooding. In summary, there is no means with a reservoir only alternative to convey either the reservoir releases or the local flood runoff out of the study area, so the flood problem in the lower reaches of Bear Creek would remain. However, to demonstrate the performance of these

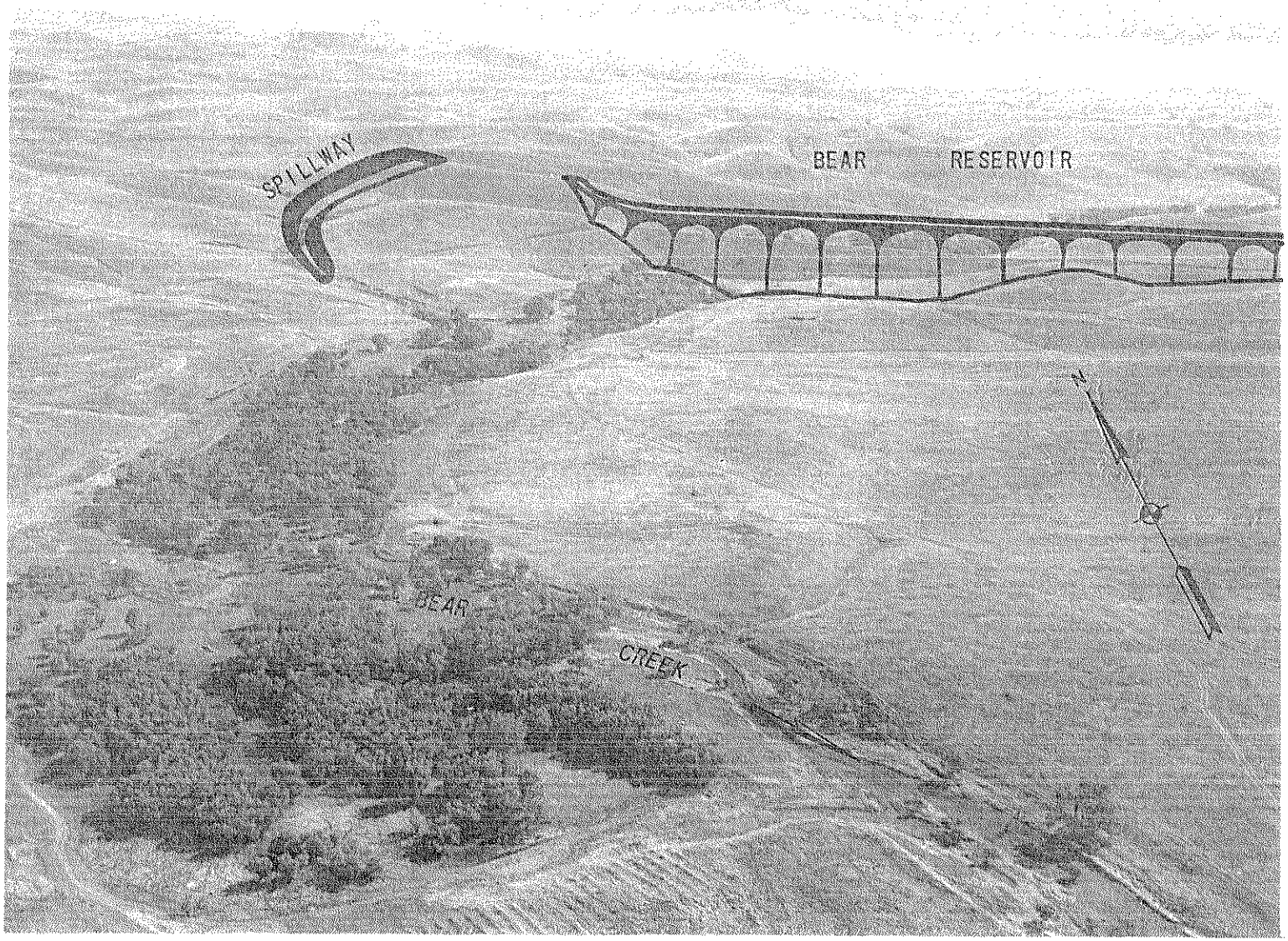
alternatives, a reservoir only plan for the Bear Creek Stream group is presented in the following tabulation. This alternative would include the most economical reservoir sizes described in paragraph 70 and would consist of a 24,000 acre-foot reservoir on Bear Creek, a 19,500 acre-foot reservoir on Burns Creek, a 2,500 acre-foot reservoir at Haystack Mountain site on Black Rascal Creek, and a 7,100 acre-foot reservoir at Castle site on Canal Creek (See photographs 6, 7, 8 and 9).

Reservoir Only

Stream Group	Costs ($1,000) First	Costs ($1,000) Annual	Annual Benefits ($1,000)	Degree of Protection (Years) Merced Central	Degree of Protection (Years) Merced North	Degree of Protection (Years) Airport Area	Degree of Protection (Years) Lower Bear Cr	B/C
Bear Cr	27,700	1,910	3,344	250	33	6	2	1.8

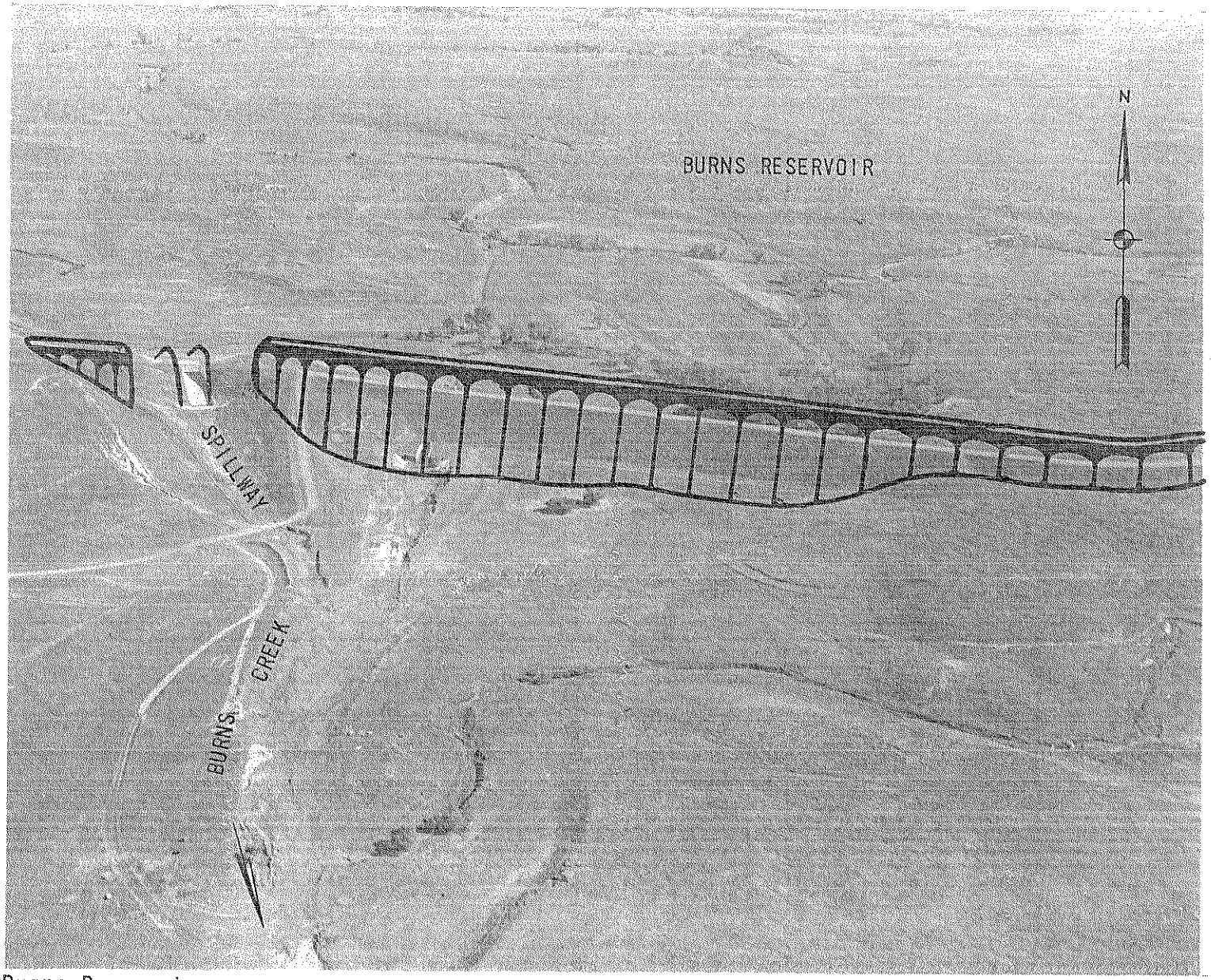
The reservoir sites are the same as those identified in the authorized plan, except for Castle, which is located upstream at a more beneficial site. Since there is no suitable reservoir site on Fahrens Creek, the urban flood plain in the north area of Merced would continue to be frequently inundated. The channel capacity of Bear Creek above Fahrens Creek is large enough, with the combined reservoir plan, to provide 250-year protection to the adjacent area. Along Bear Creek, below Fahrens Creek, the channel capacity decreases substantially so that there is relatively little improvement to the flood problem in this area. Because there is less than 100-year protection to some stream reaches, the benefits were calculated in accordance with the Flood Insurance Program, which requires that future residential and commercial structures be constructed above the 100-year flood plane, or otherwise flood proofed.

65. Combined reservoirs and channels. - Combining reservoirs and channels brings together the advantages of each. As previously noted, reservoirs alone can control the floodwaters originating above them, but the existing channels below the potential reservoir sites cannot adequately carry the local flood runoff or reservoir releases. Therefore, a combination of both measures is needed so that water may be impounded and floodflows safely conveyed out of the problem area.



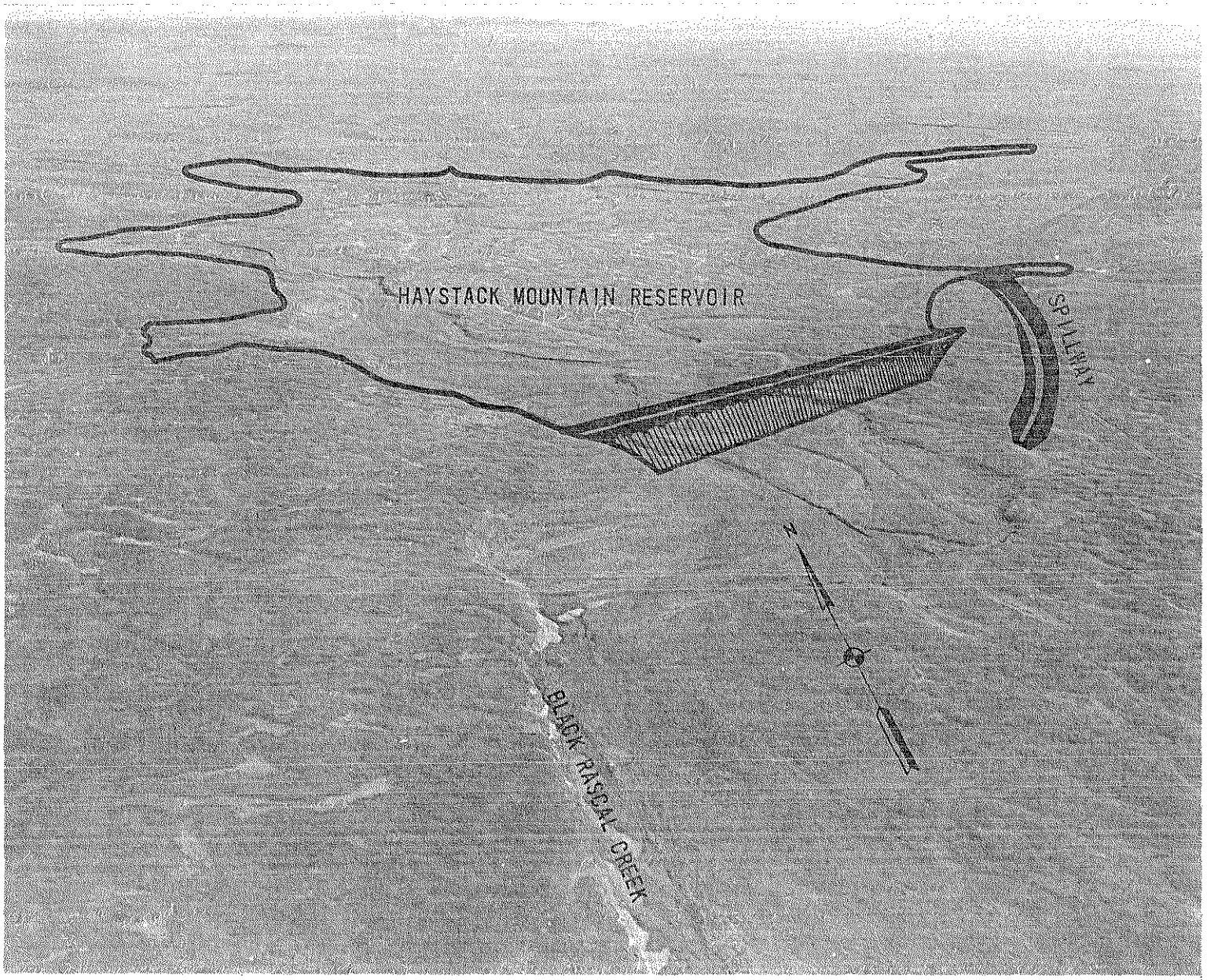
Bear Reservoir

Photograph 6



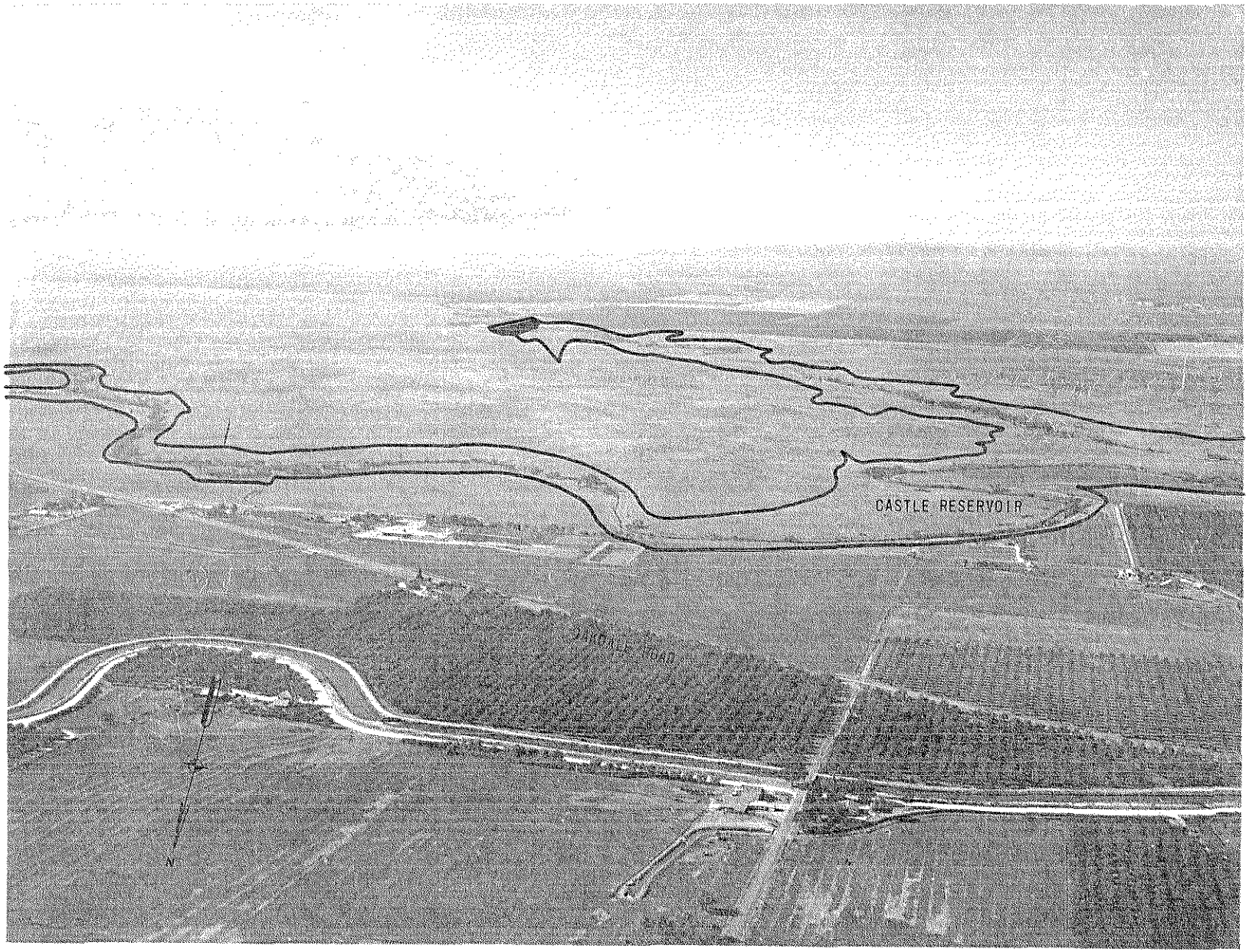
Burns Reservoir

Photograph 7



Haystack Mountain Reservoir

Photograph 8



Castle Reservoir

Photograph 9

66. Since channel modification and reservoirs are not economically feasible in the Mariposa and Deadman-Dutchman Stream groups and studies have been deferred at this time for future consideration, the detailed study was confined to Bear Creek. Even with this reduction in scope, the solution is still complex because of the large number of possible combinations of reservoirs and channels. For example, the city of Merced is flooded by five tributaries of Bear Creek. Four of the tributaries (Bear, Burns, Black Rascal, and Canal) have potential reservoir sites. The fifth, Fahrens Creek, does not have a suitable reservoir site but can be modified to carry anticipated floodflows. Downstream from the city, Bear Creek has some existing levee and channel improvements, but the reach below Crane Road has little capacity at all.

67. Ungated reservoirs are the most economical, but have the operational disadvantage of making flood control releases during the peak local floodflows in other areas, thereby increasing the magnitude of the flooding when the two combine. The existing detention reservoirs on Bear and Burns creeks are examples of this type.

68. Gated reservoirs are more expensive, but releases can be controlled to minimize flood damage downstream. The amount of flooding can be decreased by restricting the flow from the reservoirs to nothing or some minimum amount during the flood peak at other locations. The reservoirs in the authorized plan are examples of this type.

69. Developing the best combination of reservoirs and channels was simplified by using, with one exception, the best levee and channel plans described earlier, consisting of a 6,500 cfs capacity channel on Bear Creek between the Eastside Bypass and the lower city limits, and a 6,400 cfs capacity channel on Fahrens Creek. These channel capacities are the optimum sizes for accommodating the local inflows below the reservoirs. To assist in optimizing the plan, the computer program HEC-IGS, which can analyze a large number of alternative plans considering restrictions and develop the best alternative, was used to evaluate numerous combinations of remaining channel improvements and reservoirs, to consider their operating characteristics, their interrelationships, and their costs and benefits, and to develop the plan with the greatest amount of net annual benefits (National Economic Development plan). The alternatives listed in Table I and described in the following paragraphs represent the best combination of component sizes for its set of conditions. For example, the plan described for Plan 2 (Gated Bear Reservoir), is the best one of several considered by the program where Bear Reservoir has a gated outlet, the remaining reservoirs have ungated outlets, and lower Bear Creek and Fahrens Creek have channel capacities of 6,500 and 6,400 cfs, respectively. All costs and benefits are for flood control at 1977 price level and 6-5/8 percent interest for comparative purposes. The authorized features for the Bear Creek group are also displayed.

70. Plan 1. (All ungated reservoirs) - The importance of Bear and Burns Reservoirs in controlling floods relative to the other reservoirs is indicated by their comparatively large storage capacities, reflecting that Bear and Burns Creeks contribute the most floodwater. As can be seen in Table 1, the level of protection provided by this plan to the central city area and to the Fahrens Creek (north city) urban area by levees and channels is quite high (250 and 200 years, respectively). Downstream near Crocker Dam, the increased floodflows resulting from combining Bear and Fahrens Creeks and the predominantly agricultural character of the damage area make it uneconomical to provide as high degree of flood protection. Hence, the level of protection in lower Bear Creek is only 25 years.

This plan was later selected as the basis for the National Economic Development (NED) plan.

71. Plan 2. - (Gated Bear Reservoir) - This plan demonstrates the economic impact of gating Bear Reservoir. The increased costs associated with the control tower, access bridge, gates, and electrical and mechanical equipment are partially balanced by a reduction in reservoir size. Also, the other reservoirs are affected by the change in the operation of Bear Reservoir, so their economical sizes also change. The reduced protection provided by this plan to the central city (170 years), reflects the smaller size of Bear Reservoir; however, gates allow the flood control releases to be regulated so that the peak floodflows in the airport area and lower Bear Creek are smaller, resulting in a higher level of protection when compared with the ungated plan (see Table 1).

72. Plan 3. (Gated Burns Reservoir) - This alternative also indicates the economical impact of gating a reservoir. Although the flood control releases can be better regulated, the economical size of Burns Reservoir decreases from about 20,000 acre-feet to 10,000 acre-feet. The smaller reservoir offsets the advantages of the gated outlet so that the 70-year level of protection in the central city is the same as that provided by the existing Burns Reservoir alternative, described below. Without better control of Bear Creek floodflows, there is little advantage to gating only Burns Reservoir.

73. Plan 4. (Gated Bear and Burns Reservoirs) - The most economical plan with Bear and Burns Reservoirs gated results in larger storage capacities for Haystack Mountain and Burns Reservoirs, relative to plan 3. The increased storages, together with better regulation of Bear and Burns Creeks, from which the major sources of floodwater to the City of Merced originate, increase the level of protection to 100 years for the city. However, relative to plan 2, the economical sizes of Haystack Mountain and Burns Reservoirs are smaller and the overall level of protection is less (see Table 1).

74. Plan 5. (All gated reservoirs) - This alternative is a further illustration of the tradeoffs between storage capacity and gated

TABLE I

MERCED COUNTY STREAMS, CALIFORNIA
COMBINED RESERVOIRS AND CHANNELS PLANS 1/

PLAN	RESERVOIRS (Size in acre-feet)				CHANNELS (Capacity in cfs)		COSTS ($1,000)		BENEFITS ($1,000)		B/C	DEGREE OF PROTECTION (Year)			
												MERCED			LOWER BEAR CR.
	HAYSTACK MTN.	BURNS	BEAR	CASTLE	FAHRENS CR.	LOWER BEAR CR.	FIRST	ANNUAL	ANNUAL	NET		CENTRAL	NORTH	AIRPORT	
1 Ungated Reservoirs	2,500	19,500	24,000	7,100	6,400	6,500	52,140	3,636	5,155	1,519	1.4	250	200	40	25
2 Gated Bear Reservoir	5,800	22,500	Gated 18,500	7,100	6,400	6,500	49,569	3,462	4,926	1,464	1.4	170	200	60	50
3 Gated Burns Reservoir	2,300	Gated 10,000	18,500	7,100	6,400	6,500	50,423	3,580	4,603	1,023	1.3	70	200	50	50
4 Gated Bear and Burns Reservoirs	4,000	Gated 12,000	Gated 18,500	7,100	6,400	6,500	50,682	3,619	4,793	1,174	1.3	100	200	40	50
5 All Gated Reservoirs	Gated 2,600	Gated 15,700	Gated 18,500	Gated 3,500	6,400	6,500	55,528	3,991	5,156	1,165	1.3	160	200	40	50
6 Existing Burns Reservoir	3,000	7,000	29,000	7,100	6,400	6,500	52,406	3,714	4,789	1,075	1.3	70	200	30	20
7 Existing Bear Reservoir	2,900	19,500	7,700	7,100	6,400	6,500	47,330	3,352	4,211	859	1.3	25	200	20	20
8 Without Haystack Mtn. Reservoir	--	20,000	19,000	7,100	6,400	6,500	48,660	3,457	4,819	1,362	1.4	50	200	40	20
9 Without Castle Reservoir	2,000	17,000	24,000	--	8,000	6,500	52,778	3,744	5,069	1,325	1.4	230	100	40	20
Authorized (Bear Group)	Gated 3,000	Gated 30,000	Gated 14,400	Gated 11,500	--	5,500	20,616	1,511	3,290	1,779	2.2	80	80	50	50

1/ Flood Control only.

outlets. Compared to plan 2, gating all the reservoirs results in smaller economical storage capacities for Castle, Haystack Mountain, and Burns Reservoirs. The operational advantages of controlling flood releases, however, compensate for the reduced storage capacities for this plan and result in about the same level of protection as the ungated plan throughout the project area.

75. Plan 6. (Existing Burns Reservoir) - This alternative, with no modifications made to the existing 7,000 acre-foot Burns Reservoir, demonstrates the relative effect of a larger reservoir in controlling floodflows. For the SPF flood, Burns Reservoir would release about 6,500 cfs into Bear Creek. Since the Bear Creek channel capacity is about 7,000 cfs, the other reservoirs would have to be enlarged to retain the floodflows on their respective streams from entering Bear Creek during the peak flows from Burns. Haystack Mountain and Bear Reservoirs have been increased in storage capacity, but the most economical sizes are not enough to compensate for flows releases from Burns Reservoir. Consequently, the levels of flood protection through the central city and on lower Bear Creek are quite low at 70- and 20-year degrees of protection, respectively.

76. Plan 7. (Existing Bear Reservoir) - This alternative demonstrates that keeping Bear Reservoir at the original size of 7,700 acre-feet does little to solve the flood problem in the City of Merced. Burns and Haystack Mountain Reservoirs control the floodflows on their respective streams, but large flows continue to originate from the Bear Creek watershed. For the SPF event, these flows would be as much as 20,000 cfs. When this amount is combined with the flows from Burns and Black Rascal Creeks, the 7,000 cfs capacity of the channel through the city is completely inadequate to prevent flooding. As can be seen in Table 1, only about 25-year protection is possible in the central city.

77. Plan 8. (Without Haystack Mountain Reservoir) - Excluding Haystack Mountain Reservoir from a flood control plan results in no control of the floodflows from Black Rascal Creek. For the SPF flood, about 5,400 cfs of Bear Creek channel's 7,000 cfs capacity would be taken up by Black Rascal Creek, shifting the burden of control in the multiple reservoir system to Bear and Burns Reservoirs. As was the case with plan 6, the uncontrolled flows are almost equal to the channel capacity of Bear Creek through the city. The other reservoirs cannot control their respective upstream watersheds to reduce flows to compensate for the increased flows in Bear Creek, so the overall level of flood protection for the areas affected by Bear Creek is reduced substantially to about 50 years through the city and 20 years to the downstream areas.

78. Plan 9. (Without Castle Reservoir) - By not providing Castle Reservoir, Canal Creek floodflows would continue to be diverted into the Main Canal and carried to Yosemite Lake. When the combined flows of the diverted waters and local runoff exceed the capacity of the

canal, the excess water is allowed to spill into the Fahrens Creek area. The downstream urban area that is flooded can be protected by enlarged channels and levees. The most economical channel size, which is an exception to the 6,400 cfs previously used, has a capacity of 8,000 cfs and would provide about 200-year protection. This channel capacity was computed separately and imposed as a constraint on the computer program to optimize the reservoir sizes for this condition. In addition, the combined flows of Fahrens and Bear Creeks at their junction would cause backwater conditions and inundate the bridges on Fahrens Creek upstream from the confluence. Enlargement of the Bear Creek channel at Fahrens Creek and relocations of all the bridges to minimize this effect are included in the cost estimate.

79. The urban areas not affected by the diverted Canal Creek flows have a relatively high level of protection (see Table 1) from Burns and Bear Reservoirs, which have capacities of 17,000 and 24,000 acre-feet, respectively.

80. Combinations of structural and nonstructural measures. - Nonstructural measures considered were zoning and building code regulations, flood proofing, flood forecasting, and evacuation, those described in paragraph 54. Although limited nonstructural measures could be combined with various structural measures on the Bear Creek group, no such measure are economically justified overall, and adequate flood protection would not be provided.

81. Evaluation of higher levels of flood protection. - It is apparent that a number of alternative plans are economically feasible on Bear Creek and its tributaries. National economic efficiency (benefits vs. cost for each increment of protection being one or greater) is important, but by making modifications to the flood control improvements previously described and making moderate increases in sizes of the flood control reservoirs, more social, environmental, and local objectives may be achieved with little loss in national economics. Various arrangements of reservoirs, both gated and ungated, were considered in conjunction with levee and channel works to improve the level of flood protection to provide standard project flood (SPF) protection. With regard to providing levees in urban as areas, the general rule is to provide at least SPF protection where levee failure would result in substantial damages and the possiblity of loss of life. Table 2 displays alternative plans which are refinements of the most economic plan presented in paragraph 70 and demonstrates the economic tradeoffs in providing greater flood protection. These alternatives are used as the basis for the final plan selection process described in Chapter VII. As in Table 1, the authorized features in the Bear Creek group are displayed for comparative purposes. The costs and benefits in paragraphs a through f and Tables 1 and 2 are flood control only at 1977 prive level and 6-5/8 percent interest and are given for comparative purposes only.

a. Plan 1. - Plan 1 was previously described in paragraph 70 and represents the most cost effective flood control plan, therefore it

TABLE 2

MERCED COUNTY STREAMS, CALIFORNIA
PLAN SELECTION 1/

PLAN	RESERVOIRS (Size in acre-feet)				CHANNELS (Capacity in cfs)		COSTS ($1,000)		BENEFITS ($1,000)		B/C	DEGREE OF PROTECTION (Year)			
												MERCED			LOWER BEAR CR.
	HAYSTACK MTN.	BURNS	BEAR	CASTLE	FAHRENS CR.	LOWER BEAR CR.	FIRST	ANNUAL	ANNUAL	NET		CENTRAL	NORTH	AIRPORT	
1	2,500	19,500	24,000	7,100	6,400	6,500	52,140	3,636	5,155	1,519	1.4	250	200	40	25
10	2,500	19,500	Gated 24,000	7,100	6,400	6,500	54,346	3,837	5,216	1,379	1.4	270	200	100	50
11	2,500	19,500	Gated 24,000	7,100	7,000	6,500	56,486	3,982	5,229	1,247	1.3	270	270	100	50
12	5,800	23,000	Gated 24,000	7,100	7,000	6,500	57,380	4,047	5,396	1,349	1.3	330 (SPF)	330 (SPF)	100	50
13	5,800	23,000	Gated 24,000	7,100	7,000	6,500 & 9,000	61,988	4,366	5,417	1,051	1.2	330 (SPF)	330 (SPF)	330 (SPF)	50
14	5,800	23,000	Gated 24,000	7,100	7,000	9,000	63,430	4,417	5,447	1,030	1.2	330 (SPF)	330 (SPF)	330 (SPF)	330 (SPF)
Authorized (Bear Group)	Gated 3,000	Gated 30,000	Gated 14,400	Gated 11,500	—	5,500	20,616	1,511	3,290	1,779	2.2	80	80	50	50

1/ Flood Control only.

has become the basis for the NED plan. This plan is a combined reservoir and channel improvement plan, with all reservoirs ungated, Fahrens Creek improved to 6,400 cfs, and lower Bear Creek improved to 6,500 cfs. The flood damage reaches are divided into four areas: (1) Merced central; (2) Merced north, which is essentially the area protected by improvements on Fahrens Creek; (3) Merced airport, the area south and west of State Highway 99, which is essentially rural with some urbanization in the eastern portion; and (4) lower Bear Creek. As can be seen on Table 2, the Merced central and north city area are provided relatively high degrees of protection, a maximum of 250- and 200-year, respectively. However, the Merced airport and lower Bear Creek areas are provided a much lower degree of protection, 40- and 25-year, respectively. The first cost of the flood control portion of this plan is $52,140,000. Annual costs and benefits are $3,636,000 and $5,155,000, respectively, and the flood control portion of this plan is economically justified with a benefit-cost ratio of 1.4 to 1. It would be desirable to more nearly balance the degree of protection for all of the urban areas as well as provide a higher degree of protection to the rural area; therefore, other alternative improvement plans or refinements were considered.

b. Plan 10. - This plan is the same as plan 1, except control gates were added to the outlet works at Bear Reservoir. The first cost is $54,346,000, which is an overall increase of about $2,200,000 over plan 1. The benefit-cost ratio is 1.4 to 1, and the added increment has a benefit-cost ratio of 0.3 to 1. By adding control gates to Bear Reservoir, the flood protection provided to the airport area is significantly increased to 100-year level of protection, and the flood protection to lower Bear Creek area is also doubled to 50-year protection from that provided by alternative 1. Flood protection to central Merced is also somewhat increased to about 270-year protection; however, the north city area remains the same as that in Plan 1 (200-year). Increasing the level of flood protection by a significant amount for the two areas mentioned is a positive step in approaching the objective of providing a more balanced degree of flood protection for the area. Although the added increment is not completely justified economically, the economic justification of the entire plan is not compromised.

c. Plan 11. - The levee and channel improvements on Fahrens Creek pass through a highly developed urban and residential area, and the associated levees for 200-year protection are quite substantial. The levee heights are at least 10 feet, and current policy is to provide SPF design in such areas where levee failure would result in substantial damages and the possibility of loss of life. Therefore, plan 11, which provides the SPF level of design of 7,000 cfs on Fahrens Creek, was investigated. The overall first cost of this plan is $56,486,000 and represents an increase over plan 1 of over $4 million with an incremental benefit-cost ratio of 0.2 to 1. The benefit-cost ratio is 1.3 to 1. Although SPF design is provided on Fahrens Creek, SPF protection is not attained for the north city area

because this area is subject to floodwaters escaping from Bear Creek and flooding behind the levee system on Fahrens Creek. Providing an SPF level of design on Fahrens Creek and having it out-flanked by floodflows from Bear Creek is inconsistent from a design standpoint as well as being undesirable.

d. Plan 12. - By investigating the various combination plans, this plan was developed by increasing the capacity of Haystack Mountain Reservoir to 5,800 acre-feet and Burns Reservoir to 22,600 acre-feet, retaining a gated outlet on the 24,000 acre-foot Bear Reservoir, and utilizing a 7,100 acre-foot reservoir on Canal Creek. The channel capacities on Bear and Fahrens Creeks would be 6,500 and 7,000 cfs, respectively. It was determined that SPF protection would be provided for the north city area as well as central Merced; 100-year protection would be provided to the Merced airport area; and 50-year protection would be provided to lower Bear Creek. Fahrens Creek has a dense stand of oak and other types of sizeable trees, as well as numerous shrubs and brush which provide habitat for various species of wildlife. Riparian habitat is relatively scarce in the area of the project and is rapidly diminishing due to expanding agricultural practices. A desirable feature of the project, meeting part of the environmental quality objectives, would be preservation of the riparian habitat. This could be largely accomplished by constructing the levees so that the existing channel would be retained and still provide the necessary capacity for the SPF design flow. This feature would also and preserve open space, which is in consonance with the city and county master plans. This alternative has a first cost of $57,380,000, which is over $4 million greater than plan 1 and has a benefit-cost ratio of 1.3 to 1. The incremental benefit-cost ratio is 0.6 to 1. This plan was eventually chosen as the recommended plan.

e. Plan 13. - This plan provides SPF protection to just the Merced airport area in addition to the central area and north city areas. The first cost of this alternative is estimated at $61,988,000, an increase of about $10 million over plan 1, with an incremental benefit-cost ratio of 0.4 to 1. The incremental benefit-cost ratio of this addition over plan 12 is 0.07 to 1, which also represents a poor economic increment for the added level of flood protection. Further evaluation of this plan revealed that floodwaters from the potential project must flow away from the area via the State's East Side Bypass. This bypass system is designed to contain a 50-year flood. Increasing the level of design to SPF on lower Bear Creek would be inconsistent with downstream capacities in the bypass and severely overtax this facility should the SPF occur.

f. Plan 14. - This plan would be the same as the channel works described in plan 13 but would have the levees extended to the East Side Canal. This plan would provide SPF protection to all areas protected by the project. The reservoir system as envisioned in plan 12 already provides SPF to essentially all of the urban areas of

Merced. The only additional increment that could increase the degree of protection for the Merced airport and lower Bear Creek would be to provide increased capacities of levee and channel improvements to these stream reaches. The first cost for this plan is estimated at $63,290,000 which is about $11 million more than plan 1. The incremental benefit-cost ratio over the NED plan is about 0.4 to 1; however, when comparing the incremental benefit-cost ratio from plan 12 to this alternative, the incremental benefit-cost ratio is about 0.1 to 1, which is a poor economic increment.

g. Plan 15. - This plan would be the same as plan 12 except that part of the flows in Canal Creek Basin would be diverted to the Merced River and the capacity of Castle reservoir would be reduced to 1,500 acre-feet. This would reduce land requirements at the Castle site but add land requirements along the diversion to the Merced River. This plan would provide the same degree of protection but would cost $4 million more than plan 12 and have a benefit-cost ratio of 1.2 to 1.

CHAPTER VII - PLAN FORMULATION AND EVALUATION

82. General plan formulation procedure. - For the Merced County Streams project, plan formulation involved reanalysis of the authorized plan, preliminary analysis for each stream group, deferral of some plans for future consideration, detailed study of alternative plans, selection of a plan, and optimization and justification of that plan based on certain technical, economic, environmental, and social criteria. Although not applicable to this project guidelines for the formulation process generally followed the Principles and Standards developed by the Water Resources Council and related Corps of Engineers' regulations. The evaluation of preliminary alternatives has already been discussed. Evaluation of the alternatives considered for the recommended plan follow.

83. Plan formulation. - As described previously in Chapters V and VI, a number of plans, including the authorized plan, were given preliminary consideration for solution of the area's flood and related water resource problems and needs. These alternatives included no action, nonstructural measures, structural measures, and combinations of structural and nonstructural measures. Plan effects are accounted for in terms of their beneficial and adverse impacts on national economic development (NED), environmental quality (EQ), regional development (RD), and social well-being (SWB). Four alternative plans have been fully developed from among the many investigated in the planning process: (1) the authorized plan, (2) a National Economic Development or NED plan, (3) an Environmental Quality or EQ plan, and (4) a modified authorized plan. Development and presentation of NED and EQ plans are required by the Water Resources Council's Principles and Standards. The four alternatives are presented in the following paragraphs.

84. Alternatives selected for further study. -

a. Authorized plan. - The Flood Control Act of 1970 (Public Law 91-611) authorized this plan for construction. As previously described, the Bear Creek Stream group consists of four gated reservoirs for flood control and recreation as the principal project purposes. This plan was developed using the procedures, costs, and interest rates current at the time of authorization. New construction of Castle and Haystack Mountain Reservoirs would be accomplished together with the enlargement of existing Bear and Burns Dams. Castle and Burns Reservoirs would have specific storage reservations for recreation use. The plan also included 20.6 miles of levee and channel modifications on Bear Creek.

b. As mentioned previously, the authorized measures and other alternatives for Mariposa Stream group and Deadman-Dutchman Stream group are currently not economically feasible at this time and are being deferred for further studies. The economic analysis follows

current guidelines, procedures, and prevalent financial costs that are appropriate to today's conditions.

c. National Economic Development plan or NED plan. - Planning criteria used for evaluation generally followed the guidelines contained in Water Resources Council's "Principles and Standards (P&S) for Planning Water and Related Land Resources," dated 1973. P&S states that, for the NED plan, net economic benefits shall be maximized. Net economic benefits are maximized when plan scale is optimized and the plan is efficient. Scale is optimized when the benefits of the last increment (output for each measure in the plan) equals the economic costs of that increment. A plan is efficient when the outputs of the plan are achieved in a least costly manner. The NED plan developed in this study is characterized by the fact that other alternative plans will only reduce the amount of net excess benefits. It is the culmination of the comparison of the alternative systems previously described and selecting the one plan which has the greatest excess benefits.

d. The NED plan of improvement for the Merced County Streams flood control project includes construction of two reservoirs, Castle and Haystack Mountain, and the enlargement of two reservoirs, Bear and Burns. They are all earthfill dams and have ungated outlet structures. Levee and channel improvements would be constructed on Fahrens and Black Rascal Creeks, Bear Creek, and Black Rascal Slough. These facilities are for flood control only. Total flood control capacity for the reservoirs is 53,100 acre-feet.

e. The levee and channel improvements on Fahrens and Black Rascal Creeks provide a 6,400 cfs capacity with a degree of protection to the central and north portions of Merced at 250 and 200 years, respectively. However, the Merced airport and lower Bear Creek areas would receive lower degrees of protection at 40 and 25 years, respectively. The capacity of the lower Bear Creek improvements is 6,500 cfs.

f. An additional construction item for this plan would be a drainage channel adjacent to and south of Bear Creek. This feature, which will serve to drain the area south of Bear Creek, would be located between the East Side Canal and the East Side Bypass. This channel is necessary to prevent any additional ponding in this area due to the construction of the lower Bear Creek levees.

g. The NED plan includes wildlife mitigation measures. These measures would be required due to adverse project impacts caused by the downstream levees on Bear Creek and were included in the NED plan. Large areas of marshland exist adjacent to the East Side Canal. These marshlands have a very high wildlife habitat value. An easement on 2,800 acres would be acquired to prevent any land use change. In addition, two wells and pumps would be installed to provide water to sustain the marshes since flows which previously flooded the area would

be contained between project levees. Large areas of marshland exist adjacent to the East Side Canal. These marshlands have a very high wildlife habitat value. An easement on 2,800 acres would be acquired to prevent any land use change. In addition, three wells and pumps would be used to provide water to sustain the marshes since flows which previously flooded the area would be contained between project levees.

h. The recreation feature of the NED plan would consist of a 6-mile bicycle trail system which would follow certain portions of Fahrens and Black Rascal Creeks channel improvements. Included in these facilities would be two staging areas containing picnic and parking facilities. The recreation features, except the staging areas, are located on lands acquired for flood control purposes. This is in conformance with the Veysey Rules, which allows certain support facilities to be located on lands to be provided in addition to lands required for flood control.

i. The following tabulation lists the features of the NED plan.

NED Plan
Reservoir and Channel Improvements

Reservoir	Size (acre-feet)	Outlet Works
Haystack Mtn.	2,500	Ungated
Castle	7,100	Ungated
Burns	19,500	Ungated
Bear	24,000	Ungated

Channel	Capacity (cfs)
Fahrens and Black Rascal Creek	6400
Bear Creek and Black Rascal Slough	6500
Drainage Channel Adjacent to Bear Creek	9000

Recreation Trail System: 6 miles w/picnic sites.

Environmental Features: Easements on 2,800 acres for wildlife mitigation with facilities to provide water requirements.

j. Environmental Quality plan. - The P&S requires the systematic preparation and evaluation of alternative solutions to problems, under the objectives of National Economic Development (NED), as previously described, and Environmental Quality (EQ). P&S also requires that the impacts of proposed actions be displayed under four accounts: NED, EQ, Regional Development (RD), and Social Well-Being (SWB). This is to insure that both beneficial and detrimental effects are recognized so that an objective decision can be made in assessing alternative measures which are viable solutions to the problem.

k. An interdisciplinary study team of District employees developed a list of environmental objectives specific to the study area. These environmental objectives are applicable to the formulation and evaluation of the EQ plan:

(1) The plan should be formulated to the extent practicable to preserve and enhance the quality of the natural environment, specifically including fish and wildlife, vegetation, land, air, water, open space, and scenic and esthetic values.

(2) Detrimental environmental effects should be avoided where possible, and feasible mitigation for such unavoidable effects should be included.

(3) The relationship of the proposed action to land use plans should be considered, and the environmental impact of any proposed action should be evaluated. Any adverse environmental effects which could not be avoided, if a proposal were implemented, should be identified; alternatives to such proposed action should be identified; the relationship between local short-term uses and the maintenance or enhancement of long-term productivity should be determined; and any irreversible and irretrievable commitments of resources involved if a proposed action were implemented, should be identified. From this list, alternative measures were identified which maximized the environmental account. Implementable alternative plans were then developed to include as many of these environmental objectives as possible and still achieve some level of improved flood protection. The input and views of individuals of the U.S. Fish and Wildlife Service and the California Department of Fish and Game, who have a detailed knowledge of the study area, were obtained during this process. After reviewing the results, one plan was selected as the EQ plan. Subsequent to its identification, additional environmental measures were added to further increase the EQ account.

l. The EQ plan includes the construction of Haystack Mountain and Castle Reservoirs and the enlargement of Bear and Burns Reservoirs. Channel improvements and levee construction along Fahrens and Black Rascal Creeks and Bear Creek and Black Rascal Slough were also included. To avoid increased ponding resulting from project levees in the area south of lower Bear Creek, a drain channel adjacent to and south of Bear Creek between East Side Canal and East Side Bypass would be provided.

m. The combined flood storage capacities for the four reservoirs amount to 55,900 acre-feet. The improvements on Fahrens and Black Rascal Creeks would provide a total flood carrying capacity of 7,000 cfs, which would result in SPF protection to the adjacent urban area. Improvements on Bear Creek and Black Rascal Slough would provide a total capacity of 6,500 cfs, raising the degree of protection to the Merced airport and lower Bear Creek areas to 100 and 50 years, respectively.

n. The recreation aspects of the EQ plan would include a 15 mile trail system and a recreation pool at Castle Reservoir. The trail system would provide opportunities for hiking, bicycling, and equestrian activities. Trails would be located on the levees of the Fahrens and Bear Creek groups. Staging areas with parking facilities, picnic sites, trail access ramps, and fishing access sites would be located at strategic locations. The recreation facilities at Castle Reservoir would include a seasonal 3,500 acre-foot pool, and day-use and fishing facilities would be developed.

o. The following tabulation lists the reservoir, channel, and recreation improvements of the EQ plan.

EQ Plan
Reservoir and Channel Improvement Aspect

Reservoir	Size (acre-feet)	Outlet Works
Haystack Mtn.	5,800	Ungated
Castle	3,500	Gated
Burns	22,600	Ungated
Bear	24,000	Gated

Channel	Capacity (cfs)
Fahrens and Black Rascal Creek	7,000
Bear Creek and Black Rascal Slough	6,500
Drainage Channel Adjacent to Bear Creek	9,000

Recreation Facilities:

Reservoir: Day-use and fishing facilities.
Trail System: 15 miles, w/picnic sites.
Lower Bear Creek: fishing access sites.
East Side Canal: fishing access site.

p. The elements discussed below represent the specific environmental quality aspects of the EQ plan. The actions include reestablishment and protection of habitat area, establishment of recreation and public access sites, specific management procedures, and purchase of lands.

q. Several measures would be taken for enhancement of wildlife habitat at the reservoirs and adjacent lands. At the reservoirs, cattle grazing would be reduced and about 1,500 acres of selective plantings placed to improve the vegetative cover and establish upland habitat. At Castle Reservoir, in order to mitigate losses of riparian habitat due to inundation, about 25 acres of riparian habitat would be purchased immediately downstream of the dam. Also, the upstream

reaches of Canal Creek would be planted to replace this valuable riparian habitat. The recreation pool at Castle Lake would be used to enhance warmwater fishery resources. At Haystack Mountain, Burns and Bear Reservoirs, small seasonal pools for wildlife of approximately 40,100 and 100 acres respectively, would be provided. The Merced area was once the original native range for the Tule Elk, a species whose population has been reduced to a few protected herds in the State. Public Law 94-389 provides for Federal participation in preserving the Tule Elk population in California. One State preserve for these elk is presently being maintained near Buena Vista Lake southwest of Bakersfield, California. To provide further acreage for these elk, the EQ plan would include a fenced, 7,900-acre preserve. The lands surrounding Bear and Burns Reservoirs and the land between the reservoirs would be purchased in fee title for the preserve. Besides the upland habitat planting previously described, the preserve would have water sources for the elk.

r. The stream courses and adjacent lands, particularly in the lower Bear Creek area, provide a variety of valuable habitat to native wildlife, as well as nesting and feeding grounds for migrating fowl. Due to the high emphasis on agriculture in the San Joaquin Valley, wildlife habitat is steadily being converted to cropland. For this reason, extensive mitigation and enhancement measures are considered to offset all adverse impacts due to project works. Where it is possible, the natural channels would be preserved. The land between the levees on lower Bear Creek would provide about 700 acres of preserved and created habitat. The land between the Fahrens Creek levees would provide about 180 acres of preserved and created habitat. The areas within the levees on lower Bear Creek and Fahrens Creek would be planted with selected native grasses, shrubs, and trees which would create 300 acres of marsh, 130 acres of riparian and 70 acres of upland vegetation. The marshland would be created by utilizing shallow borrow areas with selected plantings. The waterside slope of the levees would be planted with upland vegetation. Certain areas in the reservoirs and the reaches where the levees are far apart would also have structural controls, such as weirs so that these reaches could be utilized for ground water recharge.

s. The marshes adjacent to lower Bear Creek and the East Side Canal and East Side Bypass would be adversely impacted because of the controlled flooding. Floodflows which once overtopped the banks and flowed overland from Bear Creek on an almost annual basis would now be directed into the East Side Bypass by the completed project levees. The wildlife quality of the marshes depends on these floodflows for flushing action. In order that this habitat retain its existing quality, the EQ plan would provide outlet structures to be constructed in the levees along lower Bear Creek. These structures and a distribution system of channels would allow from 100 to 600 cfs to pass through the levees to the marshlands.

t. To accomplish the above measures, the acquisition of the following parcels and their management as a wildlife refuge would be required:

(1) 650 acres between the lower Bear Creek levees.

(2) 5,500 acres at Bear and Burns Reservoirs.

(3) 2,400 acres between Bear and Burns Reservoirs for the Tule Elk preserve.

(4) 5,500 acres of marsh and grasslands adjacent to lower Bear Creek and the East Side Canal.

(5) 25 acres bordering Canal Creek below Castle Reservoir to protect riparian vegetation.

u. Modified authorized plan. - The plan as described here is the culmination of the studies during advanced planning. The process reviews the impacts where works are feasible (NED) and considers other social, environmental (EQ), and regional attributes in the light of current policy with a view toward modifying the authorized plan to provide the best possible plan. To a large extent, this plan is a combination of the NED and EQ plans with an objective to increase the flood protection in urban areas to reasonably high levels and expand the environmental considerations.

v. A description of the modified authorized plan is as follows: The plan would consist of flood control facilities at four reservoirs, Castle, Haystack Mountain, Burns, and Bear. Bear Dam outlet works would be gated while the other dams would be ungated. Levee and channel construction would be along Bear Creek and Black Rascal Slough; Fahrens, Black Rascal and Cottonwood Creeks; and El Capitan Canal. Lands at the reservoirs would be acquired by flowage easement except for the areas committed to the dams and dikes which would be in fee title. Lands for levee and channel improvements would be a combination of easement and fee title, also.

w. The combined flood storage capacities of the four reservoirs amounts to 59,500 acre-feet. The improvements on Fahrens and Black Rascal Creeks provides a total flood-carrying capacity of 7,000 cfs, giving an SPF level of protection to the adjacent urban area. Improvements on Bear Creek and Black Rascal Slough provide a total capacity of 6,500 cfs which yields a 100-year and 50-year level of protection for the Merced airport area and lower Bear Creek areas, respectively. The drainage channel adjacent to and south of Bear Creek will be included to prevent any possible additional ponding south of Bear Creek due to project levees.

x. This plan includes features from the EQ plan which would serve to mitigate project impacts. Between the levees on Fahrens

Creek, approximately 25 acres of marsh ponds will be created by utilizing borrow areas and about 45 acres of riparian vegetation would be planted on and adjacent to the levees and newly created marshlands. There are large marshland areas east of the East Side Canal. These marshlands are currently sustained by Bear Creek flooding. The project levees south of Bert Crane Road would contain all flood flows up to a 50-year event, thus depriving the marshes of the periodic flooding. To mitigate for these impacts, a 2,800 acre easement would be acquired adjacent to the East Side Canal. Wells would be installed to provide water to sustain the marshes.

y. For recreation, a 6-mile bike trail system with parking and picnic sites would be included; the trail will follow portions of Fahrens and Black Rascal Creeks. More detail data on recreation can be found in Appendix C.

z. The following table lists the features of the modified authorized plan.

Modified Authorized Plan
Reservoir and Channel Improvement

Reservoir	Size (acre-feet)	Outlet Works
Haystack Mtn.	5,800	Ungated
Castle	7,100	Ungated
Burns	22,600	Ungated
Bear	24,000	Gated

Channel	Capacity (cfs)
Fahrens and Black Rascal Creek	7,000
Bear Creek and Black Rascal Slough	6,500
Drainage Channel Adjacent to Bear Creek	9,000

Recreation Trail System: 6 miles w/picnic sites.

Environmental Features: 70 acres of newly created wildlife habitat between Fahrens Creek levees. Easements on 2,800 acre easement adjacent to the East Side Canal for mitigation with facilities to provide water for marshes.

85. Selection of recommended plan. -

a. Authorized plan. - The authorized plan features in the Bear Creek group would provide only a minimum degree of flood protection, which is insufficient for an urban area, based upon detailed hydrology and hydraulics. Channel improvement measures were not included on Fahrens Creek, leaving a major flood problem in an urban area unresolved. Environmental measures for mitigation of project impacts

from construction of channel improvements were not included, as now required in accordance with current evaluation procedures. The recreation features in this plan are no longer economically justified at the two reservoirs in this stream group. This plan would require the acquisition in fee title of about 7,900 acres for project features and about 900 acres of flowage easement.

b. NED plan. - The National Economic Development plan, as previously described in paragraph 84, contains only those features and levels of flood control improvements which are incrementally justified, and with only the minimum acceptable wildlife mitigation necessary as a result of construction and operation of the project. Flood control improvements on Fahrens Creek do not provide standard project flood protection to northern Merced, desirable for an urban area. The degree of flood protection resulting from the reservoirs and channel improvements included in this plan vary from 250-year protection for the central city area to 40-year protection southwest of Merced, and only 25-year protection on lower Bear Creek. This plan would require the aquisition in fee title of about 1,100 acres for project features and about 9,100 acres for easements. Of this 9,100 acres, 2,800 acres is a special wildlife easement to be provided by local interests at no cost to the Federal government.

c. EQ plan. - The Environmental Quality plan, as previously described in paragraph 84, would include project features that provide for the maximum protection of existing wildlife habitat, planting additional habitat, and controlled management of large land areas for wildlife. Also included would be social measures to provide a uniform and high degree of flood protection and to expand outdoor recreation opportunities in the area for the public. Although this plan would provide a high degree of flood protection to the area and create abundant environmental values, there is no local sponsor willing to participate financially in the cost sharing for this scope of environmental measures. There are large costs and limited economic return. Local interests would object to removal of land from private to public ownership, resulting in a substantial tax loss. The lands to be acquired are presently agricultural lands and studies indicate they will remain agricultural in the future. This purchase of adjoining lands by the Federal Government would not alter the current land usage nor increase land values. In addition, local interests have strongly objected to any plan which would include recreation at any of the reservoir sites. Therefore, this plan would not be responsive to the desires of local interests. This plan would require the acquisition in fee title of about 16,900 acres for project features and about 2,000 acres for flowage easements.

d. Modified authorized plan. - The modified authorized plan , as previously described in paragraph 84, is the best overall plan. It provides SPF flood protection to the urban areas of Merced. It is acceptable to and has been endorsed by local sponsors. About 1,210 acres would be acquired in fee title for construction of project

features, 7,200 acres would be included for flowage easements and 2,800 acres in easement for wildlife mitigation. The added increments of reservoir storage and channel flow capacities to provide SPF flood protection to Merced cost more than the economic benefit received and result in an incremental justification of about 0.6 to 1. The negative incremental B/C ratio represents a normally accepted trade-off of economic efficiency for a greater degree of flood protection. This plan solves the urban flood problems in Merced and downstream areas of Bear Creek and provides the best solution to providing environmental protection and social well-being to the area. Therefore, this plan was selected for more detailed economic analysis and is presented as the recommended plan. As stated, the recommended plan, described in Chapter VIII, provides the best solution to the flood problems in and around Merced. Therefore, the recommended plan should be approved for detailed design for construction.

TABLE 3

SYSTEM OF ACCOUNTS

(1 October 1979 prices)

ALTERNATIVES	AUTHORIZED PLAN (BEAR GROUP)	NED PLAN	EQ PLAN	RECOMMENDED PLAN
PLAN DESCRIPTION	Enlarge Burns Reservoir to 30,000 acre-feet and Bear Reservoir to 14,400 acre-feet storage capacity, and modify their outlet works to include control gates. Construct new Haystack Mountain Reservoir with 3,000 acre-feet storage capacity, and Castle Reservoir with 11,500 acre-feet storage capacity. Both new reservoirs will have control gates in their outlet works. Modify 20.6 miles of levee and channel on Bear Creek and Black Rascal Slough to improve its capacity to 5,500 cfs.	Enlarge Burns Reservoir to 19,500 acre-feet and Bear Reservoir to 24,000 acre-feet storage capacity. Construct new Haystack Mountain Reservoir with 2,500 acre-feet storage capacity and Castle Reservoir with 4,000 acre-feet storage capacity. Improve channel capacity on Fahrens and Black Rascal Creeks to 6,400 cfs and on Bear Creek and Black Rascal Slough to 6,500 cfs. Construct a drainage channel adjacent to Bear Creek. Construct a 6-mile bike trail along portions of Fahrens and Black Rascal Creeks. Acquire easements on 2,800 acres for mitigation.	Enlarge Burns Reservoir to 22,600 acre-feet and Bear Reservoir to 24,000 acre-feet storage capacity. Modify the outlet works of Bear Reservoir to include control gates. Construct new Haystack Mountain Reservoir with 5,000 acre-feet storage capacity. Construct new Castle Reservoir with 3,500 acre-feet storage capacity and control gates in the outlet works. Improve channel capacity on Fahrens and Black Rascal Creeks to 7,000 cfs and on Bear Creek and Black Rascal Slough to 6,500 cfs. Construct a drainage channel adjacent to Bear Creek. Acquire 5,500 acres for mitigation and enhancement and construct lower Bear Creek diversion structures. Construct 15.0 miles of bike trails along portions of Fahrens, Black Rascal and Bear Creeks with picnic sites and construct day use and fishing facilities at Castle Reservoir.	Enlarge Burns Reservoir to 22,600 acre-feet and Bear Reservoir to 24,000 acre-feet storage capacity. Modify the outlet works of Bear Reservoir to include control gates. Construct new Haystack Mountain Reservoir with 5,800 acre-feet and Castle Reservoir with 7,100 acre-feet storage capacity. Improve channel capacity on Fahrens and Black Rascal Creeks to 7,000 cfs and on Bear Creek and Black Rascal Slough to 6,500 cfs. Construct a drainage channel adjacent to Bear Creek. Construct a 6-mile bike trail system with picnic sites along portions of Fahrens and Black Rascal Creeks. Acquire easements on 2,800 acres for mitigation.
ACCOUNTS				
1. National Economic Development				
a. Beneficial Impacts				
(1) Value of Increased Output of Goods and Services				
(a) Flood Control	$ 3,880,000	$ 6,094,000	$ 6,380,000	$ 6,380,000
(b) Recreation	994,000	62,000	395,000	62,000
(c) Fish and Wildlife	(Included in Recreation)	--	187,000	--
(d) NED Employment Benefits	260,000	440,000	610,000	500,000
(2) Total Annual Benefits	$ 5,134,000	$ 6,596,000	$ 7,572,000	$ 6,942,000
b. Adverse Impacts				
(1) Total Project First Cost	$41,585,000	$71,310,000	$98,260,000	$81,100,000
(2) Annual Project Cost	$ 3,356,000	$ 5,370,000	$ 7,505,000	$ 6,093,000
c. Net Benefits	$ 1,178,000	$ 1,226,000	$ 67,000	$ 849,000
2. Environmental Quality				
a. Environmental Quality Enhanced				
*(1) Enhance Aesthetics of Area Protected from Flooding	Same as Recommended Plan but to a much lesser extent since there are no project improvements in the Fahrens Creek area.	Same as Recommended Plan but to a lesser extent.	Same as Recommended Plan.	Eliminates flooding on about 49,000 acres for the SPF event, of which about 13,000 are residential and commercial development. *(2,6,9,13)*
(2) Preservation of Open Space	At the reservoirs, acquire 1,175 acres for recreation uses. Also, 200 acres would be used for fish and wildlife which were acquired for other project purposes. *(1,6,9,12)*	Acquire conservation easement on 2,800 acres adjacent to the East Side Canal. *(1,6,9,12)*	Develop wildlife refuge by acquiring in fee title 5,500 acres adjacent to East Side Canal, 25 acres on Canal Creek below Castle Dam, 650 acres between levees on lower Bear Creek and 7,900 acres at Bear and Burns Reservoirs. Acquire 180 acres between levees on Fahrens Creek. Acquire 230 acres for recreation uses at Castle Reservoir. *(1,6,9,12)*	Acquire conservation easement on 2,800 acres adjacent to the East Side Canal and purchase 180 acres along Fahrens Creek. *(1,6,9,12)*
(3) Creation and Preservation of Wildlife Habitat	Environmental lands acquired for other project purposes would be provided at the reservoirs (200 acres). *(1,6,7,9,12)*	Same as Recommended Plan except that Fahrens Creek will be channelized with no wildlife plan.	Same as Recommended Plan except that 6,150 acres will be purchased adjacent to the East Side Canal. Also, create a total of 430 acres of marsh, riparian and upland habitat along lower Bear Creek. Purchase and maintain as a wildlife refuge, 7,900 acres at Bear and Burns Reservoirs and 25 acres below Castle Dam. Also, develop riparian habitat on upstream reaches of Castle Reservoir and construct 240 acres of wildlife pools at Haystack, Burns and Bear Reservoirs.	Preserve by easement 2,800 acres of marsh and associated grassland adjacent to the East Side Canal. Create a total of 70 acres of marsh and riparian habitat and preserve 110 acres of grassland along Fahrens Creek. *(2,6,9,12)*
(4) Water Quality	Same as EQ Plan with the addition of a recreation pool at Burns Reservoir which would have no significant impact.	Same as Recommended Plan.	Same as Recommended Plan except for the recreation pool at Castle Reservoir. Minor impact expected due to continual irrigation flows resulting in low temperatures and nutrient content. *(2,6,9,13)*	Detention type reservoirs have no significant impacts on water quality. *(2,6,9,12)*

Index of Footnotes

Timing

1. *Impact is expected to occur prior to or dur implementation of the plan.*
2. *Impact is expected wi in 15 years following plan implementation.*
3. *Impact is expected in longer time frame (15 or more years followi implementation).*

Uncertainty

4. *The uncertainty assoc ated with the impact 50% or more.*
5. *The uncertainty is be tween 10% and 50%.*
6. *The uncertainty is le than 10%.*

Exclusivity

7. *Overlapping entry; fu monetized in NED acco*
8. *Overlapping entry; no fully monetized in NED account.*

Actuality

9. *Impact will occur with implementation.*
10. *Impact will occur only when specific additior actions are carried ou during implementation.*
11. *Impact will not occur because necessary addi tional actions are lac ing.*

Location of Impacts

12. *Within the immediate planning area*
13. *Within the study area.*
14. *Within a larger area a fected by the project.*
15. *Within the rest of the nation.*

Section 122

**Items specifically required Section 122 and ER 1105-2-2*

TABLE 3

SYSTEM OF ACCOUNTS
(Continued)

ALTERNATIVES	AUTHORIZED PLAN (BEAR GROUP)	NED PLAN	EQ PLAN	RECOMMENDED PLAN
b. Environmental Quality Degraded				
*(1) Vegetation Lost Due to Project Construction	Construction would convert about 780 acres of grassland, 50 acres of riparian vegetation, 60 acres of agricultural land and 90 acres of marsh land to levees, channelization, dams and spoil areas. *(1,6,9,12)*	Same as Recommended Plan except that 14 additional acres of riparian habitat will be lost due to channelization of Fahrens Creek without setback levees.	Construction would convert 820 acres of grassland, 40 acres of riparian vegetation and 350 acres of agricultural lands to levees, channelization, dams and spoil areas. *(1,6,7,9,12)*	Construction would convert 905 acres of grassland, 45 acres of riparian vegetation, 320 acres of agricultural land and 25 acres of marsh to levees, channelization, dams and spoil areas. *(1,6,7,9,12)*
*(2) Soil Lost Due to Project	Same as Recommended Plan but to a lesser extent - no work in Fahrens Creek area.	Same as Recommended Plan.	Same as Recommended Plan.	Top soil will be disturbed at construction, borrow and spoil sites. *(1,6,9,12)*
(3) Air Quality	Same as Recommended Plan but to a lesser extent - no work in Fahrens Creek area.	Same as Recommended Plan.	Same as Recommended Plan.	Short term degration of air quality caused by dust and emissions from heavy equipment during project construction. *(1,6,9,13)*
*(4) Vegetation Lost or Degraded by Inundation	1,650 acres of riparian vegetation and valley grassland could be affected at the recreation reservoir sites. *(2,6,9,12)*	Same as Recommended Plan.	Same as Recommended Plan in addition to 640 acres of riparian, grassland and agricultural vegetation due to the recreation pool at Castle Reservoir and the wildlife pools at Burns, Bear and Haystack Reservoirs. *(2,6,9,12)*	545 acres of riparian and grassland vegetation could be affected by the gated Bear Reservoir. *(2,4,8,10,12)*
3. Social Well Being				
a. Beneficial Impacts				
(1) Enhancement of Safety and Community Well Being	Same as Recommended Plan but to a much lesser extent without Fahrens Creek improvements, leaving the northern portion of Merced without adequate flood protection.	Same as Recommended Plan but to a lesser extent.	Same as Recommended Plan.	Provide standard project flood protection to most of the city of Merced, thereby safeguarding human life, personal property, and residential development. *(2,6,9,13)*
*(2) Improvement of Community Cohesion	Same as Recommended Plan but to a much lesser extent without Fahrens Creek improvements, leaving the northern portion of Merced without adequate flood protection.	Same as Recommended Plan but to a much lesser extent.	Same as Recommended Plan.	Flood evacuation would be eliminated in Merced. Eliminate the need for the flood proofing measures for new and replacement structures where 100-year or greater protection is provided. *(2,6,9,13)*
(3) Enhancement of Health	Same as Recommended Plan but to a much lesser extent without Fahrens Creek improvements, leaving the northern portion of Merced without adequate flood protection.	Same as Recommended Plan but to a lesser extent.	Same as Recommended Plan.	Flood projection afforded by this plan would reduce disease hazards which arise from flooding of water systems, sewage facilities and ponding of water. *(2,6,9,13)*
(4) Transportation	The degree of flood protection to transportation in specific areas is as follows: central Merced, 80-year; north Merced, none; airport, 80-year; lower Bear Creek area below Crocker Dam, 50-year. *(2,6,9,13)*	The degree of flood protection to transportation in specific areas is as follows: central Merced, 250-year; north Merced, 200-year; airport, 40-year; lower Bear Creek area below Crocker Dam, 25-year. *(2,6,9,13)*	Same as Recommended Plan.	The degree of flood protection to transportation in specific areas is as follows: central Merced, 330-year (SPF); north Merced, 330-year (SPF); airport, 100-year; lower Bear Creek area below Crocker Dam, 50-year. *(2,6,9,13)*
*(5) Improvement of Leisure Activities and Public Facilities	Facilities to support major boating and other water related activities would be constructed at Castle and Burns Reservoirs. *(1,6,8,9,12)*	Same as Recommended Plan.	This plan provides a 15.0-mile trail system for hiking, bicycling and equestrian activities along Fahrens, Black Rascal and Bear Creeks, with parking facilities, picnic sites and trail access ramps at strategic locations. Also, maintains a 3,500 acre-foot pool at Castle Reservoir for day use and fishing. *(1,6,7,9,12)*	A 6-mile bike trail system which follows portions of Fahrens and Black Rascal Creeks will be included in this project, with parking facilities, picnic sites and trail access ramps at strategic locations. *(1,6,7,9,12)*
b. Adverse Impacts				
*(1) Disruption of Community	Generally the same as Recommended Plan.	Same as Recommended Plan.	Same as Recommended Plan.	Two residential structures and four barns would have to be relocated. *(1,6,7,9,12)*
(2) Displacement of People	Same as Recommended Plan.	Same as Recommended Plan.	Same as Recommended Plan.	Project construction would temporarily displace eight individuals. *(1,6,7,9,12)*
(3) Disruption of Transportation	Same as Recommended Plan.	Same as Recommended Plan.	Same as Recommended Plan.	Levee and channel work may require rerouting of adjacent roadways. Bridge modifications would result in temporary closures of these facilities and temporary crossings would be required at nearby locations, resulting in some inconvenience and delays for travelers. *(1,5,8,9,12)*
*(4) Disruption of Cultural Resources	Same as Recommended Plan.	Same as Recommended Plan.	Same as Recommended Plan.	18 known cultural sites would be disturbed by periodic inundation and/or construction of two reservoir sites. *(1,6,9,12)*
(5) Noise	Same as Recommended Plan.	Same as Recommended Plan.	Same as Recommended Plan.	Heavy construction equipment will increase noise levels in the project area during project construction. *(1,6,9,12)*

Index of Footnotes

Timing

1. *Impact is expected to occur prior to or dur implementation of the plan.*
2. *Impact is expected wi in 15 years following plan implementation.*
3. *Impact is expected in longer time frame (15 more years following implementation).*

Uncertainty

4. *The uncertainty assoc ated with the impact 50% or more.*
5. *The uncertainty is be tween 10% and 50%.*
6. *The uncertainty is le than 10%.*

Exclusivity

7. *Overlapping entry; fu monetized in NED accou*
8. *Overlapping entry; no fully monetized in NE account.*

Actuality

9. *Impact will occur wit implementation.*
10. *Impact will occur onl when specific additio actions are carried o during implementation*
11. *Impact will not occur because necessary add tional actions are la ing.*

Location of Impacts

12. *Within the immediate planning area.*
13. *Within the study area*
14. *Within a larger area fected by the project*
15. *Within the rest of th nation.*

Section 122

**Items specifically require Section 122 and ER 1105-2-*

TABLE 3

SYSTEM OF ACCOUNTS
(Continued)

ALTERNATIVES	AUTHORIZED PLAN (BEAR GROUP)	NED PLAN	EQ PLAN	RECOMMENDED PLAN
4. Regional Development				
a. Beneficial Impacts				
*(1) Value of Increased Income	Increased retail sales during five-year construction period would increase local tax revenue by about $12,000 annually. Additional retail sales expected due to activity associated with recreation at Castle and Burns Reservoirs. *(1,5,8,10,13)*	Increased retail sales during five-year construction period would increase local tax revenue by about $21,000 annually. *(1,5,8,10,13)*	Increased retail sales during five-year construction period would increase local tax revenue by about $29,000 annually. Additional retail sales expected due to activity associated with recreation at Castle Reservoir. *(1,5,8,10,13)*	Increased retail sales during five-year construction period would increase local tax revenue by about $24,000 annually. *(1,5,10,13)*
*(2) Quantity of Increased Employment	Estimated 31 skilled blue collar, 25 unskilled blue collar and 11 other than blue collar workers would be acquired from the local labor force during a one-year construction period. *(1,6,7,9,12)*	Estimated 18 skilled blue collar, 15 unskilled blue collar and 7 other than blue collar workers would be acquired from the local labor force during a one-year construction period. *(1,6,7,9,12)*	Estimated 26 skilled blue collar, 21 unskilled blue collar and 9 other than blue collar workers would be acquired from the local labor force during a one-year construction period. *(1,6,7,9,12)*	Estimated 22 skilled blue collar, 18 unskilled blue collar and 8 other than blue collar workers would be acquired from the local labor force during a one-year construction period. *(1,6,7,9,12)*
(3) Increased Business and Industrial Activity	Local retail sales increased $830,000 annually during construction. Local recreation oriented business should increase. *(1,5,8,10,13)*	Local retail sales increased $1,400,000 annually during construction. *(1,5,8,10,13)*	Local retail sales increased $1,900,000 annually during construction. Local recreation oriented business should increase. *(1,5,8,10,13)*	Local retail sales increased $1,300,000 annually during construction. *(1,5,10,13)*
(4) Land Use	Same as Recommended Plan but to a much lesser extent.	Same as Recommended Plan but to a lesser extent.	Same as Recommended Plan.	Eliminate or reduce flooding on approximately 11,000 acres of cultivated agricultural lands, 13,000 acres of urban lands and 24,000 acres of grasslands. *(2,5,8,9,13)*
b. Adverse Impacts				
*(1) Value of Income Lost	7,860 acres taken from county tax rolls would decrease county tax revenues. *(1,6,7,9,12)*	1,740 acres taken from county tax rolls would decrease county tax revenues. *(1,6,7,9,12)*	16,970 acres taken from county tax rolls would decrease county tax revenues. *(1,6,7,9,12)*	1,200 acres taken from county tax rolls would decrease county tax revenues. *(1,6,7,9,12)*
(2) Land Use	Present land use will be affected by purchase and easement on 8,520 acres of grassland, 230 acres of wildlife habitat and 55 acres of agricultural land. *(1,6,8,9,12)*	Present land use will be affected by purchase and easement on 5,495 acres of grassland, 285 acres of wildlife habitat and 1,185 acres of agricultural land. Also, future uses on easements of 2,800 acres will be restricted to those currently existing. *(1,6,8,9,12)*	Present land use will be affected by purchase and easement on 11,195 acres of grassland, 5,785 acres of wildlife habitat and 1,475 acres of agricultural land. *(1,6,8,9,12)*	Present land use will be affected by purchase and easement on 6,650 acres of grassland, 175 acres of wildlife habitat and 1,100 acres of agricultural land. Also, future uses on easements of 2,800 acres will be restricted to those currently existing. *(1,6,8,9,12)*

Index of Footnotes

Timing

1. *Impact is expected to occur prior to or during implementation of the plan.*
2. *Impact is expected within 15 years following implementation.*
3. *Impact is expected in a longer time frame (15 or more years following implementation.*

Uncertainty

4. *The uncertainty associated with the impact is 50% or more.*
5. *The uncertainty is between 10% and 50%.*
6. *The uncertainty is less than 10%.*

Exclusivity

7. *Overlapping entry; fully monetized in NED account.*
8. *Overlapping entry; not fully monetized in NED account.*

Actuality

9. *Impact will occur with implementation.*
10. *Impact will occur only when specific additional actions are carried out during implementation.*
11. *Impact will not occur because necessary additional actions are lacking.*

Location of Impacts

12. *Within the immediate planning area.*
13. *Within the study area.*
14. *Within a larger area affected by the project.*
15. *Within the rest of the nation.*

Section 122

**Items specifically required in Section 122 and ER 1105-2-240*

86. General. - The recommended plan consists of four reservoirs and associated channel and levee construction on Bear Creek and its tributaries, as well as a drainage channel adjacent to and south of Bear Creek below the East Side Canal (see Plate III). Of the four reservoirs, two would be new and ungated; Castle Reservoir located on Canal Creek and Haystack Mountain Reservoir, located on Black Rascal Creek. The remaining two would consist of enlargement of the existing ungated reservoir located on Burns and Bear Creeks. Bear Reservoir would be provided with a gated outlet.

87. New channel enlargement and levee construction would be provided on Bear and Fahrens Creeks, and backwater levees would be provided on Black Rascal Creek, Cottonwood Creek, and El Capitan Canal. Black Rascal Creek, Cottonwood Creek and El Capitan Canal all have a 10-year flood flow less than 800 cfs which, according to ER 1165-2-21, would require any flood control works be constructed by local interests. However, in this case the proposed work is required to provide protection from backwater conditions arising from modifications made to Fahrens Creek. The improvements on Fahrens Creek total about 6 miles and include its tributaries. The work along Bear Creek would be divided into two reaches with Bert Crane Road as the approximate boundary. Below Bert Crane Road, the natural channel would be retained and a bypass would be constructed south of and adjacent to Bear Creek betweem the East Side Canal and Bert Crane Road. Above Bert Crane Road the existing channels and levees of Bear Creek and Black Rascal Slough would be enlarged, extending up to Crocker Dam. Minor construction would be required on Bear Creek above Crocker Dam and would include enlarging the reach between the dam and the confluence of Fahrens Creek, as well as a 2,500-foot reach upstream. The modifications to the Fahrens and Bear Creek systems would have environmental and recreational features which are discussed in later paragraphs. In addition, a drainage channel would be constructed adjacent to and south of Bear Creek between the East Side Canal and the Eastside Bypass. A summary of the plan features and their design capacities follows:

RESERVOIRS

Reservoirs	Stream	Storage Capacity (ac-ft)	Outlet Capacity at Gross Pool (cfs)
Castle	Canal Creek	7,100	570
Haystack Mountain	Black Rascal Creek	5,800	450
Burns	Burns Creek	22,600	350
Bear (gated)	Bear Creek	24,000	2,000

LEVEES AND CHANNELS

Stream	Reach	Length Miles	Design Flow Capacity (cfs)
Bear Creek	East Side Bypass to Bert Crane Road	4.0	6,500
Bear Creek and Black Rascal Slough	Bert Crane Road to Crocker Dam	16.9	6,500
Bear Creek	Crocker Dam to ATSFRR Bridge	0.6	7,000
Bear Creek	W. 16th Street - upstr.	0.5	7,000
Fahrens Creek	Bear Creek to Cottonwood Creek	3.4	7,000
Fahrens Creek	Cottonwood Creek - Upstream	0.7	6,300
Black Rascal Creek	Fahrens Creek to G Street	1.6	1,800
Cottonwood Creek	Above Fahrens Creek	1.1	1,900
El Capitan Canal	to SPRR	0.9	negligible
Drain Channel Adjacent to Bear Creek	East Side Bypass to East Side Canal	3.7	9,000

88. Site selection. - Two new dams and the enlargement of two existing dams are included in the recommended plan. The existing reservoirs are Bear Reservoir on Bear Creek and Burns Reservoir on Burns Creek. The new reservoirs are Haystack Mountain Reservoir on Black Rascal Creek and Castle Reservoir on Canal Creek. The 1969 review report considered alternative sites on these streams, but the sites either lacked sufficient storage capacity, failed to sufficiently control streamflow, or lacked feasibility. Field conditions have not materially changed at these sites except at Castle Reservoir. Orchards have been located at the authorized Castle damsite. A more economical site has been selected, which is located 1-1/2 miles upstream from the authorized site. The storage capacity would be reduced from the authorized size of 11,500 acre-feet to 7,100 acre-feet. The larger storage capacity is no longer feasible or required for recreation.

89. Site review. - Annual field inspections have been made of the existing two dams. A field review of the four sites was made to establish their adequacy and a review conference was held. The selected sites are the only appropriate ones and are considered to be adequate for construction. More extensive field exploration and material testing will be accomplished during the phase II studies which will determine the necessary construction detail to insure a safe project.

90. Dams. -

a. Castle Dam. - Castle Dam, located on Canal Creek about 4 miles upstream from Santa Fe Drive, would be a zoned earthfill structure creating a reservoir with a storage capacity of 7,100 acre-feet and a gross pool area of 780 acres. The main dam would be about 2,250 feet long with a crest width of 20 feet. The crest elevation of 220.5 feet mean sea level (m.s.l.) would be about 52.5 feet above the core trench bottom. The embankment sections would include a central impervious core, upstream and downstream transition zones, a downstream vertical drain with a horizontal drainage blanket, and random fill. The upstream slope would have riprap protection while the downstream slope would be seeded. A 4,090-foot homogeneous random fill dike also would be included.

b. Haystack Mountain Dam. - Haystack Mountain Dam, located on Black Rascal Creek about 4 miles upstream from Bear Creek, would be a zoned earthfill structure creating a reservoir with a storage capacity of 5,800 acre-feet and a gross pool area of 425 acres. The dam would be about 2,300 feet long with a crest width of 20 feet. The crest elevation of 313 feet msl would be about 78 feet above the core trench bottom. The embankment sections, like Castle Dam, would include an impervious core, transition zones, a drain, and random fill. The upstream slope would have riprap protection while the downstream slope would be seeded.

c. Burns Dam. - Burns Dam, located on Burns Creek about 3 miles upstream from Bear Creek, would be an enlargement of the existing earthfill structure so as to create a reservoir having a storage capacity of 22,600 acre-feet and a gross pool area of 1,500 acres. The main dam and dikes would be about 19,670 feet long with a crest width of 20 feet. The crest elevation of 334.5 feet m.s.l. would be about 68 feet above the core trench bottom. During construction, the top 3.5 feet of the existing dam and 1 foot of the upstream and downstream slopes would be removed and replaced with embankment built up about 18 feet. The new upstream face would be an extension of the existing slope, so that the bulk of the construction, consisting of random fill and a sandy, gravel drain, would be on the downstream side. This would result in the dam axis being shifted 45 feet downstream. Both upstream and downstream slopes would be seeded.

d. Bear Dam. - Bear Dam, located on Bear Creek just upstream of the Merced County line, would also be an enlargement of the existing earthfill structure so as to create a reservoir having a storage capacity of 24,000 acre-feet and a gross pool area of about 550 acres. The main dam would be about 3,165 feet long with a crest width of 20 feet. The crest elevation of 480.5 feet m.s.l. would be about 138 feet above the core trench bottom. During construction, about 22 feet of material from the existing crest to the top of the transition fill, the downstream toe, and 1 foot of the upstream and downstream

slopes would be removed and replaced with new material. The axis of the new dam would coincide with the old dam. The new embankment sections would include an impervious core, transition zones, a drain, and sandy gravel fill. The upstream slope would have riprap protection while the downstream slope would be seeded. In addition, a dike with similar earthfill zones would extend over the existing spillway on the right abutment.

91. Spillways. -

a. Castle Dam. - The perched spillway at Castle Dam would be located on the right abutment with a crest elevation of 212.5 feet m.s.l., which is 1.5 feet above the gross pool. The concrete control sill is 2.5 feet above the approach channel and would be 300 feet wide and extend 8.5 feet downstream. The 800-foot-long approach and 860-foot-long discharge channels would be unlined and have a maximum cut of 20 feet. Spills would occur only during very rare events, less frequent than the SPF. During such events there may be erosion downstream of the dam, but it would not endanger the dam and reservoir if such an event does occur.

b. Haystack Mountain Dam. - The perched spillway at Haystack Mountain Dam would be located on the left abutment with a crest elevation of 305 feet m.s.l., or 6.0 feet above gross pool. The concrete control sill would be 210 feet wide and extend 20 feet downstream. The 400-foot-long approach channel and 570-foot-long discharge channels would be unlined and have a maximum cut of 40 feet. Spills would be similar to Castle Dam in probable frequency if not rarer and would create possible downstream erosion.

c. Burns Dam. - The existing spillway, chute, and flip bucket located on the right abutment would be replaced with a new 53-foot-wide concrete ogee section with a crest elevation of 315.0 feet m.s.l., which is equal to the gross pool. The last 65 feet of the approach channel and the 130-foot-long chute are concrete lined. A 53- by 77-foot stilling basin with a riprapped downstream exit channel would also be provided.

d. Bear Dam. - The existing spillway near the right abutment would be abandoned and replaced with a new spillway about 250 feet from the right abutment of the enlarged dam. It would be an ogee control section 90 feet wide with a crest elevation of 455.0 feet m.s.l., which is equal to the gross pool. The unlined approach channel would be 1,400 feet long with a maximum cut of 55 feet. The concrete-lined chute, which is 96 feet long, would discharge into a 90- by 110-foot stilling basin with an apron elevation of 388.0 m.s.l. Riprap would be provided on the exit side of the stilling basin for about 600 feet.

92. Outlet works. -

a. Castle Dam. - Castle Dam would have an ungated riser intake structure at the toe of the dam near the left abutment. It would be a 21.5-foot- high rectangular tower with a 2- by 1.5-foot port at elevation 183.0 to allow flood control releases of about 100 cfs at elevation 202.5 (riser crest). At the crest of the riser, flows would be directed in from one side which would have an open width of 5 feet. A gated irrigation bypass would allow up to 500 cfs of Canal Creek flow to continue downstream during the irrigation season without appreciable backwater. The irrigation bypass, would have a slide gate which would be operated from the top of the riser. This bypass would be opended at the onset and closed at the end of the irrigation season. The rectangular riser transitions through a 90 degree bent to a 7.0 foot diameter cut-and-cover reinforced concrete conduit. The conduit discharges into a 22 foot wide by 30 foot long impact basin. The impact basin exit channel would have riprap protection for at least 30 feet downstream.

b. Haystack Mountain Dam. - Haystack Mountain Dam would have an ungated riser intake structure at the toe of the dam near the right abutment. It would be a 37.5-foot-high rectangular tower with a 3.9- by 1-foot port at elevation 265 to allow flood control releases of about 100 cfs at elevation 296.5 (riser crest). At the top of the riser, flows would be directed in from two sides which have a width of 17.25 feet. The rectangular riser conduit would transition into a 5.75-foot-diameter concrete conduit and discharge into a 29- by 39-foot impact basin. The impact basin exit channel would have riprap protection 40 feet downstream of the basin.

c. Burns Dam. - The existing double box conduit would not be structurally adequate for an enlarged Burns Dam embankment. Consequently, it would be replaced with a 3.75-foot-diameter ungated concrete conduit at the same location. A reinforced concrete trash rack would be provided at the intake. The outflow would be discharged into a 24- by 32-foot impact basin. The impact basin exit channel would have riprap protection for a distance of 30 feet downstream of the basin.

d. Bear Dam. - Design of the outlet works was based on retention of most of the existing 7-foot diameter conduit and design of a new intake and energy dissipator. The intake would be gated and would consist of a dual passage, with each passage containing a service and emergency slide gate and a bulkhead gate slot at the entrance. A single bulkhead gate would be provided for use in either passage. A log rack prevents large debris from entering the conduit. The outlet works was designed based on retention of the existing 7-foot diameter conduit and is capable of discharging 1,950 cfs at gross pool with maximum head loss assumptions, while the stilling basin was designed for a discharge of 2,300 cfs at gross pool and minimum head loss assumptions. The 142-foot- long stilling basin has an exit channel with a 1 vertical on 10 horizontal upward slope, protected by riprap on the floor and side slopes.

93. Levees and Channels. -

a. Bear Creek below Bert Crane Road. - Between the East Side Canal and Bert Crane Road, a distance of about 4 miles, a 6,500 cfs capacity leveed bypass channel with an average width of about 340 feet would be provided. Material for the levees would come from the channel excavation. Under project conditions the current floodflows would be controlled and normally unavailable for sustaining the nearby permanent and seasonal marshlands. The marshlands depend on the periodic recharge for their maintenance. To sustain the marshes, 3 wells would be provided to provide water to these marsh areas when needed. In addition, a drainage channel would be provided adjacent to and to the south of Bear Creek between the East Side Bypass and the East Side Canal to accommodate any possible floodflows that would be blocked by Bear Creek levees.

b. Bear Creek above Bert Crane Road. - Above Bert Crane Road, the existing channel and levees would be enlarged to 6,500 cfs capacity up to the confluence of Bear Creek and Black Rascal Slough. Upstream from this point, the channel and levee enlargement on Bear Creek would continue about one-half mile, followed by intermittent, minor construction to provide the minimum channel capacity and levee-crown width. Modifications to Black Rascal Slough would consist of the continuous setting back of one levee to provide the necessary design capacity. In the 0.6-mile reach above Crocker Dam, the channel would be enlarged to accommodate the combined Bear and Fahrens Creek flows to minimize the backwater effects on bridges over Fahrens Creek. For the reach above West 16th Street, the road would be raised about 1.5 feet to reinforce the low existing right bank.

c. Fahrens Creek. - Levee and channel improvements on Fahrens Creek and its tributaries provide a flood carrying capacity of 7,000 cfs. Channel improvements without levees are provided on a short reach of Black Rascal Creek between M and R Streets because of existing development on the banks. This reach would have a concrete-lined channel with low, vertical retaining walls. The existing Fahren's Creek channel will be preserved above its confluence with Black Rascal Creek.A 6-mile bike trail is also proposed and is discussed in paragraph 94 and Appendix C.

d. Lower Bear Creek Drain Channel. - A drain channel adjacent to lower Bear Creek between the East Side Canal and the East Side Bypass would be provided. The 9,000 cfs capacity channel would provide interior drainage to the area south of Bear Creek and east of the East Side Canal in order to prevent additional ponding due to the Bear Creek levees. See Appendix F, Part II for further details.

94. Recreation provisions. - Recreation development would consist of a 6-mile-long trail system for bicycling, walking, jogging, and equestrian use along Fahrens Creek and its tributaries (see Plate

III). The trail would be located on top of the levees on Black Rascal and Fahrens Creeks north of State Highway 99, and would include a 10-foot-wide blacktop bikeway with staging areas at each end of Fahrens Creek, three trail access ramps, a bridge to link the Fahrens and Black Rascal Creeks portions, and selective landscaping. Each staging area would include a 10-car gravel parking area, 4 picnic tables, a potable water supply, and chemical restrooms. Details of the recreation facilities are described in Appendix C, Recreation Resources.

95. Fish and wildlife provisions. - Without mitigation considerations the project would adversely impact wildlife habitat. Project impacts include reduction of flooding to marsh lands and conversion of various types of habitat to project dams, levees and disposal areas. The U.S. Fish and Wildlife Service estimates 673,000 average annual waterfowl use days would be lost due to reduction of flooding. This includes 400,000 waterfowl use days on the grasslands and agricultural lands due to reduction of flooding within the five year flood plain, 253,000 waterfowl use days on marshlands east of the East Side Canal due to reduction in flows and 20,000 waterfowl use days on the marshes west of the East Side Canal. The Fish and Wildlife Service estimates that 80 percent of the waterfowl use is geese and 20 percent ducks. An additional 1.1 million days of use by other species of water-related birds occurs on lands that would receive water flow reduction. Also, the project would convert 25 acres of marsh habitat and 45 acres of riparian habitat to project features. In order to mitigate for these impacts, the following measures would be implemented:

a. A protective easement on 2,800 acres would be acquired by non-Federal interests at no cost to the Federal governmental. Three wells, two new and one existing, would be used to provide the necessary water to maintain the marshland and associated grassland communities.

b. Distrubances to vegetation during construction of the proposed improvements would be held to the minimum possible.

c. Trees and other vegetation would be retained where they would not adversely affect project purposes.

d. Topsoil would be stockpiled and utilized to rehabilitate borrow areas and spoil sites.

e. Levee embankments, borrow areas, and spoil sites would be seeded to help reestablish vegetation.

f. Riparian vegetation totalling 45 acres would be established along the Farhens Creek levees.

g. Up to 25 acres of marshland would be established along Farhens Creek to replace marshland destroyed by the Bear Creek Bypass.

96. The Fish and Wildlife Service believes the above mitigation actions would compensate for the potential wildlife losses caused by the construction and operation of the project. Also, there would be only minor effects on habitat for the southern bald eagle, blunt nosed lizard, giant garter snake, and thick tailed chub which could potenetially exist in the area. A list of proposed and listed endangered species has been obtained from the FWS, and a biological assessment is being made in accordance with the Endangered Species Act, as amended (16 USC 1531-1542).

97. Construction materials. -

a. Embankment. - A large portion of the dam embankment material is available at each of the reservoir sites. For all four dams, suitable material for the impervious core can be found at upstream and downstream borrow areas within 1 mile of each site, mostly within gross pool boundaries at each reservoir. Random fill material is available at Castle and Haystack Mountain Reservoirs from borrow areas and the spillway excavation, while at Bear Reservoir it is available from dredge tailings and stream deposits within 2 miles. Material for the internal drains, transition zones, bedding, and riprap for all the dams except Bear would come from commercial sources from 4 to 12 miles away. Nearby dredge tailings would be used for the drains and transition zones for Bear Dam.

b. For levee construction, material would be used from the existing levees, channel excavation, and borrow areas in the Bear and Fahrens Creek floodway berms. Road surfacing material from commercial plants would be used.

c. Concrete. - Good quality aggregate for concrete is available from commercial sources on the Tuolumne, Merced, and San Joaquin Rivers, and Mariposa Creek, with haul distances varying from 15 to 46 miles. Acceptable cement is also available from two plants within 125 miles and several other within 400 miles. Good quality water for mixing and curing can be obtained from nearby wells and irrigation canals.

d. Miscellaneous material. - Construction material such as lumber and corrugated metal and concrete pipe are available in the immediate vicinity of Merced. Cobbles for bank protection are available from the Merced River while quarry rock would originate near the San Luis Reservoir about 50 miles away.

98. Land requirements. -

a. Reservoirs. - The land required for the reservoirs would be acquired mostly by easement and would include approximately the following acreages:

Reservoir	Area (acres)
Castle	2,140
Haystack Mountain	1,080
Burns	1,300
Bear	1,650

The acreages shown for Burns and Bear Reservoirs are in addition to the existing easements currently held by the State, which are adequate. An additional 200 acres at Haystack Mountain and 145 acres at Bear Reservoir would be acquired in easement for borrow material. The res- ervoirs are located in low rolling hills covered with native grasses except for Castle Reservoir, which is adjacent to an * agricultural area. The rights acquired are in flowage easement only, except for the land directly under structures which will be acquired in fee, therefore allowing the owner to use the land as long as that use does not inhibit the flows or pose a threat to the dam. *

b. Levees and channels. - Adequate rights-of-way for construction and maintenance of the new and enlarged levees and channels, disposal areas, drainage channel, access roads and recreation features would be obtained by the non-Federal sponsor and would total about 1,900 acres. The wildlife mitigation features on Fahrens Creek would be placed on lands acquired for other project purposes. For developed urban areas, as along the right bank of El Capitan Canal, the rights-of-way presently included in the recommended plan may be decreased after further study to reduce disturbance to the existing urban development.

c. Also included in the levee and channel acreage is about 500 acres of land which would be required for a maintenance rights-of-way from the end of the proposed levees upstream to the reservoirs. This right-of-way would include the channels plus 20 feet on each side of the streambanks.

d. Prime farmland. - Of the 316 acres of agricultural lands that would be disrupted by the project, approximately 130 acres have been classified as meeting the criteria for prime farmland by the Soil Conservation Service.

e. Mitigation lands. - An easement on 2,800 acres of land adjacent to the East Side Canal and lower Bear Creek will be acquired for wildlife mitigation. The easement will be acquired by non-Federal interests at no cost to the Federal Government.

99. Relocations. -

a. Reservoirs. - Project construction would require raising about 0.3 mile of Fisher Road near Castle Reservoir and about 1.0 mile of secondary road through Burns Reservoir. A powerline on steel

towers and some residential power and telephone lines would require relocation at Castle Reservoir, as well as a powerline on wooden poles at Burns Reservoir. Two residences would require relocation at Castle Reservoir.

b. Levees and channels. - The relocations for levees and channels involve three major categories: bridges, power and telephone lines, and irrigation and drainage structures. Bridge reconstruction or modifications would be required on Bear Creek for three bridges, including Crane Road; five bridges on Fahrens Creek, including major work on the Atcheson, Topeka, and Santa Fe and Southern Pacific Railroad bridges; six bridges on Black Rascal Creek; and one bridge on Cottonwood Creek. Powerlines, telephone lines, and fences are scattered throughout the project area and would be relocated as required. The numerous affected irrigation and drainage structures would be subject to the "replacement in kind" principle with the provision that the minimum size allowed would be a 30- by 30-inch concrete culvert with concrete headwalls on each end and a flap gate on the waterside end. Larger culverts would be provided as needed where the new or enlarged levee embankments block the natural drainage patterns such as the intersection of Black Rascal Slough and Bear Creek as well as Black Rascal Creek and Fahrens Creek. The structures would allow interior drainage to enter the channels before and after
* flood-stage flows. Two new pumping plant and ponding areas are required for interior drainage. Interior drainage details are given *
in Appendix F, Part II.

100. Reservoir and downstream operation. -

a. General. - Of the four project reservoirs, only Bear Reservoir would have a gated outlet and, therefore, is the only reservoir that would require operation. It would be remotely operated by radio from the Buchanan Project Office as directed by the Sacramento District, Reservoir Control Section.

b. The objective of Bear Reservoir operation is to reduce outflow during floods to allow the passage of local flow and releases from ungated reservoirs through downstream channels. During the flood recession, releases from Bear Reservoir would be increased as soon as possible to evacuate the storage in the reservoir. Flows in Bear Creek at McKee Road, located in the City of Merced, would be monitored remotely by radio at the Sacramento District Office. Precipitation in the Merced area and reservoir releases and stages would also be monitored remotely. Bear Reservoir would be operated to achieve objective flows in Bear Creek at the McKee Road gage. However, due to errors in forecasting local flow and the reduced channel capacity downstream from McKee Road, the objective flow must be less than channel capacity at McKee Road. During floods, or when flooding is imminent, the objective flow would be 3,000 cfs, and during the flood recession it could be increased to 5,500 cfs. During large floods it may be necessary to completely close the gates at Bear Reservoir, and flood control space requirements were based upon such an operation.

Forecasts of local flow would not be necessary for the operation of Bear Reservoir. The preliminary operation plan for the project is outlined below. See plates IV to VIII for the 100-year, SPF, and historical hydrographs.

c. Bear Reservoir. -

(1) When Bear Reservoir is empty, the gates would be left partially open.

(2) When 1 inch or more of precipitation (precipitation will be determined by averaging the readings at the four reservoirs) has occurred in the last 12 hours, the objective flow at McKee Road would be 3,000 cfs.

(3) When less than 1 inch of precipitation has occurred in the last 12 hours the objective flow at McKee Road would be 5,500 cfs.

(4) Releases from Bear Reservoir would be increased or decreased at the rate of 500 cfs per hour to maintain objective flows downstream.

d. Castle Reservoir. - Castle reservoir would be an ungated flood control reservoir with a gated bypass outlet to provide additional outflow capacity during the irrigation season. The gate on the bypass outlet may be opened on 1 May and must be closed by 1 October.

e. Examples of operation. - Routings of historical and hypothetical floods through the recommended plan are shown on Plates IV to VIII. The pre-project routing used storage-outflow routings at all major stream obstructions which include existing reservoirs and several bridge crossings. Routings between these points were accomplished using Tatum's procedures. Project conditions provide for channel improvements on portions of Fahrens, Black Rascal and Cottonwood Creek east of Highway 99 and on lower Bear Creek and Black Rascal Slough west of Highway 99. Adjustments to the pre-project stream flow routing procedures in these areas to account for project conditions were made by removing the storage-outflow routings through bridge openings where these bridges will be improved for project design flows. No adjustments to the Tatum routing coefficients were made on these streams since the flow velocities used to establish the pre-project coefficients are not significantly less than the flow velocities encountered under project conditions. For example, flow velocities used to establish the pre-project coefficients vary from 3 to 5 feet per second while flow velocities for project design flow conditions vary from 3 to 6 feet per second. Project operation was modeled using the HEC-5C computer program.

f. Frequency of flooding. - The recommended plan would provide at least 100-year protection to all urban areas and SPF protection to

most portions of the city of Merced. At least 50-year protection would be provided to agricultural areas along Bear Creek downstream from the reservoirs and slightly less than 50-year protection to areas along Canal Creek adjacent to Castle AFB (See Plate III for a delineation of the 100-year and SPF flood plain). Project and preproject frequency curves are shown in Appendix E. The project frequency curves were developed by routing various floods through the project to simulate different frequencies of runoff. The resulting flows were plotted to develop frequency curves at various index points.

g. Relationship to other projects. - In general, the added flood protection of the project would be beneficial to existing flood control and irrigation projects in the area. Under existing conditions floodwaters from Canal, Edendale, Parkinson, and Fahrens Creeks are diverted to Yosemite Lake through the Main Canal. Under project conditions flows from Canal and Edendale Creeks would not be diverted, but Parkinson and Fahrens Creek flows above Main Canal would be intercepted up to the capacity of the canal and diverted to Yosemite Lake. Canal Creek is presently used to transport irrigation water from Main Canal at rates up to 500 cfs. Since the maximum outlet capacity of Castle Reservoir at elevation 206 (riser crest) would be approximately 100 cfs, a gated bypass capable of passing 500 cfs is incorporated in the project.

CHAPTER IX - COST ESTIMATES FOR RECOMMENDED PLAN

101. Cost. - Detail estimates of first cost and annual costs for the formulated plan are shown in Appendix F along with summaries of cost for features by general item classification. The cost estimates are based on 1 October 1979 price levels, 7-1/8 percent interest rate, and a 100-year amortization period.

102. Basis of estimate of first cost. - The costs of lands and relocations for the local protection features of the project were estimated by the State Reclamation Board and reviewed and supplemented by the Sacramento District to account for increased real estate requirements. Real estate estimates for the reservoir areas were prepared by the Sacramento District. Real estate costs include costs related to compliance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (Public Law 91-646). The unit prices used for construction items are based on adjustments of average bid prices received on comparable work in Sacramento District. A 20 percent contingency allowance is included in the estimate for cost fluctuations and possible design changes. Suitable allowance has been made for engineering and design and supervision and administration based on comparable work in the Sacramento District. The following table summarizes the estimated project first cost.

First Cost Summary by Classification of Work
($1,000)

First Cost

Channels

* Non-Federal	
Lands and damages	6,230
Non-Federal relocations & modifications (1)	6,520
Federal	
Railroads	1,090
Channels & levees	11,120
Recreation facilities	240
Permanent operating equipment	30
Engineering and Design	1,505
Supervision and Administration	1,005
Total Channels	27,740

Reservoirs

Federal	
Lands & damages	5,640
Relocations	310
Reservoirs	980
Dams	36,000
Roads	960
Permanent operating equipment	230
Cultural Resources Preservation	(2)
Engineering and design	4,610
Supervision and administration	3,080
Total Reservoirs	51,810

Fish and Wildlife Mitigation

Non-Federal	
Lands and Damages	1,250
Federal	
Fish and Wildlife Facilities	250
Engineering and Design	30
Supervision and Sdministration	20
Total Mitigation	1,550
Total First Cost	81,100 *

(1) Includes Non-Federal E&D, S&A.
(2) These costs will be developed during future design stages. See paragraph 43 for discussion of cost.

Summary of First Costs
($1,000)

Feature	
Bear Reservoir	25,300
Burns Reservoir	10,000
Haystack Reservoir	8,340
* Castle Reservoir	8,170
Lower Bear Creek Channel	9,410
Bear Creek nr. 16th Street	200
Fahrens Creek & Tributaries	15,380
Lower Bear Creek Drain Channel	2,750
Fish and Wildlife Mitigation	1,550
Total	81,100 *

103. Annual Cost. - The annual cost is shown below. Replacement cost for the levee and channel portion is based upon the construction replacement after 50 years for economic evaluation purposes.

	Reservoirs	Levees & Channels	Fish and Wildlife Mitigation	Total
* Interest & Amortization	$3,695,600	$1,978,500	$110,600	$5,784,700
Operation & Maintenance	178,400	92,800	4,700	275,900
Replacement	16,000	16,200	700	32,900
Total	$3,890,000	$2,087,500	$116,000	$6,093,500 *

104. Departures from project document. - A comparison of the project document cost estimate, the latest approved authorized plan cost estimate (PB-3, dated 1 October 1979) and the recommended plan cost estimate is presented in the following tabulation:

COMPARISON OF COST

Item	Project Document (July 1969) ($1,000)	Currently Authorized 1/ (PB-3) October 1979 ($1,000)	Recommended Plan (October 1979) ($1,000)
Federal 2/			
* Bear Stream Group	17,910	40,080	66,800
Reservoirs	16,570	37,050	51,810
Burns	(6,130)	(13,710)	(10,000)
Bear	(2,220)	(5,070)	(25,300)
Castle	(5,700)	(12,540)	(8,170)
Haystack Mtn	(2,520)	(5,730)	(8,340)
Channels	1,340	3,030	14,990
Lower Bear Creek	(1,340)	(3,030)	(5,390)
Upper Bear Creek	0	0	(40)
Fahrens Creek	0	0	(8,020)
Lower Bear Drain Channel	0	0	(1,540)
Mitigation	0	0	300
Mariposa Stream Group	9,510	21,000	0
Reservoirs	(7,490)	(16,890)	0
Channels	(2,020)	(4,110)	0
Deadman-Dutchman Group	6,070	14,220	0
Reservoirs	(5,740)	(12,950)	0
Channels	(330)	(1,270)	0
Total Federal Cost	33,490 3/	75,300	67,100
Non-Federal			
Bear Stream Group	650	1,505	14,000
Channels	650	1,505	12,650
Lower Bear Creek	0	(1,505)	(4,020)
Upper Bear Creek	0	0	(160)
Fahrens Creek	0	0	(7,360)
Lower Bear Drain Channel	0	0	(1,210)
Mitigation	0	0	1,250
Mariposa Stream Group	1,560	2,440	0
Channels	(1,560)	(2,440)	0
Deadman-Dutchman Group	240	1,455	0
Channels	(240)	(1,455)	0
Total Non-Federal Cost	2,450	5,400	14,000
TOTAL PROJECT COST	35,940	80,700	81,100 *

1/ Project as last reported to Congress.

2/ Non-Federal interests will reimburse the Federal Government for all costs allocated to irrigation. Based on the percentage established in the cost allocation study contained in the "Review Report for Flood Control on Merced County Streams, California," dated June 1969, non-Federal costs for irrigation are estimated at $2,690,000 for the authorized project and $6,075,000 for the currently authorized project; irrigation has been deferred in the recommended project. In addition, one-half of the separable cost of recreation will be repaid by the non-Federal interests; these costs are estimated at $4,615,000 for initial facilities in the authorized project, $10,400,000 for the currently authorized project, and $130,000 for the recommended project.

3/ Figure does not include future recreation cost. Project was authorized for $37,260,000 which included $3,770,000 future recreation cost.

105. Explanation of deviation of currently authorized (1979 PB-3) project from project document (1969 PB-3). - Detailed explanation of deviations of the currently authorized project from the project document is contained in Appendix F, Basis of Design. The differences in Federal costs are due to price level increase (+$38,385,000), increase in estimated real estate costs (+$3,265,000) and sundry increase ($160,000 - July 1973, GSA rent increase). The difference in non-Federal cost is due to increase in costs of land and damages and relocations (+$2,950,000). Total change in project cost is +$44,760,000.

106. Explanation of deviation of recommended (1979 price level) plan
* from the currently authorized project (1979 PB-3). - The differences in Federal costs (-$8,200,000) include changes in capacities and designs of Bear Creek Group reservoirs (+$14,760,000); design changes in Bear Creek channel (+$2,400,000); addition of Fahrens Creek (+$8,020,000); addition of Lower Bear Creek drain channel (+1,540,000); addition of fish and wildlife mitigation features (+$300,000); deferral of Mariposa Creek reservoirs (-$16,890,000) and Mariposa Creek channel improvements (-$4,110,000); and deferral of Deadman-Dutchman Creek reservoir (-$12,950,000) and channel works (-$1,270,000). Changes in non-Federal costs (+$8,600,000) include increase in lands and damages and relocations for Bear Creek, (+$2,675,000), addition of the lower Bear Creek drain channel (+$1,210,000); addition of Fahrens Creek (+$7,360,000); and addition of fish and wildlife mitigation lands (+$1,250,000); deferral of Mariposa Stream Group (-$2,440,000); and deferral of Deadman-Dutchman Stream Group (-1,455,000). Total change in project costs is +$400,000. *

CHAPTER X - ACCOMPLISHMENTS AND BENEFITS FOR RECOMMENDED PLAN

107. General. - The main accomplishments attributable to the recommended plan are flood control, enhancement of public recreation, and employment benefits as prescribed in the Public Works and Economic Development Act (Public Law 89-136). The benefits were evaluated on the basis of a 100-year economic period at an interest rate of 7-1/8 percent and on price levels as of 1 October 1979. Evaluations are based on 1979 physical conditions and also on the economic development projected without the project, as compared to project physical conditions projected from 1985 to 2085. Detailed consideration was given to the use of each reservoir for streamflow regulation and to determine if the reservoirs could be used for irrigation, municipal water supply, water quality control, power, or downstream fisheries. Development for these purposes was not economically justified at this time. Detailed data on flood control benefits are contained in Appendix E. Detailed data on recreation benefits are contained in Appendix C, and detailed data on employment benefits are contained in Appendix D. As previously noted, the project was analyzed in three stream groups; Bear, Mariposa, and Deadman-Dutchman Stream groups. The latter two stream groups are not economically justified and are being deferred from further analysis at this time. Therefore, the project accomplishments and benefits contained in this chapter pertain only to the Bear Creek Stream group.

108. Flood control accomplishments and benefits. - Flood control benefits are derived principally from reduction in primary damages to about 55,000 acres of agricultural and urban areas. The city of Merced, Castle Air Force Base, existing adjacent suburban areas, and most of the area in the vicinity projected for urban development would receive a very high degree of flood protection. It is anticipated that urban development would occur even without additional flood protection. Much of the land in the flood plain is used for agricultural purposes, and while, with protection, the agricultural use in some instances may become more intensive, these lands are expected to remain agricultural throughout the economic life of the project. A small increase in improved land use, with or without the project, is expected to occur along the lower reaches of Bear Creek and east of the State's East Side Bypass. Because there are no project-induced land use changes, there are no special location benefits. Benefits have been evaluated on the basis of expected preproject and project conditions, with the period of economic development corresponding to the expected usefulness of the proposed works and with floodflow-frequency curves applicable to the preproject and project conditions. Average annual flood control benefits are estimated at $6,380,000.

109. The flood control benefits noted here are derived from the reduction in primary flood damages, which are the difference in flood damages with and without the project. Location benefits, or the benefits derived by a more intensive use of land resulting from a reduction in the flood hazards, are not included. The reason is that

the agricultural lands in the Bear Creek area are expected to continue their present use throughout the 100-year economic life of the project even with the provision of flood protection. The following tabulation displays by land use category the preproject damages, residual or project damages, and the project benefits. The average annual equivalent damage is shown for the period 1985 to 2085, discounted at the current interest rate of 7-1/8 percent. Probable average annual flood damages are also shown for the study year (1979), the base year or the year the project can reasonably expected to be operational (1985), and 50 years after the base year (2035). The basis for pricing the damages are October 1979 price levels for structures and their contents and normalized prices based on trends for agricultural products. Affluence, the effect of increasing per capita income, is only applied to the residential content category. Finally, the analysis was based on implementation of the Flood Insurance Program, whereby all new and replacement residential structures located in the 100-year flood plain would have their first floors elevated above the 100-year flood elevation while all new and replacement nonresidential structures would be flood proofed to the same elevation. For projects providing 100-year protection or greater, the cost savings achieved by not having to implement these measures in the project condition may be claimed as a benefit.

DAMAGES AND BENEFITS - RECOMMENDED PLAN
1979 Price Level; 1985-2085 Conditions; 7-1/8% Discount Rate
($1,000)

Item	Equivalent Annual Damages	Average Annual Damages 1979	1985	2035
1. Preproject Damages				
Residential	1,475	1,077	1,242	1,796
Contents	606	312	438	576
Commercial	1,532	1,495	1,525	1,531
Industrial	352	301	322	402
Public	632	511	526	695
Semi-Public	48	48	48	48
Agricultural	936	594	725	1,265
Emergency Costs	93	64	76	125
Total	5,674	4,402	4,902	6,438
2. Residual Damages				
Residential	64		48	101
Contents	39		20	73
Commercial	33		25	47
Industrial	7		5	11
Public	24		19	27
Semi-Public	1		1	1
Agricultural	61		49	81
Emergency Costs	3		3	4
Total	232	NA	170	345
3. Project Benefits				
Residential	1,411		1,195	1,695
Contents	567		418	503
Commercial	1,500		1,500	1,483
Industrial	345		318	391
Public	609		506	669
Semi-Public	47		47	47
Agricultural	874		675	1,184
Emergency Costs	89		73	121
Total	5,442	NA	4,732	6,093
Flood Ins. Prog. costs saved	938			
TOTAL BENEFITS	6,380			

110. The tables demonstrate the nature of the flood damages and benefits. For example, the rate of change of damages varies through time due to increases in property values, implementation of the Flood Insurance Program, land use changes between and within categories, and affluence, among other factors. As for the distribution of damages among land use categories, residential and commercial structures and their contents together account for 67 percent of the total preproject damages. When analyzed in terms of reaches and urban and rural classifications, as shown in the following table, it can be seen that the greatest percentage of damages and benefits occurs in the urban areas east of Crocker Dam.

111. In summary, the flood control benefits for the recommended plan consist primarily of a reduction in flood damages to residential, commercial and industrial structures located in the urban area comprising the city of Merced and, to a lesser extent, to the agricultural area adjacent to lower Bear Creek. The equivalent average annual flood control benefits total $6,380,000.

112. Recreation accomplishments and benefits. - About 6 miles of levee on Black Rascal and Fahrens Creeks would have a 10-foot-wide paved bikeway. This trail system would be used for bicycling, hiking, and incidental horseback riding. Details of the proposed recreation plan are outlined in Appendix C, Recreation Resources. Based on data from similar facilities, recreation use is expected to be 60 percent bicycling, 35 percent pedestrian activities, and 5 percent equestrian activity. Average annual equivalent benefits at 7-1/8 percent interest rate and a 100-year project life are estimated at $62,000.

DISTRIBUTION OF ANNUAL DAMAGES

1. Bear Creek Group

	Urban	Rural
A. Preproject Damages		
Residential	45%	11%
Commercial	34	-
Industrial	8	-
Public	11	12
Semi-Public	1	-
Agricultural	1	77
	100%	100%
B. Residual Damage with Recommended Plan		
Residential	63%	9%
Commercial	21	-
Industrial	4	-
Public	9	12
Semi-Public	1	-
Agricultural	2	79
	100%	100%

113. Employment benefits. - Merced County is primarily an agricultural production area and has been designated as eligible for assistance under the Public Works and Economic Development Act by the Economic Development Administration of the U.S. Department of Commerce. Employment benefits, therefore, can be applied to the project and are essentially an adjustment to the cost of a project which identifies the use of an otherwise unemployed or underemployed local labor resource.

114. A detailed evaluation of costs for the project indicates that 31.8 percent of the Federal construction costs represent labor costs for onsite construction. Labor costs will be comprised of 55 percent blue collar skilled workers, 27 percent blue collar unskilled, and 18 percent in construction occupations other than blue collar.

115. Total construction costs for the recommended plan are $50,450,000 excluding costs of land, engineering and design, and supervision and administration and other non-construction costs. Labor costs amount to $15,700,000, and of that amount, $6,960,000 was estimated to go to local labor. This will provide an average of 30 local jobs per year extending over the construction period of 5 years.

116. Equivalent annual employment benefits creditable to the recommended plan are $500,000 based on 1979 prices and a 7-1/8 percent discount rate. Details of the derivation of these benefits are shown in Appendix D, "Socio-Economics," in the section concerning employment and the labor force during the construction phase.

117. Comparison of benefits and costs. - Annual costs and benefits are based on an interest rate of 7-1/8 percent. As shown in Chapter IX, the annual cost of the project is estimated at $6,064,000. The following table gives benefits and costs to show the sensitivity of the benefit-cost ratio to recreation and construction employment benefits.

	Type of Project				Benefits	Costs	B/C	
*	Total Project	w/ARA,1/	w rec,2/	w rec. ARA3/	6,942	6,093	1.14	
	"	" ,	" ,	w/o rec. ARA	6,939	6,093	1.14	
	"	" ,	w/o rec,	"	6,877	6,060	1.14	
	"	w/o ARA,	w rec,	"	6,442	6,093	1.06	
	"	"	w/o rec,	"	6,380	6,060	1.05	*

1/ Total construction employment benefits, not including recreation construction employment benefits, equaling $497,000.
2/ Represents recreation costs and benefits, equaling $33,000 and $62,000.
3/ Recreation construction employment benefits, equaling $3,000.

118. Difference in benefits from project document. - The average annual equivalent benefits for the Bear Creek group presented in the authorizing document were estimated at about $2,500,000, based on 1 July 1969 price levels at an interest rate of 4-5/8 percent. These benefits consisted of flood control, irrigation, general recreation and fish and wildlife, and area redevelopment. Currently, the average annual benefits for the recommended plan are estimated at $7,118,000, which consist of flood control, downstream recreation use, and employment benefits, computed at October 1979 price level and an interest rate of 7-1/8 percent. The change from the project document is due to several factors. Increases in benefits have primarily resulted from (1) an increase in property values with an associated increase in unit damages of 105 percent, (2) an increase in benefits due to a higher level of flood protection for the recommended plan over the authorized plan of 54 percent, and (3) an increase of 27 percent resulting from access to detail data and the ability to utilize this data through computer modeling techniques. Decreases in benefits have resulted from (1) an increase in the interest rate and a lower future growth rate which accounts for a decrease of 23 percent and (2) a net decrease of 10 percent from reduced damages to future development in the flood plain due to implementation of the Flood Disaster Protection Act of 1973 (Public Law 93-234), which is only partially offset by savings in flood proofing costs. In summary, $2.5 million x 2.05 x 1.54 x 1.27 x 0.77 x 0.90 = $6.9 million.

CHAPTER XI - COST APPORTIONMENT AND REPAYMENT FOR RECOMMENDED PLAN

119. General. - In a multiple-purpose project containing several purposes such as flood control, irrigation, municipal water supply, and recreation, the separable costs-remaining benefits (SC-RB) method is normally used to prepare an allocation of costs to the various functions. In the case of the Merced County Streams project, only two functions are presently included in the recommended plan: flood control, and recreation. The reservoirs have been identified as providing widespread flood control benefits to the communities of Merced and Atwater, to Castle Air Force Base, and a large agricultural area served by three irrigation districts. There are no land enhancement benefits. Section 2 of the 1938 Flood Control Act (Public Law 75-761) provides that no local cooperation is required for such reservoirs, and the cost of construction, operation and maintenance would be Federal.

a. The levee and channel improvements are considered to be local protection features, which, under Section 3 of the 1936 Flood Control Act (Public Law 74-738), require a non-Federal entity to provide all lands, easements, rights-of-way, and relocations for construction of the project. Maintenance and operation of the constructed works would also be a non-Federal requirement.

b. The primary recreation use of the project would consist of trail-based walking for pleasure and bicycling on the maintenance roads along the project channels. In accordance with current policy, one-half of the separable costs for recreation facilities, including all costs for recreation lands, is a non-Federal cost; also, operation and maintenance of these facilities after construction will be a non-Federal cost.

c. Mitigation features are required to preserve wildlife values which would otherwise be lost due to construction of the project levees and channel improvements. Instructions contained in ER 1105-2-129 state that for local protection projects, fish and wildlife mitigation features, including land requirements and operation and maintenance, will be cost shared by local interests in the same ratio as the remainder of project costs. However, acquisition of land specifically for wildlife mitigation was not authorized by Congress. Therefore, the easements on lands for mitigation are to be provided by non-Federal interests at no cost to the Federal Government. Cost sharing of the remainder of the mitigation features will be on the basis of the ratio of non-Federal flood control costs to the total flood control cost of the downstream channel improvements. Costs for project purposes, both Federal and non-Federal, are separable and readily identified. There are no joint use costs. Therefore, an allocation of costs by the separable costs-remaining benefits method is not required.

120. Flood control and wildlife mitigation. - The estimated Federal and non-Federal first costs for the levee and channel improvement, construction of specific mitigation features, and the estimated

non-Federal cost of operation and maintenance of the improvements, at October 1979 price levels, are shown in the following tabulation:

	First Cost ($)			
	Flood Control 1/	Flood Control with Cap. O&M Cost	Mitigation Cost 2/	O&M Cost
* Federal	14,800,000	14,800,000	189,000 4/	0
Non-Federal	12,720,000	13,878,000	1,361,000	82,600 3/
Total	27,520,000	28,678,000	1,550,000	82,600

1/ Flood Control cost of levee and channel improvement.
2/ Mitigation cost sharing is determined by the proportion of flood control costs including the capitalized O&M costs.
3/ Does not include recreation O&M of $10,200 and wildlife mitigation O&M of $4,700.
4/ This cost includes a prorated share of the capitalized value of the mitigation O&M cost amounting to $34,000. *

The O&M of the mitigation features will be the responsibility of the local interests and will be incorporated into the levee O&M work. The Federal Government will pay for a prorated amount of the capitalized O&M costs for mitigation.

121. Recreation. - The Federal Water Project Recreation Act (Public Law 89-72) provides that at least one-half of the project separable costs allocated to recreation, and all costs of maintenance, operation, and replacement, will be paid for by local interests. Of the estimated $320,000 first cost for project-related recreational facilities, $290,000 is the estimated first cost for construction and $30,000 is the estimated cost for recreation lands. For project-related recreational facilities, the estimated Federal cost for construction, including costs for engineering, design, supervision, and administration, exceed the costs for recreational lands, including acquisition costs, by $260,000. In accordance with current policy, one-half of this cost of $260,000 or $130,000 would be reimbursed to the Federal Government by local interests. Operation, maintenance and replacement costs for recreation would be $10,200.

CHAPTER XII - REQUIREMENTS OF LOCAL COOPERATION FOR RECOMMENDED PLAN

122. General. - The State of California authorized the Merced County Streams project by Senate Bill Number 1296, approved by the Governor on 23 September 1974. This statute authorized the Reclamation Board to provide the necessary assurances of local cooperation for the Merced project and also authorized the Reclamation Board to enter into a loan agreement with a local (county or city) agency for repayment to the State of local costs delegated by the State to that agency.

a. The State Reclamation Board provided a letter of intent, dated 28 November 1979, to provide the assurances of local cooperation for the project. By letter dated 20 February 1980 the Reclamation Board reaffirmed its intent to provide the local assurances and in addition provided its intent to provide the mitigation easements at no cost to the Federal Government. (See Appendix A)

b. The Merced County Board of Supervisors adopted a resolution on 1 November 1966 in regard to furnishing the assurances of local cooperation. By letter dated 11 December 1979 the County reaffirmed its intent to provide the necessary assurances of local cooperation prior to initiation of construction. By letter, the County provided its intent to provide the mitigation easements at no cost to the Federal Government (See Appendix A).

c. The City Council of the City of Merced indicated its intent to provide the required assurances of local cooperation for recreation features of the project in a letter dated 4 December 1979 (Appendix C). These features consist of the bikeway and trail system along the downstream channels as outlined in Appendix C, Recreation Resources.

123. Flood control. - Prior to construction, assurances shall be furnished to the satisfaction of the Secretary of Army that for:

a. All projects. -

Local interests will:

(1) Provide guidance and leadership in preventing unwise future development of the flood plain by use of appropriate flood plain management techniques to reduce flood losses; and

(2) At least annually, inform affected interests of the degree of protection provided by the project.

b. Castle Dam and Reservoir. - The Merced Irrigation District will continue to divert up to 1,000 cubic feet per second of the floodflows of Fahrens Creek at the Merced Irrigation District main canal into Yosemite Lake.

c. Supplemental levee and channel improvements. -

Local interests will:

(1) Furnish without cost to the United States all lands, easements, and rights-of-way necessary for construction;

(2) Make all necessary relocations and alternations to existing improvements, including highway facilities, which may be required for construction of the project;

(3) Hold and save the United States free from damages due to the construction works, but not including damages due to the fault or negligence of the United States or its contractors;

(4) Maintain and operate after completion the levee and channel improvements as well as existing project channels in accordance with regulations prescribed by the Secretary of the Army;

(5) Prevent encroachment of any type that would impair flood control effectiveness of the project works;

(6) Preserve, or restore and thereafter maintain, at the capacities prevailing in 1968, the other flood channels of Merced County streams which are within proposed project limits but are not to be improved by the proposed project (channel capacities prevailing in 1968 are listed in paragraph 13); and

(7) Comply with the applicable requirements of "The Uniform Relocation Assistance and Real Property Acquisition Policies Act" of 1970 (Public Law 91-646, 84 STAT, 1894).

124. Recreation. - With regard to recreation, local interests are required to:

a. Provide all lands specifically required for recreation.

b. Pay, or repay with interest, that portion of the cost of recreation facilities, which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and facilities.

c. Administer, maintain, operate, and replace the recreation facilities provided by the project in accordance with regulations established by the Secretary of the Army.

125. Differences from project document plan. - Studies and investigations subsequent to project authorization have necessitated modifications in the authorized plan presented in the project document and associated modifications to the requirements of local

cooperation. These modifications primarily affect the assurances for recreation. The project purpose of recreation has not changed but has been modified to reflect the desires of local interests. As noted earlier in the report, local interests do not wish to have recreation at the reservoirs but prefer recreation features in connection with the downstream channel improvements. Therefore, the requirements for recreation have been modified to reflect the current recreation plans which do not include recreation use at the reservoirs.

CHAPTER XIII - DEPARTURES FROM PROJECT DOCUMENT PLAN FOR RECOMMENDED PLAN

126. General. - Studies and investigations subsequent to project authorization have necessitated changes in the authorized plan presented in the project document. The changes reflect (1) updated hydrologic data, (2) changes in land use from that previously anticipated, (3) changes in public attitudes toward environmental and recreation considerations, (4) new legislation regarding protection of environmental and cultural resources, (5) further coordination with local interests, (6) increased price levels and interest rates used in economic evaluation and (7) the provision of fish and wildlife mitigation lands at no cost to the Federal Government.

127. The recommended plan of improvement includes work on only Bear Creek Stream group. Work on Mariposa and Deadman-Dutchman Stream groups is not economically justified at this time and has been deferred until such time as it is deemed economically feasible. Irrigation was a feature of this deferred portion of the project, so this function has been deferred at this time.

128. The capacities of the reservoirs on the Bear Creek group have been changed from those presented in the authorized plan. Castle Reservoir at 7,100 acre-feet is 4,400 acre-feet smaller, and Burns Reservoir at 22,600 acre-feet is 7,000 acre-feet smaller, primarily due to eliminating recreation at these sites. Haystack Mountain Reservoir at 5,800 acre-feet is 2,800 acre-feet larger, and Bear Reservoir at 24,000 acre-feet is 9,600 acre-feet larger, primarily due to providing a higher degree of flood protection to the urban areas of Merced.

129. Recreation was modified at the request of local interests from reservoir-oriented use to that associated with downstream channel improvements. Also, in connection with the channel improvements, the length of modifications has been reduced from about 54 miles to about 33 miles because of the deferral of Mariposa and Deadman-Dutchman Stream Groups. Levee and channel improvements on Fahrens Creek were not included in the authorized plan, but with new hydrology and the need for flood protection to Merced, it was determined that improvements to Fahrens Creek were required in order to provide a complete and integrated project.

130. Acquisition of easements on 2,800 acres for wildlife mitigation is included in the project as a result of evaluation of losses as a result of constructing and operating the project for flood control. Since acquisition of land specifically for wildlife mitigation is not a part of the authorized project, the easements will be provided by non-Federal interest as no cost to the Federal Government.

131. The first cost of the Bear Creek group in the 1969 authorized project document was estimated at $18,560,000. The recommended plan is currently estimated at $80,100,000. The benefit-cost ratio of the authorized Bear Creek group was 2.1 to 1. Currently the authorized plan is estimated to cost $41,585,000 for a benefit to cost ratio of 1.5 to 1; the recommended plan is 1.2 to 1. These changes, resulting from (1) the differences described above, (2) difference in price levels, and (3) difference in interest rates of 4-5/8 percent to 7-1/8 percent, are described in detail in Appendix F and summarized in Chapter IX and X of this design memorandum.

CHAPTER XIV - PUBLIC INVOLVEMENT AND COORDINATION

132. General. - Public involvement and coordination with local representatives has been maintained throughout the study period. The project document outlines the public involvement up to the time of publication of that document in 1970. Following receipt of funds for Advanced Engineering and Design (AE&D), a notice of initiation was mailed to Federal, State, and local agencies and all private organizations and individuals known at that time to be interested in the project and associated studies. Responses to the notice reaffirmed the need for additional flood control, irrigation, outdoor recreation and fish and wildlife mitigation in the project area.

133. Public meetings. - A public meeting was held on 24 May 1976 to inform the city, county, and interested organizations and citizens of the status of AE&D studies and present what was thought at that time to be the best plan for the project. This plan included provision of gates in the outlet works of the dams and is referred to as the "gated plan." Studies conducted prior to the public meeting showed that recreation at the reservoirs was not economically justified; therefore, only minimum facilities to protect public health and safety would be provided. Strong opposition was expressed by the county and local citizens to the concept of providing recreation facilities of any kind, citing the extreme fire hazard in the area, policing problems, lack of existing public access, and the problems of cleaning up litter and damage that would be created by the public.

134. A late stage public meeting was held on 20 March 1979 at which the selected or "bobtailed" plan of improvement formulated at that time was presented to the public. There was significant opposition to portions of the selected plan. Because of this opposition parts of the plan were restudied and altered when possible to conform with the locals desires. The plan presented at the 20 March 1979 meeting included levees on Bear Creek downstream to Bert Crane Road. The levees along Bear Creek were to be extended to the East Side Canal after authorization to acquire mitigation lands adjacent to the levees between Bert Crane Road and the East Side Canal was obtained from the Congress. The local interests strongly objected to the deferring of the levees on lower Bear Creek as well as acquisition of land for wildlife. Because of these strong objections, the present plan was reevaluated to determine if a more acceptable plan could be developed. A new plan was developed which included wildlife mitigation features between the project levees on lower Bear Breek and no acquisition of easements for mitigation. This new plan was acceptable to the Merced County Board of Supervisors at a public meeting held on 12 September 1979. The plan was accepted by the County and City of Merced and the State Reclamation Board. However, the plan was vigorously opposed by the Fish and Wildlife Service (FWS) and the California Department of Fish and Game (DFG) citing that mitigation for geese was not adequate, including the endangered Aleutian goose. The mitigation plan was based on waterfowl use days supplied by the FWS. The original information did not include a

breakdown of the various types of waterfowl. At the 12 September meeting, the FWS stated that 80% of the waterfowl affected were geese and that the proposed mitigation plan would not benefit geese. Through more coordination with the FWS, DFG, and local interests, the mitigation problem was resolved. The recommended plan presented in this report includes mitigation features acceptable to all parties.

135. The local interests also suggested that we look at some alternatives to the present design of Burns Dam. These included, (1) not raising the dam but adding a perched spillway to increase effective storage, (2) add a perched spillway and raise Burns Dam less than the current proposal, and (3) build a dam upstream of the existing dam. These alternatives had already been evaluated; however, because of the specific request, new cost estimates for these proposals were made. The present proposal of enlarging the existing Burns Dam to 22,600 acre-feet remains the most economical solution.

136. Another suggestion received was construction of a bypass for lower Bear Creek between Bert Crane Road and the East Side Canal. The alternative is included in the recommended plan.

137. The Sacramento District addressed the Merced County Board of Supervisors on 29 January 1980 and the State Reclamation Board on 14 February 1980. At these meetings, the District presented a plan which included acquisition of easements for wildlife mitigation by local interests. Both Boards voted to reaffirm their intent to provide the required accurances and stated their intent to provide the easements required for wildlife mitigation at no cost to the Federal Government. Copies of the letters from these agencies are in Appendix A.

138. Environmental working paper and environmental statement. - An environmental working paper was prepared and distributed for review and comment in October 1975. As a result of comments reviewed, the working paper was revised in December 1975 and was the basis for the revised draft Environmental Statement. The working paper was coordinated with the following agencies and organizations:

Federal

Environmental Protection Agency

Fish and Wildlife Service

Geological Survey

National Park Service

Department of Housing and Urban Development

Castle Air Force Base

Soil Conservation Service

Department of Health, Education and Welfare

National Marine Fisheries Service

State

Department of Fish and Game

Department of Parks and Recreation

Regional Water Quality Control Board

Department of Water Resources

Department of Health

Department of Navigation and Ocean Development

City and County

Merced County Planning Commission

Merced City Planning Department

Merced Irrigation District

Organizations

Central Valley Flood Control Association

Citizens Environmental Advisory Committee

California Wildlife Federation

Sierra Club

Audubon Society

139. Coordination with Federal agencies. - Close coordination has been maintained throughout the Phase I GDM studies with the Federal agencies noted in the previous paragraph, particularly with the Fish and Wildlife Service (FWS). The FWS furnished information on fish and wildlife resources of the area, evaluated impacts of the project, and recommended mitigation and enhancement measures for fish and wildlife. The recommendations of the FWS are included in the following paragraph. The Bureau of Reclamation conducted all the studies for the project related to irrigation water supply yield and benefits. The Cultural Resources Reconnaissance Survey Report and Supplement were sent to the Office of Archeology and Historic Preservation of the Heritage Conservation and Recreation Service (HCRS), formerly of the National Park Service and to the State Historic Preservation Office for comments and recommendations. A copy of the report was also sent to the National Museum at the Smithsonian Institute and to OCE. The more detailed Phase II intensive cultural resources survey will also be presented to the HCRS for their comments on that report. Mitigation will be implemented during construction subsequent to approval of a Memorandum of Agreement between the Corps, the Advisory Council on Historic Preservation, and the HCRS. Any nominations for the National Register of Historic Places would be sent through the Office of the Chief of Engineers to the Keeper of the Register.

140. Fish and Wildlife Service recommendations (see Appendix B for FWS Report): For wildlife compensation, it is recommended that the Corps of Engineers require:

Recommendation 1: That compensation for wetland and related wildlife resources losses in the vicinity of lower Bear Creek be accomplished by:

(a) Local sponsors providing perpetual easements for wildlife habitat conservation on a minimum of 2,800 acres of natural marsh and grassland, as identified in the attached Detailed Evaluation. Under conditions of the easements, up to 400 acres of grassland may be identified for future conversion to irrigated permanent pasture;

(b) Providing three water wells capable of yielding approximately 4,000 gallons per minute each for use in optimizing existing habitat and developing additional marshland habitat within the area covered by the conservation easements;

(c) Consulting with the U.S. Fish and Wildlife Service and the California Department of Fish and Game during the advanced planning and design phase and the construction phase on all aspects of implementing the program.

(d) Providing for acquisition of the wildlife habitat conservation easements prior to the construction of project works below Bert Crane Road.

(e) Granting the easement to the United States of America with administrative responsibility assigned to the U.S. Fish and Wildlife Service for the purpose of monitoring and enforcing the provisions of the easements. Operation and maintenance of the wildlife compensation area is to be the responsibility of the managing entity which is to manage the area in accordance with an operation and maintenance manual developed by the Corps of Engineers in coordination with all parties. All costs for operation and maintenance should be designated project costs.

Response: Concur. Non-Federal interests have provided assurances they will obtian the easements at no cost to the United States.

Recommendation 2: That compensation for the loss of marshland, and associated wildlife, resulting from construction of the Bear Creek Bypass channel be accomplished by creating an equivalent acreage of marshland between project levees through excavation and shaping. It is presently estimated that replacement of 25 acres of marshland will be necessary.

Response: Concur that direct impacts to marshland should be mitigated by creating an equivalent acreage of new marshland.

Recommendation 3: That compensation for the loss of 6 acres of woody riparian habitat, and associated wildlife, be accomplished by creating a minimum of 6 acres of riparian habitat on project-acquired lands between levees. Estimated development cost is $1,000 per acre.

Response: Concur.

Recommendation 4: That compensation for the loss of riparian habitat, and associated wildlife, resulting from construction-related activities at the damsites be accomplished by creating an equivalent acreage of riparian habitat on project acquired lands, preferrably at the dam and detention reservoir sites. It is presently estimated that replacement of 39 acres of riparian habitat will be necessary. Estimated development cost is $1,000 per acre.

Response: Concur that lands required for other project purposes will be used to create about 39 acres of riparian habitat between the levees.

Recommendation 5: That all acres disrupted during project construction and not specifically developed for wildlife, be seeded with grass species of value to wildlife as identified in the Detailed Evaluation.

Response: Concur.

Recommendation 6: That adverse impacts on wildlife habitat throughout the project area be held to a minimum by utilizing, to the extent reasonable, the least damaging construction methods and by leaving construction areas in a condition conducive to the regeneration of wildlife habitat, particularly emergent marsh vegetation.

Response: Concur.

Recommendation 7: That project operating criteria, developed in coordination with the United States Fish and Wildlife Service and the California Department of Fish and Game for the protection and development of fish and wildlife resources, be adhered to as long as the Corps exercises direct operational control over project features, and that any agreements entered into for the release of operational control to another agency include stipulations to prevent deviation from these criteria.

Response: Concur.

For wildlife enhancement, it is recommended that the Corps of Engineers consider:

Recommendation: That environmental easements for the purpose of wetland improvement be acquired on 2,300 acres of natural marsh and grassland, as identified in the Detailed Evaluation. The cost of the easements, presently estimated at $900,000, should be designated a nonreimbursable Federal cost. Opeation and maintenance costs for the wetland enhancement area would be assumed by the U.S. Fish and Wildlife Service.

Response: We do not concur with aquisition of a 2,300-acre wetland enhancement area due to the objections expressed by local interests concerning this proposal. We recognize that a wetland enhancement area such as described in the June 1978 Draft General Design Memorandum would have significant benefits for the National Migratory Bird Program. However the non-Federal sponsors for the project object to the acquisition of lands for this purpose and therefore do not recommend this measure as part of the Merced County Streams Project. Should non-Federal interests change their present view and support this concept, further evaluation could be made during the phase II studies and, if found to be desirable, a special report could be submitted seeking the congressional authorization which would be needed to acquire lands specifically for fish and wildlife.

141. Coordination with non-Federal interests. - Coordination was maintained with the California Department of Fish and Game (DF&G), Department of Water Resources (DWR), Reclamation Board, and Department of Parks and Recreation. The DF&G worked closely with the FWS in developing mitigation requirements for the project. In addition, close coordination has been maintained with the city and county of Merced and the Merced Irrigation District. The Cultural Resources Reconnaissance Survey Report and Supplement were sent to the State Historic Preservation Officer (SHPO) of the California Department of Parks and Recreation. No pertinent comment has been received to date. A copy of the above transmittal letter was also sent to the Native American Heritage Commission. The Phase II Field Survey Report will be sent to the SHPO for their comments and to coordinate any mitigation that might be required.

142. Comments of Federal agencies. -

a. Department of Commerce (National Oceanic and Atmospheric Administration). - Review comments on the selected plan are contained in a letter from Department of Commerce dated 27 March 1979, included in Appendix A.

In summary they requested that weather forecast services be included as a non-structural alternative.

b. Federal Energy Regulatory Commission. - Review comments are contained in a letter dated 22 March 1979, included in Appendix A.

The Commission agrees that there is no potential for hydroelectric generation at the proposed developments.

c. Department of Health, Education and Welfare (Public Health, Service). - Review comments are contained in a letter dated 1 May 1979, included in Appendix A.

Their main concern is a potential for an increase in the mosquito population.

d. Department of Agriculture (Forest Service). - Review comments are contained in a letter dated 12 April 1979, included in Appendix A.

They see no major impacts on National Forest or State and private forest lands resulting from the proposed project.

e. Department of Agriculture (Soil Conservation Service). - Review comments are contained in a letter dated 11 April 1979, included in Appendix A.

In summary they note that the draft EIS does not adequately recognize the limitations of the soils for the proposed construction

and that there was no consideration given to alternatives to the loss of prime farmlands.

f. Department of Interior (Heritage Conservation and Recreation Service). - Review comments are contained in a letter dated 21 May 1979, included in Appendix A.

They feel that the nature and character of the resources have not been addressed and that any cultural mitigation recommendations are premature.

g. Environmental Protection Agency. - Review comments are contained in a letter dated 9 April 1979, included in Appendix A.

Responses to the above noted concerns are contained in the final EIS.

The comments of EPA on the draft environmental statement have been classified as "Lack of Objection", indicating that EPA has no objection to the proposed plan as described in the draft environmental statement.

143. Comments of State Agencies. -

a. Formal comments of the State of California are summarized in a letter dated 10 May 1979 from the Resources Agency of California, included in Appendix A. State review was coordinated with the Department of Conservation, Fish and Game, Food and Agriculture, Health Services, Boating and Waterways, Parks and Recreation, and Water Resources; the Air Resources, Reclamation, State Water Resources Control, and Solid Waste Management Boards; the Energy and State Lands Commissions; and the Merced County Association. Specific comments are summarized as follows:

(1) The selected and formulated plans are easy to confuse with each other.

(2) Request that the Mariposa and Deadman-Dutchman Stream groups be monitored in the future to see if a project may become feasible for that area.

(3) The State Reclamation Board supports the project provided the Bear Creek Stream group is constructed to tie into the existing levees of the States' Lower San Joaquin River Flood Control Project and also enlarge the inlet structure at Mariposa Creek.

(4) The Department of Fish and Game would like to see a complete project with levees on lower Bear Creek and the acquistion of lands for mitigation.

(5) The EIS should discuss the potential for the established marshlands and riparian habitat to produce pests and disease mosquitoes.

(6) The EIS does not adequately discuss impacts of construction activities on the quality of waters in the area.

(7) There were numerous specific comments about channel and levee alignment which will be considered during the Phase II studies.

Responses to the above noted concerns are contained in the final EIS.

144. Comments of County Agencies. -

a. Comments from Merced County Planning Commission are contained in a letter dated 2 March 1979, included in Appendix A.

145. Comments of Local Landowners. - A number of letters commenting on the proposed plan were received by the Corps of Engineers and Merced County. Most of these letters are contained in the transcript of the public meetings held on 20 March 1979 and 12 September 1979. The comments generally are related to specific concerns over the potential impact of the project on lands and the plans of the landowners involved. The concerns expressed will be considered in detailed planning for the Phase II General Design Memorandum.

CHAPTER XV - PUBLIC ACCEPTANCE

146. General. - Local interests recognize the need for flood control in the Merced area. The State Reclamation Board, Merced County, and the City of Merced have expressed their support for the project. However, all three entities have expressed strong disappointment over the deferral of Mariposa and Deadman-Dutchman Stream groups. They cite the need for flood control south of Merced and the need for additional irrigation water, especially in times of drought. Local interests would prefer that the entire project be constructed at this time, but recognize the economic limitations and strongly support construction of flood control works on Bear Creek Stream group.

CHAPTER XVI - CONCLUSIONS

147. General. - The District Engineer has reviewed and evaluated, in light of the overall public interest, the information contained in the environmental statement and other documents concerning the Merced County Streams, California, project, and the views of other agencies, organizations, and individuals on the environmental and other impacts of the proposed work and alternatives to the proposed project. The District Engineer has personally inspected the project area and conducted meetings with local government officials, landowners, and representatives of environmental, fish and wildlife, engineering, and conservation interests. The proposed work, as well as each alternative considered, were studied and evaluated for engineering feasibility, environmental effect, social well-being, and economic factors. Specific attention was given to the need for flood control, general recreation, fish and wildlife enhancement, and irrigation purposes for which the project was authorized, while also considering the requirements of the National Environmental Policy Act. In making this evaluation, specific attention was given to the following factors in order to provide a balance of all considerations.

148. Engineering considerations. - Alternative flood control solutions considered included an all reservoir system, an all levee and channel system, combinations of levees and reservoirs, nonstructural flood protection measures, and no action. Of the various alternatives investigated, a levee and reservoir system was determined to meet the needs and desires of local interests for flood protection more satisfactorily than other methods considered. The recommended levee and reservoir plan was developed in close coordination with local interests. Modifications to Fahrens Creek and additional modifications to Black Rascal Creek, not specifically included in the authorized project, have been included in the recommended plan to increase the flood protection offered to the urban areas of Merced. The recommended plan would provide standard project flood protection (SPF) to most of the urban areas of Merced, 100-year protection to the area around the airport and a minimum of 50-year flood protection to rural areas along Bear Creek west of Merced.

149. Economic considerations. - The authorized plan of improvement for the Merced County Streams project included improvements on the Bear, Mariposa, and Deadman-Dutchman Stream groups. The results of studies conducted during the advance planning process and information obtained during coordination with Federal, State, and local agencies indicated that authorized work on Mariposa and Deadman-Dutchman Stream groups could not be economically justified at this time. For this reason, improvements on these stream groups are being deferred until such time as improvements are deemed feasible. Therefore, the recommended plan includes improvements on the Bear Creek Stream group only. As a result of this decision, the potential of providing irrigation was also deferred. The recommended plan includes flood control improvements on Fahrens Creek and additional modifications to Black

Rascal Creek that were not included in the authorized project. These features have been added to balance the level of protection provided the urban areas of the city of Merced. The economically optimum flood control plan for the Bear Creek group would have provided 100- to 200-year flood protection to existing urban areas in and adjacent to Merced. Because it is considered in the public interest to provide Standard Project Flood protection to urban areas, several modifications have been incorporated into the recommended plan that will provide this level of protection to most of urban Merced. Outlying rural areas would be provided at least 50-year flood protection; higher levels were not feasible from an economic and engineering standpoint. Recreation facilities were considered at various reservoir sites; however, local interests objected to providing access to the reservoirs, and no local sponsor was willing to participate in developing and operating recreation at the reservoirs. The city of Merced expressed interest in providing a bike trail and parkway along the channel works in and adjacent to Merced. Accordingly, the recreation plan currently consists of recreation development along Fahrens and Black Rascal Creeks. Long-term productivity of the area would be increased due to the protection offered to urban and agricultural areas; however, current land use patterns are not expected to change as a result of the project. There would be a short-term increase in the employment of local people during construction of the project and a slight, short-term increase in the retail trade resulting from construction employment. The recommended plan of improvement was found to be economically feasible, with a 1.2 to 1 benefit-cost ratio, and would prevent average annual flood damages of $5,442,000, reduce future average flood insurance costs by about $938,000, provide recreation benefits of about $62,000 annually and provide a short-term construction employment benefit which has an equivalent annual value of $676,000 over the life of the project.

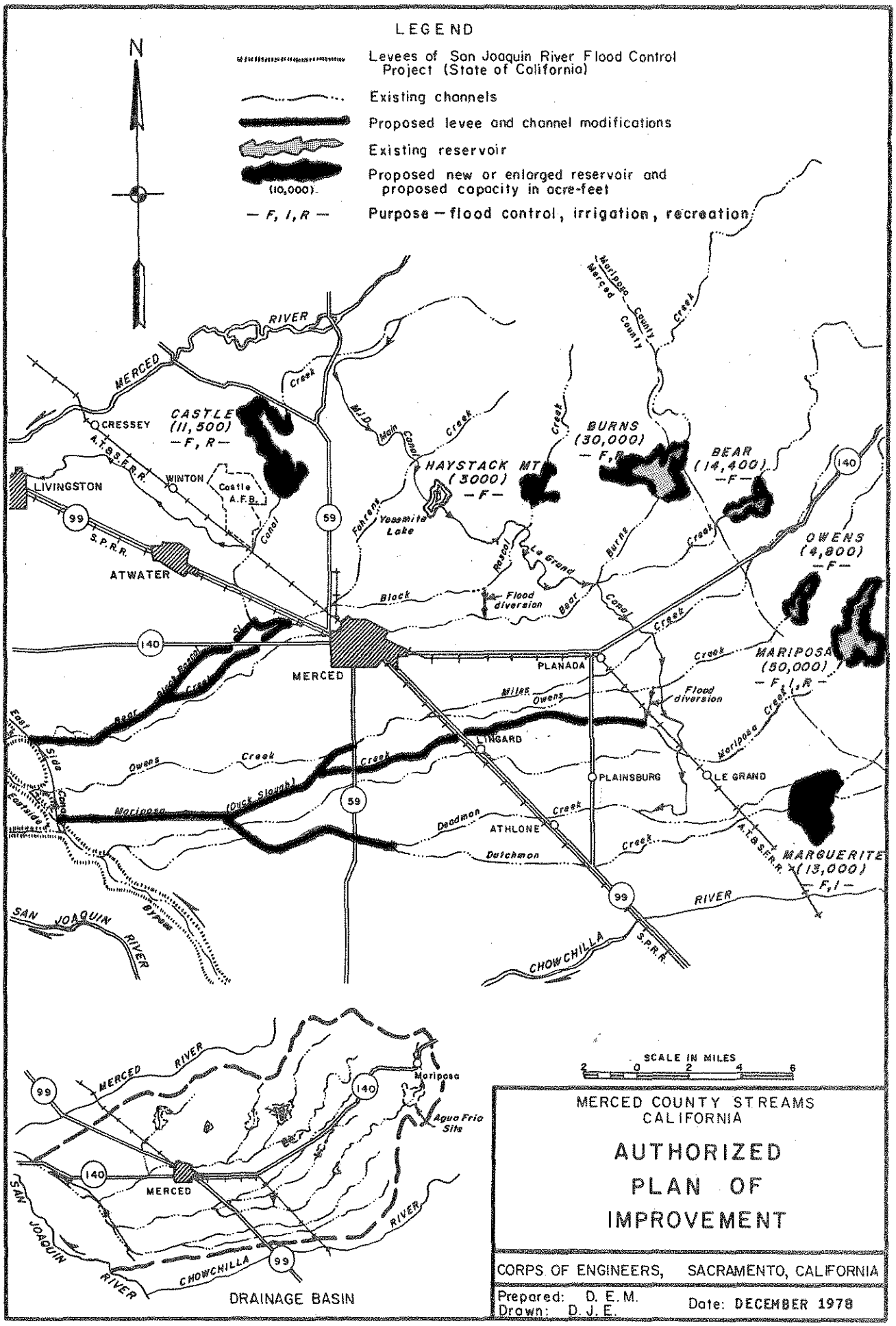
150. Environmental considerations. - The major areas of environmental concern associated with the recommended plan were: (1) marshland and riparian vegetation along lower Bear Creek, (2) riparian vegetation along Fahrens Creek, and (3) riparian vegetation at Castle, Bear, and Burns Reservoirs. To preserve wildlife habitat along Fahrens Creek, levees would be set back at a distance sufficient to include these resources and provide adequate flood protection. Borrow areas at reservoir sites would be placed to avoid at least 80 percent of the existing riparian vegetation. In accordance with Executive Order 11990, Protection of Wetlands, it has been determined that there is no practicable alternative to the proposed construction. All practicable measures to minimize harm to the existing wetlands have been included as stated above. For fish and wildlife management, (1) riparian and upland habitat between setback levees would be improved by eliminating grazing, (2) new marsh and riparian habitat would be created, and (3) cultivated agricultural lands between setback levees would be converted to wildlife habitat.

151. Social well-being considerations. - Implementation of the recommended plan would significantly reduce flood damages and would prevent serious disruptions in earnings and life-style for residents of urban areas in and adjacent to Merced. Potential losses to agricultural and livestock productivity would also be reduced in rural areas. Socioeconomic studies have indicated that the project would not significantly affect current or future land use. The majority of urban development that will take place in the flood plain has already occurred, and agricultural land uses are limited by soil type and the availability of irrigation water. The project would displace one or two families. Relocation assistance would be provided in accordance with the law. During the construction phase of the project, there would be a small short-term influx of construction workers, but it is not anticipated that community services would be significantly affected. Local hiring of construction workers would slightly reduce local unemployment and provide additional revenues to the local economy. Local tax revenues would be lost on approximately 1,200 acres of publicly acquired project lands. The project would impact 18 cultural resources sites examined in a cultural resource reconnaissance. An intensive cultural resource survey will be conducted during Phase II activities. The project would increase recreation resources in the area by providing a bikeway and recreation trail along Fahrens and Black Rascal Creeks.

152. Analysis. - The District Engineer has found that the environmental statement meets or exceeds the requirements of the National Environmental Policy Act; that the proposed action is based on a thorough analysis and evaluation of various practicable alternatives for providing flood protection, recreation, and fish and wildlife enhancement for the Merced County Streams project area; that mitigation efforts would offset almost all adverse environmental impacts and that minor remaining potential adverse environmental impacts are outweighed by other considerations; and that the recommended action is consonant with national policy, statutes, and administrative directives. On balance, the total public interest would best be served by implementation of the Merced County Streams project.

CHAPTER XVI

153. Recommendations. - It is recommended that this Design Memorandum and the plan presented herein for the Bear Creek Stream Group be approved for Phase II detailed design and construction to provide flood control, recreation, and fish and wildlife mitigation features.



MERCED COUNTY STREAMS
CALIFORNIA

AUTHORIZED PLAN OF IMPROVEMENT

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: D. E. M.
Drawn: D. J. E.

Date: DECEMBER 1978

PLATE I

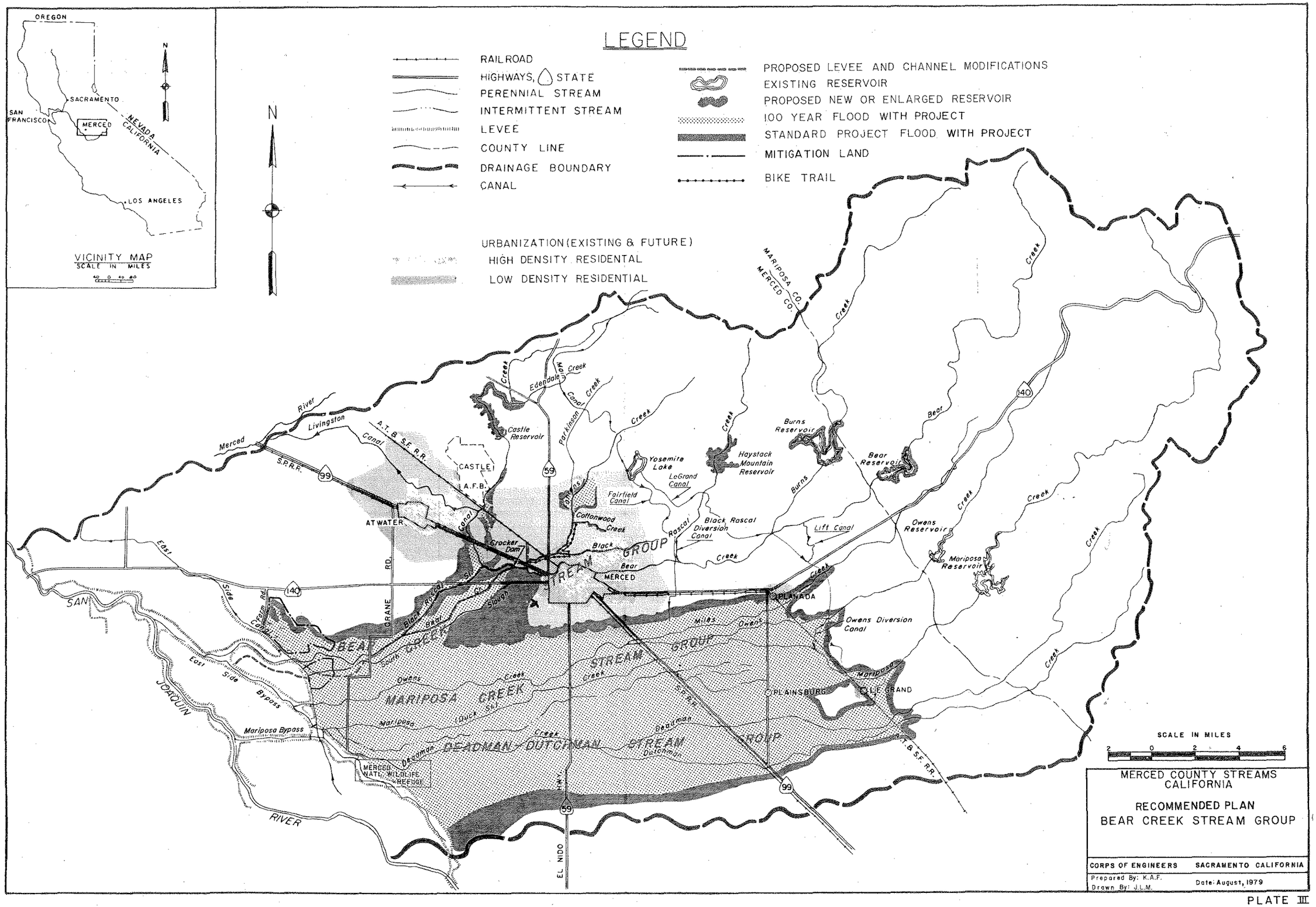

LEGEND
RAILROAD
HIGHWAYS, STATE
PERENNIAL STREAM
INTERMITTENT STREAM
LEVEE
COUNTY LINE
DRAINAGE BOUNDARY
CANAL
PROPOSED LEVEE AND CHANNEL MODIFICATIONS
EXISTING RESERVOIR
PROPOSED NEW OR ENLARGED RESERVOIR
100 YEAR FLOOD WITH PROJECT
STANDARD PROJECT FLOOD WITH PROJECT
MITIGATION LAND
BIKE TRAIL
URBANIZATION (EXISTING & FUTURE)
HIGH DENSITY RESIDENTAL
LOW DENSITY RESIDENTIAL
N
OREGON
SACRAMENTO
SAN FRANCISCO
MERCED
NEVADA
CALIFORNIA
LOS ANGELES
VICINITY MAP
SCALE IN MILES
MARIPOSA CO.
MERCED CO.
Merced River
Livingston Canal
A.T. & S.F. R.R.
S.P.R.R.
CASTLE A.F.B.
Castle Reservoir
Edendale Creek
Mac Creek
Canal Creek
Parkinson Creek
Yosemite Lake
LeGrand Canal
Haystack Mountain Reservoir
Burns Reservoir
Bear Reservoir
Fairfield Canal
Cottonwood Creek
Black Rascal Diversion Canal
Lift Canal
Owens Reservoir
Mariposa Reservoir
Cracker Dam
ATWATER
MERCED
PLANADA
Owens Diversion Canal
PLAINSBURG
LE GRAND
East Side Canal
Mariposa Bypass
SAN JOAQUIN RIVER
BEAR CREEK STREAM GROUP
MARIPOSA CREEK
DEADMAN-DUTCHMAN STREAM GROUP
MERCED NATL. WILDLIFE REFUGE
EL NIDO HWY.
140
99
59
SCALE IN MILES
2 0 2 4 6
MERCED COUNTY STREAMS
CALIFORNIA
RECOMMENDED PLAN
BEAR CREEK STREAM GROUP
CORPS OF ENGINEERS SACRAMENTO CALIFORNIA
Prepared By: K.A.F.
Drawn By: J.L.M.
Date: August, 1979

PLATE III

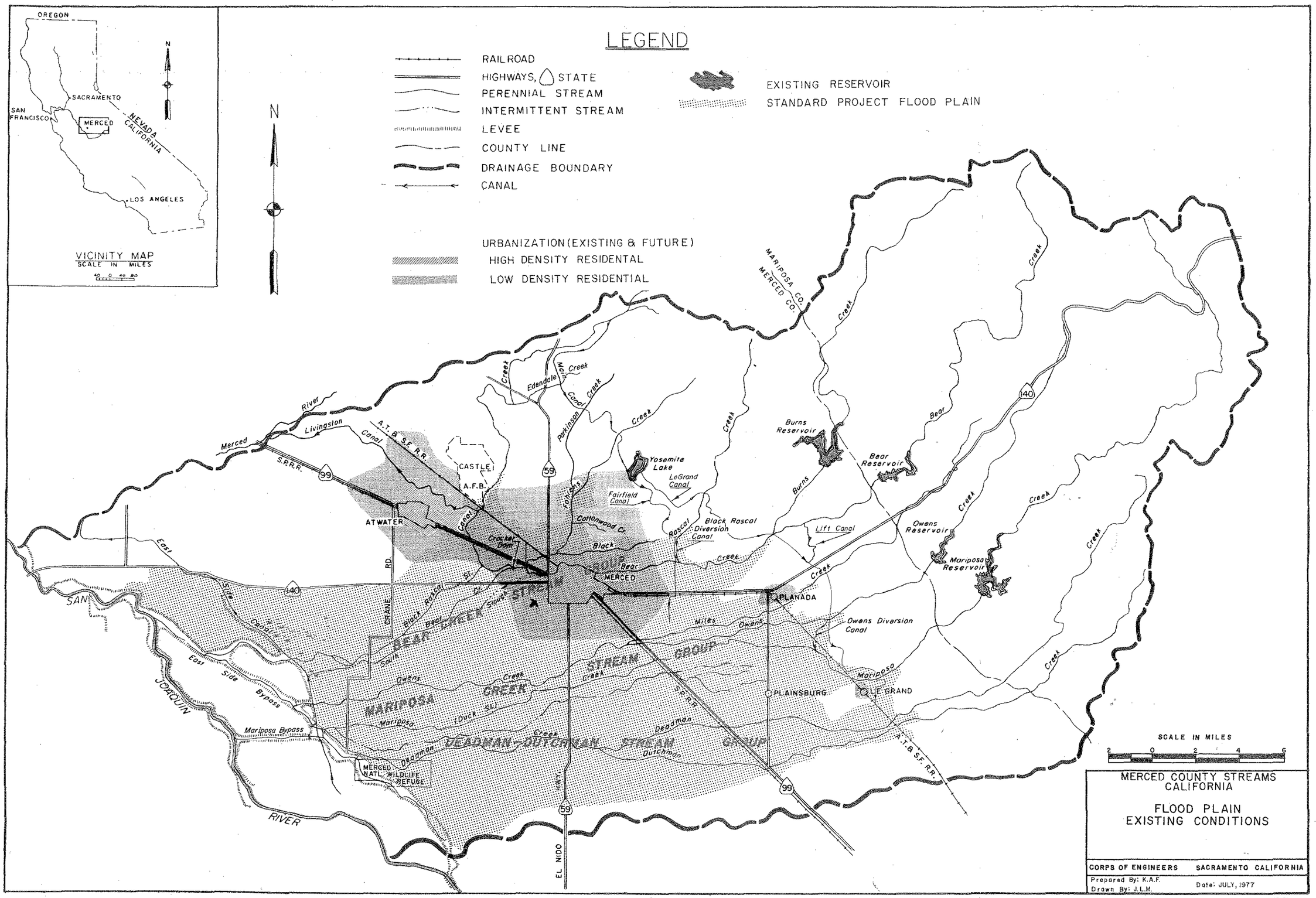
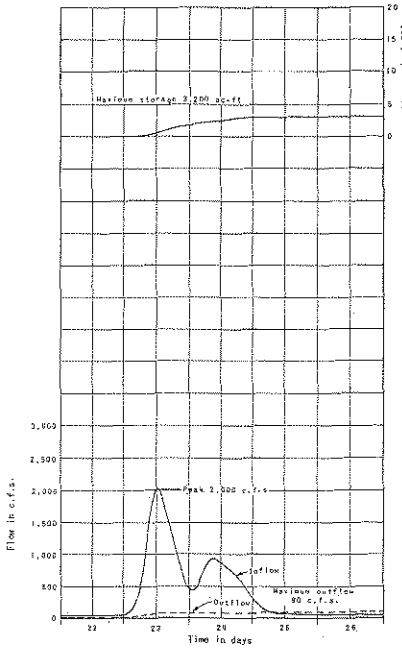

LEGEND
RAILROAD
HIGHWAYS, STATE
PERENNIAL STREAM
INTERMITTENT STREAM
LEVEE
COUNTY LINE
DRAINAGE BOUNDARY
CANAL
EXISTING RESERVOIR
STANDARD PROJECT FLOOD PLAIN
URBANIZATION (EXISTING & FUTURE)
HIGH DENSITY RESIDENTAL
LOW DENSITY RESIDENTIAL
VICINITY MAP
SCALE IN MILES
OREGON
SACRAMENTO
SAN FRANCISCO
MERCED
NEVADA
CALIFORNIA
LOS ANGELES
N
MARIPOSA CO.
MERCED CO.
Merced River
Livingston Canal
A.T. & S.F. R.R.
S.P.R.R.
CASTLE A.F.B.
ATWATER
Crocker Dam
Edendale Creek
Main Canal
Parkinson Creek
Yosemite Lake
LeGrand Canal
Fairfield Canal
Folsom Creek
Cottonwood Cr.
Black Rascal Diversion Canal
Burns Reservoir
Bear Reservoir
Lift Canal
Owens Reservoir
Mariposa Reservoir
Bear Creek
Burns Creek
Owens Creek
Mariposa Creek
Deadman Creek
Dutchman Creek
Miles Creek
Black Rascal Cr.
South Bear Cr.
East Side Canal
East Side Bypass
Mariposa Bypass
SAN JOAQUIN RIVER
MERCED
PLANADA
PLAINSBURG
LE GRAND
Owens Diversion Canal
BEAR CREEK STREAM GROUP
MARIPOSA CREEK STREAM GROUP
DEADMAN-DUTCHMAN STREAM GROUP
MERCED NATL. WILDLIFE REFUGE
CRANE RD.
EL NIDO RD.
140
99
59
SCALE IN MILES
2 0 2 4 6
MERCED COUNTY STREAMS
CALIFORNIA
FLOOD PLAIN
EXISTING CONDITIONS
CORPS OF ENGINEERS
SACRAMENTO CALIFORNIA
Prepared By: K.A.F.
Drawn By: J.L.M.
Date: JULY, 1977

PLATE II



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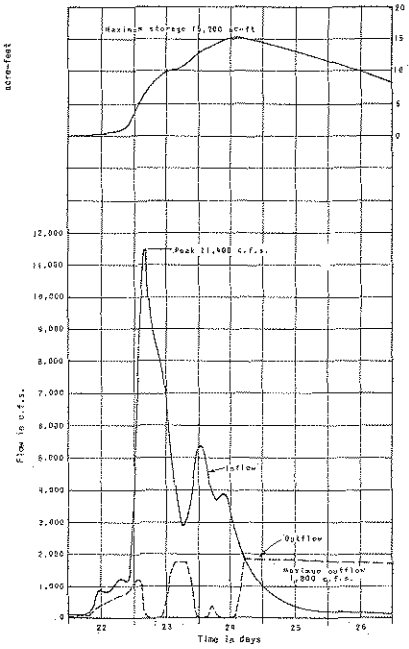

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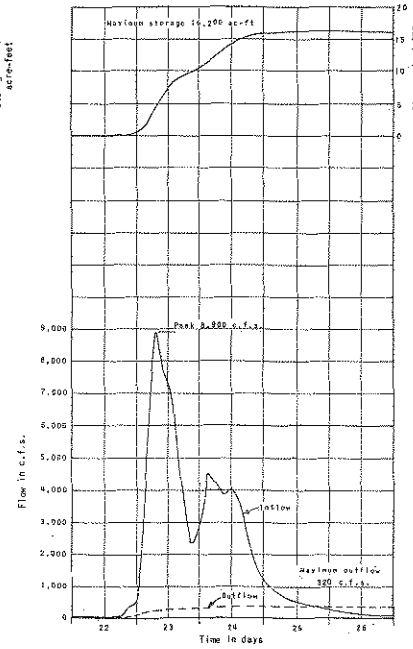

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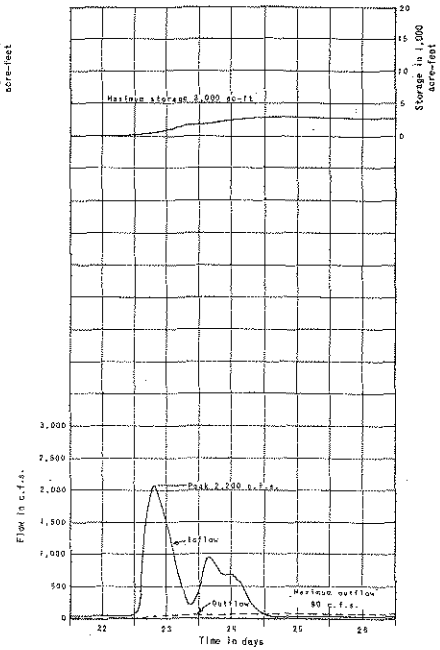

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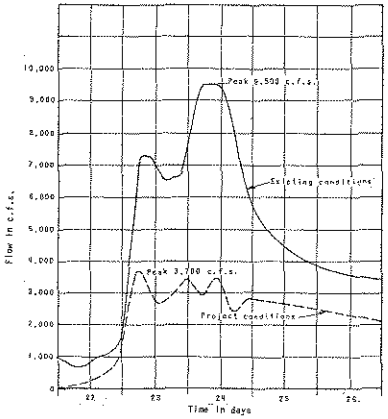
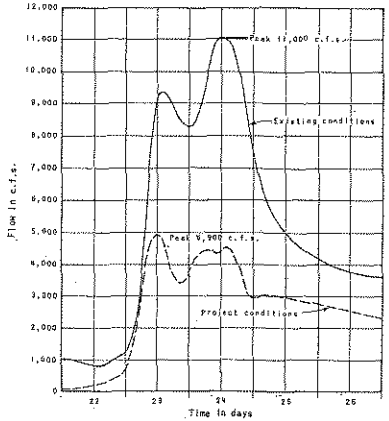


BEAR CREEK AT MCKEE ROAD



BEAR CREEK AND
BLACK RASCAL SLOUGH
BELOW CANAL CREEK

MERCED COUNTY STREAMS, CALIFORNIA

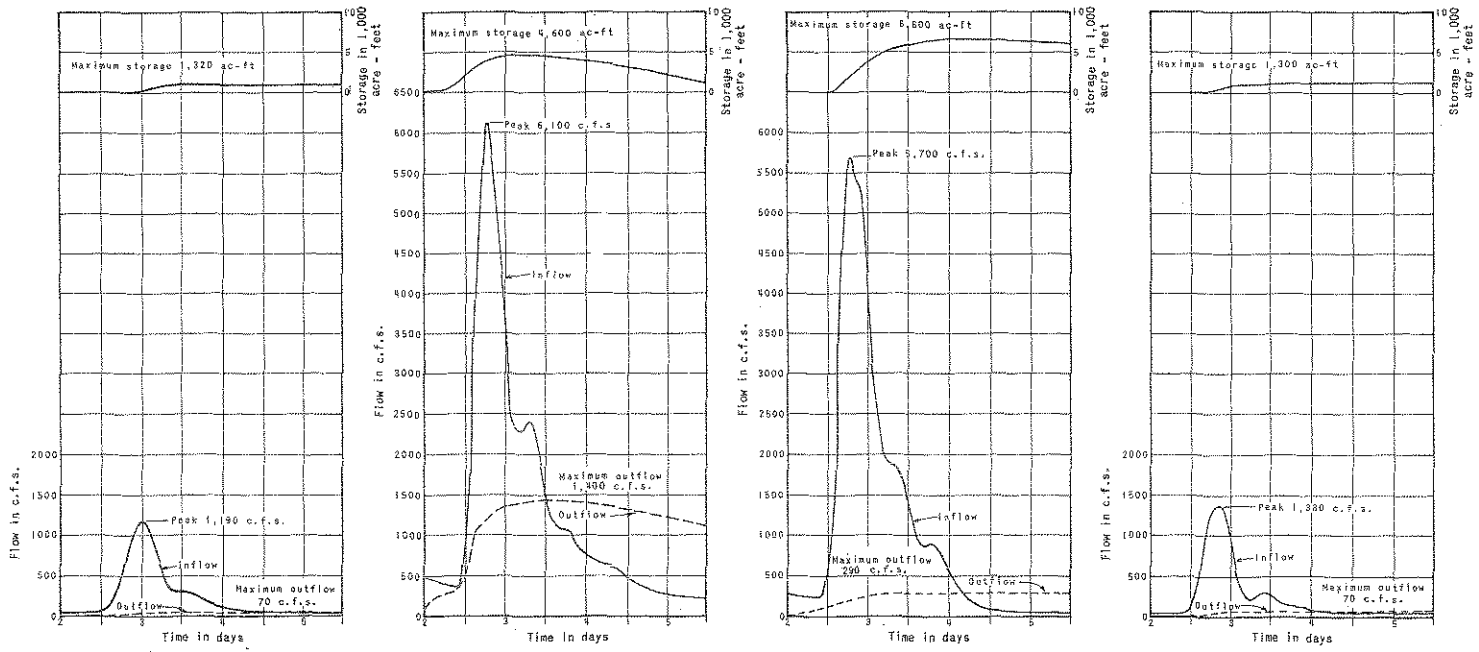
HISTORICAL FLOOD
HYDROGRAPHS
DECEMBER 1955

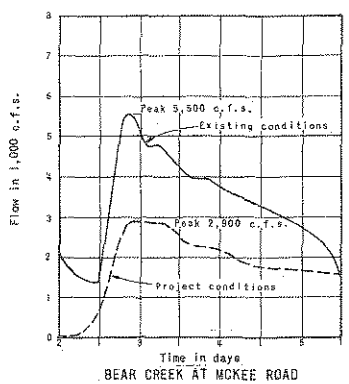
CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

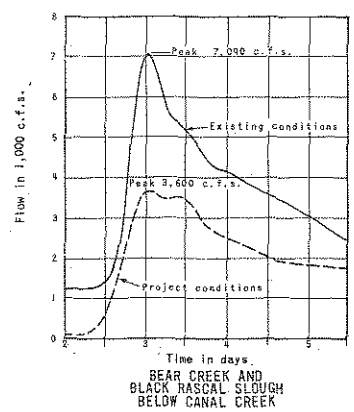
Prepared: L.H.C.
Drawn: T.K.B.
Date: JANUARY 1980

Rev. Jan. 1981

PLATE IV







MERCED COUNTY STREAMS, CALIFORNIA

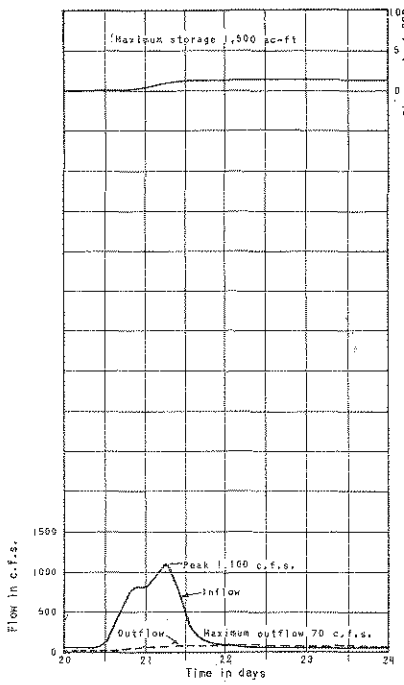
HISTORICAL FLOOD HYDROGRAPHS APRIL 1958

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

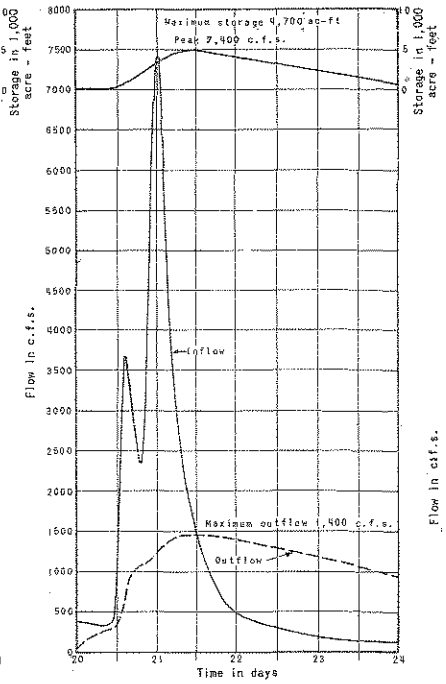
Prepared: H.T.M., L.H.C. Date: JANUARY 1980
Drawn: T.K.B.

Rev. Jan. 1981

PLATE V



CASTLE RESERVOIR



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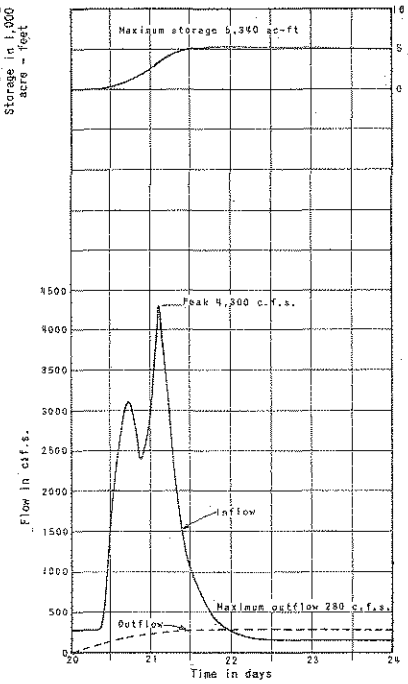

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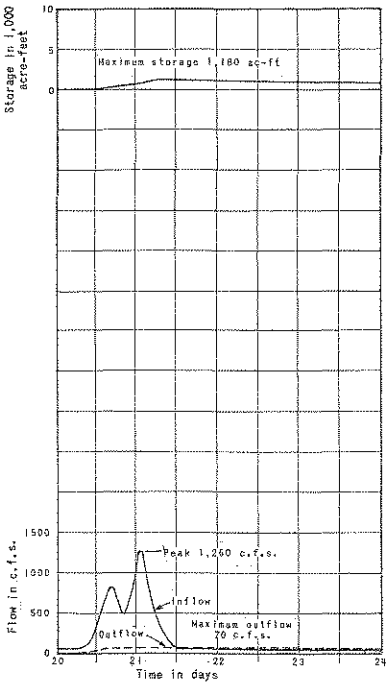

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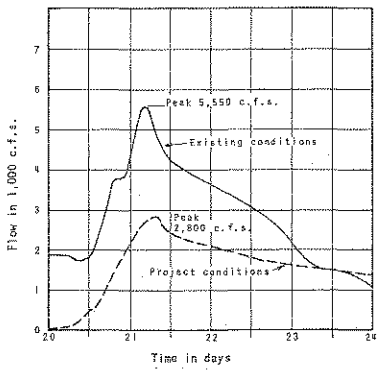
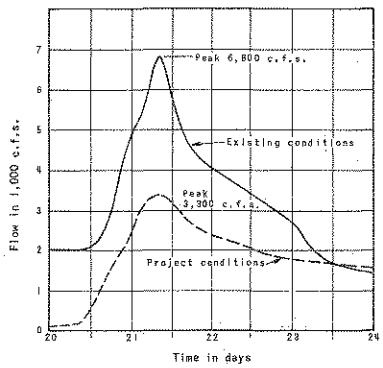


BEAR CREEK AT
MCKEE ROAD



BEAR CREEK AND
BLACK RASCAL SLOUGH
BELOW CANAL CREEK

MERCED COUNTY STREAMS, CALIFORNIA

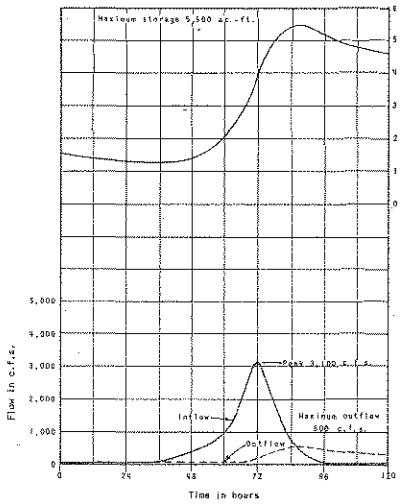
HISTORICAL FLOOD HYDROGRAPHS JANUARY 1969

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: H.T.M., L.H.C.
Drawn: T.K.B.
Date: JANUARY 1980

Rev. Jan. 1981

PLATE VI



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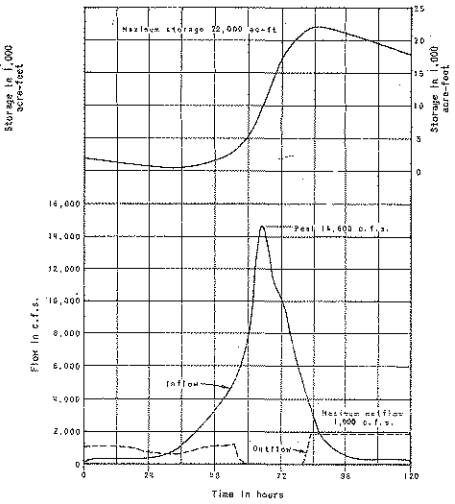
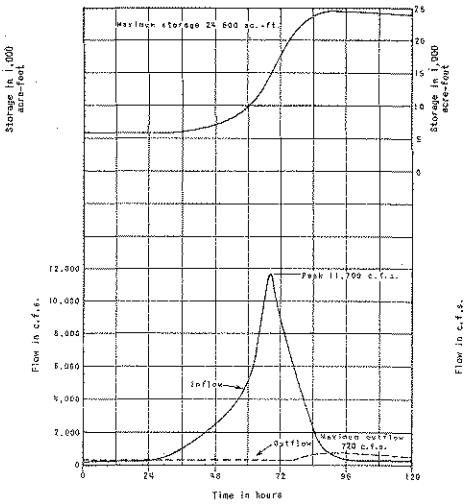
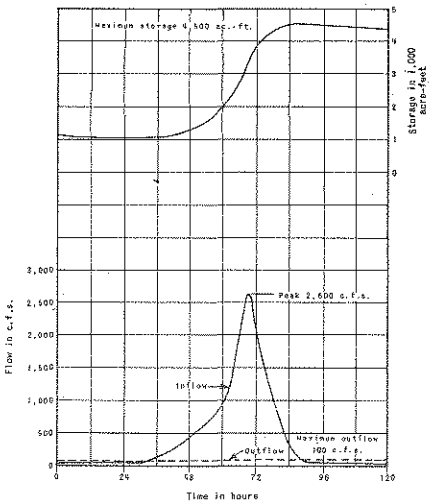


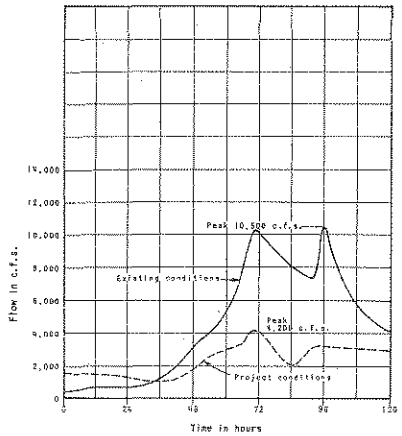
BEAR RESERVOIR



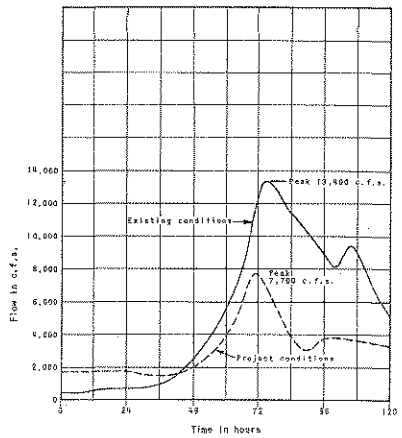
BURNS RESERVOIR



HAYSTACK RESERVOIR



BEAR CREEK AT MCKEE ROAD



BEAR CREEK AND
BLACK RASCAL SLOUGH
BELOW CANAL CREEK

MERCED COUNTY STREAMS, CALIFORNIA

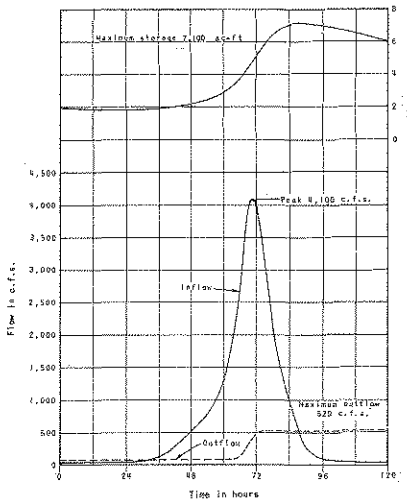
100 - YEAR FLOOD HYDROGRAPHS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

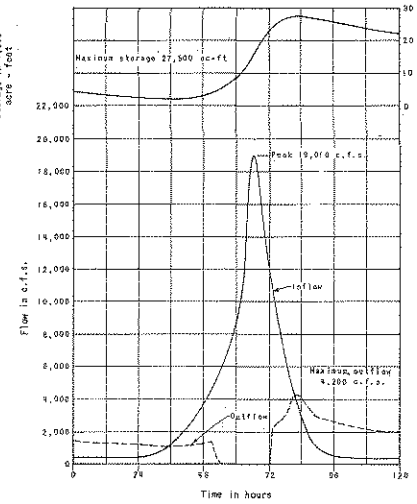
Prepared: H.T.M., L.H.C.
Drawn: T.K.S.
Date: JANUARY 1980

Rev. Jan. 1981

PLATE VII



CASTLE RESERVOIR



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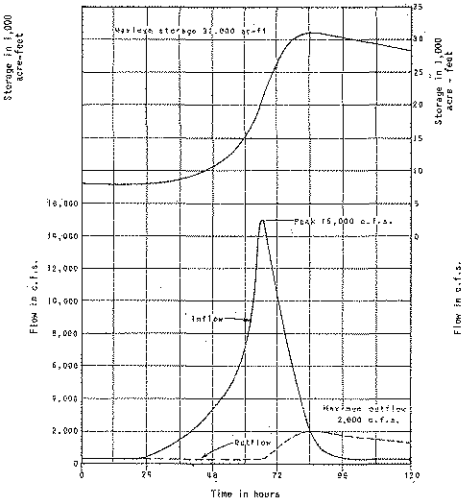

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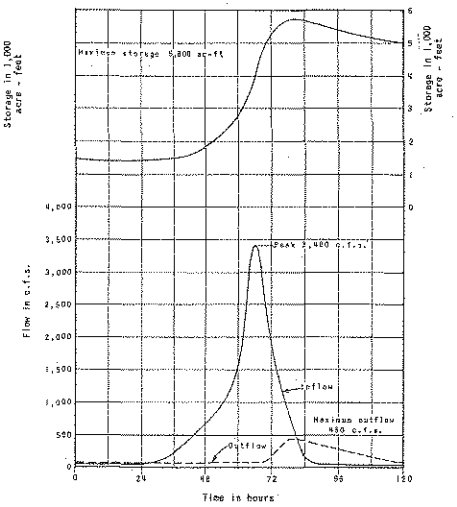
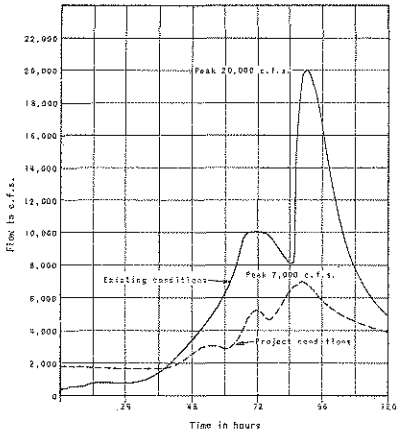
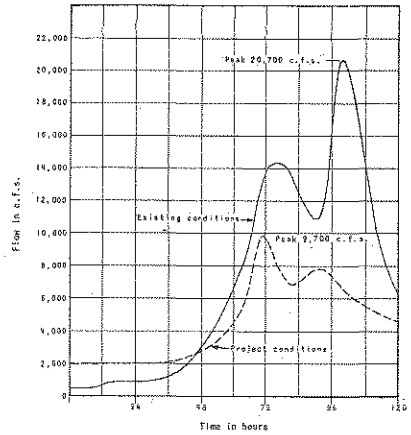


HAYSTACK RESERVOIR



BEAR CREEK AT McKEE ROAD



BEAR CREEK AND
BLACK RASCAL SLOUGH
BELOW CANAL CREEK

MERCED COUNTY STREAMS, CALIFORNIA

STANDARD PROJECT
FLOOD HYDROGRAPHS

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

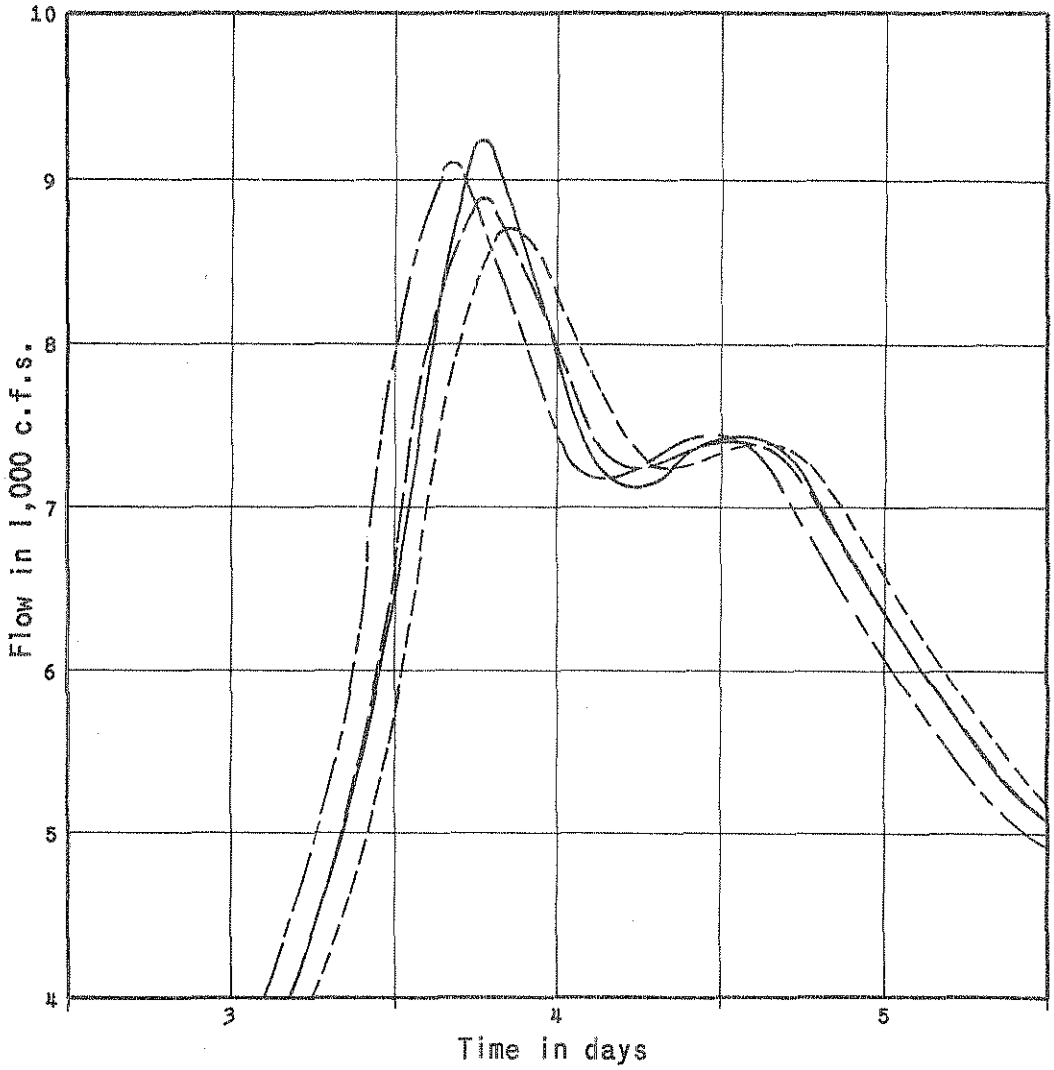
Prepared: H.T.M., L.H.C. Date: JANUARY 1980
Drawn: T.K.B.

Rev. Jan. 1981

PLATE VIII

HYDROGRAPH	REACH LENGTH (MI)	TRAVEL TIME (HRS)	VELOCITY		TATUM STEPS	MUSKINGUM COEFF.		
			MPH	FPS		X	NO. SUBREACH	SUBREACH K (HRS)
————	12.0	6	2.0	2.9	6*	–	–	–
—— ——	12.0	6	2.0	2.9	–	0	3	2
— — —	12.0	4	3.0	4.4	–	0	2	2
— — —	12.0	8	1.5	2.2	–	0	4	2

*Used in Hydrology DM (2-hour time interval).



NOTE:

This chart presents Bear Creek SPF hydrographs (project conditions) at Eastside Canal computed using different routing coefficients. Routing reach is from Canal Creek to Eastside Canal.

MERCED COUNTY STREAMS, CALIFORNIA

COMPARISON OF ROUTING METHODS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.A.P.
Drawn: C.A.P.
Date: OCTOBER 1978

PLATE IX

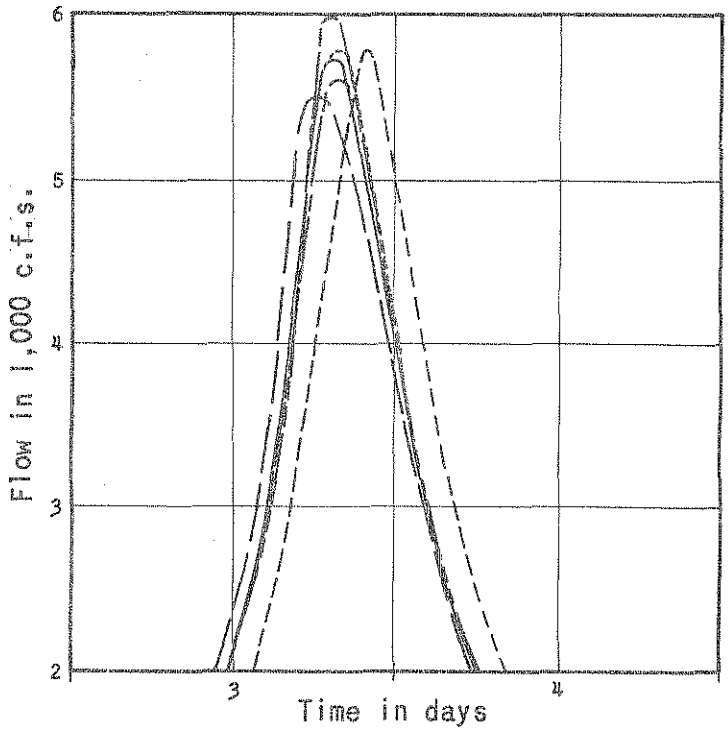
PARKINSON CREEK

HYDROGRAPH	REACH LENGTH (MI)	TRAVEL TIME (HRS)	VELOCITY		TATUM STEPS	MUSKINGUM COEFF.		
			MPH	FPS		X	NO. SUBREACH	SUBREACH K (HRS)
———	8.6	2.5	3.4	5.0	5*	—	—	—
— — —	8.6	3	2.9	4.2	—	0	3	1
- - - - -	8.6	3	2.9	4.2	—	.3	3	1
— - — - —	8.6	3	2.9	4.2	—	.5	3	1
— — — — —	8.6	6	1.4	2.1	—	.3	6	1
——— ———	8.6	1	8.6	12.6	—	.3	1	1

FAHRENS CREEK

HYDROGRAPH	REACH LENGTH (MI)	TRAVEL TIME (HRS)	VELOCITY		TATUM STEPS	MUSKINGUM COEFF.		
			MPH	FPS		X	NO. SUBREACH	SUBREACH K (HRS)
———	7.2	1.9	3.7	5.4	4*	—	—	—
— — —	7.2	2	3.6	5.3	—	0	2	1
- - - - -	7.2	2	3.6	5.3	—	.3	2	1
— - — - —	7.2	2	3.6	5.3	—	.5	2	1
— — — — —	7.2	5	1.4	2.1	—	.3	5	1
——— ———	7.2	1	7.2	10.6	—	.3	1	1

*Used in Hydrology DM (1-hour time interval).



NOTE:

This chart presents Fahrens Creek SPF hydrographs at Black Rascal Creek (pre-project conditions) computed using different routing coefficients. The hydrographs include the effects of routing flows on Parkinson and Fahrens Creeks from the Main Canal to Black Rascal Creek combined with local flows from the area below the Main Canal.

MERCED COUNTY STREAMS, CALIFORNIA

COMPARISON OF ROUTING METHODS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared:
Drawn: C.A.P.

Date: OCTOBER 1978

GPO 689-166/040

PLATE X