Sacramento River Flood Control System Evaluation
Initial Appraisal Report - Upper Sacramento Area

Attachment E

Economic Evaluation
November 1994

C-104043

Initial Appraisal Report for the Upper Sacramento Area, Phase V, Economics Update

Introduction

This report updates the economic evaluation presented in the March 1993 Colusa Trough Drainage Canal Office Report and the September 1993 Limited Reevaluation Report for the Sacramento River Flood Control System.

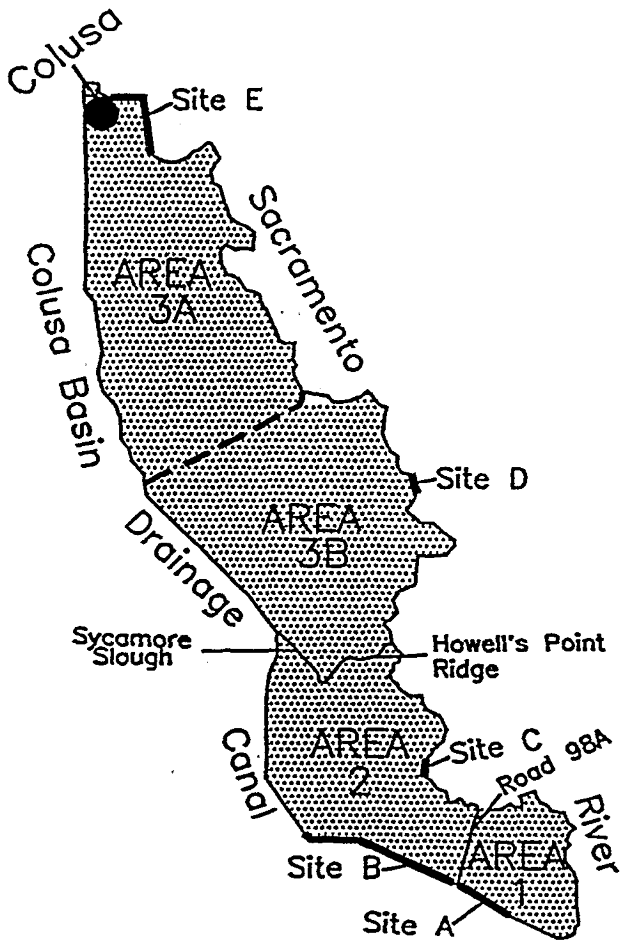
As instructed by the 1 March 1994 Headquarters' 2nd Endorsement of the Limited Evaluation Report submittal (CESPK-PD-S, dated 29 October 1993), this report has been prepared to assist in the economic evaluation of risk and uncertainty.

The economic evaluation is expressed in current (October '94) dollars. Variables of future growth have not been developed for purposes of this analysis.

Flood Plain Description

The flood plain is comprised of four areas labeled Area 1, Area 2, and Area 3A and 3B, as shown in Figure 1. The floodplain is part of the Colusa Basin which is a major agricultural area as well as one of the most notable waterfowl areas in the State. Rice has been the principal crop for many years. Area 3A includes a portion of the City of Colusa which currently has a population of about 5,000. A levee break at the west end of Site E (adjacent to the City of Colusa) would inundate much of the town, especially newly constructed areas east and south of the old town. The old town of Colusa was not inundated in the 1907 flood, but was surrounded by floodwaters. During the 1986 flood, seepage occurred at Site E which peaked at 1.5 feet below the design elevation. Structures in the area include residential (single-family and multiple-family), commercial (airport, GM Pontiac Dealer, Burger King, etc.), public (Colusa Community Hospital, golf course, Sheriff's office, etc) and farm buildings (barns, grain elevators, storage bins). The line of demarcation between Area 3A and 3B is the abandoned railroad tracks. Area 3B and Area 2 are comprised of farmsteads which include homes and buildings and appurtenant service areas of a farm. Crops grown in these areas include the following: alfalfa, corn, cucumbers, dry beans, grain, melons, prunes, rice, safflower, squash, sugar beets, sunflower, and walnuts. Area 1 is also primarily in agricultural land use (rice, field crops, truck crops, and prunes, pears, and walnuts). The potential failure points for Area 2 consist of 29,000 linear feet on the left bank of the Colusa Basin Drain and 1,500 linear feet on the Sacramento River. The potential failure point for Area 1 consists of 15,500 linear feet on the left bank of the Colusa Basin

Phase V
Upper Sacramento Area



STUDY AREA

ABANDONED RAILROAD

Figure 1

Drain, Site A. (The probable non-failure points and probable failure points under with/without project conditions for each of the areas under consideration are summarized in a subsequent tabulation.)

Structure Inventory

The present land use in the study area was determined by aerial photographs, visual inspection, agricultural land use maps, Colusa County Assessor's rolls, zoning maps, and from city and County General Plans. There are 1,470 structures in the study area valued at $133.2 million. See Table 1 for a complete breakdown of the number and value of each type of structure, by area. The values and number of potentially damageable units in this table reflect values before economic uncertainties were applied.

The value of residential, commercial, public and farm buildings was determined by using a number of sources: (1) Colusa County Assessor's rolls, (2) Marshall and Swift's appraisal handbooks, (3) the publication "Criss & Cross" and (4) local realtors and public officials at the assessor's office. There were some adjustments required depending on the source that was used. For example, when the county assessor's values were used, an adjustment had to be made to reflect current depreciated market values. Because of California's "Proposition 13", the direct use of assessor's values is not possible. Proposition 13 allows assessed values to increase at a maximum rate of two percent per year after a property is sold or resold. After a sale, the assessor value is brought up to current market (depreciated) value. To adjust for the effects of "Proposition 13", sales dates were noted and the two percent per year increase was added, and the value was then compared to the Marshall and Swift's Valuation Service changes in construction prices for the same period. When the appraisal handbooks were used, square footage was estimated for a typical size building and then a Marshall and Swift per square foot construction cost was applied. Depreciation was estimated based on the age and condition of the structure and then the Marshall and Swift value was reduced accordingly. Onsite inspections of all properties were made to determine the number of stories and estimate the foundation heights to help in the determination of first floor elevations.

TABLE 1

Damageable Units And Structure Values

	Area 1		Area 2		Area 3A		Area 3B	
	Units	Value	Units	Value	Units	Value	Units	Value
Houses	18	1,754	7	387	742	63,257	59	3,664
Apartments	0	0	0	0	183	3,385	0	0
Mobile Homes	2	48	4	40	63	745	11	357
Commercial Bldgs.	4	3,042	0	0	53	23,493	4	8,874
Public Bldgs.	2	157	0	0	21	9,281	1	107
Farm Buildings	22	1,236	14	317	132	7,725	128	5,354
Total	48	6,237	25	744	1,194	107,886	203	18,356

1. The structure values shown include "contents" or personal property.
2. Values expressed in '000 dollars.

Flood Damages

Flood damages were computed by determining relationships between damages and depths, flows, and frequencies of flooding. The principal types of flood damages are those physical damages caused by inundation. Damages were estimated for the following land use categories: Residential (single family residences, multiple family dwellings, and mobile homes), Commercial, Public, Farm Buildings, and Agriculture. Physical damages include damages to, or loss of, buildings and their contents, including furnishings, equipment, fixtures, and inventory. In addition, emergency costs and road damages were also estimated.

Once the inventory was completed, damage susceptibility relationships were established as a function of total value for each structure type. The 1988 FEMA curves were used for residential structures. The depth-damage relationship developed by the Tennessee Valley Authority for the Department of Housing and Urban Development in December 1969, Small Business Research for Flood Insurance Rate setting, were used in estimating damages to non-residential structures. These depth-damage relationships were adjusted for foundation heights.

Stage-damage relationships describe the flood damage associated with various river flows. The derivation of these stage-damage relationships are based upon estimating the probable flood damages of several hypothetical floods. The probable flood damage that results from a particular stage is derived by describing the flood plain area affected, inventorying this area by damage category and depth of flooding, and applying the appropriate depth-damage relationship for each damage category. Once the levee breaks, damages are the same for all frequencies.

Some damage categories, such as emergency costs, do not have depth damage curves. Emergency costs were based upon the numbers of people affected by the flood and the estimated amount of time it would take before reentry into the home was possible.

The number of structures in each area, their depreciated values and the physical damages prevented as a result of project implementation, are presented in Tables 2 through 7, inclusive. The number of acres in agricultural production is also shown.

TABLE 2
AREA 1

Physical Damages Prevented:

Property	Number of Units	Total Struc. & Cont. Value	Total Damages
Houses	18	$1,754,000	$1,052,000
Mobile Homes	2	48,000	48,000
Commercial Bldgs	4	3,042,000	1,825,000
Public Bldgs.	2	157,000	78,000
Farm Buildings	22	1,236,000	742,000
Subtotal:	48	$6,237,000	$3,745,000
Agriculture	8,986 Acres	-	2,696,000
Emergency Costs	-	-	30,000
Roads	-	-	507,000
Totals:			$6,978,000

TABLE 3
AREA 2

Physical Damages Prevented:

Property	Number of Units	Total Struc. & Cont. Value	Total Damages
Houses	7	$387,000	$237,000
Mobile Homes	4	40,000	25,000
Farm Buildings	14	317,000	188,000
Subtotal:	25	$744,000	$450,000
Agriculture	11,094 Acres	-	$4,332,000
Emergency Costs	-	-	16,000
Roads	-	-	626,000
Totals:			$5,424,000

TABLE 4
AREA 3A

Physical Damages Prevented:

Property	Number of Units	Total Struc. & Cont. Value	Total Damages
Houses	742	$63,257,000	$20,432,000
Apartment Units	183	3,385,000	619,000
Mobile Homes	63	745,000	473,000
Commercial Bldgs	53	23,493,000	7,048,000
Public Bldgs.	21	9,281,000	2,320,000
Farm Buildings	132	7,725,000	2,470,000
Subtotal:	1,194	$107,886,000	$33,362,000
Agriculture	29,757 Acres	-	12,829,000
Emergency Costs	-	-	1,868,000
Roads	-	-	1,058,000
Totals:			$49,117,000

TABLE 5
AREA 3B

Physical Damages Prevented:

Property	Number of Units	Total Struc. & Cont. Value	Total Damages
Houses	59	$3,664,000	$1,183,000
Apartment Units	0	0	0
Mobile Homes	11	357,000	227,000
Commercial Bldgs	4	8,874,000	2,662,000
Public Bldgs	1	107,000	27,000
Farm Buildings	128	5,354,000	1,713,000
Subtotal:	203	$18,356,000	$5,812,000
Agriculture	36,681 Acres		13,469,000
Roads			690,000
Totals:			$19,971,000

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TABLE 6
AREA 3A & 3B (Combined)

Physical Damages Prevented:

Property	Number of Units	Total Struc. & Cont. Value	Total Damages
Houses	801	$66,921,000	$21,615,000
Apartment Units	183	3,385,000	619,000
Mobile Homes	74	1,102,000	700,000
Commercial Bldgs	57	32,367,000	9,710,000
Public Bldgs	22	9,388,000	2,347,000
Farm Buildings	260	13,079,000	4,183,000
Subtotal:	1,397	$126,242,000	$39,174,000
Agriculture	66,438 Acres		26,298,000
Emergency Costs			1,868,000
Roads			1,748,000
Totals:			$69,088,000

TABLE 7
ALL AREAS

Physical Damages Prevented:

Property	Number of Units	Total Struc. & Cont. Value	Total Damages
Houses	826	$69,062,000	$22,904,000
Apartment Units	183	3,385,000	619,000
Mobile Homes	80	1,190,000	773,000
Commercial Bldgs	61	35,409,000	11,535,000
Public Bldgs	24	9,545,000	2,425,000
Farm Buildings	296	14,632,000	5,113,000
Subtotal:	**1,470**	**$133,223,000**	**$43,369,000**
Agriculture	86,518 Acres	-	33,326,000
Emergency Costs	-	-	1,914,000
Roads	-	-	2,881,000
Totals:			**$81,490,000**

Levee Break Scenario

Due to the complex nature of the Sacramento River Flood Control Project, a simplified breaking scenario is used to determine how and when levees will break in each incremental independent area. There are three separate areas. Each area has one or two sites which have been identified as deficient and which had problems in passing the 1986 floodflows.

The proposed levee reconstruction in Phase V will correct the sites that have seepage and stability problems as well as deficient levee crown elevation. A 3-day duration was used for design purposes. Stage and duration are important for defining a levee breaking scenario under existing or without-project conditions.

Levee breaks that result from seepage or stability problems are dependent on the levee embankment and foundation soils, levee geometry, peak flood stages, and duration of peak flood stages. The phreatic water surface within the levee embankment is important in determining locations where levees could fail. Higher phreatic water surfaces at a specific location increase the potential for seepage and stability problems, and higher phreatic water surfaces are generally associated with coarser soil materials and longer flood durations. Engineering judgment was used to determine where levees might break in each incremental area. During the 1986 flood, a number of sites exhibited seepage, and one site had water within 1 foot of the levee crown or 2 feet into the authorized freeboard. For most reaches of the Upper Sacramento Area, the 1986 flood was not the flood of record as it was in other areas considered in the Sacramento River Flood Control System. The 1983 flood had higher water surface elevations than the 1986 flood in many parts of the Phase V study area.

The probable non-failure points (PNPs) and probable failure points (PFPs) for each area under with-project conditions and without-project conditions are presented in the tabulation below.

<u>PNPs & PFPs for Upper Sacramento Areas, Phase V</u>

<u>Area 1</u>

Site A			
Without-Project	PNP	35.0 msl	(15% chance of failure)
	PFP	38.5 msl	(85% chance of failure)
@ Sac River 95.0R			
With-Project	PNP	41.7 msl	(15% chance of failure)
	PFP	42.5 msl	(85% chance of failure)

Area 2

Site B

without-Project	PNP	35.0 msl	(15% chance of failure)
	PFP	38.5 msl	(85% chance of failure)
@ Sac River 104.3R			
With-Project	PNP	45.8 msl	(10% chance of failure)
	PFP	46.5 msl	(90% chance of failure)

Area 3 (adjacent to City of Colusa)

Site E

Without-Project	PNP	65.0 msl	(15% chance of failure)
	PFP	66.0 msl	(65% chance of failure)
@ Sac River 131.OR			
With-Project	PNP	59.5 msl	(10% chance of failure)
	PFP	62.5 msl	(40% chance of failure)

Risk and Uncertainty In Estimating Benefits

The application of a risk analysis framework to flood damage reduction requires the identification, quantification, and evaluation of risk and uncertainty from various sources. Estimates of economic damages from flooding are frequently considered to be subject to significant errors. The problem is further exacerbated by the inherent uncertainties associated with hydrologic events and levee failures scenarios. One approach is to combine the various sources of risk and uncertainty to derive the overall risk and uncertainty associated with the stage-frequency curve. Analytically determining the joint risk or joint uncertainty from the underlying components is extremely difficult in many cases. An alternative approach employed in this analysis is the use of Monte Carlo simulation to derive a numerical approximation for the analytical solution. This basically involves developing a risk-based flood damage model where the various parameters are described by probability distributions rather than as deterministic, single values. At each river stage these distributions are "sampled" and the resulting values of damages recorded. Multiple iterations allow the estimation of the distribution of damages at any stage. By re-running the model with multiple stages, a series of complete stage-damage curves with uncertainty were developed for this study.

The mean and range in average annual benefits by area are presented in Table 8. The new risk simulation program from HEC was used for the risk assessment of this study. The program has the capacity to use either flow-frequency and stage-flow information and creating the stage-frequency relationships or of using the stage-frequency curves directly. The stage-frequency version of the simulation program including standard deviations were used for this analysis. The PNP and PFP stages were used for the with- and without-project conditions. Economics Branch generated the stage-damage relationships. The program was run using 100,000 iterations. The program's outputs include average annual damages with mean and standard deviations for the with- and without-project conditions.

TABLE 8

Average Annual (Equivalent) Damages And Benefits
(October ' 94 prices and 7.75% interest rate)

	Without Project Damages		Residual Damages		Benefits	
	Expected Mean	*Min. - Max.	Expected Mean	*Min. - Max.	Expected Mean	*Min. - Max.
Area 1	229,400	221,500-237,400	224,600	216,700-232,500	4,800	4,800-4,900
Area 2	178,300	172,200-184,500	74,200	70,100-78,200	104,100	102,100-106,300
Area 3	2,590,000	2,500,000-2,670,000	570,000	530,000-620,000	2,020,000	1,970,000-2,050,000

* Two standard deviations (within 95% confidence limits)