LOWER CACHE CREEK, YOLO COUNTY, CA
CITY OF WOODLAND AND VICINITY
FLOOD DAMAGE REDUCTION PROJECT

ECONOMIC APPENDIX
Draft Feasibility

Economics Branch
Planning Division
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Sacramento District

PURPOSE

The purpose of this Economic Appendix is to: 1) evaluate flooding and related problems in the Lower Cache Creek and tributaries watershed in the City of Woodland and the Town of Yolo, California; and 2) determine the National Economic Development (NED) benefits and costs associated with potential solutions.

METHODOLOGY

Methodology employed for this economic analysis is in accordance with current Principles and Guidelines and standard economic practices. Benefits and costs are computed at October 2001 (FY 02) price levels. The analysis uses the currently established Federal discount rate of 6 1/8 percent. The period of analysis is 50 years, with a project Base Year of 2006.

STUDY AREA

Location & Characteristics

The Study Area is located in the City of Woodland and Town of Yolo, California. Both communities are located in Yolo County in northern California, approximately 20 miles northwest of Sacramento (See Study Area Map, Figure 1). The county is primarily rural and sparsely populated. The largest urban center in the county is Davis. According to the State Department of Finance (2000), Yolo County had a population in 2000 of 162,900 (California State Department of Finance 2000).

Agriculture is an important source of employment and tax revenue for both Yolo County (California Employment Development Department 1992). In 1991, per capita personal incomes for Yolo County were $19,320. This was below the State average of $20,689, although not below the State poverty level (California State Department of Finance 2000).

Agriculture production in Yolo County is in transition from the production of field crops such as sugar beets and tomatoes to more economically stable production of tree and vine crops. A number of factors have led to this change. Internationally produced products such as sugar and canned tomatoes are available at a lower price than domestically produced products. Proper management of field crop production includes the production of wheat and corn for crop rotation which are also subject to fluctuations in world market prices and generally do not return a profit. Production of field crops have driven domestic prices down to a level that makes it very difficult for Yolo County farmers to obtain a reasonable price for produce. Tree and vine crops like nuts and fruit provide a more stable income for valley growers and can be harvested yearly. However, tree and vine crops take time to become established before they become productive. Other factors that have slowed agriculture production in Yolo County include the closure of the Spreckles sugar beet processing plant due to low international prices for sugar, and the bankruptcy of Tri-Valley Growers and their subsequent reduction in tomato demand due to their own product surplus and low international prices for processed tomatoes.

Study Area Development

Historical Population Growth

The populations of the counties in the study area are expected to continue to grow at a rate higher than that of the State primarily due to the influx of people who work in Sacramento and the bay area. Since the counties are attempting to preserve agricultural land, future development is planned adjacent to existing urban areas. County plans include additional housing, schools, water systems, and other public facilities. This future growth is anticipated to occur with or without a federally sponsored flood control project.

500-Year Floodplain

Figure 1 shows the boundary of the 500-year overflow area. As shown on this figure, the floodplain encompasses the majority of the city limits of Woodland, the town of Yolo proper, and approximately 11,500 acres of farmlands. The upper limit of the floodplain originates west of Woodland and encompasses sparsely inhabited farmlands west of Woodland proper, the mainly residential neighborhoods in the southern half of the city limits, the central historical downtown commercial area, and areas surrounding the city to the north east and southeast that are predominantly heavy commercial, industrial, and warehouse districts. North of County Road 19A, the overflow area extends downstream to include the Town of Yolo and vast stretches of farmland both north and south of Cache Creek to the existing levee along the Yolo Bypass. In addition, the floodplain extends to the south adjacent to the Yolo Bypass levee towards the city of Davis. Drive-by inspections confirmed that the areas south of Woodland towards Davis are barely inhabited and agriculturally idle.

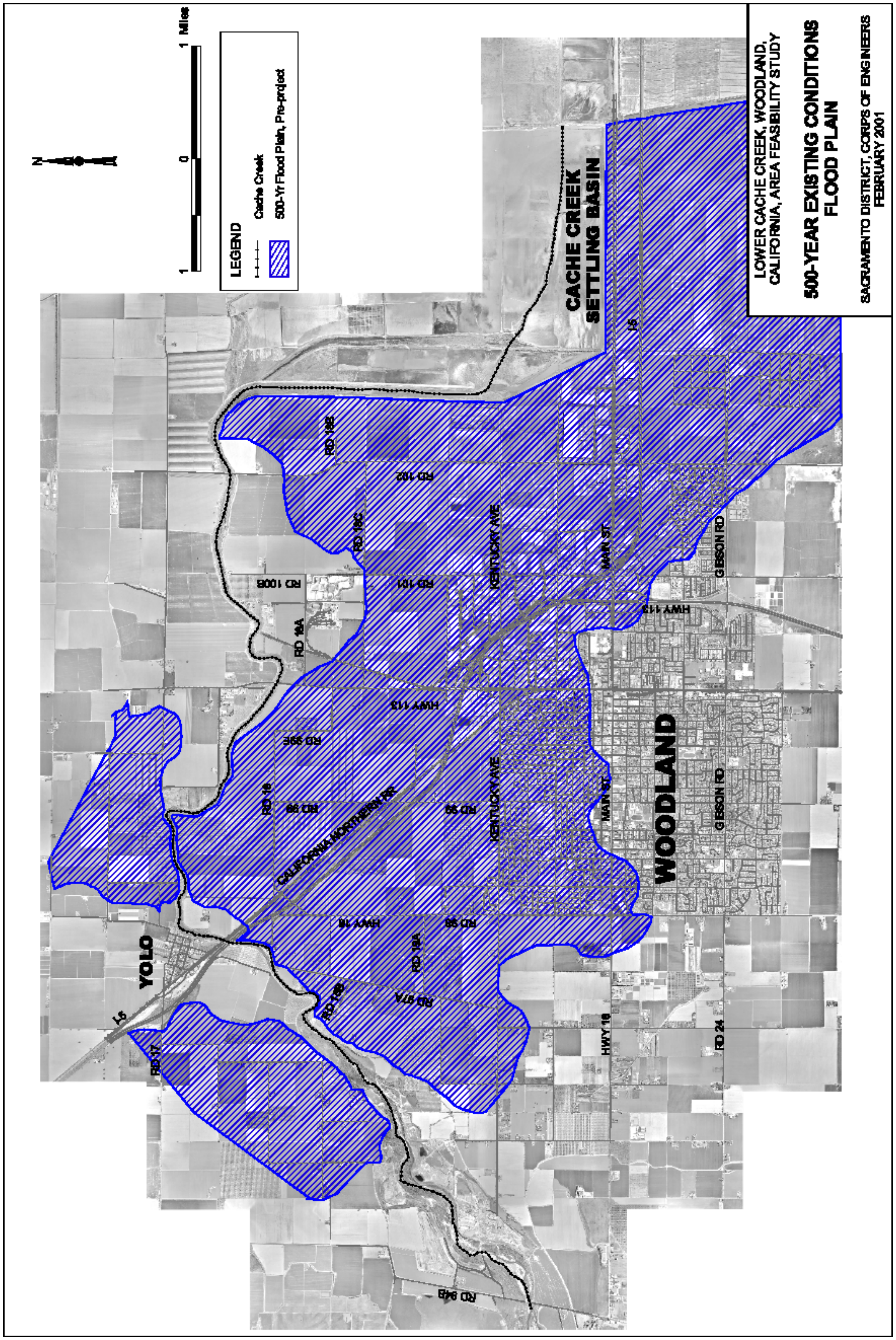
LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY
500-YEAR EXISTING CONDITIONS FLOOD PLAIN
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001
LEGEND
Cache Creek
500-Yr Flood Plain, Pre-project
1
0
1 Miles
N
CACHE CREEK SETTLING BASIN
WOODLAND
YOLO
I-5
HWY 113
HWY 16
MAIN ST
KENTUCKY AVE
GIBSON RD
CALIFORNIA NORTHERN RR
RD 102
RD 101
RD 99
RD 98
RD 18
RD 18A
RD 18B
RD 18C
RD 100B
RD 99E
RD 97A
RD 17
RD 19A
RD 24
RD 94B

TABLE 1
LOWER CACHE CREEK, YOLO COUNTY, CA, CITY OF WOODLAND AND VICINITY
FLOOD REDUCTION FEASIBILITY STUDY
REACH DELINEATION BREAKDOWN

Reach Name Economic	Hydraulic	Stream	Beg. X-Sect	End. X-Sect.	Rep. X-Sect. (Index Point)	Notes
R1—South of Road 19A	N/A	Lower Cache Creek	N/A	N/A	@ Route 113 Bridge	City of Woodland and areas south of Churchill Downs Avenue (County Road 19A)—alignment of proposed flood barrier
R2—North of 19A but south of stream	N/A	Lower Cache Creek	N/A	N/A	@ I-5 Bridge	Lands in the 500-yr floodplain between the right bank of Cache Creek and north of County Road 19A.
R3—Town of Yolo and agricultural	N/A	Lower Cache Creek	N/A	N/A	@ I-5 Bridge	Town of Yolo and areas along the left bank of Cache Creek in the 500-yr floodplain.

Reach Delineations

Economics, Hydrology, and Hydraulics study team members participated in the segmenting of the Lower Cache Creek study area into distinct reaches of homogenous characteristics. Critical factors for differentiation included: discharge/frequency characteristics, over-flow spatial characteristics, and economic activity. Table 1 provides a summary of reach delineations, including stream name and beginning, ending and representative cross sections for each reach. At the beginning stages of the study, the H & H data available dictated one (1) overall reach (due primarily to having only one index point on the stream along the study area).

Ultimately the economic analysis considered three separate Damage Areas: 1) the lands between the right (southern) bank of Cache Creek and north of the proposed flood barrier, 2) the City of Woodland and other areas in the 500-yr floodplain south of the proposed flood barrier, and 3) the Town of Yolo and the surrounding agricultural lands on the left bank (northern) of Cache Creek adjacent to the 500-yr floodplain.

The tables below, however, show results only for the two alternatives carried forward for detailed analysis in the main report, as well as three different configurations for the setback levee. This decision resulted from the following considerations. A flood barrier along the proposed alignment would provide protection to virtually all of the structures included in this analysis. Such a plan, however, would in fact induce damages in the area between Woodland and Cache Creek. Showing negative agricultural benefits for the With Project flood barrier results reflects this. There are a small number of home sites located in this area also resulting in negative structure and contents benefits. Due to data constraints, the results below do not show a separate figure for these few homes. The small value of these homes, however, relative to the total value of affected structures—and the fact that the alternatives are not "close" in the sense of an NED analysis—lead to the decision not to do a separate structures and contents analysis.

A setback levee plan would provide some flood protection to Woodland, the agricultural areas north of Woodland and south of the stream, and the town of Yolo. The results in the tables below reflect this by showing no induced damages for the setback levee plan. The tables below show figures for the city of Woodland impact area and the town of Yolo impact area. The agricultural impact area is not displayed separately since the setback levee alternative includes any benefits associated with it. The induced damages (negative benefits) included below reflect the With Project benefits associated with the Flood Barrier alternative.

Number of Structures

The number of structures in the 500-year floodplain was determined based upon GIS data, site surveys, and county assessor's data and parcel maps. Table 2 below displays the number of structures by structure type.

Table 2
Lower Cache Creek
Structures in 500 Year Floodplain

	Lower Cache Creek Study Main Reach	**Town of Yolo and Vicinity**	Total
SFR	3343	76	3419
MFR	277	17	294
Office	33	1	34
Retail	50	17	67
Restaurant	10	2	12
Service	4	6	10
Public	15	5	20
Industrial	239	0	239
Total	3971	124	4095

As shown on Table 2, there are approximately 4,095 structures in the 500-year floodplain. Out of this total, about 91% are residential (sfr, mfr), 2.5% are commercial (office, retail, restaurant, service), .1% is public, and 6% are industrial. For analysis purposes, the 500-yr floodplain is by definition identical to the Study Area. The approximate numbers of structures (all types) affected by the remaining modeled events are: 200-yr—4,100; 100-yr—3400; 50-yr—700.

Value of Structures & Contents

Depreciated structure replacement values were calculated by obtaining improvement values from assessor's data and adjusted to current price levels, taking into account special circumstances resulting from California's Proposition 13. A sample of the structures was then compared to Marshall & Swift Valuation Service multipliers to the square footage of each floodplain structure (obtained from assessor's data). Multipliers varied by structure use (residential, office, etc.), condition, and type and quality of construction. Local multipliers for the Sacramento/Yolo County area were also applied.

Contents values are not shown as a separate account in the following tables. Primarily there are two reasons for this. First, the frequency-damage curves for this study were generated outside of the HEC-FDA program due to the models used by H&H to generate the floodplains; the outputs for the model could not readily be imported into the FDA program as water surface profiles.

More importantly, new guidance from the Institute for Water Resources (IWR) is moving the economics analysis away from trying to value contents explicitly. These new procedures suggest modeling residential contents as equal to the value of the structure and then using modified depth-contents damage curves. That is the approach used in this study and, as such, contents values were estimated as ratios of the structure values.

For non-commercial structures, contents values were modeled at 100% of depreciated replacement value of the structure. Although planning guidance suggests conducting field surveys to calculate non-residential contents values, the number of non-residential structures (approximately 350) made such an endeavor impractical. Instead, it was decided to use contents percentages used in other Sacramento District studies, including the San Joaquin/Sacramento Basin Comprehensive Study. The non-residential structures were categorized according to each use, and two different sets of contents-damages curve was used in an attempt to capture at least some of the non-homogeneity between various commercial types. Although this approach could be debated, the fact remains that—as modeled—all of the detailed alternatives are economically feasible and the survey approach would have required substantial time and dollar resources that were used to obtain better accuracy for the risk and uncertainty models at the expense of precision of the specific contents values.

Summary of Structure & Content Values by Reach

Table 3—which follows—displays estimates of depreciated replacement values for structures and contents in the 500-year floodplain.

Table 3
500-year Floodplain
Structure Values ($1,000s)
(October 2001 Price Levels)

	Lower Cache Creek Study Main Reach	**Town of Yolo and Vicinity**	Total
SFR Struct	$295,300	$10,200	$305,500
MFR Struct	$21,700	$1,000	$22,800
Office Struct	$11,100	$100	$11,200
Retail Struct	$34,100	$4,100	$38,200
Restaurant	$5,500	$500	$6,000
Service Struct	$1,200	$100	$1,300
Public Struct	$18,800	$4,300	$23,100
Industrial Struct	$362,300	$0	$362,300
Total	$749,900	$20,300	$770,200

Table 3 shows that the depreciated replacement value of structures and contents in the 500-year floodplain is roughly $770.2 million. While industrial structures only account for about 6% of all floodplain structures in number, they account for approximately 48% of the total value. Residential properties account for about 42% of total floodplain property value. Commercial properties account for roughly 6%.

WITHOUT PROJECT DAMAGES

Historical Flood Problem

Reliable estimates of historical flood damages in the City of Woodland, the Town of Yolo, and surrounding areas for past floods on the analyzed stretch of Cache Creek are scarce. Information that is available is in the form of general descriptions of flooding given in newspapers, and recollections of city officials and residents. Furthermore, the City of Woodland has been notified that recent FEMA floodplains place much of the city limits of Woodland to be in the 100-yr floodplain. Current residents will then be subject to the added expense of homeowners' flood insurance and any potential future development in the area could be adversely affected.

Structure & Content Damages

Methodology

Without project structure and content damages were computed utilizing @Risk commercial software package and the HEC-FDA Flood Damage Reduction Model, Version 1.2. The model computes expected annual damages based upon the following input parameters:

1) Structure data—including: structure I.D.; category (single family residence, multi-family residence, public, commercial, industrial, mobile home); flood depths for the 500, 200, 100, & 50-yr events; first floor elevation; structure value; and content value.

2) Hydrologic and Hydraulic data, including frequency/discharge and stage/discharge relationships. This data, furnished by Engineering Division, was developed utilizing the HEC-2 Water Surface Profiles program. The output files were imported into the HEC-FDA program. Data was input for base year (2001).

3) Depth/Damage relationships were derived from the @Risk software package using Monte Carlo methodology incorporating the structure data cited above and entered directly into the program.

4) Risk and Uncertainty variables. The two variables subject to R&U variations for the economic determination of stage/damage functions are first floor elevation (FFE) and depreciated replacement cost (DRC). For FFE uncertainty, a normal distribution with a standard deviation of 1.5 feet was assumed (based upon guidance contained in EM 1110-2-1619). The mean FFE for each structure was based upon drive-by inspections and general characteristics of observed structures of the same type. For DRC uncertainty, a normal distribution with a standard deviation of 25% of structure base value was assumed (based upon variations in Marshall & Swift valuation multiples for various structure types and conditions). Structure values were obtained from assessor data; missing data or new structure values were estimated using values for structures of the same type within the same area (on the same street and/or city block).

   The hydrologic engineering relationships allowed by the HEC-FDA model to fluctuate are frequency/discharge and stage/discharge. For the frequency/discharge relationship, the model computed a statistical distribution using the graphical approach, based upon data contained in the water surface profiles and equivalent record lengths for each reach furnished by Engineering Division. For the stage/discharge relationship, a normal distribution is assumed. The Engineering Division provided standard errors for the 100-year frequency. The HEC-FDA program automatically scales down standard error estimates for more frequent events.

The HEC-FDA model computes expected annual damages using a Monte Carlo simulation process. Expected annual damages are calculated for each plan, analysis year, stream and damage area in multiple iterations by using the Frequency-Damage curves developed from the @Risk modeling runs as inputs.

Finally, this economics analysis includes only damages to structures and agricultural lands for the Town of Yolo impact area. This impact area was added quite late into the study. Due to time and budget constraints—and the fact that Yolo represented a small portion of the overall numbers of structures and acres inundated—economics branch decided to focus on the two categories that would reflect the majority of damages—structures & contents and agricultural losses. Thus, the tables below do not reflect damages for the Town of Yolo for categories other than structures & contents and crops.

Results

Table 4
Total Without Project Damages—All Categories
By Event & Expected Annual

Frequency	Estimated Damages
50	$258,850,000
100	$313,962,000
200	$324,975,000
500	$326,720,000
Expected Annual	$12,428,900

Table 5 summarizes without-project expected annual damages for structures & contents by reach for Base Year.

Table 5
Without Project Damages—Structures & Contents
Expected Annual Damages (Base Year Conditions)
(In $1,000s)

	Lower Cache Creek Main Reach	**Town of Yolo and Vicinity**	Total
Aggregated Structures & Contents	$11,500	$137	$11,637
Total	$11,500	$137	$11,637

Other Damages

Emergency/Clean Up Damages

Emergency and clean-up costs during a flood include: 1) efforts to monitor flood problems; 2) actions taken by relief agencies and to evacuate floodplain occupants; 3) flood fighting efforts—such as sandbagging; and 4) evacuation and reoccupation costs for floodplain residents.

Table 6 below summarizes expected annual emergency and clean-up costs, primarily those related to evacuating and providing temporary shelter to affected residents. Estimated by number of structures and area affected, 2.5 persons per unit, cost per day, and recovery time for each event. These parameters were taken from recent Sacramento District studies—pertaining to similar study areas in size to this one—that used figures obtained from emergency agencies (Red Cross, FEMA, local officials) operating in Northern California

Table 6

Without Project Emergency & Clean-Up Costs
By Frequency Event

FLOOD PLAIN		DEPTH	TYPE EVAC.	UNITS	PEOPLE/ UNIT	COST/ DAY	DAYS	TOTAL COSTS
500 YEAR		In Struct.	Long Term	2592	2.5	$12	120	$9,527,200
			Short	1399	2.5	$35	5.5	$687,400
								$10,214,600
200 YEAR		In Struct.	Long Term	2141	2.5	$12	120	$7,869,500
			Short	1850	2.5	$35	4.5	$743,700
								$8,613,200
100 YEAR		In Struct.	Long Term	1761	2.5	$12	120	$6,472,700
			Short	2230	2.5	$35	4	$796,900
								$7,269,600
50 YEAR		In Struct.	Long Term	406	2.5	$12	90	$1,119,200
								$1,119,200

Table 6(a)
Without Project Emergency & Clean-Up Costs
By Event & Expected Annual

Frequency	Estimated Costs
50	$1,119,200
100	$7,269,600
200	$8,613,200
500	$10,214,600
Expected Annual	$188,300

Automobile Impacts

Automobile transportation impacts were calculated for the 50, 100, 200, and 500-year events based upon delineations of floodplain areas with inundation levels exceeding one foot and durations of flooding by floodplain location. The following assumptions were made: based upon number of structures affected and an estimate of 1.7 vehicles per structure, 50% damage to the vehicle, and an updated average depreciated value per vehicle from past studies. These assumptions were obtained from various other Sacramento District studies. The 50% damage to vehicle is a broad estimation, taking into account that many vehicles could be moved out of danger once floodwaters begin to rise. It does not intend to represent the maximum damage to a vehicle; indeed, some vehicles could be totally destroyed in an infrequent even and is a function primarily of depth of flooding.

Table 7
Without Project Auto Damages—By Frequency Event

FLOOD PLAIN	DEPTH	HOUSING UNITS	CARS/ HOUSE	PERCENT DAMAGE	# OF CARS DAMAGED	VALUE/ CAR	% DEPTH /DAMAGE	TOTAL DAMAGES
500 YEAR	> 2.1 FT	450	1.7	50%	383	$7,700	80.0%	2,365,400
	2.1 to 1.5 ft	889	1.7	50%	756	$7,700	33.3%	1,945,100
	1.5 to 1.0	1807	1.7	50%	1,536	$7,700	16.7%	1,976,800
	less than 1 ft	842	1.7	50%	716	$7,700	0.0%	0
		3988						**6,287,300**
200 YEAR	> 2.1 FT	216	1.7	50%	184	$7,700	80.0%	1,135,400
	2.1 to 1.5 ft	831	1.7	50%	706	$7,700	33.3%	1,818,200
	1.5 to 1.0	1599	1.7	50%	1,359	$7,700	16.7%	1,749,300
	less than 1 ft	873	1.7	50%	742	$7,700	0.0%	0
		3519						**4,702,900**
100 YEAR	> 2.1 FT	212	1.7	50%	180	$7,700	80.0%	1,114,400
	2.1 to 1.5 ft	530	1.7	50%	451	$7,700	33.3%	1,159,600
	1.5 to 1.0	1441	1.7	50%	1,225	$7,700	16.7%	1,576,400
	less than 1 ft	541	1.7	50%	460	$7,700	0.0%	0
		2724						**3,850,400**
50 YEAR	> 2.1 FT	5	1.7	50%	4	$7,700	80.0%	26,300
	2.1 to 1.5 ft	36	1.7	50%	31	$7,700	33.3%	78,800
	1.5 to 1.0	460	1.7	50%	391	$7,700	16.7%	503,200
	less than 1 ft	375	1.7	50%	319	$7,700	0.0%	0
		876						**608,300**

Table 7(a)
Without Project Auto Damages
By Event & Expected Annual

Frequency	Estimated Damages
50	$608,300
100	$3,850,400
200	$4,702,900
500	$6,287,300
Expected Annual	$110,600

Roads Damages

Based upon number of miles affected by each event, type of road (paved or dirt, two lane or four lane), and average depth of flooding, and estimated damage per mile updated from previous studies.

Table 8
Without Project Roads Damages
By Event & Expected Annual

	Measure In Inches	Conversion Inch to ft	Number of Feet	Miles 5280ft=1m	Avg Depth of Flooding	Damage Per Mile	Total Damages
500 yr							
2 ln(urban)	123	1200	147,600	28	1.5	$22,900	$640,000
2 ln(rural)	525	1200	630,000	119	1.5	$22,900	$2,731,000
4 ln	38	1200	45,600	9	1.5	$33,200	$286,700
							$3,657,500
200 yr							
2 ln(urban)	112	1200	134,400	25	1.25	$20,600	$525,000
2 ln(rural)	500	1200	600,000	114	1.25	$20,600	$2,344,000
4 ln	38	1200	45,600	9	1.25	$30,600	$264,300
							$3,133,300
100 yr							
2 ln(urban)	105	1200	126,000	24	1	$20,000	$478,800
2 ln(rural)	500	1200	600,000	114	1	$20,000	$2,279,800
4 ln	35	1200	42,000	8	1	$26,500	$210,800
							$2,969,400
50 yr							
2 ln(urban)	24	1200	28,800	5	0.5	$12,100	$66,300
2 ln(rural)	475	1200	570,000	108	0.5	$12,100	$1,311,600
4 ln	33	1200	39,600	8	0.5	$18,000	$135,600
							$1,502,500

Table 8(a)
Without Project Roads Damages
By Event & Expected Annual

Frequency	Estimated Damages
50	$1,502,500
100	$2,969,400
200	$3,133,300
500	$3,657,500
Expected Annual	$103,600

Agricultural Damages

The discussion below indicates considerations used in the computation of agricultural damages within the Lower Cache Creek Study Area.

The current land use for the Study Area was secured from the 1990's California Department of Water Resources Land surveys. Geographic Information System (GIS) is used to summarize the land/crop use types for each flood event.

The land/crop uses were categorized into six general categories for analytical and reporting purposes. The six general categories of land/crop use are:

1. Fruits and Nuts – including Almonds, Walnuts, Peaches, Pears, and Prunes
2. Field Crops – including Cotton, Beans, Safflower, Wheat, and Corn
3. Pasture and Alfalfa – including Alfalfa for hay and pasture
4. Truck Crops – including Melons and Tomatoes
5. Rice -
6. Other – including lands that are idle, semi-agricultural, and native vegetation

Every rural acre within the Study Area is categorized within one of the six general categories. GIS provides a detailed breakdown of land/crop use, comprising over eighty different crops or land uses. These acreages are consolidated within one of the six general categories. For analytical purposes, fifteen crops were selected as being representative of these eighty crops that are generally grown. The individual crops within each category are identified above. These fifteen crops comprise the majority of all the rural acreages within the Study Area.

Agricultural damages due to flooding for each acre is computed by adding four elements:

1) The cumulative direct production or annual variable costs incurred prior to flooding
2) The net value of the crop affected by the flood event
3) Depreciated value of perennial crops lost as a direct result of flooding
4) The land clean-up and rehabilitation resulting from flooding

Direct Production Costs

Variable cultural costs are incurred periodically throughout the crop year. Examples of these direct production costs include: seedbed preparation, chemical and fertilizer application, hired labor, seed, planting, and weed and pest control. These individual crop costs for the fifteen crops are computed on a monthly basis to determine the amount of expended cultural costs at the time of the flood event.

Net Value of Crop

The second component represents the net income of the crop plus return to such fixed items of production as land, labor and management, real estate taxes, and fixed costs associated with pre-harvest and harvest activities. The net value of the crop on the flooded acreage is a significant part of agricultural damages

Seasonality

Computationally, the season of the year that the flood occurs greatly impacts amount of flood damage to the agricultural crop. If flooding occurs early within the year, the producer may be able to re-prepare the seedbed, plant and realize a return on his efforts. Conversely, a flood of substantial proportion occurring at harvest time will most certainly result in complete loss for the entire year.

The probability of a storm occurrence, and accompanying levee failure, in any particular month was provided by the District Hydrologist for the Study Area and displays the likelihood of a storm occurring for each month throughout the year.

Multiplying the direct production costs and the value of crop at risk for each month times the monthly probability provides the probable damages expected if a flood event occurred in any particular month.

Value of Perennial Crops

Damage caused by long-term duration flooding may result in permanent loss of perennial crops. The damage to perennials susceptible to flooding is computed based upon the assumption that the crop stands are at various ages, ranging from year 1 throughout their economic useful life. Accordingly, damage caused by long-term duration flooding is computed based upon a stand that is at the mid-point of its economic useful life.

Clean-up and Rehabilitation

Floods of any duration or time of year may cause erosion and deposition of debris and sediment. Additionally, drainage and irrigation ditches may become clogged with silt and debris. Interviews with cooperative extension agents, and local farmers have been conducted over the past several years. Clean up and rehabilitation of farm acreage is a genuine flood loss and is accordingly accounted for in the computation of agricultural flood damages.

Based upon GIS land use data from California Department of Water Resources. This included crop type, number of affected acres per crop, and normalized price and cost data from the U.S. Department of Agriculture census data.

Table 9
Without Project Agricultural Damages
By Event & Expected Annual

Frequency	Estimated Damages
50	$6,616,200
100	$7,159,300
200	$11,451,500
500	$11,810,000
Expected Annual	$389,400

Summary of Damages

Table 10 summarizes without-project conditions Expected Annual Damages.

Table 11
Without Project Conditions
Expected Annual Damage Summary

Category	EAD
Structures & Contents	$11,637,000
Emergency/Clean-Up	$188,300
Autos	$110,600
Roads	$103,600
Agricultural	$389,400
Total	$12,428,900

PRELIMINARY ALTERNATIVE ANALYSIS

Description of Preliminary Alternatives

Separate alternatives were developed to address flood problems in the Lower Cache Creek/City of Woodland floodplain.

Lower Cache Creek/Woodland Floodplain

Two alternatives have been carried forward for detailed economic analysis. The first plan is Setback Levees that would be constructed approximately 1000 feet back from Cache Creek. The second plan is construction of a Flood Barrier that would be built along the northern line of the city limits. Other alternatives considered, as well as the reasons for dropping them during a preliminary screening process, can be found in the main report.

Alternative 1 (Setback Levee)

This alternative calls for the construction of a levee roughly 1000 feet back from Cache Creek. This alternative involves installation of approximately 6.5 miles of setback levees on either one or the other side of Cache Creek and raising existing levees on the opposing side as required. In addition, adjacent to the 6.5-mile area, this alternative would include approximately 3 miles of newly constructed levee on both sides of the channel banks downstream from Road 96. Bridge replacements and slope protection would be constructed as required. Flooding would be substantially reduced in the downtown area of Woodland, as well as in the largely agricultural lands that lie between the stream and the city. Finally, the cost tables below will show three different setback plans—denoted narrow, wide and modified wide for the width of its base, respectively. For purposes of benefits, however, the tables reflect only one number since the Top of Levee height is assumed to be the same for each. Finally, differences in total benefits for the various setback plans proved to be statistically insignificant (less than 1%).

Alternative 2 (Flood Barrier)

This alternative involves the construction of a flood barrier along the northern border of the city of Woodland. This alternative uses the flood bypass measure reviewed during the initial screening. It would consist of constructing approximately 6.7 miles of new levee from county road 96 (1.5 miles east of road 97A) to the west levee of the Cache Creek Settling Basin. Approximately a 4,000-foot section of the west levee of the Cache Creek Settling Basin levee would be removed. Overflows from Cache Creek would generally flow from west to east over lands currently subject to flooding and discharge by gravity into the Settling Basin. Flooding would be substantially reduced in the downtown area of Woodland. This alternative, however, provides no protection for the agricultural lands that lie between the city and the stream. In fact, this alternative induces additional damages for these agricultural lands, as will be reflected in the tables below.

SIZING OPTIMIZATION FOR ALTERNATIVES

Table 12—Costs

ALTERNATIVE	Design Flow (cfs)	TOL Elev. @ the Index Point	Total Investment Cost	Interest/ Amortization	O&M	Total Annual Cost
Flood Barrier	53,000	50-yr: 57.5 ft	$39,725,400	$2,564,400	$98,000	$2,662,400
	63,000	100-yr: 58.1 ft	$41,062,000	$2,651,000	$98,000	$2,749,000
	70,000	200-yr: 58.3 ft	$42,398,000	$2,737,000	$98,000	$2,835,000
	78,000	500-yr: 58.5 ft	$43,761,000	$2,825,000	$98,000	$2,923,000
	91,000	2000-yr: 58.7 ft	$46,332,000	$2,991,000	$98,000	$3,089,000
Setback Levee	50,000	50-yr: 85.2	$120,251,000	$7,762,681	$485,000	$8,247,681
Narrow	63,000	100-yr: 87.4 ft	$123,769,000	$7,989,782	$485,000	$8,474,782
	70,000	200-yr: 88.6 ft	$127,287,000	$8,216,883	$485,000	$8,701,883
	78,000	500-yr: 90.3 ft	$139,620,000	$9,013,027	$485,000	$9,498,027
	90,000	2000-yr: 92.6	$167,660,000	$10,823,121	$485,000	$11,308,121
Setback Levee	50,000	50-yr: 85.2	$125,709,000	$8,115,017	$415,000	$8,530,017
Wide	64,000	100-yr: 87.4 ft	$128,370,500	$8,286,827	$415,000	$8,701,827
	70,000	200-yr: 88.6 ft	$131,032,000	$8,458,638	$415,000	$8,873,638
	74,000	500-yr: 90.3 ft	$142,350,000	$9,189,260	$415,000	$9,604,000
	90000	2000-yr: 92.6	$152,859,000	$9,867,657	$415,000	$10,282,657
Setback Levee	50,000	50-yr: 85.2	$156,514,000	$10,104,000	$415,000	$10,519,000
Modified Wide	63,000	100-yr: 87.4 ft	$158,935,000	$10,260,000	$415,000	$10,675,000
	70,000	200-yr: 88.6 ft	$161,356,000	$10,416,000	$415,000	$10,831,000
	78,000	500-yr: 90.3 ft	$162,975,000	$10,521,000	$415,000	$10,936,000
	90,000	2000-yr: 92.6	$168,508,000	$10,878,000	$415,000	$11,293,000

Table 13—Total Benefits for each of the sizes of the alternatives

ALTERNATIVE	Design Flow (cfs)	TOL. elev.	Residual Damages	Annual Benefits	Conditional Non-Exceedence Probability by Event	
					100-Year	200-Year
Without Project Flood			$12,428,900		N/A	
Barrier	53,000	50-yr 57.5 ft	$1,814,900	$10,614,000	55.1%	38.4%
	63,000	100-yr; 58.1 ft	$1,268,900	$11,160,000	79.4%	64.5%
	70,000	200-yr; 58.3	$1,028,900	$11,400,000	90.2%	78.0%
	78,000	500-yr; 58.5 ft	$887,900	$11,541,000	97.3%	90.9%
	91,000	1000-yr; 58.7 ft	$821,900	$11,607,000	98.2%	94.1%
Setback	50,000	50-yr; 8.52 ft	$6,050,000	$6,378,000	21.0%	9.0%
	63,000	100-yr; 87.4 ft	$2,451,920	$9,976,980	50.5%	28.8%
	70,000	200-yr; 88.6 ft	$1,347,330	$11,081,570	67.8%	45.4%
	78,000	500-yr; 90.3 ft	$973,670	$11,455,230	89.3%	78.2%
	90,000	1000-yr; 92.6 ft	$323,134	$12,105,766	97.0%	90.7%

Table 14—Net Benefits/Benefit-Cost Ratio/NED Analysis

ALTERNATIVE	Exp. Ann. Benefits	Exp. Ann. Costs	Net Benefits	B/C Ratio
FB 53k	$10,614,000	$2,662,400	$7,951,600	3.99
FB 63k	$11,160,000	$2,769,000	$8,391,000	4.03
FB 70k	$11,400,000	$2,835,000	$8,565,000	4.02
FB 78k	$11,541,000	$2,923,000	$8,618,000	3.94
FB 91k	$11,607,000	$3,089,000	$8,518,000	3.76
Nar SB 50k	$6,745,000	$8,247,681	-$1,502,681	.82
Nar SB 63k	$10,720,000	$8,555,000	$2,166,000	1.26
Nar SB 70k	$11,940,000	$8,701,883	$3,238,117	1.37
Nar SB 78k	$12,550,000	$9,498,027	$3,016,000	1.32
Nar SB 90k	$13,070,000	$11,308,121	$1,761,879	1.16
Wide SB 50k	$6,745,000	$8,530,017	-$1,785,017	.79
Wide SB 63k	$10,720,000	$8,762,000	$1,958,000	1.23
Wide SB 70k	$11,940,000	$8,873,638	$3,066,362	1.35
Wide SB 78k	$12,550,000	$9,754,000	$2,798,000	1.28
Wide SB 90k	$13,070,000	$10,282,657	$2,787,343	1.27
Mod Wide 50 cfs	$6,745,000	$10,519,000	-$3,774,000	.64
Mod Wide 63k cfs	$10,720,000	$10,730,000	$10,000	1.00
Mod Wide 70k cfs	$11,940,000	$10,831,000	$1,109,000	1.10
Mod Wide 78k cfs	$12,550,000	$10,936,000	$1,614,000	1.15
Mod Wide 90k cfs	$13,070,000	$11,293,000	$1,777,000	1.16

The preceding three tables illustrate the analysis performed to reasonably optimize the size of the various alternatives in order to arrive at the NED plan. Furthermore, this analysis incorporated the FEMA requirement that a selected plan should be 90% reliable in containing the 1% expected annual exceedance event. Table 12 displays a summary of the costs associated with each of the alternatives (Flood Barrier versus Setback Levee) as well as different sizes associated within each measure. The final Total Annual Costs have been computed including Interest During Construction as well as using a period of analysis of 50 years and a 6 1/8% federal discount rate. Detailed cost tables can be found in the Plan Formulation Chapters of the Main Report and in the accompanying Cost Engineering appendix.

Table 13 displays Total Benefits for each of the sizes of the alternatives; detailed descriptions of benefits categories follow below. This table does not distinguish benefits between the various setback alternatives (narrow, wide, modified wide) due to lack of statistical significance (see footnote); rather, the figure of $11,455,230 is used for optimization purposes. This table also summarizes the Conditional Non-Exceedance by Event statistics. To satisfy FEMA criteria of adequately protecting from the 1% event, the only plans deemed possibly acceptable were: Flood Barrier for the 70k, 78k, and 90k cfs flows; Setback Levee for the 78k and 90k cfs flows. Finally, the setback levees accrue benefits not accounted for in Without Project conditions (foregone rehab costs and advanced bridge replacement benefits; see tables below). As a result, the sum of residual damages and damages reduced is larger than Without Project damages.

Finally, Table 14 combines the Costs and Benefits in order to analyze the reasonable maximization of Net Benefits. The Net Benefits peaked for the Flood Barrier around the 70k cfs and 78k cfs designs (a statistically insignificant difference of only $53,000 dollars—less than 1%). Since the 78k cfs designed met the FEMA criterion of there being a 90% probability of containing the 1% event, this design was chosen for detailed cost and benefits break-downs; the tables throughout the remainder of this appendix pertain to it.

As for the various setback levee configurations and sizes, the remainder of this appendix will contain costs associated with the 78k cfs design. That particular design reasonably maximizes net benefits and meets the FEMA requirement. The NED analysis shows that the Flood Barrier is clearly the optimal plan in regards to net benefits ($8.6 million versus a "best-case" setback of $3.1 million). Much of the setback analysis was done at the request of the non-Federal sponsor to be used if the sponsor decided to request a non-NED/Locally Preferred Plan.

Residual Damages & Benefits

The following tables summarize the residual damages and expected annual benefits for each alternative (FY '02 price levels).

Lower Cache Creek/City of Woodland Alternatives

Structure & Content Damages

Tables 15 and 16 shows Expected Annual Residual Damages and Damages Reduced (Benefits) for Structures & Contents only, respectively, for each Alternative.

Table 15
Lower Cache Creek/City of Woodland Alternatives
Expected Annual Residual Damages ($1,000s)
Structures & Contents
By Alternative

Alternative	Cache Creek along City of Woodland	Town of Yolo	Total
1 (Setback)	$785	$26	$810
2 (Barrier)	$380	$260	$640

Table 16
Lower Cache Creek/City of Woodland Alternatives
Expected Annual Benefits ($1,000s)
Structures & Contents
By Alternative

Alternative	Cache Creek along City of Woodland	Town of Yolo	Total
1 (Setback)	$10,700	$100	$10,800
2 (Barrier)	$11,100	$0	$11,100

As shown on Table 16, Alternative 1 provides approximately $10.8 million in annual inundation reduction benefits to structures and contents only; Alternative 2 provides approximately $11.1 million in annual benefits to structures and contents only The slightly higher benefit total for Alternative 2 relative to Alternative 1 is primarily due to the flood barrier providing more reliable protection to the city of Woodland, where nearly all of the structures are located. Alternative 1 was modeled by incorporating a low-level existing levee along the stretch of Cache Creek under analysis. The existing levee was not included in modeling Alternative 2 because of its significant distance from the stream.

Other Benefits

Table 17 displays the expected annual benefits for the remaining damage categories.

Table 17
Lower Cache Creek/City of Woodland Alternatives
Expected Annual Benefits -- Other Categories ($1,000s)
By Alternative

Category	**Alt 1A** Narrow Setback	**Alt 1B** Wide Setback	**Alt 1C** Modified Wide Setback	**Alt 2** Barrier
Emergency/Clean-Up	$150	$150	$150	$145
Autos	$100	$100	$100	$90
Roads	$100	$100	$100	$90
Agricultural	$380	$380	$380	$-25
Foregone Rehab and O&M	$934	$934	$934	$0
Bridge Replacement Benefits	$152	$59	$0	$0
Total	$1,816	$1,723	$1,664	$300

Emergency and cleanup costs by alternative were estimated by examining the change in the non-damaging frequencies for various reaches to determine the extent of areas inundated. Both alternatives are expected to reduce roads impacts, since most of the downtown area would be afforded 100-year protection.

Flood Insurance Administrative Costs: Those people purchasing a new home in the 100-year floodplain via a federally insured loan are required to purchase flood insurance from the National Flood Insurance Program (NFIP). In addition, some banks mandate purchase of flood insurance even if the mortgage is not insured by a federal agency. The amount of the premiums paid by policy holders is comprised to two components: 1) funding for NFIP administrative and overhead costs, including policy-writing, floodplain management, salaries, etc.; and 2) funding for payouts after flood events. The amount paid by policyholders for administrative and overhead costs represent an NED loss, since this money would not have to be expended if the properties were not located in a floodplain. According to the latest guidance (FY 01) on the Planning Guidance website, overhead and administrative costs represent about $135 per policy. There are approximately 567 properties currently covered by flood insurance in the study area floodplains (according to the FEMA website as of 09/30/2001). Hence, total administrative and overhead costs total about $76,500 annually. Based upon the fact that the insured structures cannot easily be identified at this time and that the two alternatives protect different portions of the study area, these costs have not been claimed as benefits in this report. These data are presented for informational purposes, noting that the $76,500 figure would not cause the net benefits to change significantly for either of the alternatives presented in this appendix.

Finally, the setback levee alternative (Alternative 1) has been credited with benefits from foregone costs that will be saved by not rehabilitating the existing low-level protection levee. Such costs have been estimated to be $8.8 million. The amortized amount has been included in the above table as "Rehab Savings." Plan formulator engineers provided new bridge costs to the economics branch. Bridge life figures—100 years for the affected railroad bridge, 75 years for all others—as well as remaining life, was also obtained from the plan formulators. O&M costs were assumed to be the same for the old bridges and the replacement bridges. The FY ’02 federal discount rate of 6 1/8% was used in these bridge replacement benefits computations.

Table 18 shows the total annual benefits by alternative.

Table 18
Lower Cache Creek/City of Woodland Alternatives
Total Expected Annual Benefits ($1,000s)
By Alternative

Category	Alt 1A Narrow Setback	Alt 1B Wide Setback	Alt 1C Modified Wide Setback	Alt 2 Barrier
Structure & Content	$10,800	$10,800	$10,800	$11,100
Other	$1,800	$1,700	$1,700	$300
Total	$12,600	$12,500	$12,500	$11,400

Detailed Project Costs

Table 19
Lower Cache Creek Feasibility Study
Project Costs ($ 1,000s)

Item	Alt. 1A Narrow Setback	Alt 1B Wide Setback	Alt 1C Mod. Wide Setback	Alt 2 Flood Barrier
Construction Costs	$61,824	$42,445	$35,134	$16,063
Contingency (20%)	$13,355	$9,017	$7,111	$3,127
LERRDs	$36,926	$68,431	$91,955	$14,013
Sub-Total - Construction	$112,104	$119,893	$134,200	$33,202
Cultural Resource Preserve	$866	$623	$856	$246
Permanent Operate Equip	$0	$0	$0	$1,200
PED/EDC	$10,394	$7,474	$10,266	$2,955
S & A (8.5%)	$7,363	$5,294	$7,272	$2,093
Total First Costs	**$130,727**	**$133,283**	**$152,594**	**$39,697**
Interest During Construction	$8,893	$9,067	$10,381	$2,701
Gross Investment	**$139,620**	**$142,350**	**$162,975**	**$42,398**
Annualized (6 1/8%, 50 yrs)	$9,013	$9,189	$10,521	$2,737
Operation & Maintenance	$485	$415	$415	$98
Total Annual Cost	**$9,498**	**$9,754**	**$10,936**	**$2,923**

As shown on Table 19, the flood barrier plan has lower annual costs than any of the setback levee plans. Unlike any of the setback levee plans, however, the flood barrier alternative does not provide protection to the agricultural lands between the stream and the city nor to the Town of Yolo.

Benefit/Cost Analysis

Table 20
Lower Cache Creek Feasibility Study
Lower Cache Creek/City of Woodland
Benefit/Cost Analysis ($1,000s)

	Alt. 1A Narrow Setback	**Alt 1B Wide Setback**	**Alt 1C Mod. Wide Setback**	**Alt 2 Flood Barrier**
Expected Annual Benefits	$12550	$12,550	$12,550	$11,541
Expected Annual Costs	$9,498	$9,754	$100,936,000	$2,923
Net Benefits	$3,016	$2,798	$1,614	$8,618
Benefit/Cost Ratio	1.32	1.27	1.16	3.94

As shown above, Alternative 2 has the highest net benefits and benefit/cost ratio. Therefore, Alternative 2 would be considered the NED Plan for the study area.

Risk & Uncertainty

EAD & EAD Reduced

Table 21 shows the results of the risk and uncertainty analysis. Note that the probability that the expected annual damage reduced for both alternatives equals the mean values is less than fifty percent. This is because of the nature of the damage distribution. There is the potential for very high damages when taking into consideration the uncertainty of engineering and economic variables, whereas the lower limit of damages is obviously zero. Therefore, the resulting damage and damage-reduced distributions are not normally distributed. The table below includes structures & contents damages, emergency costs, auto damages, and agricultural damages (excludes foregone rehab and bridge replacement benefits).

Table 21
Expected Value and Probabilistic Values of EAD and EAD Reduced

	Expected Annual Damages			Probability EAD Reduced Exceeds Indicated Values ($1,000s)		
Plan	Without Plan	With Plan	Damage Reduced	.75	.5	.25
1	$12,429	$867	$11,600	$5,700	$9,300	$13,900
2	$12,429	$1,000	$11,400	$6,800	$10,500	$13,800

ALTERNATIVE ANALYSIS -- FINAL ARRAY

Based upon the analysis completed in the previous section, it was apparent that the concept for Alternative 2 (Flood Barrier) was the best from an NED perspective.

Risk & Uncertainty

Table 22 displays results of the risk and uncertainty analysis generated by the HEC-FDA program based upon With Project conditions.

Target Stage Expected Annual Exceedance Probability

These statistics show the expected annual probability that the capacity of the channel within these reaches will be exceeded. The Target Stage represents the stage at which significant damages begin to occur or the top of the levee if one is located in the reach. Table 22 shows that for both Alternative 1 (Setback Levee) and Alternative 2 (Flood Barrier), there is less than a one percent chance that the capacity of Cache Creek will be exceeded. Under without project conditions, annual exceedance probabilities were approximately 10%.

Long-Term Risk

Long-Term Risk represents the probability of the Target Stage being exceeded (or exceeding the capacity of the reach) over a given time period. Under without project conditions, there is over a 90 percent chance that capacity of the reaches in the study area will be exceeded over the 50-year period of analysis. Table 22 displays the long-term risk for 10, 20 and 50-year periods for both alternatives. As shown on the table, the long-term risk over the 50-year period of analysis ranges from about 9% to about 14% for the with project conditions along the damage reach. The long-term risk over ten years for the reach is roughly 2% for both alternatives.

Conditional Non-Exceedance Probability by Event

The conditional non-exceedance probability by event represents the probability of a reach containing the given probability event (within the Target Stage), should that event occur.

Table 22 shows that the conditional non-exceedance probability for the one-percent flood event is at 90% for the study area under both types of alternatives. However, this probability should be higher in reality. The indicated probability reflects the fact that an increasing discharge (and "rating") function was required as input for the HEC-FDA program to run, although the discharges would actually be zero for all but the rarest events. The output statistics reflect the increasing "dummy" discharges entered into the program to allow it to run. Furthermore, the analysis was limited to setting top of levee elevations only up to the 500-yr event, as this was the highest event included in the provided frequency-stage curves.

Table 22
Lower Cache Creek Feasibility Study
Risk & Uncertainty Results – Setback Alternative & Flood Barrier Alternative

	Target Stage Exp. Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability By Event					
		10 Yrs	25 Yrs	50 Yrs	10%	4%	2%	1.0%	0.4%	0.2%
Lower Cache Creek										
W/O	9%	62.7%	91.5%	99.3%	58%	6%	1%	0.0%	0.0%	0.0%
Setback Levee	0.2%	2%	5%	9%	100%	100%	98%	90%	78%	70%
Flood Barrier	0.3%	3%	7%	14%	100%	99.8%	96.2%	90%	78%	61%