LOWER CACHE CREEK, YOLO COUNTY, CA
CITY OF WOODLAND AND VICINITY

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX A

Basis for Design
for
Evaluation of Selected Alternatives

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Selected Alternatives

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CHAPTER 1

DESIGN CONSIDERATIONS AND CRITERIA

DESIGN FLOWS

The HEC-1 "Watershed Modeling Computer Program" was used to compute peak discharges and runoff volumes for the Cache Creek basin model. The base model for this study is from the study entitled "Hydrology of the Westside Tributaries of the Yolo Bypass, CA, Reconnaissance Study," prepared by the Corps of Engineers, November 1993. Additional data have been incorporated into this model by the Corps to reflect recent storm events as discussed in the hydrology study in Appendix *C*.

Discharge hydrographs were developed for the without-project condition for Cache Creek for the different chance flood events. Historical flood stages and cross sections were used to verify the channel capacity of Cache Creek as discussed in the hydraulic study in Appendix *D*.

Flows developed in the hydrology study were input into the hydraulic models of Cache Creek downstream from County Road 94B. Tabulated below are the peak floodflows and associated frequency.

Table 1

Cache Creek Peak Floodflows and Frequencies

Chance of Occurring (Per Year)	Peak Flow (cfs)
1 in 50	54,000
1 in 100	63,500
1 in 200	70,000
1 in 500	78,500
1 in 1,000	91,000

Layouts and cost estimates were developed for the selected alternatives for three design flows. The results provided information for use in the benefit-to-cost analysis.

Interior runoff from the agricultural lands in the project area were estimated using a 1 in 10 chance storm, based on the equation $Q = 140A^{0.77}$. This equation was taken from the design peak floodflow equations for non-urban watersheds larger than 0.25 square miles of the Sacramento County-Wide Hydrologic Master Plan. The computed results of discharge computations were used for sizing the drainage channel.

DESIGN WATER-SURFACE ELEVATIONS

The computer program HEC-RAS "River Analysis System" was used to compute the project design water-surface profiles in Cache Creek. HEC-RAS models were developed to simulate project conditions. The HEC-RAS models were compiled from the calibrated existing-conditions UNET model.

The computer program UNET was used to compute the existing-conditions water-surface profiles. The UNET model was calibrated to the January and March 1995 flood events. High water mark (HWM) data are collected from gage data and DWR flood freeboard surveys.

Overbank flood depths from Cache Creek were developed for the existing (pre-project) and post-project conditions using the UNET and FLO-2D computer programs. Channel spills were calculated by the calibrated UNET model and inserted into the FLO-2D model. The FLO-2D model was then used to compute the flood plain water-surface elevations. The existing-conditions models were modified to reflect post-project conditions such as for the Lower Cache Creek Flood Barrier (LCCFB) Plan. The design water surface elevations for the overflow barrier were based on the project-conditions FLO-2D model.

The design of the selected plan features was based upon the results of the various hydraulic computer models, as tabulated below.

Table 2

Hydraulic Model Used for Plan Feature Design

Project Feature	Computer Model
Setback Levees and Bridges	HEC-RAS
LCCFB Levee and Road Closures	FLO –2D
Cache Creek Settling Basin Levees	UNET
Cache Creek Settling Basin Weirs	UNET
Cache Creek Settling Basin Velocities	FLO-2D

ENERGY LOSSES

Manning's "n" values were estimated for the existing conditions by calibrating the UNET model to high-water marks from the March 1995 event. Manning's "n" values varied for each cross section, depending upon the degree of channel/overbank irregularity and cross-sectional variation, effects of obstructions, and the amount of vegetation. Overbank "n" values ranged from 0.04 to 0.052. Channel "n" values generally ranged from 0.032 to 0.042. FLO-2D overbank “n” values were set to 0.08 based on recommendations in the FLO-2D manual and on soil types in the study area.

Manning’s “n” values were not changed from existing values for evaluating the selected plans with the exception of the bridges. The “n” values were lowered to 0.015 where concrete lining was proposed at the bridges.

Contraction and expansion loss coefficients for gradual transitions were taken as 0.1 and 0.3, respectively.

For losses between bridge cross sections, contraction and expansion loss coefficients of 0.3 and 0.5, respectively, were used.

WAVE RUNUP AND WIND SETUP

The magnitude of wind induced wave action on leveed reaches that would be affected by ponded water west of the west levee of the settling basin and north of the LCCFB was assessed. The magnitude of wave runup and wind setup was estimated using the Corps’ WAVE computer program.

SIZING OF PROJECT FEATURES

The size of project features was based on water-surface elevations calculated by the hydraulic models described above. The design of top of levee was the design water surface elevation, except, where appropriate, provisions for wave runup and wind setup of 2.5 feet were added to the design water-surface elevations for levees affected by backwater from the Cache Creek Settling Basin. Elsewhere, where there was significant fetch, 1.0 foot was added to the design water-surface elevation of the levee. Existing bridges were assumed to require replacing if pressure flow in the bridge was determined to occur at the design flow. Pressure flow, in general, occurs when the water-surface elevation is above the highest point on the soffit of the bridge.

CHANNEL CONFIGURATION

The existing stream channel section would not be altered, except in the vicinity of bridges and where slope protection is required. If the channel section is steeper than IV: 2H, it would be modified to sideslopes of 1V: 2H in the vicinity of new bridges and where stone slope protection would be placed. Where site limitations require gabions, the sideslope would be a maximum 4V: 1H. Proposed interior drainage channels would have sideslope of 1V: 3H in all cases.

LEVEE CONFIGURATION

Where existing levees are to be raised, the existing waterside levee sideslope would be maintained (1V: 3H), a 12-foot-wide patrol road would be constructed on the top of the elevated levee berm, and the landside levee embankment sideslope would be constructed to the same slope (parallel – 1V: 2H) as the existing landside levee sideslope.

Where new levees are constructed, the landside levee slope would be 1V: 2H. The watersideslope of the new levee embankment would be constructed at 1V: 3H. The top width of the levee embankment (crown) would be 12 feet and would also function as a patrol road. The limits of the right-of-way would extend to the toe of the landsideslope of the new levee embankment plus an additional 10-foot easement.

For cost estimating purposes, a 12-foot levee crown was used. This configuration will be refined prior to the final design.

SLOPE PROTECTION

Slope protection was provided as appropriate to protect against scour velocities and wind-induced wave action. Slope protection consisted of riprap, gabions, hard points, and reinforced concrete lining, depending upon local conditions.

For evaluating the Setback Levee Plans, rock slope protection was placed where project channel velocities would exceed existing conditions or where slope erosion problems were known to exist. In general, protection was provided beginning at velocities of approximately 7 to 8 feet per second. These threshold velocities are comparable with a maximum suggested mean channel velocity for grass-lined earth of about 7 feet per second (fps) based upon information contained in the Corps of Engineers' publication EM 1110-02-1601, "Hydraulic Design of Flood Control Channels." These limiting velocities also appear reasonable compared to the design velocities in the 1958 Design Memorandum for the Cache Creek levees, which ranged from 5 ft/sec to 10 ft/sec with the majority of the velocities being 7 ft/sec or greater.

Where rock slope protection was required, stone riprap protection was designed in accordance with EM 1110-02-1601, "Hydraulic Design of Flood Control Channels." Where site constraints precluded modifying the channel to a sideslope of 1V: 2H, gabions were used and the section was modified to a 4V: 1H sideslope with a 10-foot bench after each 12 feet in height. Concrete lining for scour protection of the channel was used at all bridge sections, including existing bridges and proposed bridges.

ROADWAY RAISING

Roadways will be raised as required by hydraulic design consideration to cross the proposed levees and/or to conform to new bridge deck elevations. The top width of the roadway sections will conform to Yolo County standards. The road embankments have sideslopes of 1V: 3H.

ROAD CLOSURE STRUCTURES

Road closure structures (e.g., stoplog structures) will be placed as required. Several County Roads (CR 99, 101, 102) will be crossing the LCCFB levee. These roads would be raised to cross through and over the levee. Stopping sight distance was included into the design of the vertical curves for passing over or through the LCCFB. Additional stoplog structures would be required at State Highway 113 and the frontage road leading to Dubach Field. A stoplog structure would be required for the California Northern Railroad that crosses underneath Interstate 5.

DRAINAGE STRUCTURES THROUGH LEVEES

Reinforced concrete culverts would be placed under roadways, bored, jacked, and micro-tunneled through the embankment of Interstate 5. Inlet and outlet structures would be installed at all levees where culverts are needed. Flap gates and slide gates would also be installed for closure and for prevention of backwater.

FLOODWALLS

Sheet piles would be installed in areas where levees were not reasonable. Sheet piles were assumed to be 3 times the length below ground as above ground. The maximum height above the ground would be 5 feet, with no backfill.

SLURRY WALLS

Slurry walls were assumed to be constructed 40 feet deep for approximately 15 percent of the total length of the Setback Levee Plans and 15 percent of the distance between the settling basin west levee and CR 101 for the LCCFB Plan.

PROTECTION OF STRUCTURES IN THE FLOOD PLAIN

Existing homes and structures on the south Cache Creek flood plain could be damaged by flood flows escaping from Cache Creek under both existing conditions and post-project conditions associated with the LCCFB Plan. Pre- and post-project depth duration curves were developed for all groups of structures within the post-project LLCFB flood plain and used to identify homes and structures that may require floodproofing measures or other remedies; see Appendix D for depth duration curves at selected locations.

For the Setback Levee Plans, homes located on the waterside of the proposed levees would be relocated.

CHAPTER 2

PROJECT FEATURES

This section provides a general description of each of the project features used in the development of the two flood damage reduction plans. The specific features for each plan are presented in Chapter 6 report's main body. The project feature categories discussed below are consistent with the Work Breakdown Structure Check List included in Appendix C of the Corps of Engineers' ER 1110-2-1302, dated March 31, 1994.

LANDS AND DAMAGES

Land required for flood damage reduction includes the additional right-of-way necessary for channel and levee improvements proposed for each plan. Right-of-way requirements were determined based upon topographic mapping, top-of-levee profiles based upon the hydraulic analyses of Cache Creek, levee and drainage ditch profiles and layouts, and a review of existing land-use conditions. The assessor's parcel maps were used to determine the number of parcels from which right-of-way and flood easements would be needed.

Permanent easements would be required immediately underneath proposed levee embankments and other proposed new facilities. Generally, 10 feet of permanent easement would be required beyond the toe of any proposed new facility. In addition, another 40 feet of temporary easement beyond the permanent easement limits would be required for construction.

Flowage easements would be required where there is significant increase in depth, duration, or frequency of flooding compared to existing conditions. Homes and other structures would need to be purchased and/or relocated if flood damages are significantly increased compared to existing conditions.

CHANNELS

The proposed right-of-way for channel cut sections assumes an 8-foot-wide bottom and 1V: 3H sideslopes. The right-of-way would extend 10 feet to the landside of the channel.

LEVEES

The proposed right-of-way for levee embankment sections is based upon providing a 12-foot-wide patrol road on top of the levee, 1V: 3H sideslopes on the waterside, and 1V: 2H sideslopes on the landside. The right-of-way would be a minimum of 10 feet from the toe of the levee on either side for maintenance purposes.

RELOCATIONS

Relocations may include railroad, roadway and bridge demolition and replacement, and utilities such as power cables, siphons, pump houses, gage stations, and irrigation ditches. Railroad, roadway, and bridge demolition and replacement relocations are identified separately for each flood damage reduction plan. For the purposes of this report, the cost for utility relocations was taken to be 3 percent of the construction cost. This percentage is based upon a review of example feasibility level cost estimate data by the Corps of Engineers.

PROJECT ROADS

Improvements under this category include patrol roads to allow access for inspection, maintenance, and flood fighting operations. In accordance with the Corps of Engineers' EM 1110-2-1913, the proposed patrol roads would be surfaced with 4 inches of aggregate base coarse material to permit vehicular access during wet weather. The width of patrol roads proposed along channels and on top of levees is 12 feet. This category also includes roadways raised for the LCCFB Plan, Setback Levee Plans, realigned roads and bridge replacements.

CHANNELS AND DRAINS

Channel improvements involve excavating sideslopes to 1V: 2H where riprap slope protection is required and where slopes are steeper than 1V: 2H.

Where required, riprap slope protection would be provided in accordance with EM 1110-2-1601, for an average channel velocity that is greater than for existing conditions, ranging from about 7 to 8 feet per second. Riprap protection would consist of an 18-inch layer of angular stone placed on a 6-inch bedding layer of sand. The stone would have a minimum specific weight of 165 pounds per cubic foot, with an equivalent volume spherical stone diameter of 12 inches and an equivalent stone weight of 86 pounds. For cost estimating purposes, the equivalent weight of riprap in-place is assumed to be 20 percent less than the specific weight of the stone, or 132 pounds per cubic foot, to account for voids between stones.

This category also includes provisions for clearing and installing a concrete lining beneath bridges.

LEVEES

Levee improvements include enlarging existing levees and/or constructing new levee embankments, as required, to provide the necessary level of flood damage reduction. The proposed height of a raised or new levee is based upon the design water-surface elevation.

The crown width of both raised and new levees would be 12 feet. A watersideslope of 1V: 3H and a landsideslope of 1V: 2H would be used for both existing and new levee embankments.

The various aspects of levee construction used to develop feasibility-level cost estimates include clearing, grubbing, stripping, embankment, road base, slope protection, and identifying, locating, and relocating utility crossings.

Clearing consists of removing all objectionable matter and/or obstructions above the ground surface, including trees, brush, vegetation, loose stone, abandoned structures, fencing, and debris. Grubbing includes the removal of all stumps, roots, buried logs, old piling, paving, drains, and other objectionable subsurface matter. Clearing and grubbing would be performed beneath the proposed new embankment foundation and on easement areas.

Once the foundation area has been cleared and grubbed, all areas to receive fill would be stripped to a depth of 6 inches to remove low-growing vegetation, organic topsoil, and other objectionable ground cover.

Where required, riprap slope protection would be placed on the watersideslope of levee improvements in accordance with EM 1110-2-1601. The parameters for riprap slope protection would be similar to those described earlier for channels. Landside slopes and waterside slopes not requiring riprap would be seeded with grass to provide erosion protection similar to channel sections.

While the project features reflect a 12-foot levee crown/patrol road width, the crown may vary in width up to 20 feet for ease and safety of maintenance operations. Crown widths between 12 and 20 feet have the same level of significance in potential environmental effects, as increases in width can be accommodated by corresponding reductions in the size of the temporary construction easement that parallels the base of the levee, without a change in the width of the project footprint. Related refinements in the project cost for a levee crown up to 20 feet wide are within the currently estimated contingency costs (less than $0.8 million, or 2 percent for the LCCFB Plan or $3.3 million, or 2 percent for the Modified Wide Setback Levee Plan). Analyses of the effects of levee crown widths up to 20 feet are included in Appendixes F and K and the EIS/EIR.

BORROW AREAS

Potential borrow areas for both plans would be materials from the Cache Creek Settling Basin. Other borrow areas could be from the existing levees, the channel on the waterside of the LCCFB, material from the west levee of the settling basin, and on the waterside of the Setback Levees.

OPERATION AND MAINTENANCE

Operation and maintenance activities will be similar to those currently practiced. The local sponsor will maintain channel capacity by removing debris and vegetation as required. Repairs will be made to levee sideslopes and patrol roads as a result of any localized erosion as required.

FUNCTIONAL OPERATION

The ongoing operation and maintenance program should prevent malfunction of each plan. Significant accumulation of debris at the upstream face of the bridges should be removed prior to the wet seasons and maintained as often as necessary.

CARE OF WATER

The care of water during construction will be an issue during the entire year as there are flows in Cache Creek all year round. All channelization work will be done during the dry months of the year. All erosion control measures will be in place prior to November 1.

The concrete lining, riprap slope protection, and bridge replacement associated with the Setback Levee Plans would be constructed during the dry season.