US Army Corps of Engineers
Sacramento District

City of Woodland

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL
FLOOD DAMAGE REDUCTION PROJECT

Cache Creek Levee Failure, January 27, 1983, looking south towards Woodland.

MARCH 2003

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

DRAFT FEASIBILITY REPORT
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THE RECLAMATION BOARD
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REDUCTION PROJECT

Executive Summary

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Executive Summary

EXECUTIVE SUMMARY

This Draft Feasibility Report addresses flooding problems and potential effects of alternative plans for flood damage reduction along the lower reach of Cache Creek, including the city of Woodland and vicinity. This report presents the results of a feasibility study performed jointly by the Federal sponsor, the U.S. Army Corps of Engineers, Sacramento District, and the non-Federal sponsors, the Reclamation Board of the State of California (Board) and the City of Woodland. The "Lower Cache Creek, Yolo County, CA, City of Woodland and Vicinity Draft Environmental Impact Statement/Environmental Impact Report for Potential Flood Damage Reduction Project" (Draft EIS/EIR) is available under a separate cover.

STUDY AREA

The area addressed in this report includes the entire Cache Creek watershed from the eastern foothills of the Coast Range Mountains to the western levees of the Yolo Bypass. (See Figure ES-1.) The area includes parts of Yolo, Colusa, and Lake Counties. The focus of the report is flood damage reduction opportunities specific to the problem/study area, the city of Woodland, and areas north and east of Woodland.

NEED FOR ACTION

Lower Cache Creek has a history of flooding. Twenty severe floods have occurred since 1900 in the Cache Creek basin. The most severe floods of recent years downstream from Clear Lake occurred in 1955,1956, 1958, 1964,1965, 1970, 1983, 1995, and 1997. In 1983, a levee failure near County Road (CR) 102 caused flooding in the area which is now Woodland's industrial area.

The flood hazard evaluation conducted for this study also determined that a significant portion of the project area is subject to floods having a 1 in 100 chance of occurring in any given year, as shown on Figure ES-2. The primary purpose of this study is to identify economically feasible and environmentally sensitive methods to reduce flood-related damages to Woodland and adjacent areas.

Without a flood damage reduction project, average annual flood damages to real property from overflows from Cache Creek are expected to be about $12.4 million, most of which would be in Woodland. Other adverse effects and losses would include the potential for flood-related loss of life, contamination from sanitary sewage and hazardous materials, and the extended closure of the section of Interstate 5 (I-5) east of Woodland.

SIGNIFICANT ISSUES

The current flood protection system along the lower Cache Creek was designed to convey floodflows having a 1 in 10 chance of occurring in any given year with 3 feet of freeboard. Historically, the existing levee system has conveyed floodflows having an annual chance of occurrence of 1 in 20 by encroaching into the freeboard. Due to the

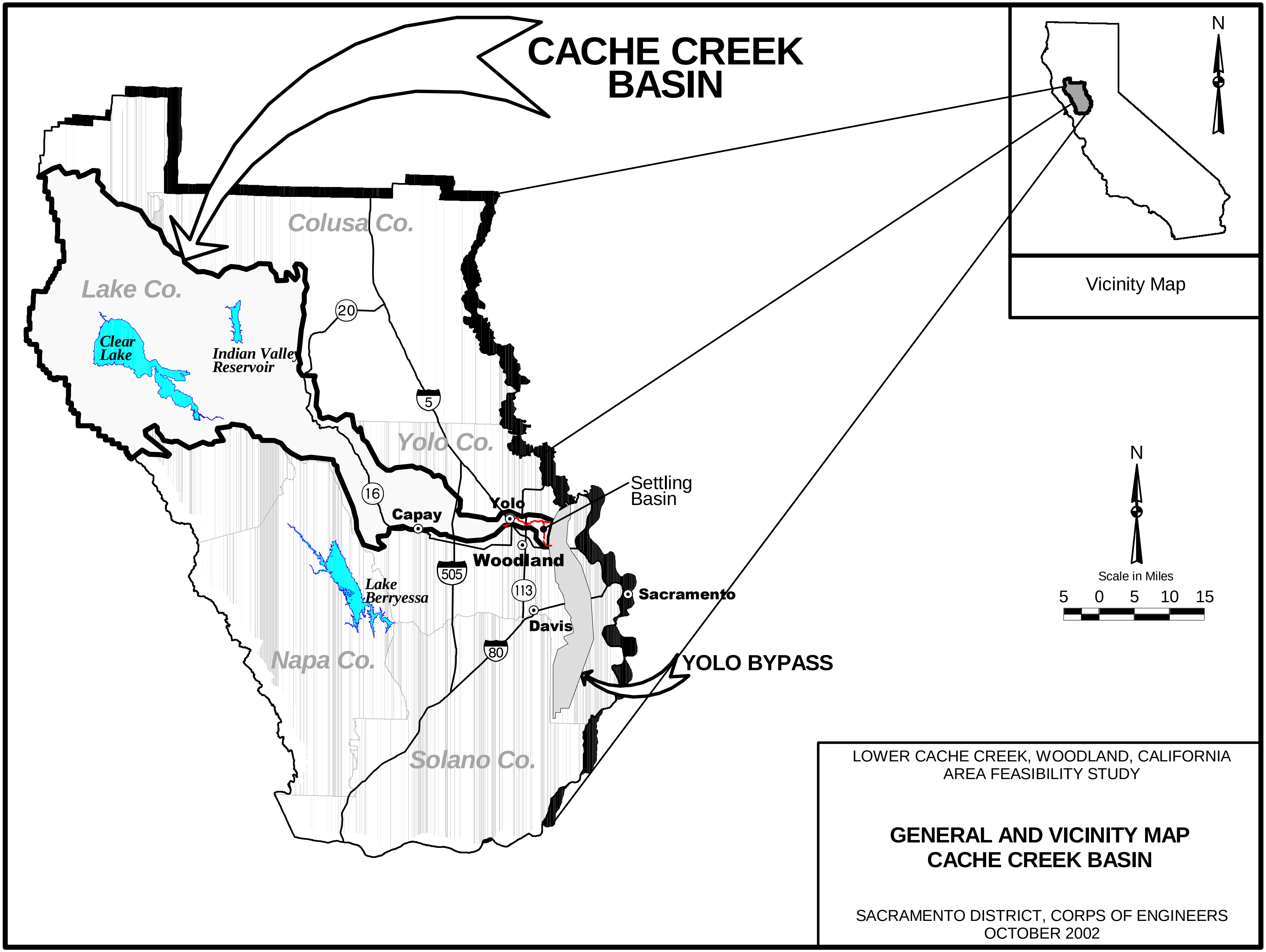

CACHE CREEK
BASIN
Colusa Co.
Lake Co.
Clear
Lake
Indian Valley
Reservoir
Yolo Co.
Capay
Yolo
Woodland
Settling
Basin
Sacramento
Davis
Lake
Berryessa
Napa Co.
Solano Co.
YOLO BYPASS
20
5
16
505
113
80
N
Vicinity Map
N
Scale in Miles
5 0 5 10 15
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
GENERAL AND VICINITY MAP
CACHE CREEK BASIN
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure ES-1

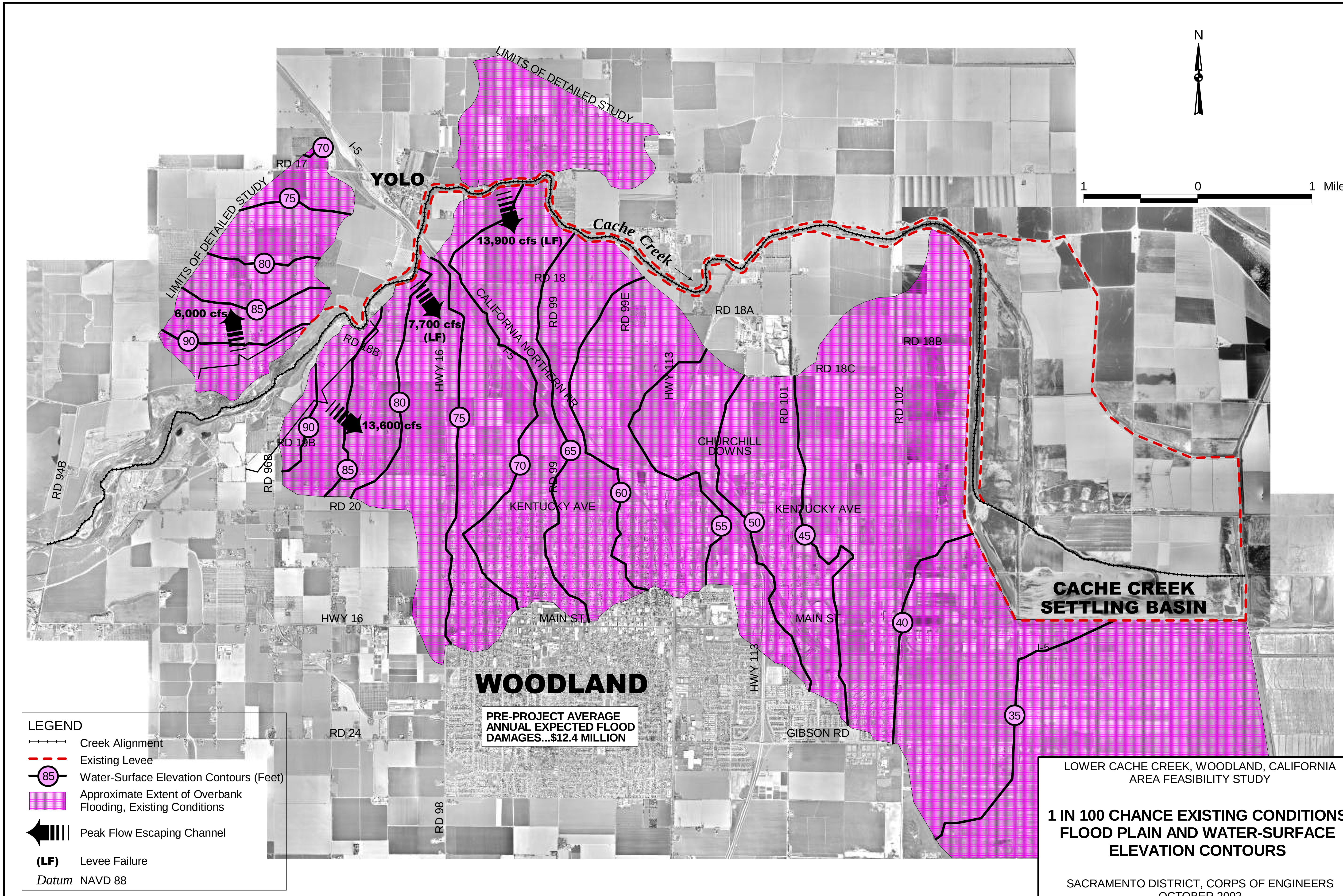

LIMITS OF DETAILED STUDY
LIMITS OF DETAILED STUDY
N
1 0 1 Miles
YOLO
I-5
RD 17
Cache Creek
13,900 cfs (LF)
7,700 cfs (LF)
6,000 cfs
13,600 cfs
RD 18
RD 18A
RD 18B
RD 18B
RD 18C
RD 19B
RD 20
RD 24
RD 94B
RD 96B
RD 98
RD 99
RD 99E
RD 101
RD 102
HWY 16
HWY 113
CALIFORNIA NORTHERN RR
CHURCHILL DOWNS
KENTUCKY AVE
MAIN ST
GIBSON RD
CACHE CREEK SETTLING BASIN
WOODLAND
PRE-PROJECT AVERAGE ANNUAL EXPECTED FLOOD DAMAGES...$12.4 MILLION
70
75
80
85
90
65
60
55
50
45
40
35
LEGEND
Creek Alignment
Existing Levee
Water-Surface Elevation Contours (Feet)
Approximate Extent of Overbank Flooding, Existing Conditions
Peak Flow Escaping Channel
(LF) Levee Failure
Datum NAVD 88
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
1 IN 100 CHANCE EXISTING CONDITIONS FLOOD PLAIN AND WATER-SURFACE ELEVATION CONTOURS
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure ES-2

limited conveyance capacity of the lower reach of Cache Creek, the Federal Emergency Management Agency (FEMA) has issued new flood insurance rate maps that show significant areas of Yolo County and Woodland are subject to floods having a 1 in 100 chance of occurring in any given year.

Factors other than limited channel capacity also affect flooding in the area. These include the I-5 embankment and the west levee of the Cache Creek Settling Basin. These features tend to divert portions of the easterly overflow from Cache Creek toward Woodland.

Solving the flooding problems is not a simple matter of increasing the capacity of the existing system. Increasing the design flow of the channel and levee system without a corresponding increase in the flow area results in increased flow velocities. At some point, increased channel velocities require substantial rock slope protection measures (riprap) to protect banks and bridges against excessive scour. The rock slope protection measures are generally associated with significant environmental impacts.

Construction of new levees, raising existing levees, and rock slope protection require environmental mitigation. The shaded riverine aquatic habitat along the creek and the abundant number of elderberry bushes along the creek bank (the habitat of the endangered valley elderberry longhorn beetle) make the creek area an environmentally sensitive area. Other significant environmental considerations include the presence of habitat of the following special-status species: giant garter snake, Swainson’s hawk, bank swallow, northwestern pond turtle, central valley steelhead, and chinook salmon.

FLOOD DAMAGE REDUCTION MEASURES AND PRELIMINARY PLANS

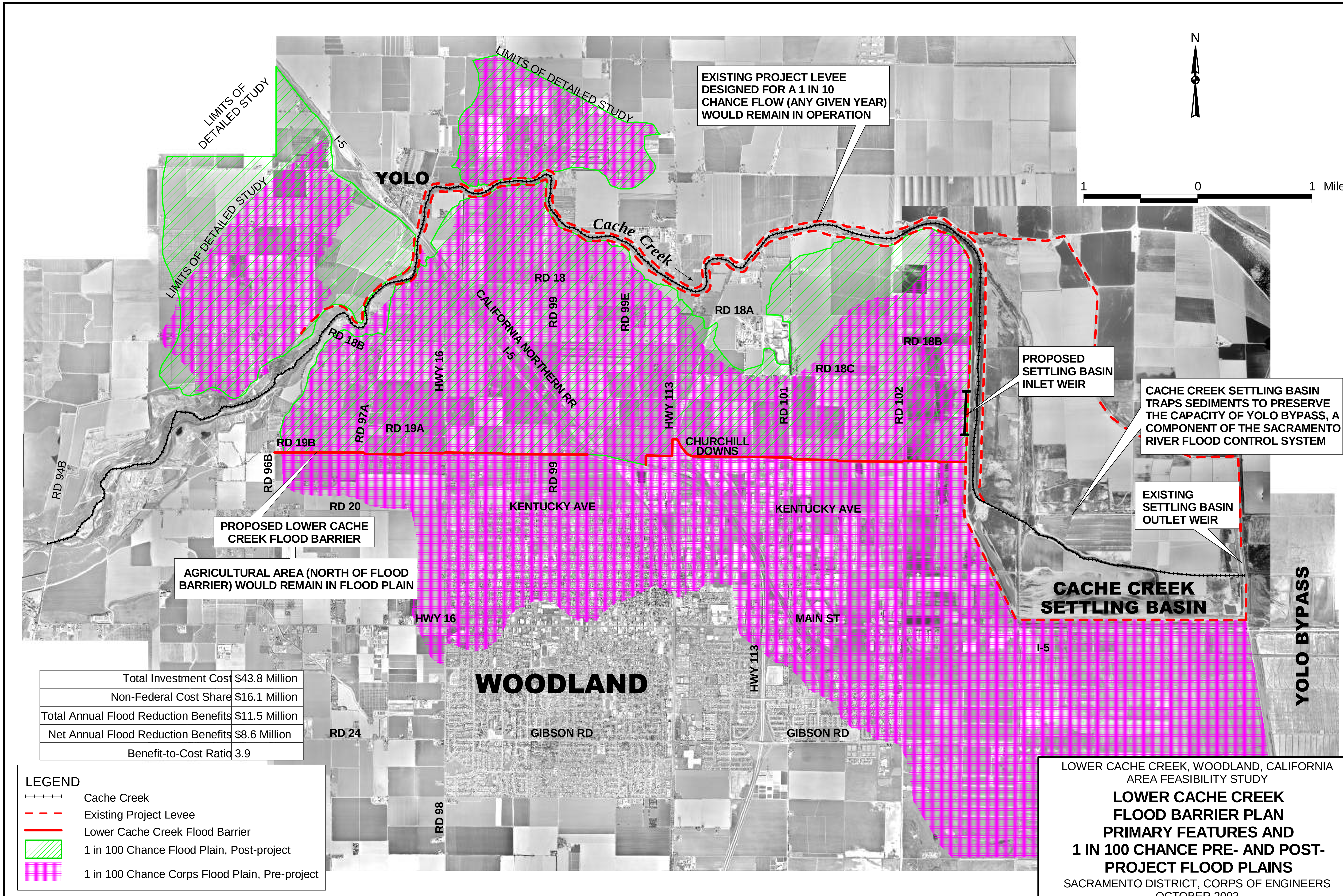
Structural and nonstructural measures were considered and evaluated based on their estimated costs, whether they met the planning objectives, and environmental feasibility. Preliminary plans that did not meet the project’s objectives, had excessive costs, or had significant adverse environmental effects were eliminated from further study. Eliminated plans included flood storage on Cache Creek, channel clearing, raising the levees along approximately 8 miles of Cache Creek, and a combination of channelization and levees. Two plans, herein referred to as the Lower Cache Creek Flood Barrier (LCCFB) Plan and the Modified Wide Setback Levee (MWSL) Plan, were selected for further evaluation. Design details, costs, flood reduction benefits, potential environmental effects, and mitigation requirements were determined for these two plans.

The Draft Feasibility Report was prepared for a range of levee crown widths between 12 and 20 feet for the MWSL and the LCCFB Plans. Crown widths will be refined for the selected plan.

EVALUATION OF PLANS CONSIDERED IN DETAIL

LOWER CACHE CREEK FLOOD BARRIER PLAN

The LCCFB Plan would include constructing a levee along the northern urban limit line of Woodland, as shown on Figure ES-3. The LCCFB levee would be



Total Investment Cost	$43.8 Million
Non-Federal Cost Share	$16.1 Million
Total Annual Flood Reduction Benefits	$11.5 Million
Net Annual Flood Reduction Benefits	$8.6 Million
Benefit-to-Cost Ratio	3.9

LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER PLAN PRIMARY FEATURES AND 1 IN 100 CHANCE PRE- AND POST-PROJECT FLOOD PLAINS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure ES-3

approximately 6 miles in length, originating near the intersection of CR 19B and CR 96B and extending to the Cache Creek Settling Basin, just north of Woodland. At the west end, the levee would be outflanked by floods having a peak flow greater than 70,000 cfs. The volume of these flows is small and would not result in flood damages in Woodland.

Where possible, existing roads would be raised to match the top-of-levee elevation of the LCCFB. In locations where the roads could not be raised sufficiently, stoplog structures would be constructed to close the gap in the levee. A stoplog structure would also be provided at the California Northern Railroad opening in the I-5 embankment.

A section of the west levee of the settling basin would be removed for the construction of a concrete inlet weir. Water levels above the weir crest elevation would drain into the settling basin and then into the Yolo Bypass. Water levels below the inlet weir crest elevation would drain into the settling basin through a low-level drainage structure with culverts. Flapgates would be installed on the culverts to prevent backflow from the settling basin into the area west of the settling basin. Gated culverts would also be installed through the LCCFB levee to convey water to Woodland's pumping station. The amount of water flowing through this culvert would be controlled by the City of Woodland.

A flood warning system would be incorporated to initiate evacuation of the flood plain and closure of crossings.

The LCCFB would not reduce flood damages to the largely agricultural area north of the city or to the area north of Cache Creek. The plan would require occasional flowage easements on some areas north of the LCCFB where increases in the depth and duration of flooding would be substantial. The area where occasional flowage easements would be required is primarily between CR 101 and the west levee of the settling basin. Flood protection to the area between the LCCFB and Cache Creek would continue to rely on the existing Cache Creek levee system, which the State of California would continue to operate and maintain.

The estimated first cost is $41.0 million and total investment cost (includes interest during construction) is $43.8 million for the LCCFB Plan, with a non-Federal cost share of $16.1 million. The total annual flood damage reduction benefits are estimated at $11.5 million, resulting in a net annual benefit of $8.6 million. The benefit-to-cost ratio is estimated to be 3.9.

<u>Plan Accomplishments</u>

- The LCCFB Plan would have a 97 percent conditional annual chance of not flooding for the 1 in 100 chance flood event.
- The LCCFB Plan would remove Woodland and an area of Yolo County south of the LCCFB from the FEMA 1 in 100 chance flood plain associated with Cache Creek.

- Although not a feature of the LCCFB Plan, the existing levee system would continue to be maintained to provide the existing level of flood protection to the areas adjacent to lower Cache Creek.

- The LCCFB Plan would involve significantly less direct effects to the Cache Creek biological environment than the Modified Wide Setback Levee Plan.

- The LCCFB Plan would involve the acquisition of significantly fewer residences and structures than the Modified Wide Setback Levee Plan and the conversion/loss of significantly less agricultural land.

MODIFIED WIDE SETBACK LEVEE PLAN

The MWSL Plan consists of constructing approximately 19 miles of levees along lower Cache Creek, as shown on Figure ES-4. Levee improvements begin at the west levee of the settling basin and terminate upstream near CR 94B.

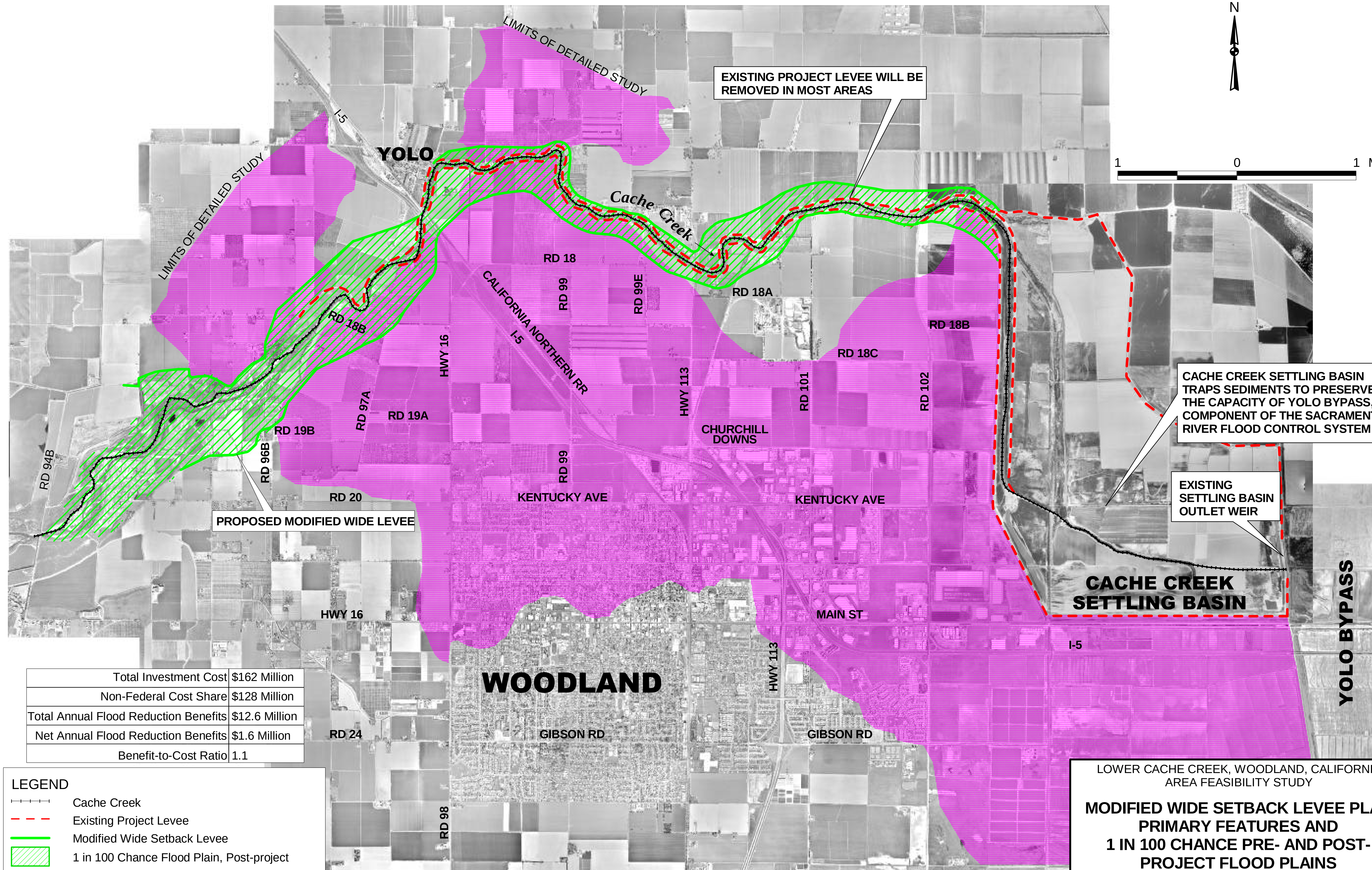
The levee alignments were selected to reduce the environmental mitigation associated with the location of elderberry plants and also to reduce effects to homes and farm structures. All bridge approaches would be modified. Modifications to the bridges would consist of rebuilding the bridge approaches and replacing the existing embankment approaches with viaduct approaches. These viaducts would substantially increase bridge openings and flow capacity, reducing the flow velocities and eliminating the need for rock slope protection and subsequent environmental mitigation. Concrete linings would still be necessary under bridges and in the main channel for erosion and scour protection.

Although rock slope protection is reduced at the bridges, rock slope protection would be required on a small portion of the left bank downstream from I-5. Furthermore, hard points (stone fills) would be installed at the outer bend near the vicinity of the town of Yolo. Due to the geomorphology of Cache Creek in these locations, bank protection is necessary to ensure lateral channel stability.

Toe drains, acting as lateral drainage channels, would also be installed on the waterside of the levees to facilitate overbank drainage. Additionally, approximately 70 percent of the existing levee system would be removed to allow water to flow back and forth from the channel and overbank area. The other 30 percent is expected to naturally degrade over time, minimizing disturbance to the nearby elderberry shrubs and substantially reducing environmental effects.

The MWSL Plan would, however, protect a larger area than the LCCFB Plan, including areas both north and south of the creek. The area between the levees of the MWSL would be inundated.

The estimated first cost is $153 million, and the total investment cost (includes interest during construction) is $163 million for the MWSL Plan, with a non-Federal cost share of $128 million. The total annual flood damage reduction benefits are estimated at $12.6 million, resulting in a net annual benefit of $1.6 million. The benefit-to-cost ratio is estimated to be 1.1.



Total Investment Cost	$162 Million
Non-Federal Cost Share	$128 Million
Total Annual Flood Reduction Benefits	$12.6 Million
Net Annual Flood Reduction Benefits	$1.6 Million
Benefit-to-Cost Ratio	1.1

LEGEND

- Cache Creek
- Existing Project Levee
- Modified Wide Setback Levee
- 1 in 100 Chance Flood Plain, Post-project
- 1 in 100 Chance Corps Flood Plain, Pre-project

LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

MODIFIED WIDE SETBACK LEVEE PLAN PRIMARY FEATURES AND 1 IN 100 CHANCE PRE- AND POST-PROJECT FLOOD PLAINS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure ES-4

Plan Accomplishments

- The MWSL Plan would have an 89 percent conditional annual chance of not flooding for the 1 in 100 chance flood event.
- The MWSL Plan would remove Woodland and a large portion of the land north and south of lower Cache Creek from the FEMA 1 in 100 chance flood plain.
- The MWSL Plan would allow for future restoration of Cache Creek.
- The MWSL Plan would involve fewer transportation effects from flooding than the LCCFB Plan.

MAJOR CONCLUSIONS AND FINDINGS

The No-Action Plan would continue to provide reliable protection from floods in lower Cache Creek that have up to a 1 in 10 chance of occurring in any given year[1]. Residences within the FEMA 1 in 100 chance flood plain that have federally insured mortgages and some businesses/facilities would be required to acquire flood insurance. Approximately one-third of Woodland would continue to remain subject to damages from future floods, and the flood hazard would continue to be significant. Socioeconomic effects of this would be significant. According to the planning objectives, this plan is unacceptable.

The LCCFB Plan would reduce flood damages to the city of Woodland and unincorporated areas south of the LCCFB. The plan would eliminate flood insurance requirements for residences and businesses within the city limits. Unincorporated areas to the north of the LCCFB and north of Cache Creek would remain within the FEMA 1 in 100 chance flood plain and continue to have reliable protection from floods with a 1 in 10 chance of occurrence in a given year. Continued flood fighting would be necessary; bank erosion and undercutting of the existing levee system would continue and repairs would be required. The LCCFB would be constructed along the northern urban limit line. This plan is consistent with the General Plans of the city and county. Environmental effects of the LCCFB on endangered species can be mitigated, and there appear to be no extraordinary construction requirements that would make this plan difficult to implement.

The MWSL Plan would provide Woodland and the unincorporated land to the north and south of the levee system with a minimum protection from floods from Cache Creek with a 1 in 100 chance of occurring in any given year. This plan would eliminate flood insurance requirements for residences and businesses in this area and would reduce the risk of flooding and closure of the transportation system, including I-5. Continued maintenance of the existing levee system would not be necessary, and, in general, the creek would be allowed to meander. This plan would have significantly greater effects to

[1] Although designed for a flow capacity of a 1 in 10 chance of occurring, the existing levee system has historically contained flow events of a 1 in 20 chance of occurring in any given year.

biological resources and special-status species compared to the LCCFB Plan, require extensive mitigation.

A summary comparison between the No-Action, the LCCFB, and the MWSL Plan is provided in Table ES-1, located at the end of this Executive Summary. Review of the table indicates that only the LCCFB and the MWSL Plan meet the planning and evaluation criteria. Of these two, the LCCFB Plan is the National Economic Development (NED) Plan, has the greatest net benefits, has the greatest benefit-to-cost ratio, and has the least environmental impacts.

The environmental effects, mitigation measures, and the level of significance with mitigation are evaluated in the Draft EIS/EIR. A summary of this information is presented in Table ES-2, located at the end of this Executive Summary, for the LCCFB Plan and Table ES-3 for the MWSL Plan.

UNRESOLVED ISSUES

Unresolved issues are defined as subject matter that requires further information or areas where a consensus is needed to make a final determination on a given issue. At the time of this report, certain studies and reports have either not been undertaken or have not been completed, and a resolution of where public support lies has not been attained. It is anticipated that resolution of the unresolved issues will not alter the major conclusions and findings of this report.

A quantitative analysis of the impacts that the LCCFB and MWSL Plans would have on the sedimentation characteristics of the settling basin has not been completed. A qualitative analysis of the sedimentation has been performed and it is clear that the LCCFB Plan would have a lower level of impacts than the MWSL Plan. A quantitative analysis is not necessary during the feasibility phase to determine that the impacts from the LCCFB Plan are less than the MWSL Plan. This conclusion was made based on the fact that design flows for the MWSL Plan would be contained in Cache Creek and directed into the settling basin, whereas, the LCCFB Plan would allow Cache Creek overflow to pond adjacent to the LCCFB and settling basin levees (allowing sediment to drop out) prior to discharging into the settling basin. Therefore, the sedimentation study for the LCCFB Plan will be conducted during the planning, engineering, and design (PED) phase to detail operational impacts and to describe modified operation and maintenance for sedimentation in the settling basin.

This proposed action has the potential to affect several special-status species. Potential conservation measures to reduce effects on special-status species due to the construction of the LCCFB are identified in the Special-Status Species Technical Appendix (Appendix B of the Draft EIS/EIR). The Special-Status Species Technical Appendix, along with the rest of the Draft EIS/EIR will be used as supporting documents for a Biological Assessment. The purpose of the Biological Assessment is to request concurrence from USFWS with the Corps' determination of no effect or not likely to adversely affect the palmate-bracted bird's beak and valley elderberry longhorn beetle. The Biological Assessment would also serve as a request to initiate formal Section 7 and

Essential Fish Habitat consultation on the giant garter snake, chinook salmon, and steelhead. The USFWS and NMFS would use the Biological Assessment as the basis for their Biological Opinions. It is expected that these Biological Opinions would be rendered before the completion of the Final EIS/EIR. Neither the Corps nor the Board would approve the initiation of construction on the proposed action prior to consideration of these Biological Opinions.

There are historic buildings within the project area. It may be determined in the PED phase that these buildings may require flood proofing. If action were taken to protect these buildings from flood damage, then consultation with the California State Historic Preservation Officer (SHPO) would need to be initiated. Under Section 106 of the National Historic Preservation Act, an intensive cultural resources evaluation would need to be conducted.

The California Department of Water Resources (DWR) would pay its share of the non-Federal cost of the Lower Cache Creek Flood Damage Reduction Project from the general California State Fund. The City of Woodland is investigating ways to finance its share of the non-Federal cost of the project.

The acquisition of the lands and easements necessary to construct and operate the project is expected to be difficult, costly, and time consuming. Both plans are controversial with the affected property owners. A number of issues over compensation for lands and easements required for and affected by the LCCFB are expected to be raised during the public comment period. Some of the issues that have been raised to date include loss of value/development potential, loss of opportunity to plant higher value crops, compensation for flood damages, loss in financing capability, and loss of value for being in a formalized flood plain.

TENTATIVELY RECOMMENDED PLAN

To this stage of the planning process, the study team has focused on the development and evaluation of an array of alternative plans to reduce flood damages in Woodland and vicinity, consistent with protecting the environment and with pertinent laws, regulations, and policies. Based on the evaluation of estimated costs and benefits, and potential environmental and socioeconomic conditions and effects, the LCCFB Plan has been identified by the study team as the Tentatively Recommended Plan. The partners for the potential project (the Corps, the Board, and the City of Woodland) will fully consider the comments received from the public regarding this Draft Feasibility Report and Draft EIS/EIR before formally selecting a Recommended Plan in the Final Feasibility Report. The LCCFB Plan has also been identified by the study team as the least environmentally damaging plan. It is also the plan with the highest net benefits, consistent with the Federal objective for a project to contribute to National economic development while protecting the environment; it is the NED Plan.

Several additional regulatory requirements will need to be met as the project moves forward toward implementation. The Status of Compliance of the flood damage reduction study for each law and executive order is outlined in Table ES-4, following this Executive Summary.

Table ES-1. Summary Comparison Between the No-Action, the LCCFB, and the MWSL Plans

	No Action	LCCFB Plan (NED)	MWSL Plan
1. PLAN DESCRIPTION			
Annual Performance (chance of being exceeded in any year)	1 in 10	1 in 500	1 in 500
Conditional Annual Percent Chance of not Flooding for 100-year event		97.3%	89.3%
2. IMPACT ASSESSMENT			
A. Economic			
(1) First Costs	$0	$40,973,000	$152,594,000
(2) Total Investment Cost	$0	$43,761,000	$162,975,000
(3) Annual Cost	$0	$2,923,000	$10,936,000
(4) Total Annual Benefits	$0	$11,541,000	$12,550,000
(5) Annual Net Benefits	$0	$8,618,000	$1,614,000
(6) Benefit-to-Cost Ratio	NA	3.9	1.1
B. Environmental Quality (EQ)			
(1) Air/Noise	Normal air quality and noise levels created by traffic, business, and industrial activities.	Temporary increased air quality pollutant and noise levels during 2-year construction period.	Temporary increased air quality pollutant and noise levels during 3-year construction period.
(2) Vegetation &Wildlife	Existing vegetation typical for streams in northern California. Good habitat for woodland songbirds and urban wildlife.	Permanent loss of 137 acres to project features.	Permanent loss of 199 acres to project features.
(3) Land Use	No effect	Converts 104 acres of agricultural lands to flood control uses; loss of 100 acres of prime farmland.	Converts 216 acres of agricultural lands to flood control uses; loss of 158 acres of prime farmland and indirect effects to farm operations on 1,254 acres of prime farmland between the setback levees.
(4) Special Status Species	Loss of habitat associated with rehabilitation and maintenance of existing levee system (2,100 linear feet of riprap and 6 miles of new levee construction).	Loss of habitat (160 acres and 100 trees) affecting Swainson's hawk, giant garder snake, northwestern pond turtle, steelhead, and Chinook salmon.	Loss of habitat (199 acres and 1,176 trees) affecting: valley elderberry longhorn beetle (100 stems direct, 200 stems indirect), Swainson's hawk, giant garder snake, northwestern pond turtle, steelhead and chinook salmon.

Table ES-1. Summary Comparison Between the No-Action, the LCCFB, and the MWSL Plans

	No Action	LCCFB Plan (NED)	MWSL Plan
(5) Settling Basin	No effect	Possible effect on the distribution of sediments within basin. No decrease in project life of basin. Removal of 1 mile of training levee.	Possible effect on the distribution of sediments within basin. Substantial increase in peak floodflows into the settling basin. No decrease in project life of basin. Removal of 2 miles training levee.
(6) Cultural Resources & Historic Properties	Cultural resources and historic properties subject to flood damages from events greater than 1in 20 chance.	Protects cultural resources and historic properties in Woodland (south of the LCCFB). Resources and historic properties between Cache Creek and the LCCFB would remain subject to flood damages.	Archeological and historic sites could be affected by levee construction, degradation of the present levee, and accelerated erosion. Once levee construction is complete, all archeological and historic sites on the landside of the MWSL would be protected.
C. Other Social Effects			
(1) Life, Health, and Safety	Significant flood threat to one-third of Woodland.	Reduces flood threat to Woodland.	Reduces flood threat to city of Woodland and to residents “behind” the setback levees.
(2) Community Cohesion (displacement of people & businesses)	Increased insurance costs to owners within the FEMA floodplain. Additional costs to develop properties within the FEMA floodplain.	Some displacement of residents north of flood barrier levee. Flood depths and durations increased in some areas north of flood barrier levee requiring the acquisition of occasional flowage easements (1,816 acres), the acquisition and relocation of one resident and structural measures to mitigate for induced flooding at six residential properties.	Increased displacement of residents and agricultural operations to residents between the new levees. Requires the acquisition of permanent flowage easements (1,679 acres) and the acquisition and relocation of 32 residential and business structures.
3. PLAN EVALUATION			
A. Contribution to Planning Objectives			
(1) Efficiently reduces flood damages to maximum practical extent	Average Annual Flood Damages (AAD) is $12,429,000. Does not meet objective	Residual AAD = $888,000 for a 93% reduction in AAD. Meets objective.	Residual AAD = $794,000 for a 94% reduction in AAD. Meets objective.

Table ES-1. Summary Comparison Between the No-Action, the LCCFB, and the MWSL Plans

	No Action	LCCFB Plan (NED)	MWSL Plan
(2) Provide optimum level of flood protection	Damage outputs starting at the 20-year flood level. Does not meet objective	1 in 500 chance for Woodland, NED plan. Meets objectives.	1 in 500 chance for Woodland and most of the floodplain. Meets objectives
(3) Minimize environmental impacts	Existing vegetation typical for streams in northern California. Excellent habitat for woodland birds and urban wildlife. Meets objective.	Permanent loss of 104 acres to project features. Temporary disturbed areas to be restored. Meets objective.	Permanent loss of 216 acres to project features. Potential loss of 2,135 acres between the levees. Temporary disturbed areas to be restored. Meets objective.
B. Response to Planning Constraints			
(1) Financial capability of local partners to cost-share project construction	N/A	Local cost share of $16,092,000 is within local capabilities.	Local cost share of $127,702,000 is not within local capabilities.
(2) Institutional acceptability	Ongoing high level of flood damages not acceptable to local partners. Does not meet constraint.	1 in 500 chance protection acceptable to local partners and meets Federal criteria. Meets constraint.	1 in 500 chance protection acceptable to local partners and meets Federal criteria. Meets constraint.
(3) Public acceptability	Not acceptable. Does not meet constraint.	Not fully acceptable. Partially meets constraint.	Not fully acceptable. Partially meets constraint.
C. Response to Evaluation Criteria			
(1) Completeness	Does not meet objective.	Meets objective.	Meets objective.
(2) Effectiveness	Does not meet objective.	Meets objective.	Meets objective.
(3) Efficiency	Does not meet objective.	Meets objective.	Meets objective.
(4) Acceptability	Does not meet objective.	Meets objective. Public opposition to increased flood depths and durations north of flood barrier levee.	Meets objective. No public support for conversion of agricultural land to flood control uses.

Table ES-2. Summary of Environmental Effects and Mitigation – LCCFB Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Social and Economic Resources		
Project-induced flooding on some lands north of the flood barrier would cause a potential decrease in land value.	Agricultural landowners would be compensated for land value effects/takings to the extent required by law.	LTS[1]
One home would be relocated.	Landowners and homeowners would be compensated for land/home value effects/takings.	LTS
Land Use		
The flood barrier footprint would convert 100 acres of row crop, 2 acres of orchard, and 2 acres of agricultural support lands for flood control purposes.	This effect represents an incompatible land use change and is a significant effect that cannot be mitigated.	SU[2]
Agriculture, Prime and Unique Farmlands		
The flood barrier would result in a loss of 100 acres of prime farmland and 2 acres of statewide important/locally important farmland.	The conversion of prime farmlands represents an effect that cannot be mitigated.	SU
Transportation		
Temporary direct transportation effects would include lane closure during road repair, roadway safety hazards, and an increase in traffic volume.	• Lead agency to provide traffic management plan. • Contractors would use construction easements as much as feasible when hauling materials to the construction site. • Traffic would be rerouted when necessary to avoid construction areas. • Flaggers would be stationed to slow or stop approaching vehicles to avoid conflicts with construction vehicles or equipment.	LTS
Indirect transportation effects result from the flooding of CR 102 for a greater length of time than under existing conditions. Under existing conditions, a 5' levee perpendicular to CR 102 would cause flooding of the roadway. With project conditions, the levee height would be increased to 18', increasing the depth and duration of flooding at CR 102. This impact would occur for floods that have greater than a 1 in 40 chance of occurring. These road closures could cause lengthened response times for emergency vehicles traveling to residents northeast of the city of Woodland.	The mitigation listed below would reduce the effects, but not to a less-than-significant level. • Detours would be available to circumvent flooded roadways.	SU

[1] LTS = Less than significant
[2] SU = Significant unavoidable

Table ES-2. Summary of Environmental Effects and Mitigation – LCCFB Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Noise		
Construction of the flood barrier would temporarily produce decibel levels above the significance threshold for some sensitive receptors during construction.	The mitigation listed below would reduce the effects, but not to a less-than-significant level. • Construction equipment would be outfitted and maintained with noise-reduction devices such as mufflers. • Construction would be limited to daytime hours.	SU
Air Quality		
NO_x emissions would exceed the significance thresholds established by the Yolo-Solano Air Quality Management District (YSAQMD). The exceedence would be a temporary effect during construction.	The mitigation listed below would reduce NO_x emissions, but not to a less-than-significant level. • Incorporate NO_x mitigation measures into construction plans and specifications.	SU
PM_{10} emissions would exceed the significance thresholds established by the YSAQMD. The exceedence would be a temporary effect during construction. Sensitive receptors would also be exposed to the high levels of fugitive dust emissions.	The mitigation listed below would reduce PM_{10} emissions, but not to a less-than-significant level. The lead agency would provide a dust suppression plan that would likely include the following measures: • All construction areas, unpaved access roads, and staging areas would be watered as needed during dry soil conditions, or soil stabilizers would be applied. • All trucks hauling soil or other loose material would be covered or have at least 2 feet of freeboard. Construction vehicles would use paved roads to access the construction site wherever possible. • Vehicle speeds would be limited to 15 mph on unpaved roads and construction areas, or as required to control dust. • Streets would be cleaned daily if visible soil material is carried onto adjacent public streets. • Soil stabilizers would be applied to inactive construction areas on an as-needed basis. • Exposed stockpiles of soil and other excavated materials would be enclosed, covered, watered, or applied with soil binders as needed.	SU

Table ES-2. Summary of Environmental Effects and Mitigation – LCCFB Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Air Quality (continued)		
	• Vegetation would be replanted in disturbed areas as quickly as possible following the completion of construction.	
Settling Basin		
The removal of the training levee could alter the distribution of sedimentation in the settling basin.	Design of the LCCFB Plan would incorporate the function of the settling basin.	LTS
Water Quality		
Pollutants from construction equipment and erosion at the construction site could temporarily degrade the water quality of local runoff during construction.	The proper permitting procedures would be adhered to. In addition, appropriate best management practices and monitoring would be implemented to preserve the quality of surface runoff.	LTS
Vegetation and Wildlife		
Project-related effects, as determined by the USFWS in its draft CAR, would include the loss of 122 acres of agricultural habitat, 100 native and non-native trees, 0.52 acre of upland habitat, and 0.28 acre of scrub shrub.	Mitigation for habitat loss has been outlined by the Fish and Wildlife Service in its Coordination Act Report (Appendix A of Draft EIS/EIR).	LTS
Construction-related effects would include disturbance from equipment and crews and potential disturbance of species.	Mitigation measures include: • Restricting construction crews to the right-of-way and confinement of disturbance to as small an area as possible; • Requiring construction crews to maintain a 15 m.p.h. speed limit on all unpaved roads to reduce the chance of wildlife being mortally wounded if struck by construction equipment; and • Conducting nest surveys prior to the removal of any trees or scrub shrub to ensure migratory birds would not be lost during construction, pursuant to the Migratory Bird Treaty Act.	LTS

Table ES-2. Summary of Environmental Effects and Mitigation – LCCFB Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Special-Status Species		
Project-related effects to special-status species (Swainson's hawk, giant garter snake, northwestern pond turtle, chinook salmon, steelhead) would include temporary and permanent loss of habitat.	Incidental Take Conditions for effects to special-status species would be determined through formal consultation with the Fish and Wildlife Service and National Marine Fisheries Service and outlined in their Biological Opinion. Proposed conservation measures are outlined in Section 5.7 of Draft EIS/EIR.	LTS
Construction-related effects would include disturbance from equipment and crews and potential take of species.	Incidental Take Conditions for effects to special-status species would be determined through formal consultation with the Fish and Wildlife Service and National Marine Fisheries Service and outlined in their Biological Opinion. Incidental Take Conditions for effects to State special-status species would also be determined through formal consultation with the California Department of Fish and Game. Proposed conservation measures are outlined in Section 5.7 of Draft EIS/EIR.	LTS
Cultural Resources		
Increased flooding may occur at sites between the creek and barrier.	Mitigation measures would be developed in consultation with the State Historic Preservation Office and could include flood proofing some structures.	LTS
Esthetic and Visual Resources		
The flood barrier would create a new linear feature and a view block to residents.	The LCCFB would be reseeded with grasses and forbs; however, this would not reduce the overall effect to less-than-significant.	SU

Table ES-3. Summary of Environmental Effects and Mitigation - MWSL Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Social and Economic Resources		
The proposed setback alignment would result in the relocation of 32 residences and up to 182 farm structures.	Landowners and homeowners would be compensated for land and home value effects/takings to the extent required by law.	LTS[1]
Land Use		
The levee system would convert 123 acres of row crop, 35 acres of orchard, 11 acres of riparian, and 47 acres of agricultural support lands. Potential conversion of an additional 2,135 acres of land confined between the levees.	This effect represents an incompatible land use and is a significant effect that cannot be mitigated.	SU[2]
Agriculture, Prime and Unique Farmlands		
The setback levee would result in a loss of 158 acres of prime farmland. A total of 1,254 acres of prime farmland confined by the levee system has the potential of conversion (to native habitat) due to indirect effects (inability to farm due to size, accessibility, or other factors).	The conversion of prime farmlands represents an effect that cannot be mitigated.	SU
Transportation		
Temporary direct transportation effects would include lane closure during road repair, roadway safety hazards, and an increase in traffic volume.	• Lead agency to provide traffic management plan. • Contractors would use construction easements as much as feasible when hauling materials to the construction site. • Traffic would be rerouted when necessary to avoid construction areas. • Flaggers would be stationed to slow or stop approaching vehicles to avoid conflicts with construction vehicles or equipment.	LTS
Noise		
Construction of the setback levees would temporarily produce decibel levels above the significance threshold for some sensitive receptors during construction.	Mitigation would reduce the effects, but not to a less-than-significant level. • Construction equipment would be outfitted and maintained with noise-reduction devices such as mufflers. • Construction would be limited to daytime hours.	SU

[1] LTS = Less than significant
[2] SU = Significant unavoidable

Table ES-3. Summary of Environmental Effects and Mitigation - MWSL Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Air Quality		
NO_x emissions would exceed the significance thresholds established by the YSAQMD. The exceedence would be a temporary effect during construction.	The following mitigation would reduce NO_x emissions, but not to a less-than-significant level. Incorporate NO_x mitigation measures into construction plans and specifications.	SU
PM_{10} emissions would exceed the significance thresholds established by the YSAQMD. The exceedence would be a temporary effect during construction. Sensitive receptors would also be exposed to the high levels of fugitive dust emissions.	The following mitigation would reduce PM_{10} emissions, but not to a less-than-significant level. The lead agency would provide a dust suppression plan that would likely include the following measures: • All construction areas, unpaved access roads, and staging areas would be watered as needed during dry soil conditions, or soil stabilizers would be applied. • All trucks hauling soil or other loose material would be covered or have at least 2 feet of freeboard. Construction vehicles would use paved roads to access the construction site wherever possible. • Vehicle speeds would be limited to 15 mph on unpaved roads and construction areas, or as required to control dust. • Streets would be cleaned daily if visible soil material were carried onto adjacent public streets. • Soil stabilizers would be applied to inactive construction areas on an as-needed basis. • Exposed stockpiles of soil and other excavated materials would be enclosed, covered, watered, or applied with soil binders as needed. • Vegetation would be replanted in disturbed areas as quickly as possible following the completion of construction.	SU
Settling Basin		
The removal of the training levee could alter the distribution of sedimentation in the settling basin.	Design of the MWSL Plan would incorporate the function of the settling basin.	LTS

Table ES-3. Summary of Environmental Effects and Mitigation - MWSL Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Water Quality		
Pollutants from construction equipment and erosion at the construction site could temporarily degrade the water quality of local runoff during construction.	The proper permitting procedures would be adhered to. In addition, appropriate best management practices and monitoring would be implemented to preserve the quality of surface runoff.	LTS
Vegetation and Wildlife		
Project-related effects, as identified by the USFWS in its draft CAR, would include loss of 174 acres of agricultural habitat, 49 acres of orchard trees, 9.01 acres of riparian habitat, and 0.69 acre of shaded riverine aquatic habitat.	Mitigation for habitat loss would be outlined by the Fish and Wildlife Service according to guidelines detailed in the CAR. (Appendix A of Draft EIS/EIR)	LTS
Vegetation and Wildlife (continued.)		
Construction-related effects would include disturbance from equipment and crews and potential disturbance of species.	Mitigation measures include: • Restricting construction crews to the right-of-way and confinement of disturbance to as small an area as possible; • Requiring construction crews to maintain a 15 m.p.h. speed limit on all unpaved roads to reduce the chance of wildlife being mortally wounded if struck by construction equipment; and • Conducting nest surveys prior to the removal of any trees or scrub shrub to ensure migratory birds would not be lost during construction, pursuant to the Migratory Bird Treaty Act.	LTS
Special-Status Species		
Project-related effects to special-status species (valley elderberry longhorn beetle, Swainson’s hawk, giant garter snake, northwestern pond turtle, chinook salmon, steelhead) would include loss of habitat.	Incidental Take Conditions for effects to Federal special-status species would be determined through formal consultation with the Fish and Wildlife Service and National Marine Fisheries Service and outlined in their Biological Opinion. Incidental Take Conditions for effects to State special-status species would also be determined through formal consultation with the California Department of Fish and Game. Proposed conservation measures are outlined in Section 5.7 in Draft EIS/EIR.	LTS

Table ES-3. Summary of Environmental Effects and Mitigation - MWSL Plan

Significant Effects	Mitigation and Best Management Practices	Level of Significance with Mitigation
Special-Status Species (continued)		
Construction-related effects would include disturbance from equipment and crews and potential take of species	Incidental Take Conditions for effects to special-status species would be determined through formal consultation with the Fish and Wildlife Service and National Marine Fisheries Service and outlined in their Biological Opinion. Incidental Take Conditions for effects to State special-status species would also be determined through formal consultation with the California Department of Fish and Game. Proposed conservation measures are outlined in Section 5.7 of Draft EIS/EIR.	LTS
Cultural Resources		
Archeological and historic sites could be affected by levee construction, degradation of the present levee, and accelerated erosion.	Mitigation measures could consist of avoidance; data recovery; and, for structures, recordation under the Historic American Buildings Survey/Historic American Engineering Recordation criteria.	LTS
Esthetic and Visual Resources		
Effects would include the extension of bridges and the presence of a new viewblock to numerous rural residences.	Mitigation measures would include reseeding the new levees; however, this would not reduce the effect to a less-than-significant level.	SU

Table ES-4. Status of Compliance

Federal Statute	Status of Compliance
National Environmental Policy Act of 1969	Ongoing
National Historic Preservation Act of 1966	Ongoing
Clean Air Act	Ongoing
Water Resources Development Act of 1986	Ongoing
Clean Water Act	Ongoing. A 404(b)(1) evaluation has been completed.
Endangered Species Act	Ongoing. Informal consultation has been initiated.
Federal Water Project Recreation Act	In compliance.
Fish and Wildlife Coordination Act	Ongoing. A draft CAR has been furnished by the USFWS.
Migratory Bird Treaty Act	Ongoing. Conservation measures have been identified to aid in compliance.
Federal Agriculture Improvement and Reform Act of 1996 and 1985 Food Security Act	No effect.
Executive Order 11988, Flood Plain Management	Ongoing
Executive Order 11990, Protection of Wetlands	Ongoing
Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	In compliance.
Farmland Protection Policy Act	In compliance.
Executive Order 13148, The Greening of Government Through Leadership in Environmental Management	In compliance.
Executive Order 13007, Indian Sacred Sites	In compliance.
Note: Ongoing – Some requirements of the regulation remain to be met by subsequent installation actions before implementation of some of the actions associated with this project. Once the statutory requirement for each action has been met, compliance will be labeled "in compliance."	

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Chapter 8 – Plan Implementation, Conclusions, and Recommendations

REFERENCES

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ABBREVIATIONS AND ACRONYMS

ADT	Average Daily Traffic Volumes
AQMD	Air Quality Management District
B/C	Benefit/Cost
BFE	Base Flood Elevation
Board	Reclamation Board of the State of California
CalTrans	California Department of Transportation
CAR	Coordination Act Report
CCRMP	Cache Creek Resources Management Plan
CCSB	Cache Creek Settling Basin
CEQA	California Environmental Quality Act
CFR	Code Federal Regulation
cfs	Cubic Feet per Second
CNRFC	California Nevada River Forecast Center
Corps	U.S. Army Corps of Engineers
CR	County Road
CRMP	Coordinated Resource Management Plan
DFG	Department of Fish and Game (California)
DWR	Department of Water Resources (California)
EDR	Environmental Data Resources, Inc.
EIR	environmental impact report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FS	Feasibility Study
USFWS	U.S. Fish and Wildlife Service
HTRW	Hazardous, Toxic, Radiological Waste
LCCFB	Lower Cache Creek Flood Barrier
LPP	Locally Preferred Plans
msl	Mean Sea Level
MWSL	Modified Wide Setback Levee
NAVD88	North America Vertical Datum, 1988
NAWQA	National Water-Quality Assessment
NED	National Economic Development
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NMFS	U.S. National Marine Fisheries Service
NOI	Notice of Intent
NOP	Notification of Preparation
NRHP	National Register of Historic Places
NSL	Narrow Setback Levee

ABBREVIATIONS AND ACRONYMS *(Continued)*

NRCS	USDA Natural Resources Conservation Service
NWS	National Weather Service
OCMP	Off-Channel Mining Plan
OMRR&R	Operation, Maintenance, Repair, Rehabilitation, and Replacement
O&M	Operations and Maintenance
PCB	Polychloride Biphenyls
PED	preconstruction engineering and design
PFP	Probable Failure Point
PM_{10}	Suspended Particulates
PNP	Probable Nonfailure Point
RWQCB	Regional Water Quality Control Board
SHPO	California Sate Historic Preservation Office
SRA	Shaded Riverine Aquatic
SRFCP	Sacramento River Flood Control Project
SWRCB	State Water Resources Control Board
YSAQMD	Yolo-Solano Air Quality Management District
SH	State Highway
SHPO	California State Historic Preservation Office
TMDL	Total Maximum Daily Load
UPNCRR	Union Pacific Northern California Railroad
USGS	U.S. Geological Survey
WSL	Wide Setback Levee

Abbreviations and Acronyms

ADT	Average Daily Traffic Volumes
AQMD	Air Quality Management District
B/C	Benefit/Cost
BFE	Base Flood Elevation
CCRMP	Cache Creek Resources Management Plan
CCSB	Cache Creek Settling Basin
cfs	Cubic Feet per Second
CNRFC	California Nevada River Forecast Center
CR	County Road
CRMP	Coordinated Resource Management Plan
DFG	Department of Fish and Game (California)
DWR	Department of Water Resources (California)
EDR	Environmental Data Resources, Inc.
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FS	Feasibility Study
USFWS	US Fish and Wildlife Service
HTRW	Hazardous, Toxic, Radiological Waste
LCCFB	Lower Cache Creek Flood Barrier
LPP	Locally Preferred Plans
msl	Mean Sea Level
NAVD	North America Vertical Datum
NAWQA	National Water-Quality Assessment
NED	National Economic Development
NFIP	National Flood Insurance Program
USNMFS	US National Marine Fisheries Service
NOI	Notice of Intent
NOP	Notification of Preparation
NRCS	USDA Natural Resources Conservation Service
NWS	National Weather Service
OCMP	Off-Channel Mining Plan
OMRR&R	Operation, Maintenance, Repair, Rehabilitation, and Replacement
O&M	Operations and Maintenance
PCB	Polychloride Biphenyls
PFP	Probable Failure Point
PM_{10}	Suspended Particulates
PNP	Probable Nonfailure Point
RWQCB	Regional Water Quality Control Board
SRA	Shaded Riverine Aquatic
SRFCP	Sacramento River Flood Control Project
SH	State Highway

TMDL	Total Maximum Daily Load
UPNCRR	Union Pacific Northern California Railroad
USACE	US Army Corps of Engineers
USGS	US Geological Survey

Chapter 1

CHAPTER 1
INTRODUCTION

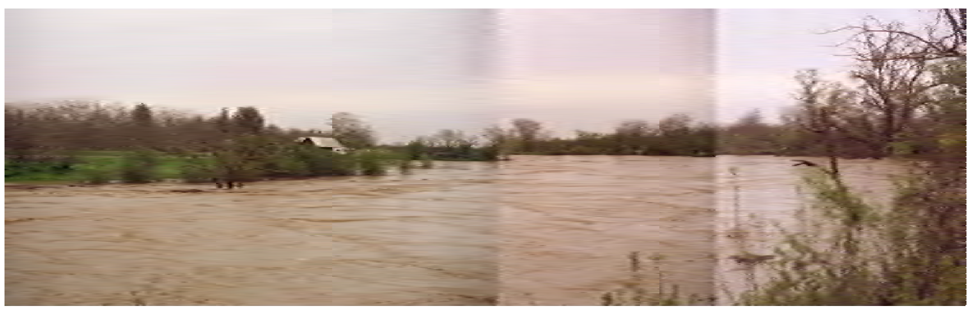
North from County Road 95A toward County Road 18A – 1995.

Downstream from right bank at Olivers – 1995.

Highway 99, upstream of East Frontage Road - 1995

CHAPTER 1
INTRODUCTION

North from County Road 95A toward County Road 18A – 1995.



Downstream from right bank at Olivers – 1995.

Highway 99, upstream of East Frontage Road - 1995

CHAPTER 1

INTRODUCTION

PURPOSE AND SCOPE OF REPORT

This Draft Feasibility Report addresses the results of the feasibility study concerning flooding problems in the lower reach of Cache Creek and the City of Woodland, California. This report was prepared jointly by the Federal sponsor, the U.S. Army Corps of Engineers, Sacramento District (Corps), and the non-Federal sponsors, the Reclamation Board of the State of California (Board) and the City of Woodland.

The Feasibility Report and the accompanying *Lower Cache Creek, Yolo County, CA, City of Woodland Vicinity Draft Environmental Impact Statement/Environmental Impact Report for Potential Flood Damage Reduction Project* (Draft EIS/EIR) address potential effects of alternative plans as solutions to the identified problems and opportunities and recommend that Congress authorize the implementation of the proposed solution. This Draft Feasibility Report presents an evaluation of the planning, technical, and environmental information, including:

- The planning objectives to reduce flood damages within the identified problem area (lower Cache Creek, east of County Road (CR) 94B and north of Woodland);
- The project setting and without-project conditions;
- The problems and opportunities;
- The plan formulation process;
- The evaluation of the potential effects of alternative plans;
- The evaluation and comparison of final plans; and
- The identification of the Tentatively Recommended Plan.

NEED FOR THE PROPOSED PROJECT

LOCATION OF STUDY AREA

The area addressed in this report includes the entire Cache Creek watershed from the eastern foothills of the Coast Range Mountains to the western levees of the Yolo Bypass. The area includes parts of Yolo, Colusa, and Lake Counties. The focus of the report is flood damage reduction opportunities specific to the problem/study area: the city of Woodland (Figure 1-1).

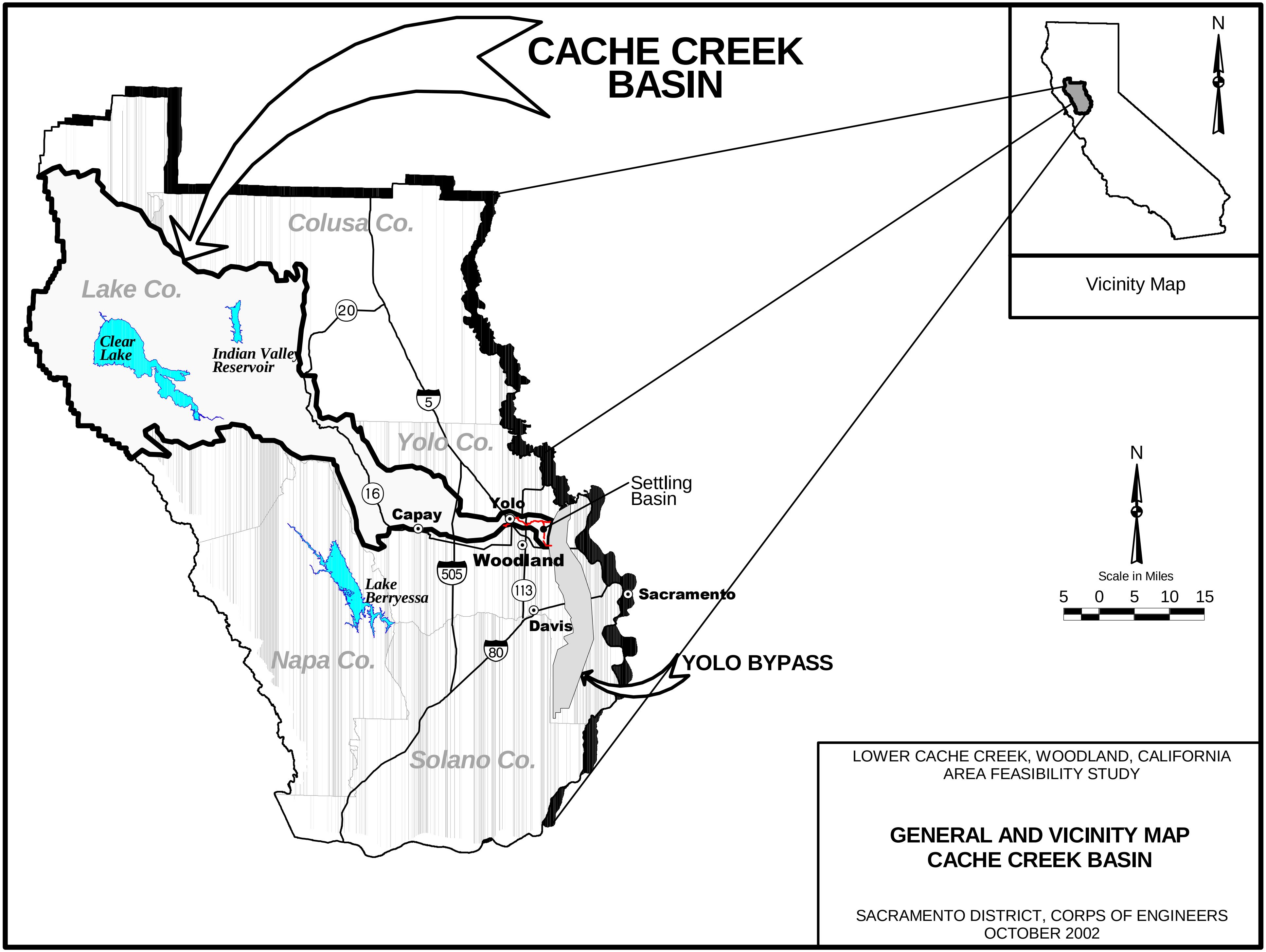
BACKGROUND

Cache Creek originates below the outlet channel of Clear Lake on the western foothills of the Coast Range Mountains and is fed by the North Fork of Cache Creek, on which is Indian Valley Dam and Reservoir, and Bear Creek on the northern slope of the upper watershed. The creek meanders from the upper watershed to the flat plain near Woodland and Yolo and ends at the settling basin near the Yolo Bypass, as shown on Figure 1-2. Cache Creek is no longer directly connected to the Sacramento River. In addition to providing water and habitat for fish and wildlife, Cache Creek is a source of water for domestic use, farming, cattle grazing, gravel mining, other industrial uses, and recreation. The creek is owned primarily by private parties and is not considered a navigable waterway of California.

Within the last 100 years, the creek has experienced dramatic human-induced and natural changes. The natural changes include shifting of the stream channel as a result of eroding banks and storms; eroding soil from the upper watershed; and poor water quality due to boron, mercury, and other naturally occurring chemicals. During periods of heavy runoff, the creek carries a significant sediment load, requiring the use of the Cache Creek Settling Basin to protect the Yolo Bypass from filling in with sediment. The human-induced changes include channel and levee work for flood damage reduction and irrigation, gravel mining within the channel, agricultural runoff, soil erosion due to overuse and livestock in the rangeland portion of the creek watershed, and introduction of nonnative plant species such as tamarisk and giant reed.

New Flood Insurance Rate Maps (FIRM's) issued by the Federal Emergency Management Agency (FEMA) took effect on April 2, 2002. These maps show a significant increase in the areas of Yolo County and the city of Woodland that have at least a 1 in 100 chance of flooding in any given year (100-year expected recurrence interval). The City of Woodland and surrounding local areas seek to reduce flood hazards. The Corps reconnaissance report indicates that there is an economically feasible project to provide the necessary flood damage reduction measures.

The Corps is conducting the feasibility study of flood damage reduction alternative plans with the cooperation of the California Department of Water Resources


CACHE CREEK
BASIN
Colusa Co.
Lake Co.
Clear
Lake
Indian Valley
Reservoir
20
5
Yolo Co.
16
Capay
Yolo
Settling
Basin
Woodland
505
113
Lake
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Davis
80
Napa Co.
YOLO BYPASS
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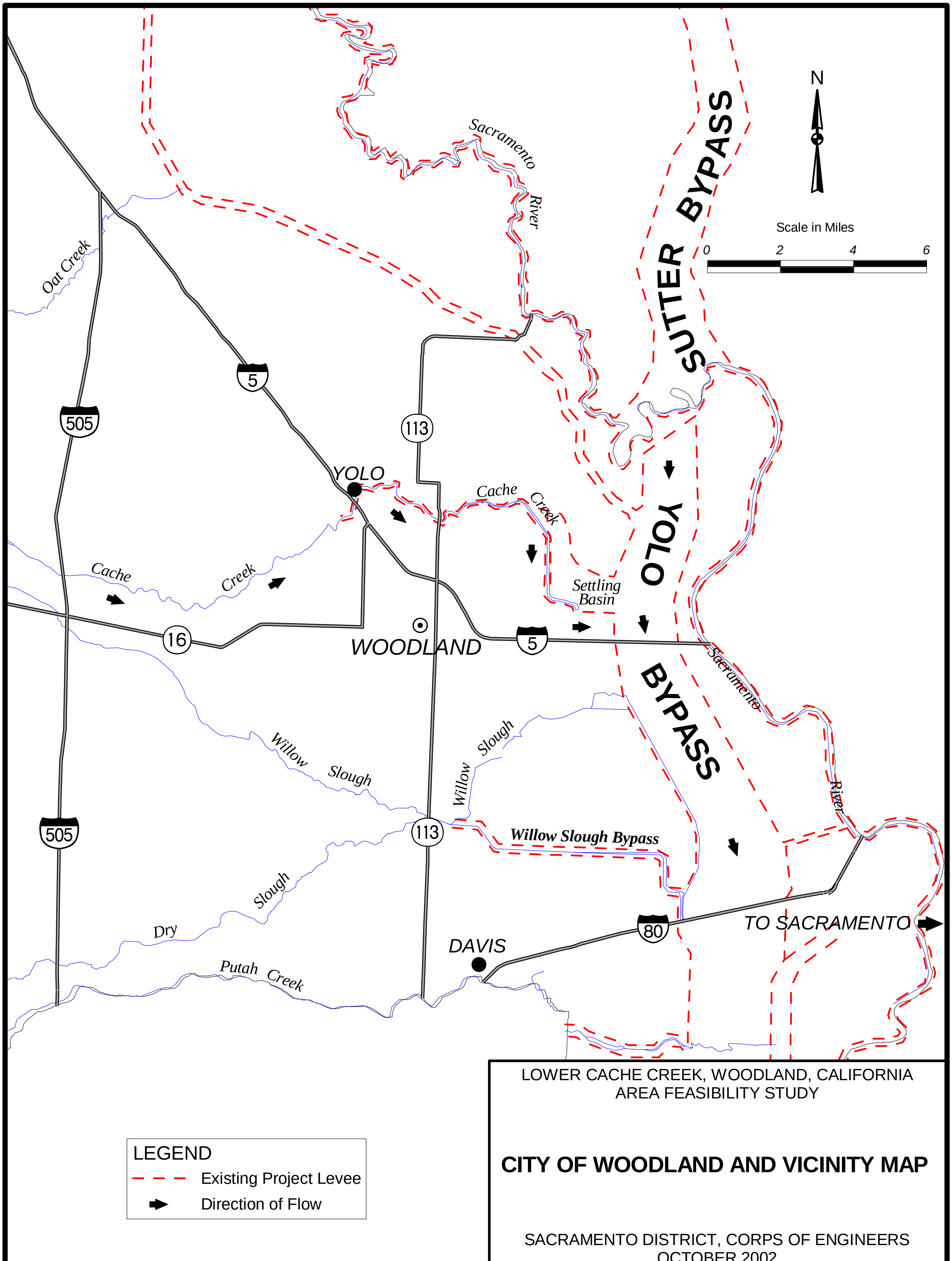
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
GENERAL AND VICINITY MAP
CACHE CREEK BASIN
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure 1-1



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

CITY OF WOODLAND AND VICINITY MAP

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure 1-2

(DWR), Yolo County, City of Woodland, California Department of Fish and Game (DFG), U.S. Fish and Wildlife Service (USFWS), and other local agencies.

STUDY AUTHORITY

The general authority for this investigation is provided by the Flood Control Act of 1962 (Public Law 87-874). In the Energy and Water Development Appropriations Act of 1993 (Public Law 102-377), Congress directed the Corps to conduct a "…reconnaissance study of flooding problems in the westside tributaries, Putah and Cache Creeks, of Yolo Bypass." The reconnaissance study was initiated in April 1993 at the request of the Yolo County Board of Supervisors. Sufficient potential Federal interest was identified to proceed with a feasibility-level investigation of flood damage reduction alternative plans along lower Cache Creek. A feasibility cost-share agreement between the Corps and the Board and a local feasibility cost-share agreement between The Board and the City of Woodland were signed in January 2000.

RELATED STUDIES AND REPORTS

Numerous studies and reports have provided background information and detail on flooding problems and environmental resources in the study area. These studies and reports are described below.

CORPS OF ENGINEERS

"Reconnaissance Report, Northern California Streams, Cache Creek Environmental Restoration, California," December 1995. This study examined options for restoring fish and wildlife habitat along the Cache Creek riparian corridor. Natural and human-induced changes, including aggregate extraction, nonnative plant growth, erosion and sedimentation, ground-water overdraft, agriculture and urban development, and channel and levee work for flood damage reduction have significantly affected fish and wildlife populations and their habitats. The study evaluated three environmental restoration plans to address these issues; however, no sponsor has been identified for any of the environmental restoration projects. The study identified a levee along the northern city limits as an economically feasible flood damage reduction project.

"Westside Tributaries to Yolo Bypass, California, Reconnaissance Report," June 1994. This reconnaissance study was to evaluate the water resource problems and opportunities of the Cache Creek, Willow Slough, and Putah Creek basins. The results of the reconnaissance study indicated that sufficient potential Federal interest existed to proceed with a feasibility-level flood damage reduction study for the city of Woodland and town of Yolo. The two plans that were economically feasible were the channel improvement plan and the setback levee plan. Due to financial uncertainties, Yolo County and the City of Woodland requested that the detailed feasibility studies be postponed.

“Cache Creek Basin, California, Final Feasibility Report and Environmental Impact Statement for Water Resources Development,” February 1979. This study investigated flood sediment deposits and related water-resource problems in the Cache Creek basin. This study resulted in the authorization for enlargement of the Clear Lake Outlet Channel and construction of a bypass channel 1.8 kilometers (1.1 miles) long. However, the July 1990 “Cache Creek Basin Outlet Channel, California, Final General Design Memorandum” found this project to be economically infeasible; therefore, the project was never constructed. The “Cache Creek Basin (Lake County), California, Reconnaissance Report,” October 1992, determined that nonstructural flood proofing was economically feasible.

“Cache Creek Basin, California, Cache Creek Settling Basin, General Design Memorandum,” January 1987. This project was authorized by Congress in 1986 to enlarge and raise the perimeter levees of the settling basin for sediment storage. Construction was completed in September 1993.

“Sacramento Metropolitan Area, Final Feasibility Report, California,” February 1992. This study investigated flooding problems along the Sacramento River and Yolo Bypass in the city of West Sacramento. This study recommended levee raising around the West Sacramento area to reduce the risk of flooding to less than 1 in 400 in any given year.

“Sacramento River Flood Control System Evaluation, Initial Appraisal Report – Lower Sacramento Area, Phase IV,” October 1993. This study identified portions of the project levees along Cache Creek, Willow Slough Bypass, and South Fork Putah Creek that do not have adequate freeboard above the design water surface. This report indicated that this deficiency might have been caused by regional subsidence due to excessive ground-water pumping, underground gas extraction, or seismic fault movement. The study recommended that the State and local agencies raise the levees to the 1956 design criteria of reliably passing a 1 in 10 chance flow event. The California Department of Water Resources completed the levee maintenance in October 1995.

“Sacramento River Flood Control System Evaluation, Design Memorandum Report – Mid-Valley Area, Phase III, California,” September 1995. This study is the third phase of the comprehensive analysis and evaluation of about 386 kilometers (240 miles) of project levees along the Sacramento and Feather Rivers and their tributaries. This study concluded that the project levees are susceptible to seepage and stability problems and recommended reconstruction of some of the levees.

“Yolo Bypass, California, Reconnaissance Report,” March 1992. This study investigated flooding and related water-resource problems associated with the Yolo Bypass. Results of the study indicated that there were no economically feasible plans to reduce flooding in the study area. However, the tributaries west of the Yolo Bypass were not investigated due to complex hydrologic and hydraulic conditions. This study recommended that a separate study be conducted to investigate the flooding problems along the westside tributaries of the Yolo Bypass.

"Yolo Basin Wetlands, Sacramento River, California, Project Modification Report (Section 1135)," April 1992. This study evaluated the potential of wetland restoration/modification in the Yolo Bypass and vicinity. The study recommended restoration of seasonal wetlands, permanent wetlands, shorebird foraging areas, riparian forests, and grasslands. The work includes irrigation and drainage systems for flooding of the restored wetland areas. The areas recommended for wetland restoration were the Putah Creek Sinks and the Yolo Causeway site.

"Cache Creek Basin (Lake County), California, Reconnaissance Report," October 1992. This reconnaissance study evaluated the need for additional flood damage reduction in the Clear Lake area of the Cache Creek basin. Flood damage reduction measures evaluated included a detention basin, upstream storage, outlet channel improvements, modification and reoperation of Clear Lake Dam, pumped storage, and nonstructural measures. Only nonstructural measures appeared to be economically feasible. Due to financial uncertainty, however, Lake County could not meet the cost-sharing requirement.

FEDERAL EMERGENCY MANAGEMENT AGENCY

"City of Woodland, California, Flood Insurance Study," revised preliminary, April 17, 2001. This study, conducted for FEMA, identified the flood-prone areas of Woodland. This Flood Insurance Study revises and updates a previous Flood Insurance Study/Flood Insurance Rate Map for Woodland. This Flood Insurance Study covers the incorporated areas of the Woodland. The data developed in this study were used to establish actuarial flood insurance rates. Approximate analyses were used to study areas with a low development potential or minimal flood hazard. A substantially larger area was mapped in the FEMA 1 in 100 chance flood plain for this study than for the previous Flood Insurance Study.

"Yolo County, California, Unincorporated Areas, Flood Insurance Study," Revised March 30, 1990. This study investigated the existence and severity of flood hazards in the unincorporated areas of Yolo County. It contains developed flood risk data for four areas of the county including the area south of the Port of Sacramento to the cross levee near Riverview except for the areas west of the main canal and south of Bevan Road, the Town of Knights Landing, the Madison-Esparto area between Yolo County and the City of Winters, and Dry Creek. The data developed in this study were used to establish actuarial flood insurance rates. Approximate analyses were used to study areas with a low development potential or minimal flood hazard.

FEMA administers the National Flood Insurance Program (NFIP) in which Woodland participates. The purpose of the NFIP is to provide previously unavailable flood insurance protection to property owners in flood-prone areas, provided that the community follows certain flood plain management regulations. FEMA has identified areas of special flood hazard in the vicinity of Woodland. Flood zones are designated on published FIRM's for Yolo County and Woodland. These maps indicate a significant portion of Woodland is subject to flooding from Cache Creek[1].

U.S. DEPARTMENT OF AGRICULTURE – NATURAL RESOURCES CONSERVATION SERVICE

"The Blue Ridge Coordinated Resource Management Plan," signed in 1984. The plan included the area within Yolo County from the Colusa County line to the Solano County line along Cache Creek. The plan identified the need for proper livestock grazing; stabilization of critically eroding areas; and, especially, control of catastrophic wildfire through fuel reduction using the Vegetation Management Program of the California Department of Forestry. Due to Forestry's funding constraints, the fuel reduction program became inactive after a few years. It is the goal of both the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), and the Yolo County Resource Conservation District to reactivate the Blue Ridge Coordinated Resource Management Plan (CRMP) through the cooperation of landowners; local, State, and Federal agencies; and local conservation, rancher, and business organizations.

BUREAU OF LAND MANAGEMENT

"Coordinated Resource Management Plan (CRMP)," initiated in 1990 and restarted in 1993. The purpose of the CRMP was to seek a balance between public use and protection of natural resources. The plan included areas in Yolo, Lake, and Napa Counties, from Rumsey to the upper Cache Creek watershed. The plan was scoped, and public workshops were held from January to May 1995.

U.S. GEOLOGICAL SURVEY

"Water-Quality Assessment of the Sacramento River Basin, California: Water-Quality, Sediment and Tissue Chemistry, and Biological Data, 1995-1998," February 2001. This report presents data collected and compiled during the first high-intensity phase of the Sacramento River Basin National Water-Quality Assessment (NAWQA) Program study unit. Data are presented from 78 ground-water wells and 55 stream sites. Ground-water measurements compiled in this report include chemical, physical, and water-level data. Stream water measurements compiled include chemical, physical, streamflow, bed-sediment contaminants, aquatic-tissue contaminants, fish community, invertebrate community, and periphyton algae assemblages. Quality-control chemical data are also presented.

[1] FEMA 1998.

STATE OF CALIFORNIA

"State Water project Conjunctive Water Use – Eastern Yolo County," February 24, 1994. The report presents the results of a pre-feasibility level investigation of the potential for developing a conjunctive-use project in eastern Yolo County, summarizes hydrogeology and water supply conditions of the area, and presents a preliminary design for a modest conjunctive-use project. The investigation was conducted in cooperation with the Conway Conservancy Group.

"Mercury Concentrations and Loads from the Sacramento River and from Cache Creek to the Sacramento-San Joaquin Delta Estuary," June 1998. The objectives of this study were to examine mercury concentrations in the Sacramento River to find out if mercury concentrations are in excess of U.S. Environmental Protection Agency (EPA) standards, to estimate bulk mercury loads to the estuary from the Sacramento watershed, and to determine the source(s) and fate of the bulk material. The study confirmed that Cache Creek was a major source of mercury and that EPA standards for mercury are exceeded when flows in the lower reaches exceed 100 cubic feet per second (cfs). Bulk mercury loads from Cache Creek to the Cache Creek Settling Basin were estimated to be 980 kg/year; and export to the Yolo Bypass from the settling basin was estimated to be 495 kg/year for the 1995 water year. Most subbasins in the Cache Creek watershed export significant amounts of mercury, but the majority came from Cache Creek Canyon downstream of the confluence of the north and south forks, but upstream of the confluence with Bear Creek. Runoff from storms accounts for the majority of the mercury exported from the basin.

YOLO COUNTY

"Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan (Technical Studies)," October 1995. The report analyzed the lower reaches of Cache Creek from Capay to about 5 kilometers (3 miles) north of the town of Yolo. The report evaluated geomorphology, hydrology, riparian vegetation, and ground-water data based on the channel condition and computer modeling. The proposed recommendations included changes to instream gravel extraction and other human-induced practices to increase channel stability; improve riparian habitat; protect ground-water resources; provide opportunities for esthetic, recreational, and educational enhancement; increase instream flood-carrying capacity; protect county infrastructure; and gather and monitor data to promote a self-sustaining fluvial system. The study was completed in October 1995.

"Final Off-Channel Mining Plan for Lower Cache Creek" (OCMP), July 1996. The OCMP is one of two plans prepared by the county for managing the resources of the mining reaches of Cache Creek. The OCMP addressed a variety of issues relevant to mining outside the creek channel. The plan encourages off-channel, deep-pit mining under controlled and monitored circumstances as a plan to continue in-channel mining. It recommends a Technical Advisory Committee to assist the county in reviewing the annual monitoring data, to provide feedback regarding the conditions of the creek, and to assist in identification of appropriate "creek improvement projects." The OCMP seeks to secure a regular source of surface water in the remaining reaches of the creek when there is sufficient rainfall; to accept multiple reclamation uses; and to develop a future parkway plan to allow for public activities and uses along the creek.

"Final Cache Creek Resources Management Plan for Lower Cache Creek" (CCRMP), August 1996. The CCRMP is the second of two plans prepared by the county for managing the resources of the mining reaches of Cache Creek. The CCRMP addresses issues within the creek channel. Following initial shaping, sculpting, and smoothing within the creek, as prescribed in the technical studies, the plan would substantially limit the amount of annual mining within the channel to the amount of sand and gravel deposited during the previous year. Future commercial mining within the creek would be prohibited. Riparian woodland restoration and a continuous riparian habitat corridor are primary goals of the plan.

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Chapter 2

CHAPTER 2
EXISTING AND LIKELY FUTURE WITHOUT-PROJECT CONDITIONS

Overbank spill upstream of existing project, just west of I-5 – 1995.

Upstream of railroad bridge near town of Yolo – 1995.

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Overbank spill upstream of existing project, just west of I-5 – 1995.

Upstream of railroad bridge near town of Yolo – 1995.

CHAPTER 2

EXISTING AND LIKELY FUTURE WITHOUT-PROJECT CONDITIONS

This chapter describes the existing and likely future without-project conditions in the study area. The project setting includes the physical setting, social and economic conditions, and environmental resources. More-detailed descriptions of these conditions and expected future changes are discussed in the *Lower Cache Creek, Yolo County, CA, City of Woodland Vicinity Draft Environmental Impact Statement/Environmental Impact Report for Potential Flood Damage Reduction Project* (Draft EIS/EIR).

EXISTING CONDITIONS

PHYSICAL SETTING

Cache Creek Basin

Cache Creek originates in the Coast Range Mountains and generally flows southeasterly to the Yolo Bypass. The watershed is approximately 1,139 square miles and includes portions of Colusa, Lake, and Yolo Counties (Figure 1-1). The Cache Creek basin consists of two areas. These areas are known as the Clear Lake area, including the tributaries to Clear Lake, and the Cache Creek area, including Cache Creek and its tributaries.

The Clear Lake area encompasses approximately 528 square miles of the Cache Creek watershed. Water flows from Clear Lake through the Clear Lake Outlet Channel, and then through the Clear Lake Dam into Cache Creek.

Downstream Clear Lake Dam, Cache Creek flows approximately 46 miles to the Capay Diversion Dam. Two major tributaries, the North Fork of Cache Creek and Bear Creek, enter within this reach. Downstream Capay Dam, Cache Creek flows east to its confluence with the Yolo Bypass. The Cache Creek Settling Basin is located at the mouth of the creek.

Existing Water Resources Projects

The Flood Control Act of 1917 authorized the Sacramento River Flood Control Project (SRFCP), and the local sponsor was the California Reclamation Board. Construction began in 1918, and most facilities were completed by 1958. The SRFCP consists of a complete set of levees, leveed bypass floodways, and improved channels. The design flows for the SRFCP were not based on a specific level of protection, so the level of flood damage reduction afforded by the project varies throughout the system.

SRFCP facilities near Woodland include levees along the Willow Slough Bypass, portions of Cache Creek, the Cache Creek Settling Basin, and the Yolo Bypass (Figure 1-2). Under the SRFCP, flows are diverted into the Yolo Bypass from the Sacramento River where levees provide protection against overbank flooding. Levees along the lower reaches of the Willow Slough Bypass and Cache Creek also provide some protection from overbank flooding. The primary function of the settling basin is to remove a significant portion of the sediment load from Cache Creek to avoid its deposition in the Yolo Bypass, thereby preserving the capacity of the bypass for conveying floodflows.

Indian Valley Dam and Reservoir was completed on the North Fork of Cache Creek in 1975. Indian Valley Reservoir has a total storage capacity of 300,000 acre-feet, of which 40,000 acre-feet is for flood damage reduction storage. It has an active reservoir storage capacity of 260,000 acre-feet and is primarily operated for irrigation water supply and energy production.

Clear Lake Dam is operated to control the level of the lake during nonflood periods, regulate summer irrigation releases, and generate hydroelectric power.

Topography

Topographic features of the Cache Creek basin vary from the steep hills of the eastern slopes of the Coast Range Mountains to the nearly flat valley floor. Elevations range from 6,000 feet at the north end of the basin to nearly sea level near the town of Yolo. Stream channel gradients in the upper basin are steep; gradients in the lower basin are very flat. Flood damage reduction and land reclamation levees provide some topographic relief in the relatively flat project area, ranging from 91 feet mean sea level (msl) within the gravel mining reach downstream of CR 94B to 35 feet msl at the settling basin.

Geology and Soils

The study area is in both the Coast Range Mountains and the Great Valley geomorphic areas. The lower basin consists of continental deposits of silt-clay, sand, and gravel. The overlying alluvium deposits are similar and generally not as coarse as the continental deposits. This material forms significant aquifers that underlie the valley portion of the basin downstream from Rumsey. The size and extent of the aquifers are not known.

Lower Cache Creek flows on alluvial fan and flood plain deposits ranging from clay and silt to coarse sand and gravel.[1] Borehole data show clay deposits to be common

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[1] Wahler Associates. 1982. Geologic Report, Cache Creek Aggregate Resources, Yolo County, California. For: Aggregate Resources Advisory Committee, County of Yolo, Community Development Agency.

at depths in excess of 20 to 25 feet from the ground surface, whereas more recently deposited silt and sand characterize sediments above the 20- to 25-foot depth.[2]

Several faults are located in the vicinity of the project area. The Dunnigan Hills Fault is less than 5 miles northwest of the project area and is considered active due to recent activity during the Holocene epoch (the last 10,000 years).[3] Other faults in the region include the Zamora and Capay Faults, both of which are considered to be inactive.[4]

Lower Cache Creek has experienced a small amount of land subsidence due to ground-water withdrawal. From 1942 to 1987, the city of Woodland had an estimated maximum cumulative land subsidence of 2.25 feet.

Geomorphology

Lower Cache Creek exhibits several geomorphically distinct reaches along its length (Figure 2-1). The most significant reach change is 1.7 miles upstream from I-5. Upstream from this location, Cache Creek was historically mined for aggregate, whereas areas downstream were not. As a result, channel morphology is vastly different between these two sections of the project area. These and other geomorphic changes can be used to subdivide the creek into the six project-distinct reaches, described below.

Reach 1 is 12,000 feet in length. Cache Creek flows south in an artificially constructed channel that directs Cache Creek flows into the settling basin. The artificial channel exhibits a regular, trapezoidal cross section with little or no change in flow capacity along its length. Dense vegetation cover throughout this reach greatly restricted the observation of in-channel features during the field inspection. As a result, in-channel features were assessed primarily from year 2000 aerial photographs, which showed no apparent bank erosion sites in Reach 1.

Reach 2 is 15,500 feet in length and located between SH 113 and Reach 1. From aerial photographs, bank vegetation in Reach 2 varied from forest cover with dense understory to open areas of tall grass extending to the water's edge. Channel banks in Reach 2 appeared stable, and no areas of significant bank erosion were observed. However, some small, isolated areas of streambank erosion were identified in the reach. In addition, vertical scarps of exposed bank sediments approximately 3 feet high were also observed near the top of bank in the upstream part of the reach. These breaks in bank

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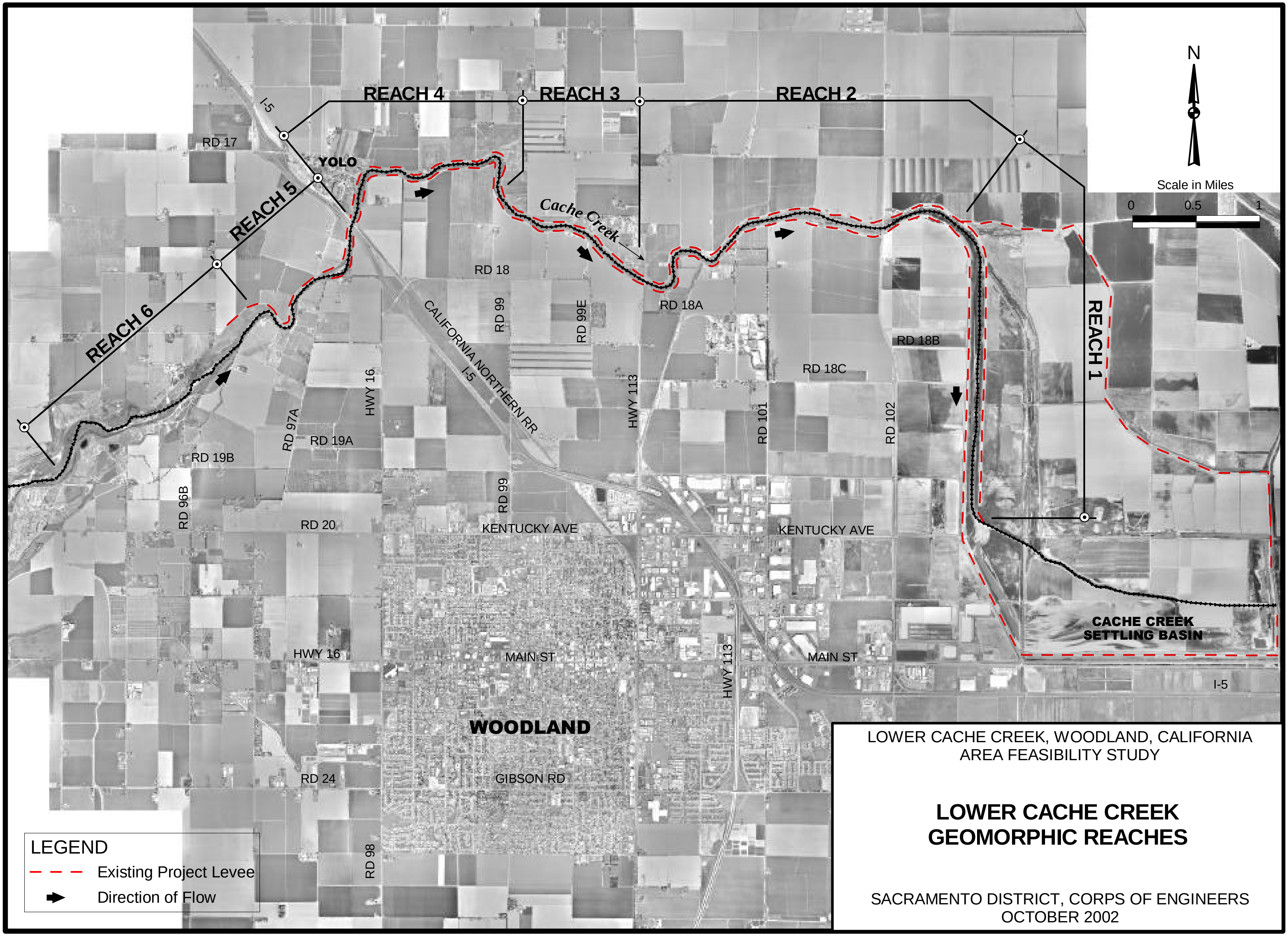
[2] U.S. Department of the Army, Corps of Engineers; "Design Memorandum No. 10, Cache Creek, Yolo Bypass to High Ground Levee Construction," November 1, 1958.

[3] Toppozada, T., D. Branum, M. Petersen, C. Hallstrom, C. Cramer, and M. Reichle. 2000. Epicenters of and Areas Damaged by M>5 California Earthquakes, 1800-1999. California Division of Mines and Geology, Map Sheet 49.

[4] Jennings, C.W. 1994. Fault Activity Map of California and Adjacent Areas With Locations and Ages of Recent Volcanic Eruptions. California Division of Mines and Geology, Geologic Data Map No. 6, Scale 1:750,000.



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK GEOMORPHIC REACHES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 2-1

slope indicate possible slump failures along the bank, although no indications of active or excessive erosion along the toe of these banks were evident at any of these locations.

Three meander bends are located in the upstream part of Reach 2. Rock bank protection was observed at the edge of water in some parts of these meander bends, indicating that these areas had once been eroding and were later stabilized.

Reach 3 is 6,500 feet long and forms a transitional reach between the wider Reach 2 downstream and the narrower Reach 4 upstream. The downstream 1,500 feet of Reach 3 exhibits a fairly consistent line of trees along the south bank, probably planted there several decades ago. These trees occupy the lower part of the streambank near the water's edge, indicating that little or no bank erosion has occurred here over the last several decades. Other areas of Reach 3, particularly along the north bank, are largely devoid of tree cover and instead exhibit grass- and shrub-covered bank slopes.

Reach 3 is significantly narrower and more entrenched than Reach 2, resulting in higher, steeper channel banks that are more prone to bank erosion and instability. In contrast to Reach 2, significant areas of bank erosion and instability are evident in several locations in Reach 3. These areas are typically characterized by eroded, vertical streambanks; slump failures; and single or multiple vertical scarps (2 to 3 feet high) at varying levels on the bank slope, indicating slumping of the downslope segment of bank.

Reach 4 is 10,000 feet long. Trees line much of the south bank of Reach 4, whereas the north bank is virtually devoid of tree cover. Dense shrubs and grasses typically line both banks in this reach.

The frequency of bank erosion and bank instability is greater in Reach 4 than in Reach 3. Reach 4 exhibits the narrowest channel cross section in the project area and is deeper and more entrenched than Reach 3. Both factors contribute to the higher incidence of bank erosion in this reach. Similar to Reach 3, 2- to 3-foot-high vertical scarps occur at varying elevations in several parts of the streambank (both low and high), indicating probable areas of bank slumping. A large bank erosion site on the north bank is very near the levee road and will be repaired by the California Department of Water Resources (DWR) in the near future. A tight meander bend in Reach 4 also exhibits a large bank failure on the inner bank. A grade control structure, constructed of sac-crete, is also located in this reach.

The frequency and magnitude of instream bar features also increase in this reach relative to Reach 3. Well-developed instream gravel bars cause the low-flow channel to migrate from one side of the creekbed to the other.

Reach 5 is 9,000 feet in length and characterized by large meander bends that exhibit severe bank erosion along high (30 feet and greater) vertical banks over hundreds of lineal feet. This morphology results in the most severe and extensive bank erosion in the project area. In general, the low-flow channel in this reach is narrower than in downstream reaches due to lower water depths and confinement of the low-flow channel by large gravel bars that occupy much of the channel bed. A borrow area in Reach 5 is separated from the creek by a high, narrow ridge of material left in place between the creek and borrow area.

A widening trend in channel morphology begins in this reach and continues with distance upstream toward Reach 6 where historical gravel mining has greatly increased channel width and depth from pre-mining levels.

Reach 6 is 11,000 feet long and located in a historically gravel-mined section of the project reach. This reach is very broad in comparison with the rest of the project area and is characterized by large gravel bars, areas with little vegetation that were mined as recently as the mid-1990's, and undisturbed areas of dense vegetation. Vegetation is gradually returning to denuded portions of the creek following the cessation of instream gravel mining operations in 1996.

The following general comments regarding the geomorphic characteristics of the project area can be made from the reach descriptions listed above:

- The frequency and severity of bank erosion and bank instability in the project area increases with distance upstream from Reach 1 to Reach 5.

- Channel width generally decreases with distance upstream from Reach 1 to the I-5 bridge (Reach 5). Conversely, channel depth increases with distance upstream from Reach 1 to the I-5 bridge. In other words, Cache Creek exhibits a narrower, more entrenched channel cross section with distance upstream from the settling basin to the I-5 bridge. This results in channel banks that are generally higher, steeper, and more prone to bank erosion and instability with distance upstream.

- Cache Creek exhibits a widening trend with distance upstream from the I-5 bridge due to active meander bend migration in Reach 5 and channel widening caused by gravel mining in Reach 6.

- Bank instability in the project area is characterized primarily by areas of active bank erosion and by bank slumping. Areas of active bank erosion typically exhibit nearly vertical banks of exposed sediment, indicative of recent erosion. Bank slumping is evidenced by single or multiple vertical scarps (2 to 3 feet high) at varying levels on the bank slope, indicating slumping and subsequent erosion of the downslope segment of the bank.

- Historically, numerous bank protection works have been constructed in the project areas, primarily in river bends. Thus, bank stability in these areas is due to artificial bank protection rather than inherent stream stability. Future maintenance of existing and construction of new bank protection works will be necessary in the project area, even for without-project conditions.

Prior to significant gravel mining, Cache Creek is described as being a wide, relatively steep braided channel upstream from Yolo and a narrow, incised channel flowing in fine-grained overbank deposits and tule marsh downstream from Yolo.[5] In general, average channel width in gravel-mined reaches of Cache Creek has decreased from this historic condition due to bridge and levee construction and aggregate extraction. Conversely, average channel depths have increased as a result of channel degradation and confinement by levees and bridges.

Based on the review of the longitudinal profiles and historical planforms, the following key points are listed below:

- The channel bed has lowered 4 to 26 feet since 1955 along the project reach, resulting in a narrower and entrenched channel cross section as compared to historical channel morphology. Generally, channel bed lowering within the project reach increases with distance upstream from the settling basin.

- The active channel width appears to have decreased since 1937.

- The planform alignment has remained relatively constant since 1937.

- Reaches 4 and 5 exhibit the greatest degree of channel instability manifested primarily as bank erosion and bank sloughing.

- Stream gradient on lower Cache Creek varies from about 0.0015 upstream from I-5 to about 0.00011 near the settling basin. An unusual convex-up “hump” is present in the stream profile between I-5 and SH 113. A sac-crete grade-control structure, 2,300 feet downstream from I-5, is a likely contributor to the unusual profile.

Cache Creek Levee System

In the late 1950’s, the Corps enlarged and extended the levees along both banks of Cache Creek. The primary work extended from slightly above I-5 to the settling basin (Figure 1-2). The design flow for the project was 30,000 cfs, which has approximately a 1 in 10 chance of occurring in any given year, although the levee system has passed larger peak flows.

[5] EIP Associates, 1995. Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan for Yolo County Community Development Agency

On April 17, 1958, the Yolo County Board of Supervisors requested that only a minimum amount of work be performed on the Cache Creek levees to preserve the benefits from the potential Wilson Valley Reservoir Project. At that time, the State of California and Yolo County were contemplating constructing the Wilson Valley Reservoir on the main stem of Cache Creek to a capacity of 1 million acre-feet, reserving space for flood damage reduction. The Wilson Valley Reservoir Project was not constructed due to seismic and sedimentation considerations.

<u>Interstate 5</u>

The April 2001 FEMA Flood Insurance Study (FIS) found that I-5, completed through Woodland in 1973, forms a barrier to overland flow resulting from very large floods on Cache Creek and diverts some of the flow toward the city (see Plate 10).

<u>Cache Creek Flooding</u>

Floodflows are most likely between November and April; no known floods have occurred between June and August. Large floods result from rainstorms. Due to the nature of the storms, floods often have multiple peak flows over a 4- to 5-day period. Large peaks result from cloudbursts within a regular storm.

Lower Cache Creek has a history of flooding. Four major flood periods have been documented for the Cache Creek basin during the last half of the 20th century, and 20 severe floods have occurred since 1900. The most severe floods of recent years in the Cache Creek basin downstream from Clear Lake occurred in 1939,1955, 1956, 1958, 1964 and 1965, 1970, 1983, 1995, and 1997.

According to the April 2001 FEMA FIS, the city of Woodland has no recorded history of flooding. However, in 1958, 1983, and 1995, Cache Creek rose to the top of both levees and overflowed its banks toward the cities of Woodland. In 1995, the overland flow came within 1 block of Woodland. In 1983, overland flow flooded areas in the easterly part of what is now in the city limits of Woodland. According to the USGS, the peak flow in January 1983 at the Rumsey gage was estimated to be 53,000 cfs, which is a 1 in 50 chance event at this location. There was a levee break downstream from County Road CR 102 during this flood. Federal, State, and local agencies patched levee boils at that time to prevent additional levee breaks along both sides of the Cache Creek levee system.

The peak flow at CR 94B in January 1995 was approximately 48,000 cfs. An estimated 3,800 cfs overflowed the south bank and almost nothing overflowed the north bank upstream of the levee system. The total flow (approximately 48,000 cfs, peak) represents a 1 in 40 chance event. The volume of the flood hydrograph was approximately a 1 in 20 chance event. The City of Woodland observed and prepared a sketch of high-water marks in the vicinity of the city of Woodland for the March 1995 event. These observations do not define the full extent of the flood boundary.

Cache Creek Settling Basin

The Cache Creek Settling Basin, located adjacent to the Yolo Bypass, was constructed to prevent sediment being carried by Cache Creek from adversely affecting the hydraulic capacity of the Yolo Bypass through excess sediment deposition (Figure 1-2). It is bounded by levees on all sides and covers 3,600 acres. The basin was originally constructed by the Corps in 1937. The levee heights and locations have been modified to control sediment deposition and enhance basin sediment storage.

Sediment data were collected on Cache Creek at a USGS gage near the town of Yolo from 1943 to 1971.[6] Results indicate that 93 percent of the total sediment load at the Yolo gage is suspended sediment, of which approximately 86 percent consists of silts and clays with an average diameter less than 0.064 mm. The annual suspended sediment load into the settling basin area between 1904 and 1963 was approximately 675 acre-feet.[7] The annual deposition rate in the settling basin from 1934-68 was calculated to be 340 acre-feet, yielding a 50 percent trap efficiency. Data concerning sediment loadings for single-flow events are not available.

From 1991 to 1993, modifications to the settling basin included an additional 50-year storage capacity with an average of 340 acre-feet of sediment accumulation per year. This corresponds to an average trapping efficiency of 55 percent, assuming existing levee project conditions. Flows from Cache Creek enter the northwest corner of the basin and exit the basin via two structures in the southeast corner of the basin—the high-flow outlet, a 1,740-foot concrete weir, and the low-flow outlet, a gated, double-box culvert. The crest elevation of the weir is currently set at an approximate elevation of 35 feet (North American Vertical Datum of 1988 [NAVD88]). It is planned that the weir will be raised 6 feet in 2017 or when the basin fills with sediment such that the trap efficiency decreases to less than 30 percent.

A training levee in the settling basin parallel to the west levee ties into the end of the north bank levee of Cache Creek. The training levee is designed to direct flows to the southern portion of the settling basin, maintaining flow velocities and preventing sediment deposition and clogging near the inlet of the basin. At the end of the training levee, the flow expands horizontally, reducing the flow velocity and increasing sedimentation. The training levee is planned to be removed in increments, encouraging an even distribution of sediment deposition across the basin.

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[6] U.S. Department of the Army, Corps of Engineers; “Design Memorandum No. 1 – Cache Creek Settling Basin – Final General Design Memorandum,” January 1987.

[7] State of California, Department of Water Resources; “Investigation of Alternative Plans for Control of Sediment From Cache Creek,” Memorandum Report, December 1968.

The settling basin features, including increases in levee heights, modifications to the training levee, and raising of the outlet weir, were designed to safely contain and pass a design flow of 30,000 cfs. This flow represents the current design capacity of the original settling basin and the upstream channel/levee system. The 30,000-cfs discharge was chosen for design so as not to exceed the capacity of the upstream channel system. The basin's low-flow outlet structure was designed to pass 400 cfs. Review of streamflow gaging data for Cache Creek at Yolo indicates that flows exceed 400 cfs most years for several days at a time.

<u>Existing Storm Drainage System</u>

The City of Woodland has evaluated the existing storm drainage system serving the city and the portions of Yolo County located between Woodland and the Cache Creek levee system. The purpose of the evaluation has been to identify existing storm drainage problems and to develop a plan for storm drainage facilities. These efforts only consider local runoff. The evaluation is presented in the report entitled "City of Woodland Storm Drainage Facilities Master Plan," December 1999, by Borcalli and Associates.

In general, the storm drainage system conveys runoff by gravity flow from west to east. The agricultural lands are served by a minimal drainage system, whereas the city is served by piped trunk systems. The trunk systems discharge into the North or the South Canals. The canals convey the runoff to the city's three pump stations. The pump stations discharge into the Outfall Channel, which conveys runoff to the Yolo Bypass.

The city's existing trunk system is not adequate to convey the runoff from the agricultural areas on the west and south sides of the city, resulting in overflow onto the city streets. Inadequate trunk capacity results in street flooding during the 1 in 2 and 1 in 10 chance storm events. The extent and magnitude of street flooding increases significantly between the 1 in 2 and 1 in 10 chance storm events. The peak flows reaching the North and South Pump Stations exceed pumping capacities, resulting in high stages and ponding in the North Canal and South Canal.

The North Canal flows from north to south parallel to the west levee of the settling basin and conveys runoff that originates from the west to the North Pump Station. When flows in the North Canal exceed the pumping capacity (approximately the 1 in 10 chance storm event) ponding along the west levee of the settling basin occurs.

The South Canal flows from south to north. It conveys runoff that originates to the west and south of I-5 to the South Canal Pump Station. The water-surface elevations in the South Canal exceed its bank elevations for approximately the 1 in 10 chance storm event.

The pump stations are referred to as the North Canal Pump Station, the East Main Pump Station, and the South Canal Pump Station. The pumping capacity of these pump stations is estimated to be 150 cfs, 270 cfs, and 30 cfs, respectively. During storm events, all three pump stations discharge into the Outfall Channel, which is located between the new and the original south levee of the Cache Creek Settling Basin. Provisions exist for gravity discharge from the pump stations to the outfall channel during low-flow conditions.

The Outfall Channel flows from west to east and discharges directly into the Yolo Bypass. The settling basin discharges into the Yolo Bypass immediately north of the city's outfall channel. There is no defined channel to convey flows across the Yolo Bypass to the Tule Canal. The lack of a defined channel has reportedly resulted in scouring near the Yolo Shortline Railroad trestle within the Yolo Bypass. The City, Reclamation District No. 2035, the Shortline Railroad, and DWR are studying the scour problem to identify and implement a solution.

Noise

Major noise sources in the study area are roadway traffic on State and county roadways, particularly I-5; California Northern Railroad and Yolo Shortline Railroad operations, which generally occur between 7 a.m. and 7 p.m.; agricultural activities; and fixed noise sources. Fixed noise sources are a result of many industrial operations, including Adams Grain Dryer, Pacific International Rice Mill, and Woodland Biomass.

Hazardous, Toxic, and Radiological Waste Sites

In March 2000, a Phase I Environmental Site Assessment (ESA) was performed by the Environmental Design Section of the Corps, Sacramento District. In all, approximately 12 miles of Cache Creek and levees on both banks were evaluated; see Appendix E.

No items of environmental concern were observed within the project area during the site visit with the exception of pesticide (chemical) mixing trailers at one location. Although there were no observations of spills at the mixing location, the potential for spills exists. There were no soil, surface-water, or ground-water samples collected as part of the site visit at this location or any other location within the project area.

As part of the records review for hazardous, toxic, and radiological waste (HTRW) sites within the project area, Environmental Data Resources, Inc. (EDR), identified 12 potential HTRW sites. However, they no longer pose environmental hazards, since they had been investigated prior to this inquiry and had been subject to removal actions, as necessary.

Climate

The Cache Creek basin experiences the same Mediterranean climate as the Sacramento Valley, characterized by hot, dry summers and mild, rainy winters. Prevailing winds are moderate in strength and vary from dry, overland wind from the north to moist, clean sea breezes from the south.

Air Quality

The Yolo-Solano Air Quality Management District (YSAQMD) monitors and regulates air quality in the Woodland area and regulates air pollution emissions of commercial and industrial operations. Between 1989 and 1993, exceedences of the State and Federal standards were recorded in Yolo County for the State/Federal ozone standards and State PM_{10} standards. Both pollutants are regional problems affecting the entire Sacramento Valley Air Basin. Under the Federal Clean Air Act (CAA), Yolo County is designated as “severe” nonattainment for the Federal ozone standard, and attainment or unclassified for other pollutants. Under the California CAA, the county is a “serious” nonattainment area for the State ozone standard, and is also considered nonattainment for the State PM_{10} standard.

Woodland contains a multitude of air pollution sources. Motor vehicle exhausts and pesticides are major contributors to the regional ozone problem. Industrial combustion, combustion of natural gas in homes and businesses for space and water heating, and evaporation of paints and solvents are other sources of urban air pollutants. Agricultural lands that surround Woodland generate pollutants through equipment and vehicle exhaust, tilling, burning, unpaved road travel, and evaporation of pesticides.

Water Quality

All the various sources of surface water in the county are of suitable quality for agricultural use and, except for the Colusa Basin Drain, could be treated for municipal use. However, there is a local concern about high levels of boron, salts, and mercury in Cache Creek.

The salts and boron are a result of geothermal releases found in the upper reaches of the basin. Concentrations of boron vary depending on the volume of flow in Cache Creek. However, these concentrations are regularly monitored to ensure suitability of the water for agricultural use.

The Central Valley Regional Water Quality Control Board (RWQCB) currently designates Cache Creek as an Impaired Water Body. RWQCB’s toxic monitoring program has demonstrated that mercury is present in sediments throughout the basin as a result of prior mercury mining activities within the upper basin. Studies have demonstrated biomagnification of methyl mercury in the tissues of invertebrates and fishes within the system. RWQCB is concerned about any activity within Cache Creek that could result in disturbance of mercury-contaminated sediments. Disturbance could mobilize the mercury and make it more available for biological intake.

Groundwater quality is generally very good except for localized areas containing high boron levels such as along Cache Creek, where boron concentrations in the groundwater are high, ranging from 2 to 4 ppm, in comparison to background levels of 0.6 to 1.0 ppm in other parts of the county. Other localized areas of groundwater pollution are due to (1) nitrates near Dunnigan, east of Woodland, and west of the University of California at Davis and (2) pesticides near Mace Boulevard north of Putah Creek.

SOCIAL AND ECONOMIC CONDITIONS

Yolo County

Most of the study area is in Yolo County, but it also extends into the southwestern portion of Colusa County and the northeastern portion of Solano County. The area is primarily rural and sparsely populated. The zoning for Yolo County is shown on Plate 1.

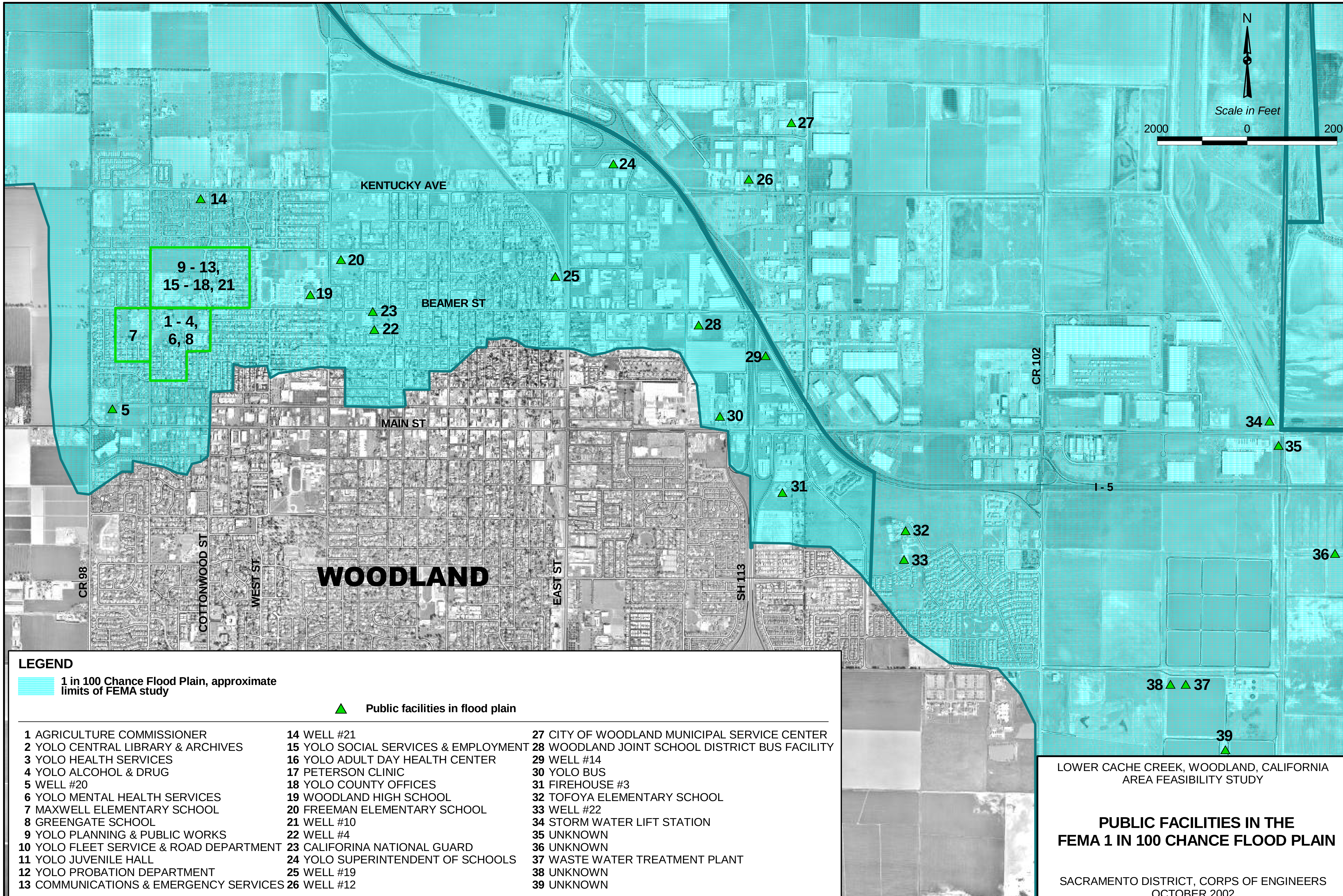
Agriculture is an important source of employment and tax revenue for both Yolo and Colusa Counties. Agricultural production in Yolo County is in transition from the production of field crops such as sugar beets and tomatoes to more economically stable production of tree and vine crops. Tree and vine crops such as nuts and fruit provide a more stable income for valley growers and can be harvested yearly.

The population of the counties in the study area is 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.

City of Woodland

The City of Woodland is the largest incorporated community within the study area; the population in 2002 was 50,614. The zoning for the city is shown on Plate 2. Originating as an agriculture support community, Woodland remains surrounded by agricultural lands. Most industrial development occurs in the north and eastern parts of the city, which are within the FEMA flood plain. Residential areas lie primarily to the west of downtown; current developments are to the south. The residential areas in the north and east part of Woodland are in the FEMA flood plain.

The northern residential areas are in the FEMA flood plain (about 3,200 single-family homes and 300 multiple-family homes). An additional 500 structures (industry,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Scale in Feet
2000 0 2000
KENTUCKY AVE
BEAMER ST
MAIN ST
I - 5
CR 102
CR 98
COTTONWOOD ST
WEST ST
EAST ST
SH 113
WOODLAND
9 - 13,
15 - 18, 21
1 - 4,
6, 8
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LEGEND
1 in 100 Chance Flood Plain, approximate limits of FEMA study
Public facilities in flood plain
1 AGRICULTURE COMMISSIONER
2 YOLO CENTRAL LIBRARY & ARCHIVES
3 YOLO HEALTH SERVICES
4 YOLO ALCOHOL & DRUG
5 WELL #20
6 YOLO MENTAL HEALTH SERVICES
7 MAXWELL ELEMENTARY SCHOOL
8 GREENGATE SCHOOL
9 YOLO PLANNING & PUBLIC WORKS
10 YOLO FLEET SERVICE & ROAD DEPARTMENT
11 YOLO JUVENILE HALL
12 YOLO PROBATION DEPARTMENT
13 COMMUNICATIONS & EMERGENCY SERVICES
14 WELL #21
15 YOLO SOCIAL SERVICES & EMPLOYMENT
16 YOLO ADULT DAY HEALTH CENTER
17 PETERSON CLINIC
18 YOLO COUNTY OFFICES
19 WOODLAND HIGH SCHOOL
20 FREEMAN ELEMENTARY SCHOOL
21 WELL #10
22 WELL #4
23 CALIFORINA NATIONAL GUARD
24 YOLO SUPERINTENDENT OF SCHOOLS
25 WELL #19
26 WELL #12
27 CITY OF WOODLAND MUNICIPAL SERVICE CENTER
28 WOODLAND JOINT SCHOOL DISTRICT BUS FACILITY
29 WELL #14
30 YOLO BUS
31 FIREHOUSE #3
32 TOFOYA ELEMENTARY SCHOOL
33 WELL #22
34 STORM WATER LIFT STATION
35 UNKNOWN
36 UNKNOWN
37 WASTE WATER TREATMENT PLANT
38 UNKNOWN
39 UNKNOWN
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
PUBLIC FACILITIES IN THE
FEMA 1 IN 100 CHANCE FLOOD PLAIN
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 2-2

retail, and restaurants), including the city wastewater treatment plant, are within the 1 in 100 annual chance flood plain. Of the 18 schools in Woodland, 6 are in the 1 in 100 annual chance flood plain, as are juvenile detention, social services, elder care, medical treatment, and emergency response facilities and City, county, and State road maintenance yards; see Figure 2-2. Woodland has one hospital, which is not in the FEMA flood plain.

Town of Yolo

The population of the town of Yolo in 1997 was 457. Zoning for Yolo is shown on Plate 1. There were an estimated 161 housing units in the town according to 1997 data. There is one school, and the town does not have a hospital.

Land Use

Land uses in the study area are predominantly agricultural and also include urban and industrial, recreation, and flood damage reduction. Land use in the southern part of the project area includes urban and industrial areas of the city of Woodland. North of the city, agriculture is the predominant land use. North of Cache Creek, land use includes the unincorporated town of Yolo and a mixture of agricultural croplands, orchards, and individual residences (Plate 3).

Gravel Mining Operations

Cache Creek yields high-quality aggregate material between the Capay Bridge and the town of Yolo. This reach has been mined since the late 1800's. Yolo and Solano Counties use the aggregate as construction material for roads, railroad beds, and concrete structures.

Currently, there are five active aggregate mining extraction and processing (gravel mining) operations in the study area. The gravel mining companies are Syar Industries, Inc.; Solano Concrete Company, Inc.; Teichert Aggregates; Schwarzgrubber & Sons, Inc.; and Granite Construction Company.[8] The facilities include sand and gravel processing plants, asphalt-concrete hot-mix plants, concrete batch plants, material stockpiles, settling ponds, water wells, stationary and mobile equipment, and haul roads.

Cultural and Historic Resources

Cultural resources include buildings, structures, objects, sites, districts, and archeological resources associated with historic or prehistoric human activity. The cultural value of these resources may be of national, State, or local significance and may be listed in, or eligible for listing in, the National Register of Historic Places (NRHP) on

[8] Teichert Aggregates, April 3, 2000.

the Federal level or in the California Register of Historic Places as outlined in CEQA. CEQA has similar criteria for the evaluation of the significance of cultural resources to the California Register of Historic Places. If properties are eligible under the NRHP, they are also eligible under the California Register.

Ethnography

The Penutian-speaking Patwin Indians occupied a large area west of the Sacramento River north from the town of Princeton south to the city of Benicia. There is little evidence of occupation away from the streams in the study area, although temporary campsites certainly must have been established. The village of Churup, a Patwin name, was recorded near the town of Yolo. The village of Chila was located near Cache Creek at its lower terminus.

History

Euro-American occupation in the Sacramento Valley is represented first by Spanish interests, then Mexican dominion, and finally by American claim of the region.

William Gordon, the first major settler in the study area, came to Yolo County in 1842 and claimed the Mexican land grant of Rancho Guesesosi along Cache Creek as his own. The rancho boundaries are defined by County Road (CR) 19 on the north, CR 94B on the east, State Highway SH 16 on the south, and CR 89 on the west.

Settlement in Woodland began when John Morris, from Kentucky, moved to the current site of First and Clover Streets in 1849. Although growth in Yolo County, including the communities of Yolo and Woodland, continued steadily in the mid- and late 1800's, the coming of the railroad to Woodland in 1869 accelerated that development. Farmers such as Camillus Nelson, R. H. Beamer, Harvey Gable, W. B. Gibson, and others prospered and built grand homes in Woodland or in the outlying areas. Some of these are still standing and are within the study area.

Cultural Resources Investigations

Only one archeological survey has been completed in the study area. "An Archaeological Reconnaissance of Cache Creek between Capay and Yolo in Yolo County, California," written in 1978 by Archaeological Consulting and Research Services, Inc., indicates that no sites were located in the study area identified on the Woodland topographic map. Two previously recorded prehistoric archeological sites were probably destroyed sometime before 1978.

In 1982, a building inventory was completed of the potentially historic buildings in the city of Woodland.[9] A county-wide survey was completed in 1986. The 1982

[9] Wirth, G.F., A.I.A & Associates/Architects, Inc. 1982. Woodland Historical Resource Inventory Final Report 1981-82: City of Woodland.

inventory identified 32 properties that were recommended for inclusion in the NRHP. Two buildings are State Historical Monuments, and five buildings are listed in the NRHP. One additional house had been nominated for the NRHP. The Camillus Nelson house on CR 18C, north of Woodland, is listed on the NRHP. This two-story brick residence was built in 1872 and has intact outbuildings. It is located within the 1 in 100 chance FEMA flood plain.

The NRHP Internet site listed three individual historic properties in the City of Woodland and one historic district. The three individual properties are the R.H. Beamer house at 19 3rd Street, the William B. Gibson house at 512 Gibson Road, and the Hotel Woodland at 426 Main Street. The historic district is the entire Downtown Woodland Historic District, which is on Main Street between Elm and Third Streets.

The Wells Fargo express stop and bank, Spreckles Sugar processing plant, John E. Taylor residence, Nelson's Grove, and Robinson olive trees are located between Woodland and Cache Creek to the north. None have been evaluated for the NRHP. Because virtually none of the study area has been systematically examined for historic or prehistoric resources due to real estate constraints, and because many of the structures have not been evaluated for the NRHP, a draft Programmatic Agreement is included (Appendix C of the EIS/EIR) that stipulates the steps that would be taken to be in compliance with Section 106 of the National Historic Preservation Act NHPA) and 36 Code of Federal Regulations (CFR) 800. The Area of Potential Effect, while broadly drawn at the present, would be refined depending on the selected plan.

Additional archeological and historic building surveys and NRHP evaluation would be undertaken during later project planning phases to fully assess potential adverse effects.

Transportation

One interstate and two State highways traverse the study area. I-5 provides north-south circulation through the eastern portion of the county and Woodland. SH 16 provides east-west circulation through Woodland. SH 113 provides north-south circulation in the study area.

Esthetics and Visual Resources

The study area is in the Sacramento Valley region, which has its own unique esthetic qualities. This includes the linear and checkerboard pattern of fields, crops, and orchards contrasted by the curvilinear meandering form of the creek and its associated riparian vegetation. The rural/agricultural nature of orchards, croplands, and the occasional farm structure contrasts greatly with the adjacent developed areas of Woodland and Yolo. New warehouses in Woodland are introducing an urbanized scene to the agronomic setting. Orchards, croplands, and the urban areas of Woodland and Yolo characterize the valley portion of the study area. The riparian vegetation adjacent to the levees is visible from the town of Yolo and from I-5. The north Coast Range Mountains and the Sierra Nevada Mountains are visible, but not dominant landscape features, when weather or air quality conditions allow.

Recreation

Yolo County has 11 parks and recreational facilities. Of the 11 parks within Woodland, 7 lie within the floodplain. Within the study area, there is a special-use park (ball field) on county land. Public access to Cache Creek within the study area is limited and restricted as a result of adjacent private lands and locked gates at the entrances to the levees.

ENVIRONMENTAL RESOURCES

Cache Creek flows roughly east-southeast from Clear Lake for approximately 75 miles out of the Coast Range Mountains and into the Sacramento Valley, one of only a few large Coastal Range creeks that follow this path. Unfortunately, 90 percent of California's riparian habitat has been reduced or modified in the past 200 years, and the lower portion of Cache Creek is a prime example of this degradation.

Vegetation and Wildlife

A number of wildlife species are associated with the types of habitat available for food, cover, and nesting along Cache Creek. Typically, riparian forest, valley oak woodland, and freshwater marsh are highly productive wildlife areas. Species found in these habitat types include hawks, quail, deer, raccoon, fox, coyote, and squirrels. The creek itself serves as habitat for a number of reptiles and amphibians, as well as an assortment of fish. Lower Cache Creek is within the Pacific Flyway. The Pacific Flyway is used by 10 to 12 million ducks, of which 300,000 winter in the Yolo Bypass and the Cache Creek Settling Basin.

Lower Cache Creek is dry part of the year as a result of a diversion dam constructed near Capay in 1912 and related irrigation diversions. Some riparian vegetation continues to grow on the banks and terraces of the low-flow channel despite limited water availability. Generally, the vegetation grows in narrow strips between 37 and 75 feet wide along both sides of the low-flow channel. The range of the riparian vegetation is constrained by nearby agricultural activity. Crops cultivated near the creek include rice, wheat, tomatoes, melons, and fruit and nut orchards. The 3,600 acres within the settling basin are also farmed.

Agricultural fields provide foraging and resting areas for Swainson's hawk, red-tailed hawk, Brewer's blackbird, and black-tailed hare. Agricultural fields also provide habitat for western fence lizards, gopher snakes, California ground squirrel, California quail, coyote, skunk, and fox. These species often nest in nearby riparian areas and feed on agricultural field and annual grassland.

Fisheries

The variable streamflow, shallow depths, and agricultural runoff in Cache Creek influence the number and type of fish found in the study area. Historically, fish populations in Cache Creek included anadromous species such as steelhead trout, chinook salmon, and the Pacific lamprey. Due to flood control actions, including the settling basin and agricultural withdrawals, fish migration between the Sacramento River and Cache Creek is limited, but not precluded. Lower Cache Creek has been designated as critical habitat for the Central Valley Steelhead and Essential Fish Habitat for the Central Valley fall-run chinook salmon.

Due to the already degraded nature of Cache Creek, there would be no additional effects to fisheries within the creek. Nevertheless, NMFS has declared Cache Creek to be special-status species' critical habitat and essential fish habitat. (Critical habitat for steelhead included lower Cache Creek; however, an April 30, 2002 court ruling vacated this critical habitat.)

Threatened and Endangered Species

The Federal Endangered Species Act (ESA) provides legal protection and requires definition of critical habitat and development of recovery plans for plant and animal species in danger of extinction. The State provides parallel legal protection in the California Endangered Species Act (CESA). The status of an animal or plant is listed as endangered, threatened, or, in the case of plants, rare by the ESA and CESA.

Species listed by the Federal and California State governments that would potentially be affected by this project include:

Swainson's hawk – There are numerous documented occurrences of Swainson's hawks within the project area from I-5 eastward and throughout the settling basin. These hawks can be habituated to human activity such as crop cultivation if the activity is consistent. Disturbances, particularly during the breeding season, from late March to late August, may include construction actions (a change in current activity routine) and personnel near nesting sites. These disturbances during prenesting, egg-laying, and incubation could result in nest abandonment.

Northwestern pond turtle – There are documented occurrences of the turtle within Cache Creek and various stock ponds of the project area. Loss of upland nesting habitat through human disturbance is a potential source for the turtles' decline.

Bank swallow – There are documented occurrences of bank swallows within the project area, including observations of birds in flight by project biologists during site visits. Breeding bank swallow populations seem to be fairly tolerant of moderate levels of human activity. Bank swallow susceptibility is primarily tied to habitat losses of their nesting banks from flood control measures.

Giant garter snake – During an October 15, 2001, survey, five potential areas of giant garter snake habitat in the project area were logged. These include (1) bed and bank of Cache Creek and the levees adjacent to the creek, (2) agricultural ditch between CR 101 and CR 102, (3) agricultural ditch between CR 102 and the Cache Creek west levee, (4) narrow channel east of CR 102 on the south side of the farm road (levee), and (5) agricultural ditch at the base of the north-south segment of the Cache Creek west levee.

Valley elderberry longhorn beetle – Elderberry shrubs are located on both banks of Cache Creek in the project area.

Palmate-bracted bird's beak – A survey was conducted in September and October of 2001 for this species' habitat. The survey identified potential habitat; however, the areas were outside the project boundary and therefore would not be affected by construction.

Central Valley chinook salmon – Although National Marine Fisheries Service (NMFS) considers Cache Creek to be essential fish habitat for the Central Valley fall-run chinook salmon, currently, Cache Creek no longer flows directly into the Sacramento River, making it highly unlikely that salmon winter and spawn within the creek at present.

Central Valley steelhead trout – Critical habitat has been designated for this species (February 16, 2000) to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin Rivers and their tributaries (NMFS, 1998). This critical habitat includes lower Cache Creek.

WITHOUT-PROJECT FUTURE CONDITIONS

This section describes the changes expected in the study area over the period of analysis used for this study, assuming a long-term flood damage reduction project is not built. This without-project condition serves as the basis for comparison against which alternative flood damage reduction plans (potential projects) are evaluated to determine their potential effectiveness and effects that could result from them.

Listed below are the categories and related assumptions that may affect without-project future conditions as compared to the existing conditions summarized previously in this chapter. Further analysis can be found in the EIS/EIR.

PHYSICAL SETTING

Flooding

Cache Creek and the Yolo Bypass would continue to be the primary flood hazards to the city of Woodland. The primary flood hazard within the project area would be from Cache Creek. The Corps enlarged and extended the existing constructed levees along both banks of Cache Creek in the 1950's. The design flow for the levees is 30,000 cfs, which has approximately a 1 in 10 chance of occurring in any given year. Historically, the levee system has passed flows up to 34,000 cfs, a 1 in 20 chance flow, without failures. Without a new project, larger flows would continue to flood agricultural lands and would likely flood the city of Woodland.

The only substantial flood threat to Woodland is from Cache Creek. From the west of the city, the runoff area is small and does not pose a flood threat. From the south, Willow Slough floods towards the south; from the east, the Yolo Bypass would flood to a maximum elevation of 32 feet (NAVD88), which affects only a small portion of Woodland. Interior drainage and localized flooding is not expected to generate major flood damages.

Maintenance of the existing Cache Creek levee system is the responsibility of DWR. By State law, operation and maintenance will continue to be the responsibility of DWR. Because the existing system was designed to reliably pass 1 in 10 chance floodflows, flood fighting and repair are expected to be done relatively frequently. Due to existing bank erosion and bank instability problems of the existing levee system, rehabilitation on the existing levee system would be necessary to maintain the current function of the system. Without the rehabilitation, flooding risk to agricultural land and the city of Woodland would likely increase. Rehabilitation work needed to maintain the existing system is described in Chapter 6.

Risk of flooding may affect the City's development plans. The City's General Plan policies outlined in the February 1996 General Plan seek to protect development from flood damage.

The applicable policies include the following:

8.B.1 *"The City shall continue to implement flood plain zoning and undertake other actions required to comply with State flood plain requirements, and to maintain the City's eligibility under the Federal Flood Insurance Program."*

8.B.2 *"The City shall require evaluation of potential flood hazards prior to approval of development projects. The City shall require proponents of new development to submit accurate topographic and flow characteristics information. This will include depiction of the 100-year flood plain boundaries under fully-developed, pre- and post-project runoff conditions."*

8.B.3 *"The City shall not allow development in areas subject to deep flooding (i.e., over four feet deep) unless adequate mitigation is provided, to* *include project levees designed for a standard project flood or a minimum of 400-year protection, whichever is less."*

8.B.4 "The City shall require flood-proofing of structures and outdoor storage areas for hazardous materials in areas subject to flooding. Hazardous materials and wastes shall be contained within floodproofed structures or storage areas."

8.B.5 "The City shall prohibit the construction of facilities essential for emergencies and large public assembly in the 100-year flood plain, unless the structure and road access are free from flood inundation."

8.B.6. "The City shall continue to work closely with the U.S. Army Corps of Engineers, the Yolo County Resource Conservation District, the Federal Emergency Management Agency, the State Department of Water Resources, and the Yolo County Flood Control and Water Conservation District in defining existing and potential flood problem areas and solutions."

8.B.7. "The City shall recognize flood plains as a potential public resource to be managed and maintained for the public's benefit and, where possible, shall view flood waters as a resource to be used for waterfowl habitat, aquifer recharge, fishery enhancement, agricultural water supply, and other suitable uses."

The Corps' SRFCP will continue to provide the area with varying levels of flood damage reduction from the Yolo Bypass. In addition to the SRFCP, the Indian Valley Dam and Reservoir, located on the North Fork of Cache Creek, will continue providing some flood damage reduction to lands along Cache Creek using the 40,000 acre-feet allocated for flood damage reduction. The Indian Valley Dam and Reservoir provide a limited amount of flood damage reduction to the lower reaches of Cache Creek and regulates about 20 percent of the Cache Creek watershed area.

The lands to the east of Woodland could potentially be subject to deep flooding from overflows from the Willow Slough Bypass or the Yolo Bypass, depending on the particular flood event or levee failure and the associated volume of overflow. The deep flooding could occur as a result of water ponding against levees of the Yolo Bypass and the Willow Slough Bypass. The proposed document that outlines the method of assessment for operation and maintenance of Reclamation District (RD) 2035 states that lands to the east of Woodland would be subject to 6.5 to 16 feet of inundation should the bypass levee fail.

The possibility for deep flooding can be demonstrated by comparing the ground elevations in the area with the top-of-levee elevations of the Yolo Bypass. The ground elevations range from approximately 32.5 feet mean sea level (msl), North American Vertical Datum 1988 (NAVD88), in the vicinity of the city's sewage treatment plant to approximately 22.5 feet msl (NAVD88) near the Yolo Bypass levee. The top-of-levee elevation of the Yolo Bypass west levee is approximately 39.5 feet msl (NAVD88) between the Cache Creek Settling Basin and the Willow Slough Bypass. The top-of-levee elevation of the Willow Slough Bypass is approximately 35.5 feet msl (NAVD88).

Land Use

The unincorporated agricultural lands comprising the majority of the project area are zoned by Yolo County for agriculture (Plate 1). Unless zoning laws are altered, no significant change is expected for the agricultural lands. The City of Woodland General Plan identifies an Urban Limit Line, shown on Plate 2, that encompasses all land to be considered for urban development within the timeframe of the General Plan (by 2020). The City's General Plan Policy states that these urban limit lines are permanent on the north and east borders; see General Plan policy 1.A.12. This urban development includes much of the eastern and northern portions of the city bordering the settling basin and unincorporated Yolo County. Current urban development trends are expected to continue. New developments would need to be in accordance with the National Flood Insurance Program.

SOCIAL AND ECONOMIC CONDITIONS

On a short-term basis, flooding from a greater storm than one having a 1 in 10 chance could disrupt economic activity in Woodland, Yolo, and the unincorporated areas in the study area, depending on floodflow and duration.

On a more permanent basis, landowners in the FEMA 1 in 100 chance (100-year) flood plain with a federally insured mortgage would be required to purchase flood insurance. New development in the FEMA 1 in 100 chance flood plain would be possible, but only with flood proofing measures and added insurance costs. Woodland's industrial sector could be less competitive due to potential risk and insurance costs. The city may not attract as many new businesses for the same reasons. The loss of businesses within the city would cost Woodland revenue.

Transportation

The potential for flooding during major storms remains without a flood damage reduction project. Transportation would be affected during a severe storm due to the temporary disruption and potential damage to the California Northern Railroad, a north-south freight transportation railway, and I-5. The portion of I-5 east of the city would be particularly subject to disruption and damage because the floodflows would pond against the Yolo Bypass levees. County roads within the study area would also be flooded.

ENVIRONMENTAL RESOURCES

Cache Creek

The environmental resources of Cache Creek has been affected by gravel mining and the construction of bridges and flood control facilities. The outlet of the creek through a wier and box culvert system, and the operations of the settling basin minimize the utility of the creek to anadromous fish. Maintenance of the levee system, which includes vegetation removal and burning by the State and landowner agricultural activities, serves to reduce habitat quality. Because the banks of the leveed channel are failing in some locations, flood fighting (including installation of bank protection) is expected to continue to degrade habitat quality. These factors, coupled with a lack of sponsor support for restoring creek biological functions, indicate the potential for further degradation of the stream over time.

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Chapter 3

CHAPTER 3
PROBLEMS AND OPPORTUNITIES

Cache Creek Levee Failure, January 27, 1983, looking south towards Woodland.

CHAPTER 3
PROBLEMS AND OPPORTUNITIES

Cache Creek Levee Failure, January 27, 1983, looking south towards Woodland.

CHAPTER 3

PROBLEMS AND OPPORTUNITIES

This chapter describes the Lower Cache Creek flood and natural resource problems and opportunities in the study area. The information is useful in identifying potential flood damage reduction measures and plans.

PROBLEM IDENTIFICATION PROCESS

Geotechnical, hydrologic, hydraulic, geomorphological, and economic analyses of existing flooding conditions were completed to identify flood problems.

Discussions with agencies, technical support groups, and individuals were important to the problem identification process. Primary coordination activities included the May 30, 2000, public workshop; monthly team meetings; weekly technical review meetings; and the February 8, 2001, City of Woodland Flood Task Force meeting, as well as many other Flood Task Force meetings. Entities involved in the process included the Corps, USFWS, DWR, DFG, Yolo County Department of Public Works, City of Woodland Department of Public Works, Technical Advisory Committee for the Flood Task Force, City of Woodland Flood Task Force, Woodland City Council, Yolo County Board of Supervisors, Woodland Chamber of Commerce, Farm Bureau, Yolo County Flood Control and Water Conservation District, Cache Creek Conservancy, and Citizens at Large.

Ongoing communication between agencies and the public is documented in the Draft EIS/EIR. In addition, USFWS has been involved in the mitigation analysis and, along with NMFS, has provided a species list.

LOWER CACHE CREEK FLOOD PROBLEMS

NONDAMAGING CHANNEL CAPACITIES AND LEVEE FAILURES

The potential for flooding in the city of Woodland from overflow from Cache Creek is attributable in varying degrees to a number of factors, primarily insufficient conveyance capacity. Other factors include hydraulic restrictions imposed by bridges, the diversion of overflow by the I-5 embankment, the California Northern Railroad embankment, and the Cache Creek Settling Basin levees.

The conveyance capacity of the leveed reach of lower Cache Creek depends on the ability of the levees to withstand the floodflows. Levees can fail for several reasons, and it is generally not possible to predict how, when, and where they will fail. A geotechnical risk-based analysis was conducted to estimate the reliability of the levee system in this study.

The geotechnical analysis assessed the probable failure point (PFP) and the probable nonfailure point (PNP) of the lower Cache Creek levee system. The PFP is the point at which the water-surface elevation would result in an 85 percent chance of failure. The PFP was not determined because the probability of failure at the top of the levee was determined to be 50 percent. The PNP is the point at which the water surface would have a 15 percent chance of failure, and it was determined to be approximately 2 feet below the top of levee.

The nondamaging channel capacities of Lower Cache Creek were estimated as the bank-full capacity for the non-leveed reach and at the PNP for the leveed reach. The nondamaging channel capacity was estimated to be 30,000 cfs in the leveed and non-leveed reaches. The nondamaging flow for the leveed reach compares well with the design flow of 30,000 cfs for the Lower Cache Creek Levee Project. At the time of design, the levees were intended to provide protection from a flood having a 1 in 10 chance of occurring in any given year.

FREQUENCY OF FLOODING

The frequency of flooding in the city of Woodland from lower Cache Creek depends on the frequency of floodflows in Cache Creek, on the condition of the levees, and on flood fighting. A hydrologic model using the HEC-1 computer program was used to develop discharge-frequency information at points of interest. (See Appendix C.) A hydraulic model using the UNET computer program was used to develop stage (water surface elevation)–discharge information at points of interest. (See Appendix D.) The flooding frequencies from lower Cache Creek were determined based on this discharge-frequency and stage-discharge information, geotechnical information, and topography.

Flood frequencies and peak flows at CR 94B are indicated in Table 3-1 for flood events having chances of 1 in 10, 20, 50, 100, 200, and 500 of occurring in any given year (recurrence intervals of 10, 20, 50, 100, 200 and 500 years). The existing levee system was designed to convey 30,000 cfs with a freeboard of 3 feet. The capacity of the existing system has decreased since it was constructed, and 30,000 cfs is expected to have only about 2 feet of freeboard under current conditions. Results of the geotechnical analysis conducted for this feasibility study indicated that the levees could reliably pass a flow of 30,000 cfs.

The risk of levee failure increases as the freeboard decreases and becomes about a 100 percent chance of failure at the point that a levee is overtopped. The point of failure is very difficult to predict as it depends on levee construction, channel and levee maintenance, duration of flood events, operations during flood events, flood fighting efforts (sandbagging and levee protective measures) as well as such things as debris accumulations at bridges, obstructions, and upstream failures. In 1995, floodwaters overtopped the levees/banks upstream from I-5 at a flow of about 36,500 cfs. Although floodwaters did escape from Cache Creek during the 1995 flood event, the levees downstream from I-5 did not fail, and the volume of water that escaped was not large enough to reach the city of Woodland. At CR 94B, the 1995 flood event is estimated to have had a peak flow with a chance of occurring of approximately 1 in 40 and a 3-day volume with approximately a 1 in 20 chance of occurring in any given year. The existing levee system is estimated to have a maximum capacity of a flow with a 1 in 10 to 1 in 20 chance of occurring.

Table 3-1. Estimated Peak Flows for Cache Creek at Road 94B

Return Period[1] (years)	Peak Flow (cfs)
10	31,500
20	42,000
50	53,300
100	63,700
200	70,100
500	78,600

[1]Return period equals (1 divided by the chance of flooding in any given year).

FLOOD PLAINS AND FLOOD DAMAGES

The areas that would be subject to flooding from lower Cache Creek were identified to assess potential flood damages. The flood plains were developed on the basis of computed Cache Creek stages, levee stability, and topography using the UNET and FLO-2D computer programs. (See Appendix D.) The flood plains associated with the flood events with chances of 1 in 50, 100, 200, and 500 of occurring in any given year (recurrence intervals of 50, 100, 200, and 500 years) were delineated. The flood plain and flood elevations associated with a flood event with a 1 in 100 chance occurrence in any year (100-year flood event) are shown on Figure 3-1.

In addition to this hydraulic analysis, FEMA has identified areas of flood hazard in the vicinity of Woodland. The 1 in 100 chance per year flood plain delineated from the April 2001 FEMA Flood Insurance Study (FIS) is shown on Figure 3-2. This delineation has resulted in an increase in flood insurance requirements for existing structures within the FEMA 1 in 100 chance per year flood plain. Due to different methodologies, differences exist between the flood plain determined by FEMA and this study (Figure 3-2). However, both studies indicate that a significant portion of the city of Woodland is within the 1 in100 chance per year flood plain.

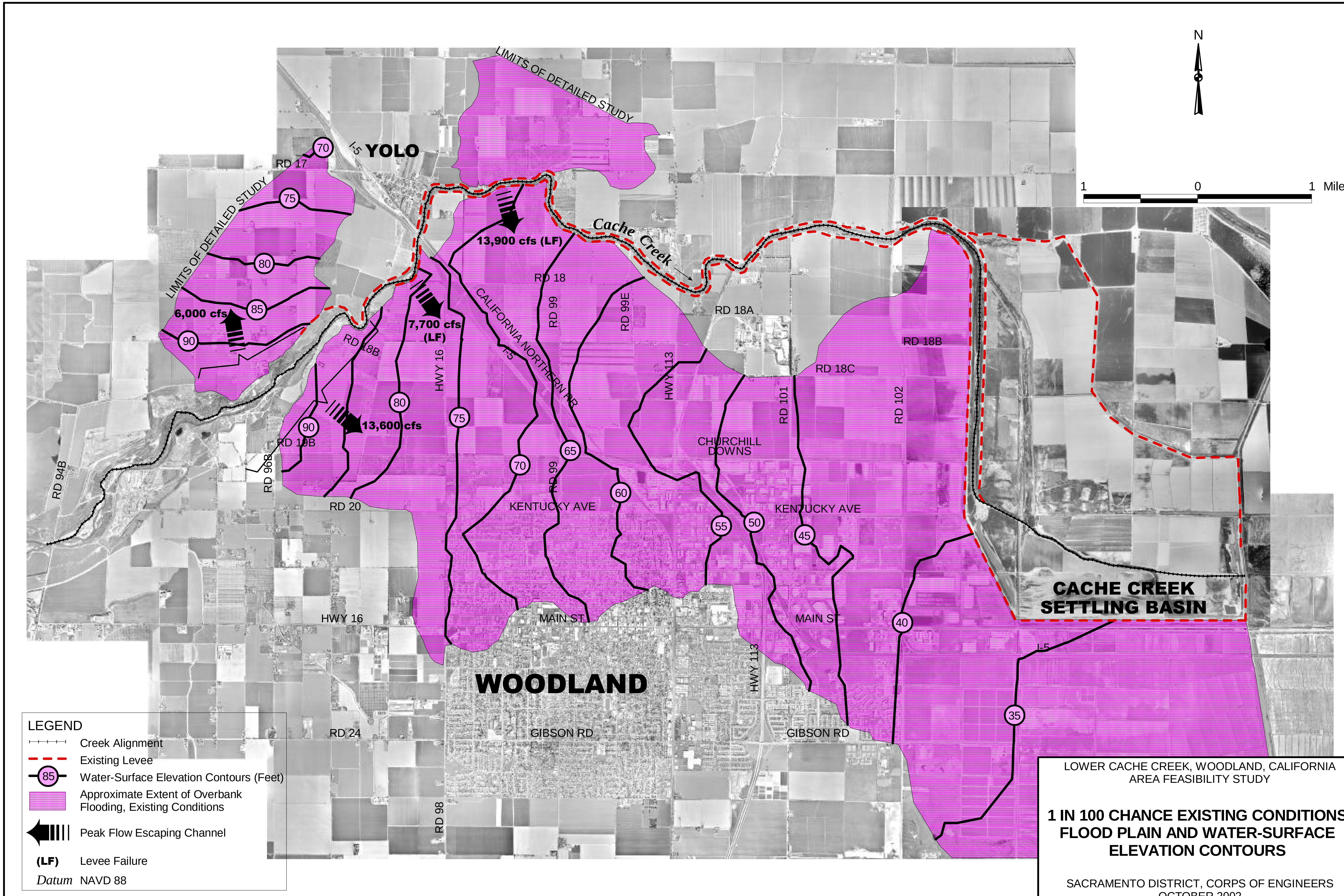
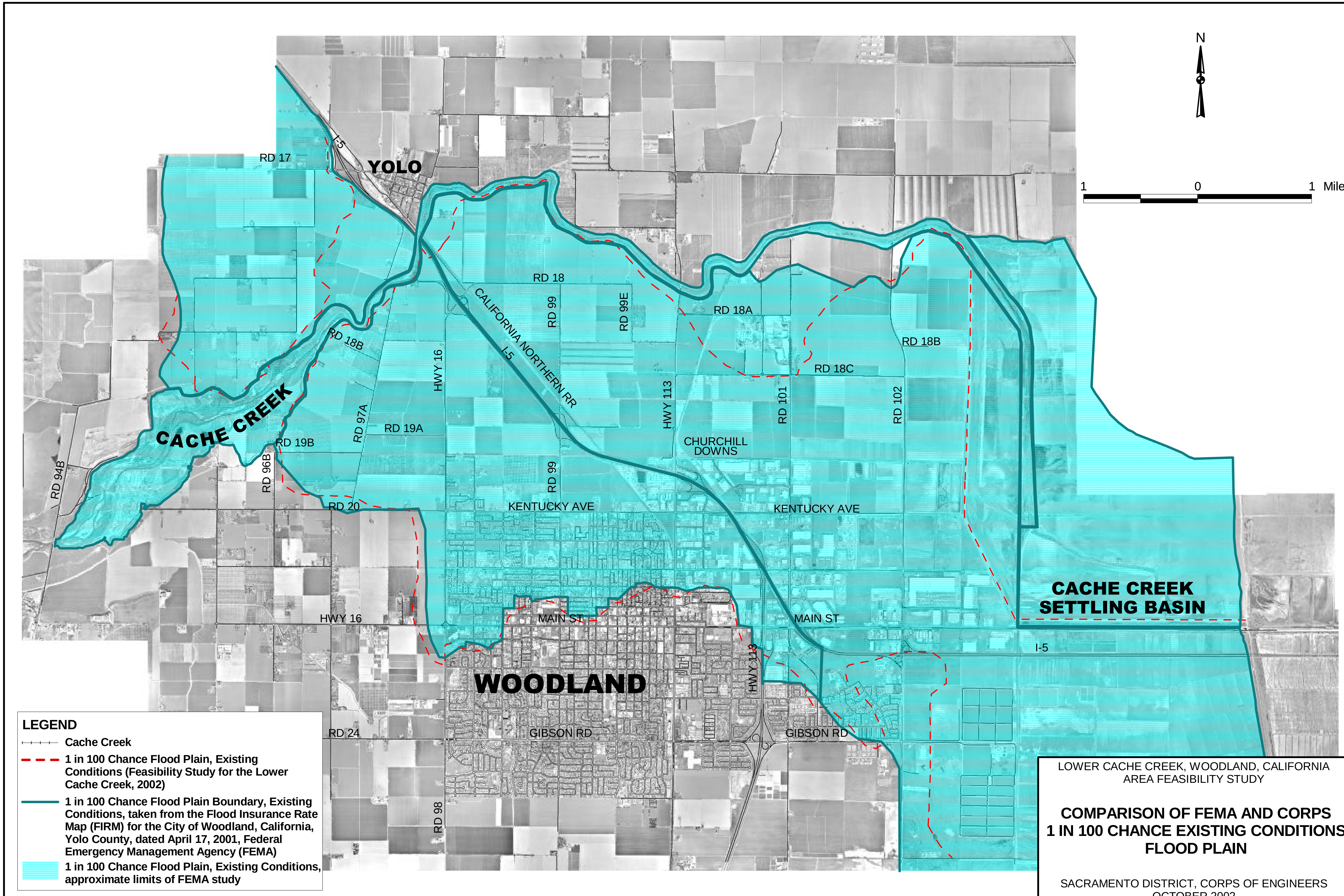

N
1 0 1 Miles
LIMITS OF DETAILED STUDY
LIMITS OF DETAILED STUDY
YOLO
I-5
RD 17
Cache Creek
13,900 cfs (LF)
6,000 cfs
7,700 cfs (LF)
13,600 cfs
RD 18
RD 18A
RD 18B
RD 18B
RD 18C
RD 99
RD 99E
RD 101
RD 102
RD 19B
RD 96B
RD 94B
RD 20
RD 24
RD 98
HWY 16
HWY 113
CALIFORNIA NORTHERN RR
CHURCHILL DOWNS
KENTUCKY AVE
MAIN ST
GIBSON RD
WOODLAND
CACHE CREEK SETTLING BASIN
70
75
80
85
90
65
60
55
50
45
40
35
LEGEND
Creek Alignment
Existing Levee
Water-Surface Elevation Contours (Feet)
Approximate Extent of Overbank Flooding, Existing Conditions
Peak Flow Escaping Channel
(LF) Levee Failure
Datum NAVD 88
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
1 IN 100 CHANCE EXISTING CONDITIONS
FLOOD PLAIN AND WATER-SURFACE
ELEVATION CONTOURS
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure 3-1



YOLO
WOODLAND
CACHE CREEK
CACHE CREEK
SETTLING BASIN
RD 17
I-5
RD 18
RD 99
RD 99E
RD 18A
RD 18B
RD 18B
RD 18C
CALIFORNIA NORTHERN RR
HWY 16
HWY 113
RD 101
RD 102
RD 97A
RD 19A
RD 19B
RD 96B
RD 94B
CHURCHILL
DOWNS
RD 99
RD 20
KENTUCKY AVE
KENTUCKY AVE
HWY 16
MAIN ST
MAIN ST
I-5
HWY 113
RD 24
GIBSON RD
GIBSON RD
RD 98
N
1 0 1 Miles
LEGEND
Cache Creek
1 in 100 Chance Flood Plain, Existing Conditions (Feasibility Study for the Lower Cache Creek, 2002)
1 in 100 Chance Flood Plain Boundary, Existing Conditions, taken from the Flood Insurance Rate Map (FIRM) for the City of Woodland, California, Yolo County, dated April 17, 2001, Federal Emergency Management Agency (FEMA)
1 in 100 Chance Flood Plain, Existing Conditions, approximate limits of FEMA study
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
COMPARISON OF FEMA AND CORPS
1 IN 100 CHANCE EXISTING CONDITIONS
FLOOD PLAIN
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 3-2

The city of Woodland was the primary focus of this study; therefore, the detailed flood plain analysis did not extend beyond the areas indicated on Figure 3-2. An assessment of Cache Creek flooding on the areas south of this study area was presented in a Technical Memorandum prepared by West Yost and Associates dated March 24, 1995. (See Appendix L.) The assessment was based on the hydrology and hydraulics analyses completed for the Corps' 1994 reconnaissance study of Cache Creek. It was estimated that during a flood with a 1 in 100 chance occurrence in any year (100-year flood), between 25,000 and 43,000 acre-feet would pond in the area bounded by the Cache Creek Settling Basin levees on the north, the Yolo Bypass levees on the east, and the Willow Slough Bypass levees on the south. Based on the USGS topographic maps, it was estimated that the maximum pond elevation would be 25.0 feet and 27.6 feet, NAVD88 (22.5 feet and 25.1 feet NGVD29), for the above-mentioned volumes, respectively, and that the flooding would not overtop the Yolo Bypass or the Willow Slough Bypass levees, which are at elevation 30 feet NAVD88 (south end). The land use in this area is agricultural, and the flood damages are anticipated to be relatively small.

Flooding from lower Cache Creek results in both monetary and nonmonetary effects. Monetary loss is the primary way of depicting flood damages and assessing the effectiveness of flood damage reduction plans. Monetary losses were assessed by estimating the without-project average annual equivalent flood damages. This was accomplished by weighting the estimated damages from varying degrees of flooding by their probability of occurrence. (See Appendix G.**)** Average annual equivalent flood damages (excluding future development) would be about $12 million.

In addition to the physical damage to the city of Woodland, a major flood would result in significant disruption and potential damage to the California Northern Railroad, a north-south freight transportation railway, and I-5, a major north-south transportation corridor. The portion of I-5 east of the city would be particularly subject to disruption and damage because the floodflows would pond against the Yolo Bypass levees with no release point.

Flooding could also result in the releases of toxic and hazardous substances stored within the flood plain. Floodflows would also overwhelm the sanitary sewer system, resulting in the release of inadequately treated or untreated wastewater. In addition, the cleanup process would generate significant flood-related debris, which would likely be disposed of in local landfills.

LOWER CACHE CREEK NATURAL RESOURCES PROBLEMS

Within Yolo County there is general concern and interest in the potential to restore environmental resources along lower Cache Creek. Resource problems are summarized as follows:

- Basin characteristics and land use activities result in relatively large sediment yields from the Cache Creek watershed.
- Gravel mining, agriculture, urban development, and flood damage reduction efforts have reduced or removed much of the historic riparian corridor along Cache Creek and have significantly altered the channel morphology of Cache Creek.
- Species numbers and community diversity have been reduced or been lost due to the corresponding degradation or loss of the natural stream process and riparian habitat as well as the introduction of nonnative species.
- Cache Creek is currently designated as an Impaired Water Body due to the presence of mercury in suspended sediment and fish tissue. It is a major source of mercury into the Sacramento-San Joaquin Delta.

Chapter 4

CHAPTER 4
PLAN FORMULATION & EVALUATION PROCESS

Cobble Weir, Cache Creek Settling Basin – 1958.

CHAPTER 4
PLAN FORMULATION & EVALUATION PROCESS

Cobble Weir, Cache Creek Settling Basin – 1958.

CHAPTER 4

PLAN FORMULATION AND EVALUATION PROCESS

This chapter describes the process for formulating flood damage reduction plans for the Lower Cache Creek area, including the identification of planning objectives, constraints, and planning criteria, and screening measures that would be most effective in reducing flood damage. This chapter also discusses the merits of combining various measures and establishes the preliminary plans to be considered as candidates for selection.

The Corps planning process consists of six basic and iterative tasks:

1. Identifying problems and opportunities, which were discussed in Chapter 3, including defining specific objectives and constraints for plans to reduce flood damages within the study area.

2. Developing an inventory and forecast of critical resources (physical, demographic, economic, and social) relevant to the problems and opportunities under consideration in the planning area, as discussed in Chapter 2.

3. Identifying and assessing potential management measures to achieve objectives and recognizing constraints and combining these measures into preliminary plans. This step includes defining the criteria for formulating and evaluating plans.

4. Evaluating potential effects and screening preliminary plans to select those which best meet the planning objectives and criteria and eliminate others from further detailed consideration.

5. Evaluating and comparing the plans.

6. Providing the rationale for selection of the tentatively recommended plan.

PLANNING OBJECTIVES

The City of Woodland, the Board, and the Corps have identified the following objectives for formulating flood damage reduction plans based on professional judgment and input from concerned residents and public agencies. The primary plan objectives are limited to flood damage reduction. The local sponsor's primary interest at this time is flood damage reduction. Plans will be formulated according to the Federal objective of water and related land resources planning, which requires water resources projects to contribute to the national economic benefit while protecting the Nation's environmental resources, consistent with Federal, State, and local laws, regulations, and policies.

The specific planning objectives are:

- Maximize the use of existing flood damage reduction facilities prior to constructing new facilities.

- Reduce flood damages in the city of Woodland.

- Protect existing environmental resources and mitigate potential adverse effects to the maximum practical extent.

PLANNING CONSTRAINTS

Constraints to the plan formulation and evaluation process have been identified as follows:

- Minimize the associated costs of the flood damage reduction system.

- Minimize adverse effects to the area's residents as well as environmental, cultural, and agricultural resources.

PLANNING EVALUATION CRITERIA

Four planning process evaluation criteria have been established in Federal principles and guidelines for planning water resource projects to lend more specificity to the planning objectives and provide a uniform set of guidelines for further information and evaluation of plans. They include (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. These criteria and the manner in which they apply to this study are described below.

COMPLETENESS

Completeness is the extent to which a given plan provides and accounts for all necessary investments or other actions to ensure the realization of the planning objectives. To satisfy the criteria, each plan should:

- Be capable of consistently and reliably providing identified project outputs.

- Need no further actions to ensure complete fulfillment of the stated degree of flood damage reduction.

- Mitigate unavoidable adverse environmental effects as fully as is found to be reasonable and justified.

- Fully compensate or offset adverse hydraulic effects to other areas to the extent justified or required by law.

EFFECTIVENESS

Effectiveness is the extent to which a plan alleviates the identified problems and achieves the planning objectives. Several important factors in measuring the effectiveness are:

- The level and reliability of flood damage reduction provided.

- One or more of the planning objectives addressed.

- Capability of being physically implemented.

EFFICIENCY

Efficiency is the extent to which a plan is the most cost-effective means of alleviating identified flood problems while realizing the specified objectives, consistent with protecting the Nation's environment. It is measured by comparing estimated monetary costs and benefits of the plans.

ACCEPTABILITY

Acceptability is the workability and viability of the plans with other Federal agencies, affected State and local agencies, and public entities given existing laws, regulations, and public policies. Acceptability is measured by:

- Willingness and capability of a non-Federal sponsor to pay its share of the project cost.

- Willingness of local affected governments to work toward agreements allowing implementation of the plans.

- Ability of a plan to minimize or avoid irreversible effects on the environment and irretrievable commitments of nonrenewable resources.

- Ability to obtain required permits and certification.

PERIOD OF ANALYSIS

The economic period of analysis for this study is considered to be 50 years, from 2006 to 2056.

HYDROLOGIC AND HYDRAULIC ANALYSES

Recent hydrologic information for the Cache Creek basin was updated with current information for this feasibility study; refer to Appendix C for more detail. Hydraulic information for this feasibility study was developed from current information and was not based on any previous hydraulic models; refer to Appendix D for more detail. This current hydrologic and hydraulic information was used in the models and analyses for plan formulation, evaluation, and selection.

INITIAL SCREENING OF FLOOD DAMAGE REDUCTION MEASURES

Preliminary nonstructural and structural measures were identified during the initial screening process with the objective of providing increased flood damage reduction to the city of Woodland. Nonstructural measures reduce the threat to public health and safety and flood damages at the point of damage instead of attempting to control the floodwater. Nonstructural measures considered include (1) raising or flood proofing structures, (2) relocating structures, and (3) implementing flood warning and evacuation systems.

Most structural measures to control flood damage are directed at the source of flooding. Structural measures considered during the initial screening process include (1) constructing additional storage, (2) implementing channelization, and (3) installing levees, setback levees, and backup levees. Nonstructural and structural measures reviewed and evaluated during the screening process are shown in Table 4-1.

Table 4-1. Initial Screening of Nonstructural and Structural Measures

Measure	Comparative Cost Range	Environmental Effects	Socioeconomic Effects	Potential for Combining with Other Measures	Status
Nonstructural					
Raising/Flood Proof Structures	High	Minimal	High	Low	Retained
Relocate Structures	High	Extensive	High	Low	Retained
Flood Warning Systems	Low	Minimal	Low	High	Retained
Structural					
Storage	High	Extensive	High	Low	Dropped
Channel Improvements	High	Extensive	High	Medium	Retained
Levee Modification	High	Extensive	Moderate	Low	Retained
Setback Levees	Moderate	Moderate	Moderate	Medium	Retained
Backup Levees	Low	Low	Low	High	Retained

NONSTRUCTURAL

Nonstructural measures reduce flood damages without significantly altering the extent of flooding; that is, nonstructural measures are aimed at reducing flood damage at the point of damage. Nonstructural measures range from physically moving structures to implementing evacuation plans. As a result, the costs associated with assorted nonstructural measures vary considerably.

Raising/Flood Proofing Structures

Approximately 4,000 homes of the approximately 10,000 homes in the Woodland area lie in the 1 in 100 chance (100-year) flood plain. Assuming approximately $60,000 as a cost to raise an average-size home, the cost to raise 4,000 homes would be $240 million. This cost does not include the cost to raise or flood proof industrial and commercial structures or the costs associated with raising residential garages and other residential structures. In addition to these costs, there may be stability issues associated with raising older homes, as well as elevated costs associated with raising homes initially erected on concrete slabs instead of block foundations.

Socioeconomic effects are judged to be high since families are displaced during raising of homes. Other significant damages would continue, such as the prolonged flooding of the portion of I-5 east of the city, the flooding of the sanitary sewer system, and the flooding of hazardous materials stored within the flood plain.

Raising or flood proofing existing structures in urban areas would have extraordinarily high costs. Raising or flood proofing of existing structures in sparsely populated areas was considered further as a measure to mitigate project-induced effects.

Relocate Structures

As indicated above, approximately 4,000 homes in the Woodland area lie within the 1 in 100 chance (100-year) flood plain. Costs associated with moving homes ($100,000 for an average-size house) and businesses to new locations would be prohibitive. In addition, structural damage experienced during movement of the homes may be extremely costly. Families would have to be temporarily housed, and environmental effects could be significant, given the new home site requirement. The other socioeconomic and continuing flood damages would be similar to those associated with raising and flood proofing.

Excluding land acquisition costs, the cost to move homes is even greater than the cost to raise homes. Relocating structures in urban areas was not considered further. Relocating structures in sparsely populated areas was considered further as a measure to mitigate project-induced effects.

Flood Warning System

A flood warning system is an operational framework designed to integrate a set of independent components which collect watershed data; analyze, interpret, and forecast downstream river stages; recognize potential threats of inundation within the flood plain; convey flood threat information to affected local agencies; coordinate public and private responses to imminent flood events; and facilitate implementation of preparedness and recovery plans. This type of system can provide warning time to close flood gates, to prepare for flood fighting, and to evacuate citizens from flood areas. Flood warning systems that have been recently developed have cost about $1 million (Corps, Reno flood warning system study).

The existing flood warning system includes a river forecast for Cache Creek at the Rumsey stream gage near the town of Rumsey produced by the National Weather Service (NWS) and the California-Nevada River Forecast Center (CNRFC). This forecast allows about 15 hours of notice to the Rumsey area for storms centered upstream from Rumsey. No river forecast is conducted downstream from Rumsey, but it is known that the travel time from Rumsey to the Woodland area is about 10 hours, for a total warning time of 25 hours for Woodland for storms centered upstream from Rumsey. Storms centered downstream from Rumsey can have a lag time of as little as 11 hours to reach the Yolo stream gage near the town of Yolo and the city of Woodland. Expanding the river forecast to include the Yolo gage would provide additional reliability to the flood warnings for the residents of Yolo County and Woodland.

The City of Woodland and Yolo County are responsible for receiving and responding to the flood threats identified by the CNRFC. Receiving information from the CNRFC can take several hours. Acquiring a storm watch system that allows access to real-time precipitation and streamflow data would allow the city and county to recognize a threat sooner and give several more hours to protect property and evacuate citizens. A reverse “911” system would save more time in notifying the public. This measure was considered further as a flood damage reduction measure.

STRUCTURAL

Structural measures identified by the Corps and local interests to increase flood damage reduction include upstream storage, levee modifications/new levee construction, channel improvements, and combinations of these measures.

Storage

In 1988, the Corps evaluated the economic feasibility of several combinations of storage space and downstream objective peak flows. The objective was to attenuate the peak flow downstream on Cache Creek so that the chance of flooding would be no more frequent than 1 in 100 in any given year. The only plan that was economically feasible was a dam and reservoir at the Blue Ridge site on Cache Creek just upstream from Rumsey. The project design was a roller-compacted concrete dam with a 300-foot-wide overflow type spillway. The proposed reservoir had a surface area of 7,000 acres and a storage capacity of 945,000 acre-feet. This dam was further studied in 1994 by the Corps in the West Side Tributaries reconnaissance study. This study concluded that the damsite is not feasible because, among other reasons, it straddles five seismic faults. Furthermore, there appears to be no local support for a multipurpose dam and reservoir. Therefore, this measure was not carried forward.

In the reconnaissance study, flood storage on Cache Creek was evaluated at three other sites: Bear Creek, Wilson Valley, and a third site just downstream from the existing Capay Diversion Dam. The results are summarized below.

The Bear Creek site was first identified by the State Department of Water Resources in the early 1970's as part of the State's Eel River project. The Corps' reconnaissance hydrologic analyses indicated that even when 100 percent of the runoff is stored at the Bear Creek site, downstream flows in Cache Creek would only be reduced by about 9 percent of the total Cache Creek inflow. Based on these results, a significant reduction in floodflows in Lower Cache Creek is not possible.

The Wilson Valley site is on Cache Creek about 5 miles downstream from the confluence with the North Fork of Cache Creek. In the early 1970's, the State Department of Water Resources conducted a foundation analysis of the onstream site as part of the Eel River project. The analysis indicated that weak foundation conditions limited the storage capacity of the Wilson Valley site to 37,000 acre-feet, and this volume would be filled with sediment in 80 to 90 years. The Corp's reconnaissance hydrologic analyses indicate that the peak discharge for the 1 in 100 chance flow at the town of Yolo would be decreased by 25 percent using a maximum storage volume of 37,000 acre-feet in the storage basin. The reduced peak discharge for the 1 in 50 chance flow event with the 37,000 acre-foot basin was found to be well above the estimated nondamaging channel capacity of lower Cache Creek. As a result, significant reductions in flood damages would not be achieved with the storage available at the Wilson Valley site.

The Capay site is downstream from Capay Dam on Cache Creek. The project would involve constructing offstream detention ponds adjacent to Cache Creek. The reconnaissance hydrologic analysis indicated that 75,000 acre-feet of detention capacity is required to decrease the peak discharge of the 1 in 100 chance flow event at the town of Yolo to the nondamaging capacity. Assuming a storage depth of 20 feet, the required detention area is estimated to be 5.9 square miles. Due to this large land requirement, as well as construction and operational difficulties, the Capay site was not considered further.

In summary, flood storage on Cache Creek was not considered further as a flood damage reduction measure. This was due largely to the relatively high costs, environmental effects, and the lack of local interest associated with storage measures.

Channel Improvements

Channel improvements could range from clearing to enlarging the existing channel. Clearing would increase conveyance capacity by reducing the amount of vegetation in the channel. Enlarging the channel would increase conveyance by increasing the flow area of the channel. Channel improvements could include enlarging existing bridges and would likely require slope protection due to increased channel velocities.

Levee Modification

Levee modifications and/or constructing new levees would protect areas on the landside of the levees from flood inundation and provide for conveyance of floodwater through the project area. Levees could be constructed along the streambank to minimize effects on adjacent lands or set back from the banks to reduce the required levee height and effects to riparian vegetation and wildlife. Slope protection would be required where scour velocities are erosive to levee embankment.

Setback Levees

A setback levee approach would involve constructing a new levee some distance from the streambank or existing levee and removing the existing levee or breaching it at various locations. This approach could be used to increase conveyance capacity while minimizing the associated increases in water-surface elevations and flow velocities. Doing so could reduce the need for improving the levee on both sides of the channel, the need for slope protection, and the environmental effects to the channel.

Backup Levees

A backup levee is a levee that is set back some distance from an existing levee system to provide a lower chance of flooding on its landside than the existing levee system provides. Unlike setback levees, the existing levees would be retained and would allow flooding of areas behind existing levees for flood events exceeding the design capacity of the existing levees. The area between the existing levees and the proposed backup levee would have the same percent chance of flooding in any given year as it would without the backup levee. The existing levee system would continue to be maintained and operated in the same manner as they are maintained. This type of system could be used to give a higher level of protection to a densely populated area such as a city while still maintaining the same level of protection to a sparsely populated area such as an agricultural production area.

FINDINGS

Structural and nonstructural measures were combined to provide flood damage reduction plans for the city of Woodland. Table 4-1 identifies those measures that were retained after the screening process.

The nonstructural measures involving raising/flood proofing structures, relocating structures, and implementing flood warning and evacuation systems were found to warrant further consideration for combining with the other measures.

In terms of structural measures, storage measures were dropped from further consideration due to high costs, environmental effects, and lack of local support. However, channel improvements, levee modifications, and construction of new levees were found to warrant further consideration.

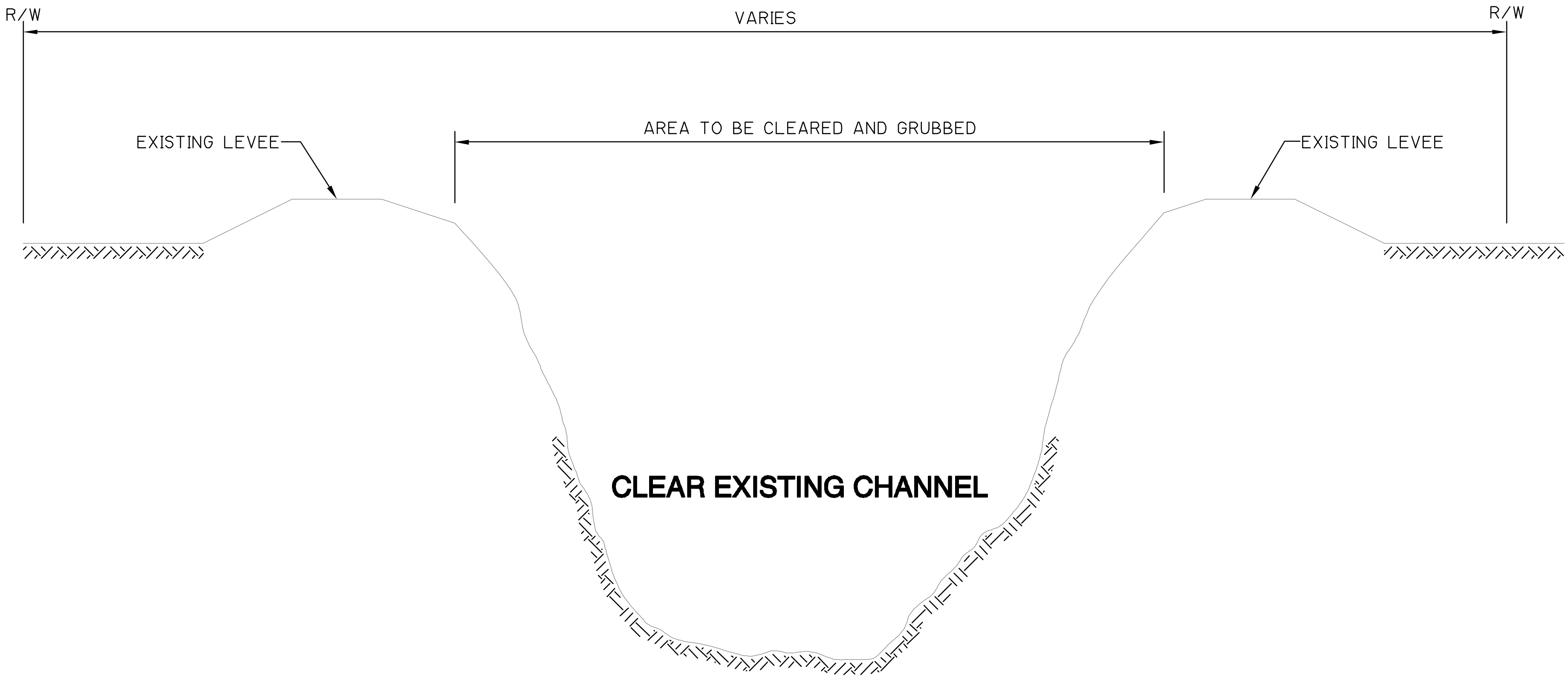
PRELIMINARY PLANS CONSIDERED

Based on the results of the initial screening of measures and on public comments, five preliminary flood damage reduction plans were developed to represent the overall range of practical flood damage reduction opportunities available for the lower Cache Creek. In addition to the no-action plan, they include:

- Channel Clearing
- Raising Existing Levees and Constructing New Levees
- Channelization and Constructing New Levees
- Constructing Setback Levees and Raising Existing Levees
- Constructing a Flood Barrier Levee (Backup Levee)

CHANNEL CLEARING

This plan would include clearing the existing channel and would improve conveyance of floodwater within the channel area by removing riparian vegetation, sediment deposits, and other obstructions. The cleared area would be reseeded with grass, and slope protection would be placed where required. This plan was formulated largely in response to the interest expressed by some of the landowners adjacent to the creek (Figure 4-1).



CHANNEL CLEARING

NOT TO SCALE

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
CHANNEL CLEARING

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 4-1

RAISING EXISTING LEVEES AND CONSTRUCTING NEW LEVEES

With this plan the levees would be raised on both sides along approximately 8 miles of Cache Creek from CR 97A to the Cache Creek Settling Basin. New levees would be constructed on the south bank of the creek from CR 97A upstream 2 miles. On the north bank of the levee upstream from CR 97A, 1 mile of existing project levee would be raised, and approximately 1 mile of new levee would be constructed. This plan would involve bridge replacement and slope protection where required (Figure 4-2).

CHANNELIZATION AND CONSTRUCTING NEW LEVEE

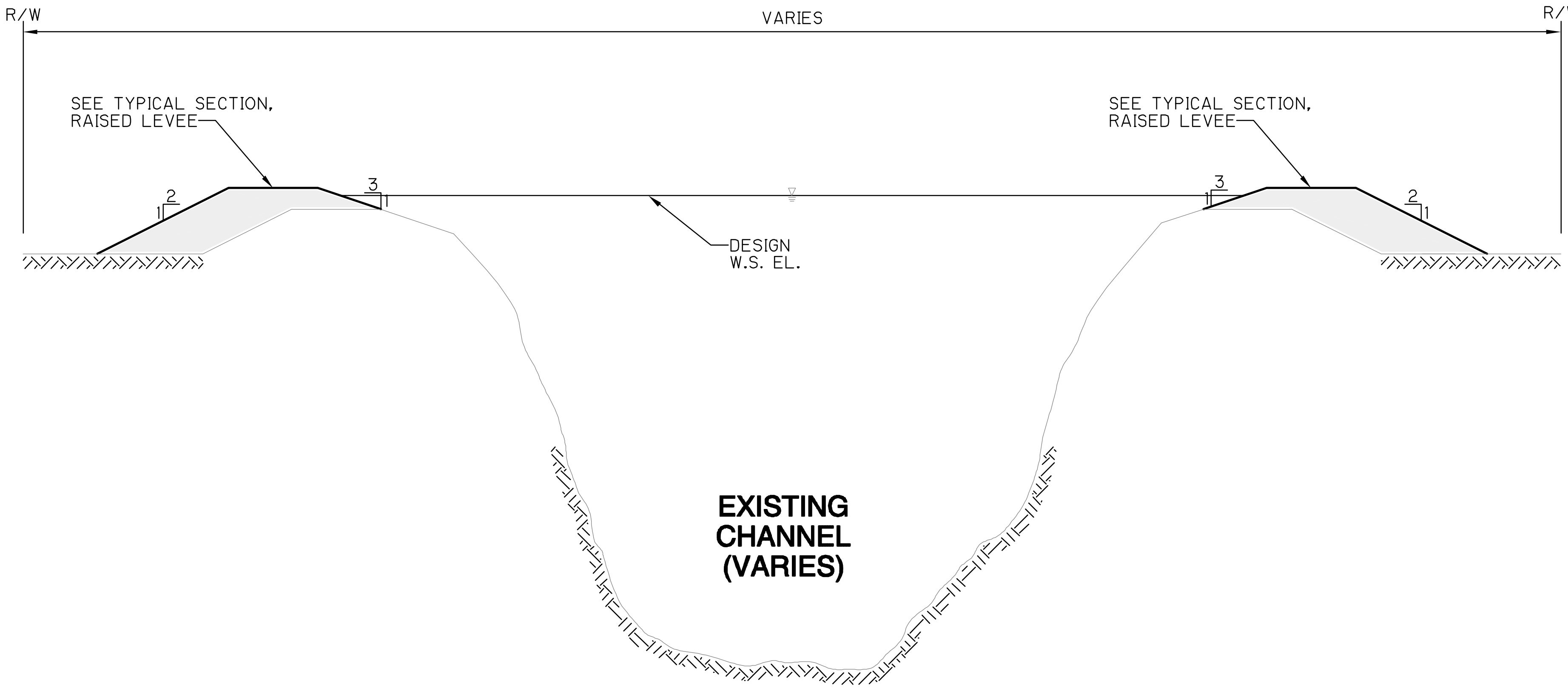
This plan combines two measures evaluated during the screening process: (1) excavating a bench along the channel and (2) constructing a new levee adjacent to the bench. These features would be constructed along a 9.3-mile reach of Cache Creek from about 1 mile west of CR 97A to the Cache Creek Settling Basin. The channel bench would be constructed at approximately the water-surface elevation associated with the 1 in 2 chance flood event and would be wide enough to maintain the design water-surface elevation at or below the PNP of the remaining existing levee. Where required, the existing levee affected by the bench would be removed and reconstructed adjacent to the bench. Bridge replacements and slope protection would be constructed as required (Figure 4-3).

CONSTRUCTING SETBACK LEVEES AND RAISING EXISTING LEVEES

Approximately 6.5 miles of setback levees would be constructed on either one or the other side of Cache Creek and existing levees on the opposite side would be raised, as required. In addition, adjacent to the 6.5-mile reach, this plan would include approximately 3 miles of newly constructed levee on both sides of the channel banks downstream from CR 96. Bridge replacements and slope protection would be constructed as required (Figures 4-4 and 4-5).

CONSTRUCTING A FLOOD BARRIER LEVEE

This plan would consist of constructing approximately 6.7 miles of new levee from CR 96 to the west levee of the Cache Creek Settling Basin (Figures 4-5 and 4-6). 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.



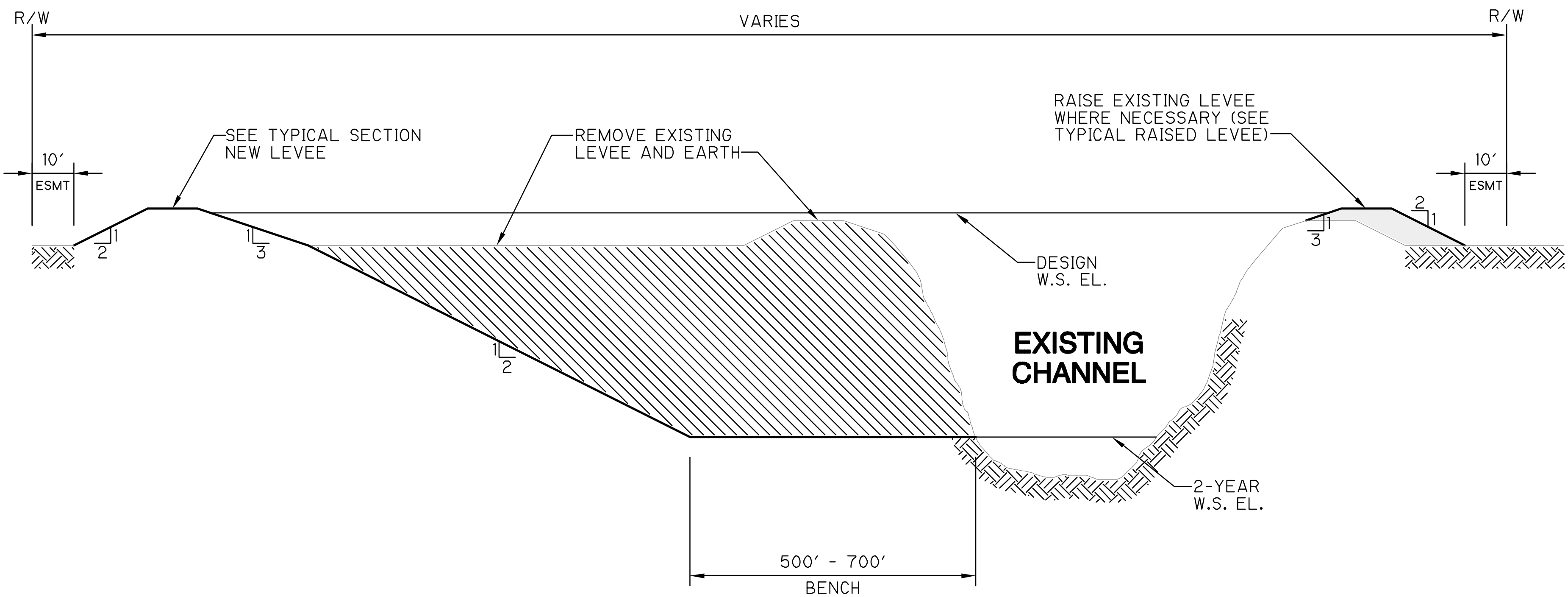
LEFT & RIGHT BANK
LEVEE RAISING
NOT TO SCALE

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
RAISE EXISTING LEVEES AND CONSTRUCT NEW LEVEES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 4-2



CHANNELIZATION AND CONSTRUCTING NEW LEVEES

NOT TO SCALE

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
CHANNELIZATION AND
CONSTRUCTING NEW LEVEES

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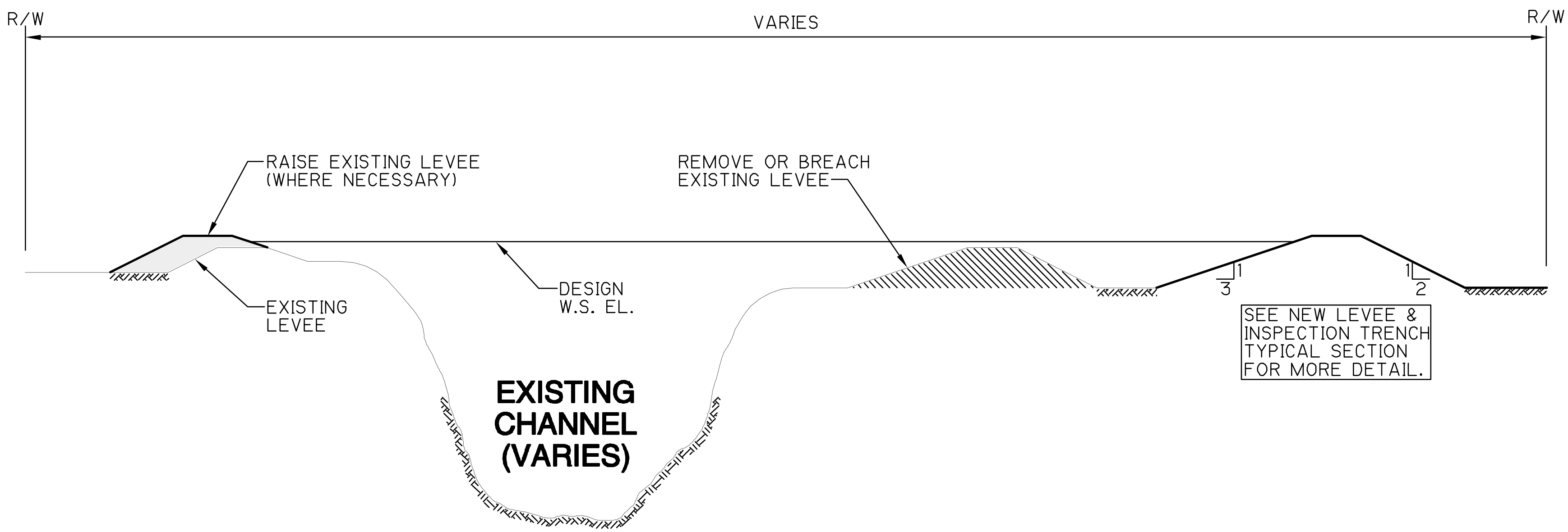
OCTOBER 2002

FIGURE 4-3



SETBACK LEVEES

NOT TO SCALE

NOTE

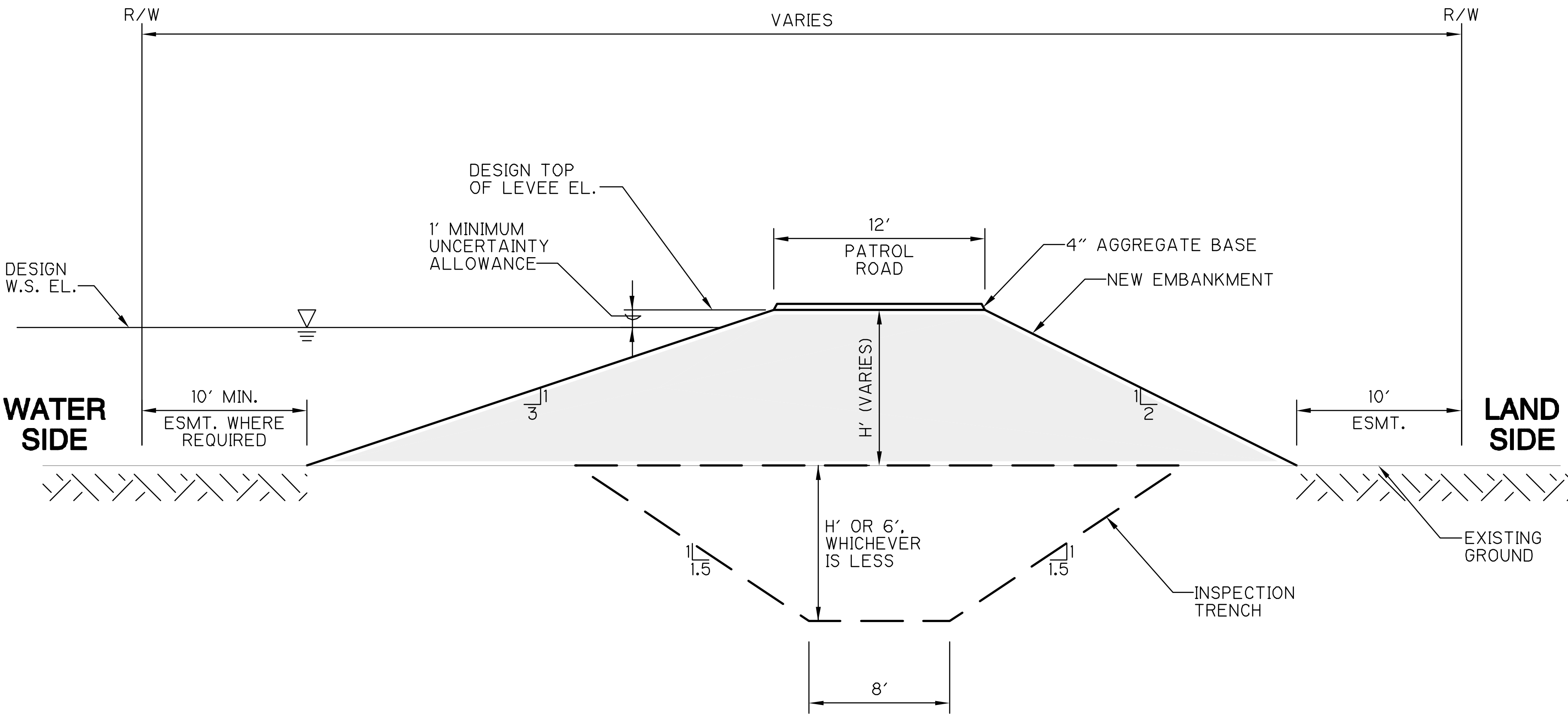
SLOPE PROTECTION IS REQUIRED ALONG REACHES WITH VELOCITIES GREATER THAN EXISTING-CONDITIONS VELOCITIES FOR TOP-OF-LEVEE FLOWS.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
CONSTRUCTING SETBACK LEVEES AND RAISING EXISTING LEVEES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 4-4



NEW LEVEE &
INSPECTION TRENCH

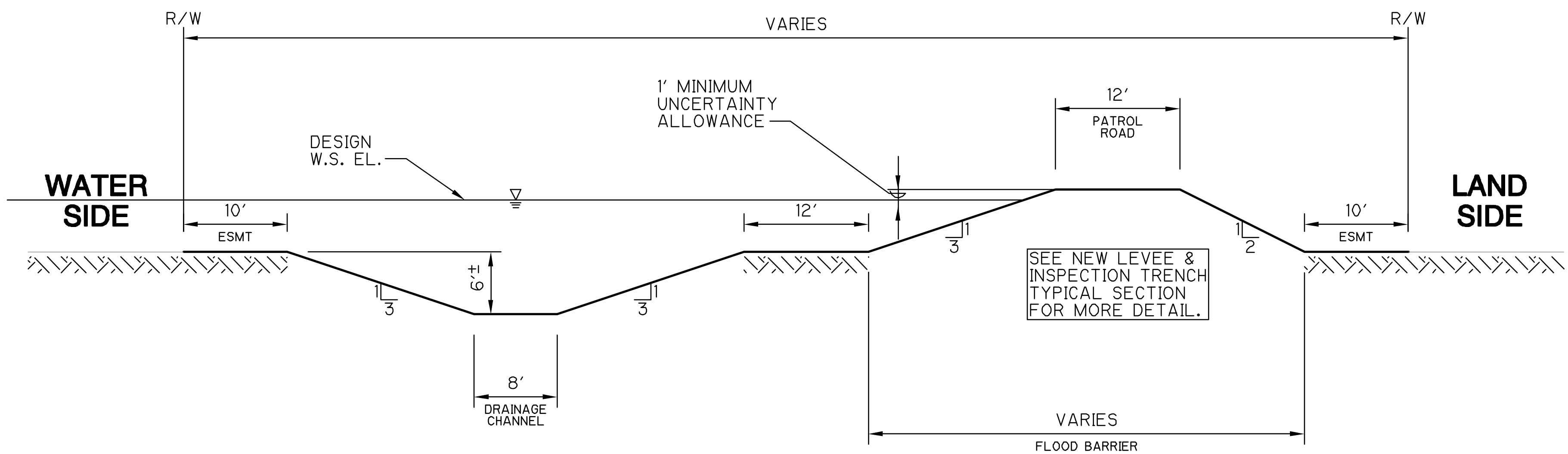
NOT TO SCALE

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
NEW LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 4-5



LOWER CACHE CREEK
FLOOD BARRIER
NOT TO SCALE

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
CONSTRUCTING A
FLOOD BARRIER LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 4-6

A ditch would be constructed adjacent to the levee to generate borrow material and to convey local runoff. Culverts would be placed at road and railroad crossings. Closure structures would be constructed as required at all crossings. Provisions would be made to protect some homes and structures within the associated flood plain.

A flood warning system would be implemented as well. This would allow time for evacuation of the flood plain and installation of the necessary closures.

Chapter 5

CHAPTER 5
EVALUATION OF PRELIMINARY PLANS

Levee boils in 1983.

CHAPTER 5
EVALUATION OF PRELIMINARY PLANS

Levee boils in 1983.

CHAPTER 5

EVALUATION OF PRELIMINARY PLANS

PRELIMINARY EVALUATION

The five preliminary action plans were evaluated, and comparative quantity and costs estimates were developed. The preliminary action plans include (1) Channel Clearing, (2) Raising and Constructing New Levees, (3) Channelization and Constructing New Levees, (4) Constructing Setback Levees, and (5) Constructing a Flood Barrier.

Except for the first plan, the evaluation of preliminary plans was based on the peak flow estimated to be associated with a flood event having a 1 in 200 chance of occurring in any given year. This chapter presents the results of the preliminary assessment of each plan in terms of its benefits or accomplishments and the environmental effects associated with implementation.

Preliminary assessment provides information for selection of two plans for feasibility-level analysis. The actual level of protection, which would be afforded by the final plan, is determined after further refinement and evaluation.

NO-ACTION PLAN

The No-Action Plan is the same as the without-project condition, which is described in Chapter 2. This plan serves as the baseline against which the effects and benefits of the action plans are evaluated. The Federal Government would take no action to implement a specific plan to reduce flooding of the city of Woodland under the No-Action Plan; and the Cache Creek levee system, with continued maintenance and repairs/rehabilitation, would continue to provide for the reliable conveyance of the 1 in 10 chance flood event. Annual damages to real property from overflows from Cache Creek would be expected to continue to be about $12 million. Other losses or adverse effects would continue to include the potential for flood-related loss of life, contamination from sanitary sewage and hazardous materials, and the extended closure of the section of I-5 east of the city of Woodland.

CHANNEL CLEARING, PRELIMINARY PLAN

GENERAL DESCRIPTION

This plan would include clearing the existing channel to improve conveyance of floodwater within the channel area by removing riparian trees, brush and associated root balls, and other obstructions in the watercourse. The cleared area would be reseeded with grass once the other obstructions are removed. Plate 4 shows the boundaries of this plan.

Clearing would take place from approximately 2 miles east of CR 94B to 1 mile east of CR 102 near the entrance of the settling basin, about 9.5 miles.

PLAN ACCOMPLISHMENTS

To assess the primary benefit of this plan, the hydraulic computer models were adjusted to reduce the Manning's roughness coefficient in the channel from the existing value of 0.032-0.042 to 0.022-0.031. The model results indicate that this preliminary plan would increase channel capacity to accommodate approximately a 1 in 40 chance flood event.

Removing flow constrictions through clearing would significantly increase channel velocity; therefore, slope protection to stabilize the banks would be required through most of the affected reach.

POTENTIAL ENVIRONMENTAL EFFECTS

Because trees, brush, and other obstructions would be removed during channel clearing, this plan would result in the significant loss of valuable riparian habitat. This plan could also disturb mercury-laden sediments that could remobilize and ultimately be deposited in the Yolo Bypass and Delta. Biomagnification of mercury could adversely affect organisms throughout the food chain. The plan would not affect agricultural land or Yolo County's goal for agricultural land preservation.

RAISING EXISTING LEVEES AND CONSTRUCTING NEW LEVEES, PRELIMINARY PLAN

GENERAL DESCRIPTION

This plan is similar to the levee-raising measure reviewed in the reconnaissance study. Existing project levees would be raised on approximately 8 miles of Cache Creek from CR 97A to the settling basin. Levees would be raised on both sides of this 8-mile reach. Four miles of new levees would be constructed upstream from the existing project levee on the south bank from CR 97A to CR 96. On the north bank of the levees, 1.5 miles of levee would be constructed from CR 96B to CR 95B. Plate 5 shows the locations of the raised levees and newly constructed levees for this plan.

Levees would be raised from 1 to 14 feet. This plan would require replacement of several bridges, including the I-5 bridges, CR 99W bridge, SH 113 bridge, CR 102 bridge, and a railroad bridge. In general, this plan would also require installation of slope protection for bank stabilization along the raised and newly constructed levees due to high velocities.

PLAN ACCOMPLISHMENTS

Implementation of this plan would reliably pass a peak flow with a 1 in 200 chance of occurring in any given year. This plan includes factors to characterize and meet levee stability requirements at the PNP and PFP flows. A benefit of implementing this preliminary plan is that impacts on lands outside the existing levee system would be limited.

POTENTIAL ENVIRONMENTAL EFFECTS

Hydraulic effects associated with this plan include the resulting high channel velocities and increased peak flow entering the settling basin. The requirement for slope protection would result in the significant loss of valuable riparian habitat. This plan could also result in the disturbance of mercury-laden sediments with potential ecological effects in the Yolo Bypass and Delta. Effects to agricultural lands would be minimal.

CHANNELIZATION AND CONSTRUCTING NEW LEVEES, PRELIMINARY PLAN

GENERAL DESCRIPTION

Under this plan, the channel would be benched, and new levees would be constructed along several sections of a 9.3-mile reach of Cache Creek from about 1 mile west of CR 97A to the settling basin, as shown on Plate 6. A bench would be constructed along one side of the existing channel. The existing levee would be removed and the overbank area adjacent to the channel is excavated. The levee would be reconstructed approximately 500 to 700 feet from its existing location. The bench or terrace would be located at the 1 in 2 chance flow water-surface elevation, which is the average high flow over a 2-year recurrence interval. Bench channelization is planned for the reach approximately 2 miles upstream from California Northern Railroad on Cache Creek. Bench channelization and levee raising are planned on the southern bank of Cache Creek over approximately a 3-mile area directly downstream. Channelization and levee raising are planned on the opposite bank of Cache Creek for approximately 2 miles beginning at SH 113 and extending to CR 102. At CR 102, channelization and levee raising are begun again on the southern bank and extend to the settling basin. Implementation of this plan would require replacement of a railroad bridge and installation of slope protection.

PLAN ACCOMPLISHMENTS

Similar to the plan to raise the existing levees, the plan to improve the channel and construct new levees would reliably pass a flow with a 1 in 200 chance of occurring in any given year. An important feature of this plan is that in most of the 9.3-mile reach, the PFP of the remaining existing levee would not be exceeded; therefore, levee construction would be required on only one side of the channel, instead of both sides.

POTENTIAL ENVIRONMENTAL EFFECTS

The environmental effects of this plan would be the removal of some riparian habitat. However, the bench area would likely provide an area for onsite mitigation. Also, high floodflow velocities will require rock slope protection at some locations. Although channelization and levee construction are required for the most part on only one side of the channel, the overall land requirements for this plan are still high given the requirement for 500-700 feet of terraced land adjacent to the channel. This land is currently cultivated. This plan could also result in the release of mercury-laden sediments with potential ecological effects in the Yolo Bypass and Delta. New levee construction would also result in minor agricultural land loss.

CONSTRUCTING SETBACK LEVEES AND RAISING EXISTING LEVEES, PRELIMINARY PLAN

GENERAL DESCRIPTION

This plan involves installing about 6.5 miles of setback levees on one side of Cache Creek and raising existing levees on the opposing side. In addition, this plan would require construction of about 3 miles of new setback levees on both sides of Cache Creek upstream from the 6.5-mile reach. Levees would be set back 1,000 to 2,000 feet from the existing levees. The proposed setback areas, raised levee areas, and locations for newly constructed levees are illustrated on Plate 7.

Setback levees would range from 1 foot to 14 feet in height. Raised levees would range from 1 foot to 7 feet in additional height. The farther the levees are set back, the greater the increase in channel capacity, providing more conveyance capacity and reducing the overall channel velocity.

Setbacks were calculated at 1,000-, 1,500-, and 2,000-foot distances from the existing levee. Although the 1,000-foot setback would require less land acquisition, velocities would be higher, and more bank stabilization would be needed. Conversely, the 1,500- and 2,000-foot setbacks would increase the flood plain significantly and require more land acquisition and the relocation of some existing homes and other structures.

This plan would also involve the replacement of the railroad bridge and construction of slope protection along creek banks where setback levees, raised levees, and newly constructed levees would be installed.

PLAN ACCOMPLISHMENTS

This plan would reliably pass a flow with a 1 in 200 chance of occurring in any given year.

POTENTIAL ENVIRONMENTAL EFFECTS

Effects to the creek channel would be minimal; channelization would only be required at the railway bridge. Land between the old levee and the new setback levee would remain undisturbed; however, this land would be isolated and potentially inaccessible for continued agricultural use. In addition, agricultural land would be lost due to the construction of the new setback levees. The loss of agricultural land would need to be addressed as related to Yolo County's General Plan and agricultural land preservation goals.

High water would flow over the bank for at least 1,000 feet before being retained. As a result, this plan more closely mimics the natural flooding process and reduces effects due to minimal velocities and associated scour.

CONSTRUCTING A FLOOD BARRIER, PRELIMINARY PLAN

GENERAL DESCRIPTION

This plan consists of the construction of about 6.8 miles of new levee. The new levee would be located 1 to 2 miles south of Cache Creek between CR 96B and the settling basin, just north of the city of Woodland, as indicated on Plate 8. The area between the new levee and Cache Creek, which is currently a portion of the existing flood plain, would remain in the flood plain with increased flood depth and duration in the vicinity of the settling basin. The chance of flooding in any given year would remain unchanged.

In the remaining flood plain, provisions would be made to flood proof the structures that would have significant, induced flood damages. Closure structures would be provided on the levee at road and railroad crossings. A flood warning system would also be incorporated to initiate evacuation of the flood plain and closure of crossings.

The new levee would vary from 4 to 17 feet in height. A 450-cfs canal on the flood side of the levee would be included for internal drainage of more frequent events.

Another major component of the preliminary plan would be the removal of a 4,000-foot section of the west levee of the settling basin. This feature will allow floodflows to drain by gravity from the flood plain.

PLAN ACCOMPLISHMENTS

This plan has many benefits and meets all the planning objectives for the project. As shown on Plate 9, the plan would reduce the risk of flooding to Woodland to flooding associated with a flow having a 1 in 200 chance of occurring in any given year. Because the existing levee system would remain the same, use of existing flood damage reduction facilities would be maximized. Larger flood events would be confined to agricultural land currently in the flood plain. Implementation of the Flood Barrier Plan would, however, increase flood depths and durations on lands east of CR 101.

Peak floodflows on the flood plain would also increase over their current levels. Plate 10 shows that the peak flows on the flood plain would also increase for most of the flood plain area north of the flood barrier as an effect of diverting flows that would have gone through industrial and residential portions of Woodland.

POTENTIAL ENVIRONMENTAL EFFECTS

This plan would cause minimal environmental effects to the creek and its riparian habitat. Some loss of agricultural land along the boundary with the city of Woodland would be expected, but not to the extent of the land lost under the Setback Levee Plan. Depth and duration of ponded water would increase west of the west levee of the settling basin.

COMPARATIVE COST ESTIMATES

Comparative cost estimates were developed for the five preliminary plans. These estimates are summarized in Table 5-1. The estimates are not intended for budgetary purposes. They were developed to assist in screening the plans and selecting the two preliminary plans for feasibility-level analysis.

The estimates only reflect the major cost elements of these plans. Fish and wildlife mitigation costs were estimated at 10 percent, utility relocations at 1 percent, and operation and maintenance at 0.2 percent of construction costs. Lands, Easements, Relocations, Rights-of-Way, and Disposal Area (LERRDS) costs are based on preliminary design and cost estimates of these items.

Table 5-1. Comparative Cost Estimates of Preliminary Plans

Plan Description	First Cost ($)	Investment Costs ($)	Annual Costs ($)
Channel Clearing[1]	37,383,000	40,241,000	2,945,000
Raising Levees and Constructing New Levees	75,376,000	81,139,000	5,937,000
Channelization and Constructing New Levees	64,286,000	69,201,000	5,063,000
Constructing Setback Levees and Raising Existing Levees 1,000 Feet 1,500 Feet 2,000 Feet	 42,375,000 41,053,000 33,868,000	 45,615,000 44,192,000 36,457,000	 3,339,000 3,234,000 2,668,000
Constructing a Flood Barrier	25,739,000	27,707,000	2,028,000

[1]Does not meet minimum flood damage reduction objectives.

PRELIMINARY EVALUATION

The criteria for the preliminary plans were evaluated in terms of the ability of each plan to meet the four general planning criteria presented in Chapter 4: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. The results of this evaluation provided the basis for selecting two of the preliminary plans for a feasibility-level evaluation. The results of the criteria evaluation are presented in this section.

COMPLETENESS

Completeness is the extent to which a given plan provides and accounts for all necessary investments or other actions to ensure the realization of the planning objectives. The degree of completeness is measured with respect to the five primary factors. The ability of the plans to meet these factors is described below.

Yolo County is particularly interested in preserving agricultural lands. Of the plans that meet the primary flood damage reduction objective, the Flood Barrier Plan has the least impact on agricultural lands.

The Flood Barrier Plan has the highest degree of reliability because it would be least sensitive to flows exceeding the design capacity. Flows significantly higher than the design capacity could cause relatively small increases in water-surface elevations. This characteristic is attributable to the large flood plain area that would remain active under this plan. This characteristic also exists to a lesser extent with the Setback Levee Plan, depending on how far the levees are set back from the creek.

Further Actions

To achieve completeness, no further actions should be needed to ensure fulfillment of the stated degree of flood damage reduction. None of the preliminary plans would require additional facilities to achieve the stated degree of protection. However, the Channel Clearing Plan cannot meet the primary flood damage reduction objective.

Environmental Effects

Completeness also considers the ability to mitigate unavoidable adverse environmental effects. The types of potential effects and scope of mitigation varies significantly between the plans.

The Channel Clearing Plan and the Raising Existing Levees and Constructing New Levees Plan would involve the permanent removal of significant amounts of riparian vegetation in and along lower Cache Creek. Mitigation for the effects of these plans would be difficult onsite, and potentially offsite as well, due to the limited amount of suitable habitat in and near the area. Additionally, the mitigation would be very costly.

The Channelization and Constructing New Levees Plan and the Constructing Setback Levee and Raising Existing Levees Plan would also involve removal of riparian habitat (considerably more habitat would be removed for the former). However, both of these plans could provide an area for onsite mitigation.

The Flood Barrier Plan requires minimal construction activities in Cache Creek, although there is significant construction involving the settling basin levees. The channel and project levees would be maintained according to the current project requirements. The flood barrier levee and associated drain would traverse agricultural lands, so construction of these facilities would have little impact on riparian vegetation and wildlife habitat.

All plans involving construction activity within the creek raise the potential for release of mercury-laden sediment. Constructing a Flood Barrier Levee Plan minimizes this potential. All plans, except Channel Clearing, would involve the loss of prime agricultural land covered by the levee footprint. This effect would not be able to be mitigated. The Constructing Setback Levees and Raising Existing Levees Plan would potentially result in the greatest loss of prime agricultural land.

Hydraulic Effects to Other Areas

Another measure of completeness is the ability to fully compensate or offset adverse hydraulic effects to other areas. The preliminary plans have been formulated to reflect compensation for hydraulic effects and include costs for flood easements as deemed appropriate.

The hydraulic effects to the Yolo Bypass were assessed in the hydrology analysis and determined to be insignificant due to non-concurrent flood peaks.

Constructing a Flood Barrier Plan would adversely affect some farmhouses/structures in the remaining flood plain between the creek and the flood barrier. The comparative cost estimates reflect the cost of flood proofing/protecting these structures.

EFFECTIVENESS

The primary objective for every plan is to protect the city of Woodland from a flood event on Cache Creek having a 1 in 100 chance of occurring in any given year. Effectiveness is the extent to which a plan alleviates identified problems and achieves the planning objectives. The objectives addressed by the preliminary plans are shown in Table 5-2. All plans except Channel Clearing can meet these objectives.

Another objective is to maximize the use of existing flood damage reduction facilities prior to constructing new facilities. The Channel Clearing Plan, the Raising Existing Levees Plan, and Flood Barrier Plan fully use the existing flood damage reduction facilities. The Channelization Plan and Constructing New Levees and the Setback Levee Plan require removing the existing levee and constructing a new levee on one side of the creek.

EFFICIENCY

Efficiency is a measure of the extent to which a plan is cost effective in terms of alleviating flood problems while realizing the specified objectives. It is measured by comparing estimated monetary costs and benefits of plans. Table 5-2 provides a qualitative comparison of the estimated benefit and cost for the five preliminary plans. These comparison indicate that the Flood Barrier Plan and the Setback Levee Plan are the most cost effective.

ACCEPTABILITY

Acceptability is the workability and viability of an alternative with the plans and projects of Federal, State and local agencies, and public entities in accordance with existing laws, regulations, and public policies. The relative acceptability of the five preliminary plans was judged on the basis of feedback and tentative support indicated by potential non-Federal sponsors.

Table 5-2

Table 5-2. Comparison of Ability of Flood Damage Reduction Plans to Meet Planning Criteria Preliminary Screening

Plan	**Cost ($ millions)**	**Plan Formulation Criteria**			
	Investment Cost*	**Completeness**	**Effectiveness**	**Efficiency**	**Acceptability**
Channel Clearing	$40	Does not meet 1 in 200 chance event flood damage reduction goal and has significant adverse environmental effects.	Meets 5 of 8 planning objectives; however, does not provide adequate flood damage reduction.	Does not provide 1 in 100 chance protection.	Judged to be unacceptable because flood damage reduction is only provided for 1 in 40 chance flood events.
Ranking		Unacceptable	Unacceptable	Poor	Unacceptable
Raising Existing Levees and Constructing New Levee	$81	Meets flood damage reduction goal, maximizes use of existing facilities, and has significant adverse environmental effects.	Meets 5 of 8 planning objectives, provides adequate flood damage reduction.		High price is unacceptable to general public.
Ranking		Good	Moderate	Poor due to cost	Poor
Channelization and Constructing New Levees	$69	Meets flood damage reduction goal, maximizes use of existing facilities, but requires significant changes to existing facilities and land acquisition.	Meets 4 of 8 planning objectives, requires large land acquisition. Moderate		High price and large land acquisition needs are unacceptable to general public.
Ranking		Moderate		Poor due to cost	Poor
Constructing Setback Levees and Raising Existing Levees	$36 to $46	Meets flood damage reduction goal, maximizes use of existing facilities, but also requires large setback area and new levee.	Meets 4 of 8 planning objectives, but with significant environmental damage while meeting flood damage reduction goals. Has potential for ecosystem restoration component.		Public acceptance of cost; however, little public approval for using large sections of agricultural land for new levee construction.
Ranking		Good	Good	Good	Moderate
Constructing a Flood Barrier	$27	Meets flood damage reduction goal; no further action required, but does include hydraulic impact to new area.	Meets 7 of 8 planning objectives, is easily physically implemented.		Public acceptance of cost; public approval for minimization of environmental damage and land acquisition.
Ranking		Good	Excellent	Good	Moderate

*Investment cost includes interest that would accrue over a 2-year construction period (6.875 percent).

Federal, State, and other local agencies have participated in various steps of formulating and evaluating the preliminary plans. These entities include the Corps, U.S. Fish and Wildlife Service, California Department of Fish and Game, California Department of Water Resources, Yolo County, City of Woodland, and the City of Woodland Flood Task Force.

Non-Federal participation in the project is essential, since a non-Federal sponsor must share costs associated with project components. In addition, non-Federal input is critical to identify and establish plans that will be acceptable to the public and address the needs and concerns of local stakeholders.

The City of Woodland Floodplain Task Force includes members of the Woodland City Council, the Yolo County Board of Supervisors, an Association of General Construction member, a Cache Creek Conservancy member, the Farm Bureau, the Woodland Chamber of Commerce, the Woodland Economic Reconnaissance Corporation, and three citizens at large. The City of Woodland Floodplain Task Force helped identify measures for the initial screening process. On February 8, 2001, task force members were presented with the evaluation of the five preliminary plans described in this report. The City Council and Yolo County Supervisors unanimously endorsed those recommendations to the Corps.

SUMMARY AND SELECTED PRELIMINARY PLANS

A comparison of estimated costs and the ability to meet the planning criteria of the preliminary plans is shown in Table 5-2. Careful review of the table shows that the setback levees and flood barrier should be selected for further study as final plans.

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Chapter 6

CHAPTER 6
EVALUATION AND COMPARISON OF FINAL PLANS

Cache Creek upstream of I-5 near town of Yolo in 1995.

CHAPTER 6
EVALUATION AND COMPARISON OF FINAL PLANS

Cache Creek upstream of I-5 near town of Yolo in 1995.

CHAPTER 6

EVALUATION AND COMPARISON OF FINAL PLANS

Based on the evaluation of the preliminary plans, three plans, the No-Action Plan, the Lower Cache Creek Flood Barrier (LCCFB) Plan, and the Setback Levee Plan, were evaluated in greater detail. To maximize the acceptability, refinements were evaluated for the LCCFB Plan (three options: Plans *A, B, C*) and several setback levee alignments were developed for the Setback Levee Plan (three options: Narrow Setback Levee (NSL) Plan, Wide Setback Levee (WSL) Plan, and Modified Wide Setback Levee (MWSL) Plan). The first setback plan, the Narrow Setback Plan, concentrated on minimizing effects to landowners and agricultural operations in the study area. Due to the increased flow velocities and potential erosion for this plan, an extensive amount of rock slope protection would be necessary, which have severe environmental effects. A second setback plan, the Wide Setback Plan was developed to reduce the environmental effects of the Narrow Setback Plan. However, it was deemed that, due to the extensive amount of environmental mitigation required for the rock slope protection at the bridges and the number of residences proposed for relocation, a third setback plan was necessary. The third setback plan, the Modified Wide Setback Plan, minimizes environmental effects even further by lengthening the bridges with viaducts, eliminating the need for rock slope protection at the bridges.

While the project description, design, cost and graphics 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 MWSL Plan). Crown widths will be refined for the selected plan.. Analyses of the effects of levee crown widths up to 20 feet are included in Appendixes F and K and in the Draft EIS/EIR.

EVALUATION OF NO-ACTION PLAN

The No-Action Plan is assumed to have the same conditions as for the without-project future conditions, which are described in Chapter 2. This plan serves as the baseline against which the effects and benefits of the action plans are evaluated. The Federal Government would take no action to implement a specific plan that would reduce flooding in Woodland, and the existing Cache Creek levee system would continue to provide the current level of performance. Historically, the system has passed flows with between a 1 in 10 and 1 in 20 chance of occurring in any given year.

Table 6-1. Estimated Present-Worth Costs of Future Repairs of the Existing Cache Creek Levee System

Year	Feature	Location	Unit Price per Linear Foot ($)	Total Cost ($)	Present Worth Factor	Present Worth of Costs ($)
2009	1,400 Lineal Feet of Slope Protection	Through I-5 Bridges	2,000	2,800,000	0.84	2,342,600
2009	700 Lineal Feet of Slope Protection	Bend near town of Yolo	2,000	1,400,000	0.84	1,171,300
2011	6,500 Lineal Feet of 150-foot Setback Levee	Upstream from I-5 on Left Bank	500	3,250,000	0.74	2,414,300
2024	1,500 Lineal Feet of 150-foot Setback Levee	Downstream from I-5	500	750,000	0.34	257,200
2024	4,000 Lineal Feet of 150-foot Setback Levee	Downstream from I-5	500	2,000,000	0.34	686,000
2024	3,000 Lineal Feet of 150-foot Setback Levee	Upstream from SH113	500	1,500,000	0.34	514,500
2024	6,000 Lineal Feet of 150-foot Setback Levee	Downstream from SH113	500	3,000,000	0.34	1,029,000
2024	1,000 Lineal Feet of 150-foot Setback Levee	Upstream from County Road 102	500	500,000	0.34	171,500
2044	8,750 Lineal Feet of 150-foot Setback, Extend Project Levee Upstream	Upstream from I-5 and existing project on right bank	500	4,375,000	0.10	457,000
					Total	$9,043,400

Notes:

Present worth is back to year 2006, and the period of analysis is 50 years.
Interest rate is 6.125 percent.
Unit prices include environmental mitigation.
Unit prices do not include price escalations.

Without a flood damage reduction project, average annual damages to real property from overflows from Cache Creek would be expected to be about $12 million. Other adverse effects and losses would continue to include the potential for flood-related loss of life, contamination from sanitary sewage and hazardous materials, and the extended closure of sections of I-5 both north and east of Woodland.

This plan would include the stabilization of Cache Creek in areas of concern determined by a study team that includes a geomorphologist and the Department of Water Resources. (See Appendix I.) Over the 50-year period of analysis, rehabilitation of the existing levee system using rock slope protection and setback levees for erosion areas would likely be required to maintain the design functions of the system. Table 6-1 shows these repairs over time. Operation and maintenance of the existing levee system and subsequent need for environmental mitigation would also be necessary. The total present worth of the rehabilitation is $9.0 million, which equals an annualized cost of approximately $600,000/year, not including operation and maintenance.

EVALUATION OF THE LOWER CACHE CREEK FLOOD BARRIER

NEED FOR REFINEMENT

The preliminary Lower Cache Creek Flood Barrier (LCCFB) Plan in Chapter 5 included breaching the west levee of the Cache Creek Settling Basin to allow the overflow from Cache Creek to enter the settling basin northeast of Woodland (Plate 8). However, the preliminary plan would allow backwater from the settling basin to flood lands west of the settling basin whenever flow occurred over the existing settling basin outlet weir. This condition would occur annually for several days at a time, and the 1 in 10 chance flood would pond water 5 to 10 feet deep in this area. Due to the frequency and duration of flooding, Yolo County opposes this preliminary plan. Country Road (CR) 102, a major arterial road, would be inundated with floodwaters, resulting in the road being closed for long periods of time. Consequently, the preliminary plan was refined to reduce the frequency of flooding of CR 102 associated with the LCCFB Plan.

REFINEMENTS CONSIDERED

Three additional options of the LCCFB Plan that differed by the method of connection of the levee to the Cache Creek Settling Basin and by the associated flooding of CR 102 were investigated. The west end of the project was also modified to eliminate excessive turns in the LCCFB levee and to avoid homes. The new west end levee alignment begins at the intersection of CR 96B and CR19B and reaches east along CR 19B to the intersection of CR 97A and CR19B. From this intersection, the LCCFB levee has the same alignment as the preliminary alignment. (See Plates 11, 12, and 13 for the new alignments and plans.) These plans were evaluated for three different design flows at the ultimate outlet weir elevation of the settling basin (41 feet msl [NAVD88]). The plans are described below.

Plan *A*

The LCCFB Plan *A* reflects constructing an inlet weir in a section of the west levee of the settling basin (Plate 11) and removing a portion of the settling basin training levee. The proposed inlet weir varies in length from 2,000 to 3,000 feet, depending on the design flow. The inlet weir crest elevation was set at 45 feet msl (NAVD88), preventing water originating in the settling basin from flooding lands west of the settling basin. Floodflows would enter the settling basin by flowing through culverts in the west levee and by flowing over the inlet weir. Hydraulic analysis has shown that this inlet weir would be submerged given high enough flow conditions (higher than the current design flow).

Plan *B*

With the LCCFB Plan *B* the impact to CR 102 would be reduced by reconstructing CR 102 at a higher elevation on an embankment (Plate 12). CR 102 would be raised 10 feet for approximately 9,000 feet and would essentially function as the new west levee of the settling basin. Under this plan, the lands to the west of CR 102 would have a similar level of protection as existing conditions. The lands east of CR 102 would essentially become a part of the settling basin. Floodflows from the flood plain would enter the settling basin by flowing through culverts under CR 102 and by overtopping CR 102. A 4,000-foot section of the west levee and 5,250 feet of training levee would be breached to allow flows from the flood plain into the settling basin.

Plan *C*

The LCCFB Plan *C* is identical to Plan *B* except that the entire west levee from where the LCCFB levee intersects the west levee of the settling basin to approximately 9,000 feet north of this intersection would be breached (Plate 13). The hydraulic analysis shows no significant differences from breaching the entire west levee of the settling basin as compared to breaching the 4,000-foot section. The materials from the existing west levee of the settling basin would be used for the construction of the LCCFB levee. The entire training levee of the settling basin (approximately 12,000 feet) would also be removed under this plan.

COMPARISON OF COSTS

Table 6-2 summarizes the total investment costs and total annual costs for the three alternative LCCFB Plans. The estimates are for comparison of the plans and are not intended for budgetary purposes.

Table 6-2. Comparative Cost Estimates for Three Alternative Lower Cache Creek Flood Barrier Plans

Plan Variation	Option	Design Peak Flow (X 1,000 cfs)	Total Investment Cost	Total Annual Cost
Plan *A*				
Lower Cache Creek Flood Barrier Plan with the provision of an inlet weir to the settling basin	1	53	$38,444,600	$3,190,900
	2	70	$40,544,600	$3,357,900
	3	91	$42,775,600	$3,527,200
Plan *B*				
Lower Cache Creek Flood Barrier Plan with the provision of raising CR 102 and breaching 4,000-foot section of west levee of the settling basin	1	53	$44,332,200	$3,645,400
	2	70	$45,261,800	$3,716,000
	3	91	$46,463,200	$3,807,200
Plan *C*				
Lower Cache Creek Flood Barrier Plan with the provision of raising CR 102 and breaching entire west levee of the settling basin	1	53	$41,944,000	$3,464,100
	2	70	$42,873,500	$3,534,700
	3	91	$44,428,200	$3,652,700

The comparative costs show that the LCCFB Plan *A*, which has an inlet weir to the settling basin, is the lowest cost plan and therefore is selected as the refined plan.

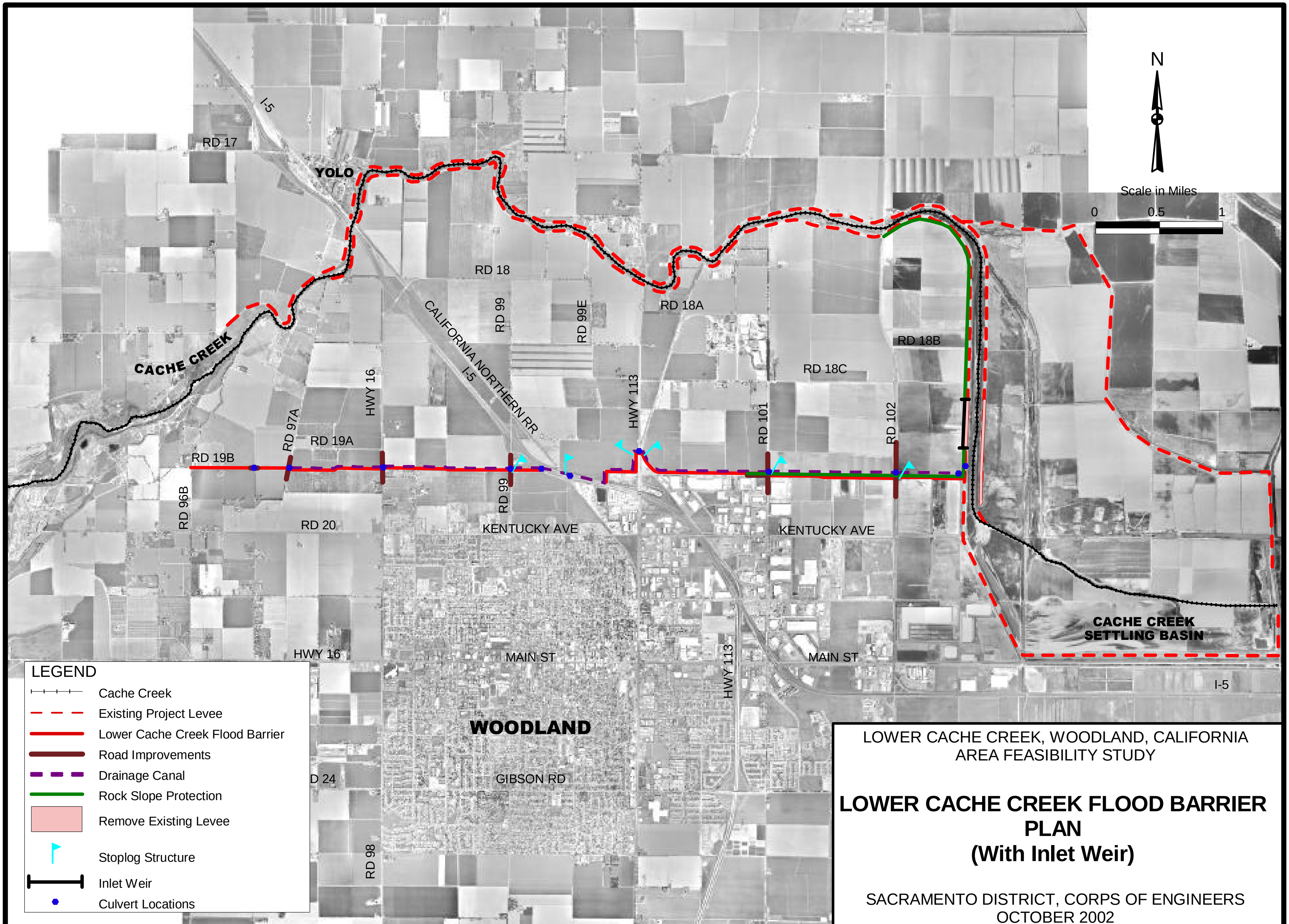
DESCRIPTION OF REFINED LCCFB PLAN

The LCCFB Plan with an inlet weir in the west levee of the settling basin (Plan A) was selected as the refined plan (Figure 6-1 and Plate 11). This plan eliminates overflow from the settling basin onto the lands west of the settling basin and has a lower construction cost. A more in-depth evaluation to further evaluate costs (including real estate and mitigation costs), slope protection, drainage, and environmental effects follows.

This section describes the features, accomplishments, and effects of the final plan for the LCCFB Plan. This plan was analyzed in greater detail for the three design flows of 53,000, 70,000, and 91,000 cubic feet per second (cfs) (the 1 in 50, 1 in 200 and 1 in 1,000 chance flood events, respectively). The design flow of 78,000 cfs was also analyzed based on these three more detailed analyses. This range of design flows provides the basis to (1) determine the economic feasibility of the plan, (2) optimize the benefits, and (3) identify the National Economic Development (NED) Plan.

PHYSICAL FEATURES

The proposed LCCFB Plan would include constructing a levee along the northern urban limit line of Woodland. The LCCFB levee would be approximately 6 miles in length, originating near the intersection of CR 19B and CR 96B and extending to the Cache Creek Settling Basin, just north of the city of Woodland (Figure 6-1). At the west end, the levee would be outflanked by floods having a peak flow greater than 70,000 cfs.

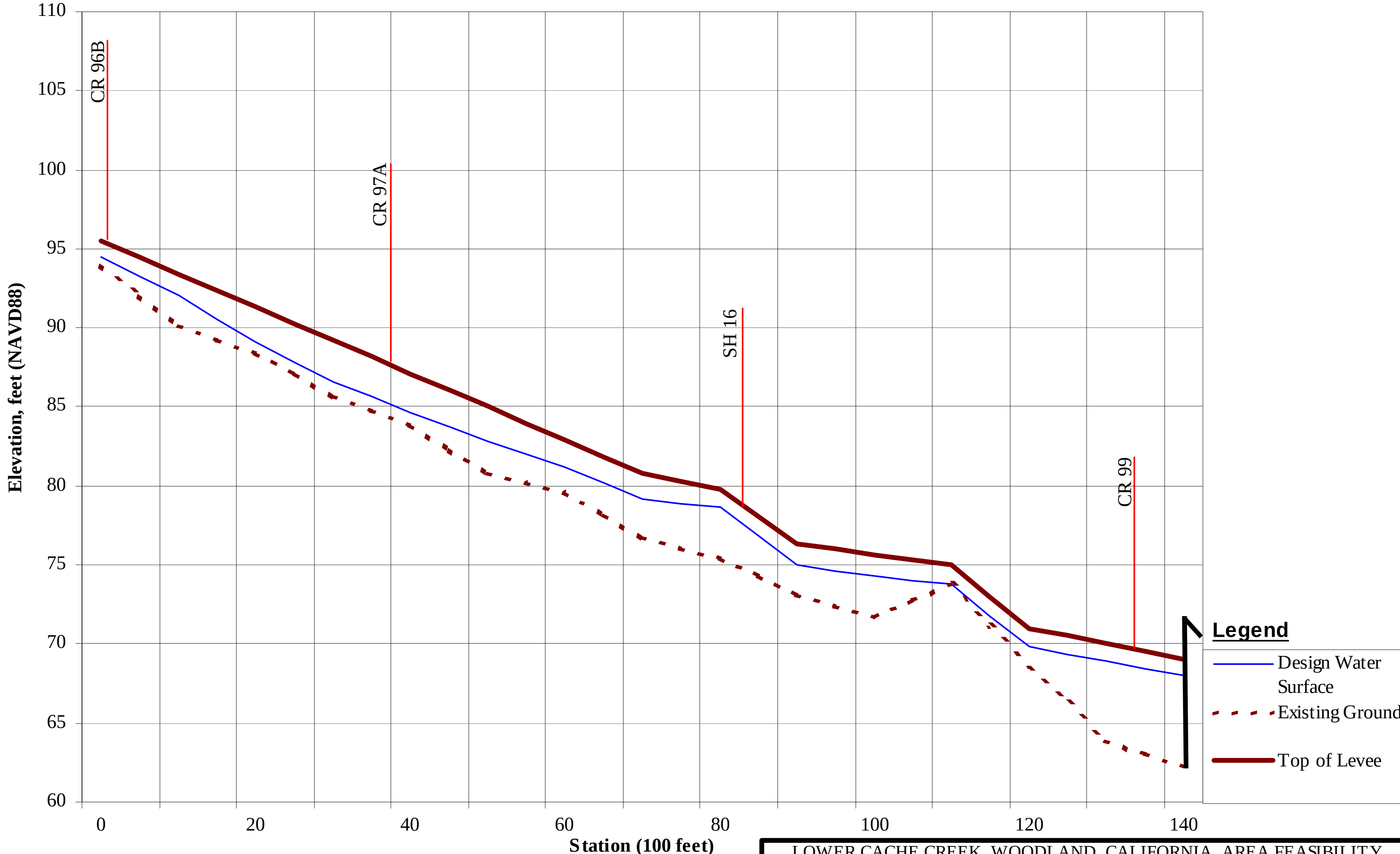


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER PLAN (With Inlet Weir)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-1

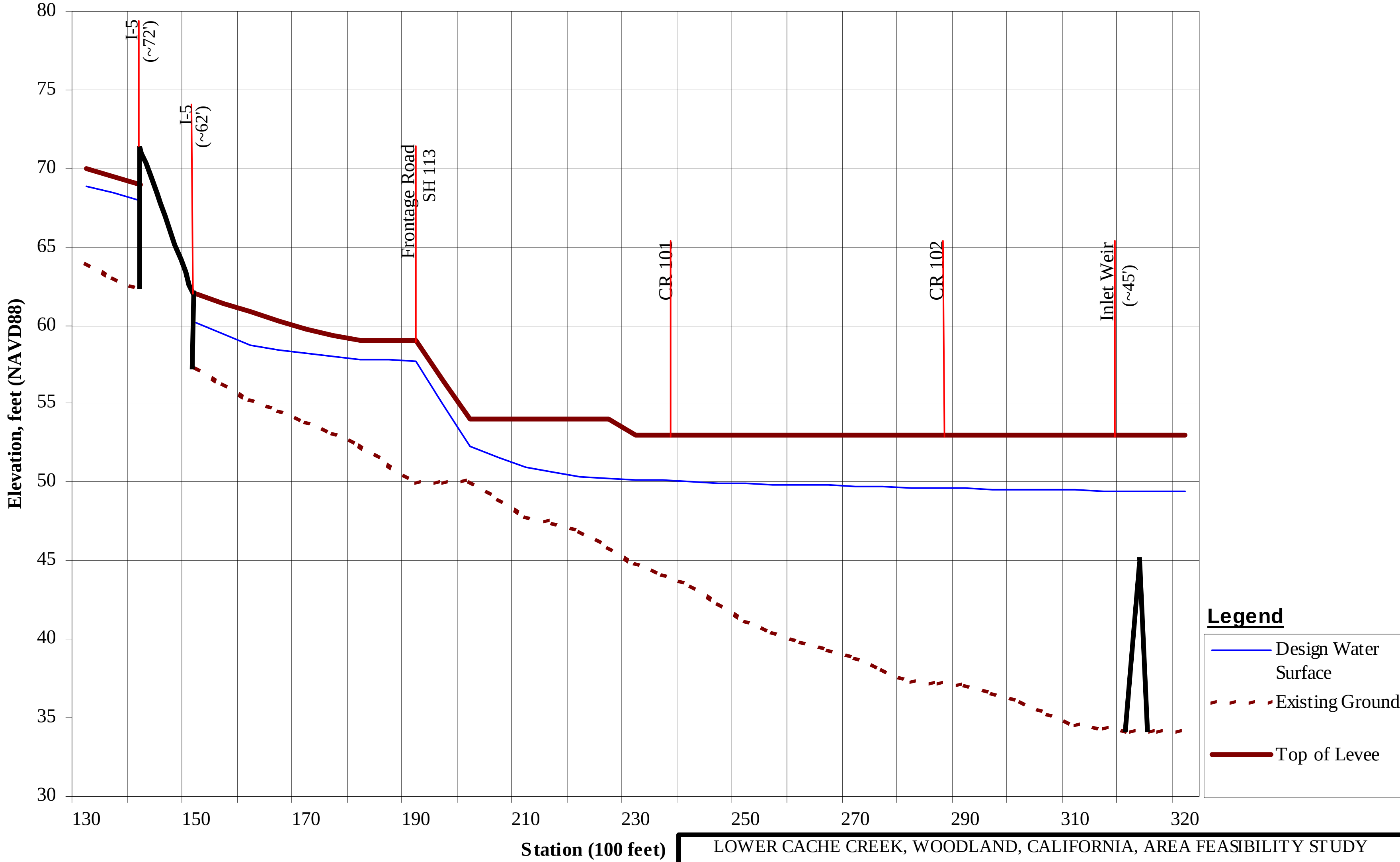


LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY

LOWER CACHE CREEK FLOOD BARRIER LEVEE PROFILE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER, 2002

Figure 6-2

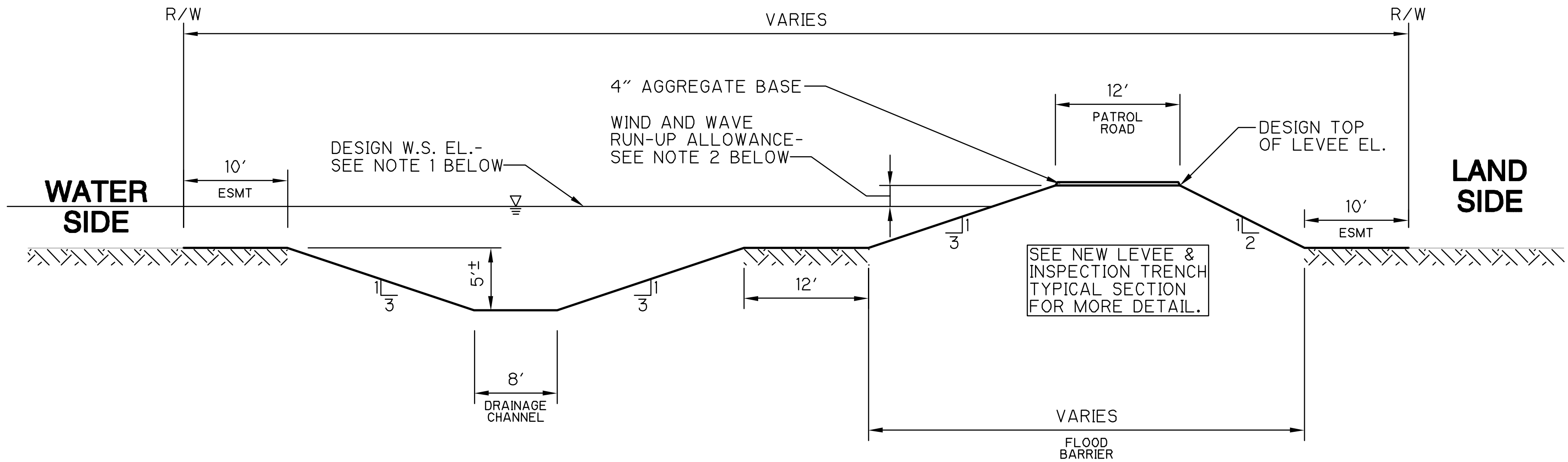


LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER LEVEE PROFILE (continued)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER, 2002

Figure 6-2 (continued)



LOWER CACHE CREEK
FLOOD BARRIER
NOT TO SCALE

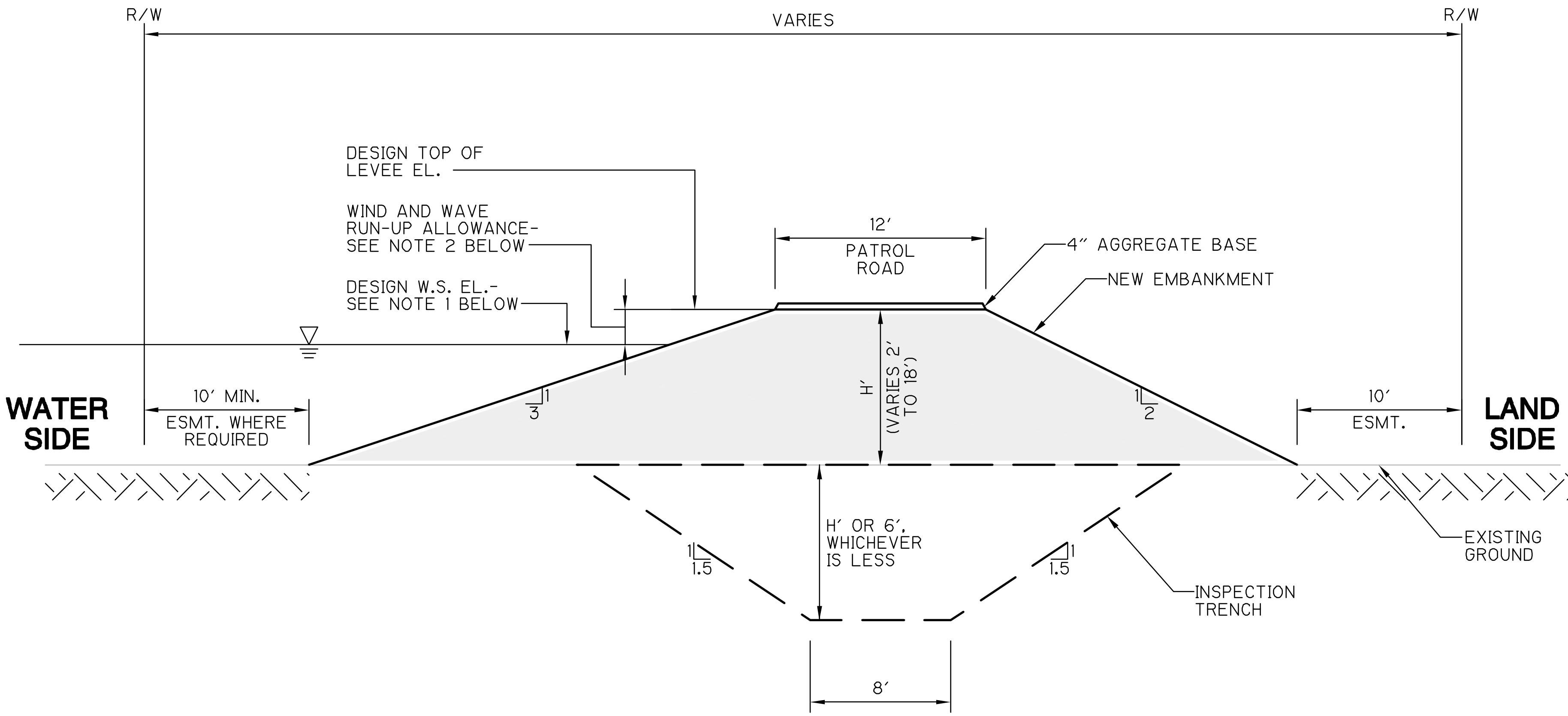
NOTES
1. REFLECTS A RISK AND UNCERTAINTY APPROACH TO DESIGN.
2. VARIES 1 TO 2.5 FEET.

LOWER CACHE CREEK
FLOOD DAMAGE REDUCTION STUDY EIS/EIR

**TYPICAL SECTION
LOWER CACHE CREEK
FLOOD BARRIER**

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-3



NEW LEVEE & INSPECTION TRENCH

NOT TO SCALE

NOTES

1. REFLECTS A RISK AND UNCERTAINTY APPROACH TO DESIGN.
2. VARIES 1 TO 2.5 FEET.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION NEW LEVEE AND INSPECTION TRENCH

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

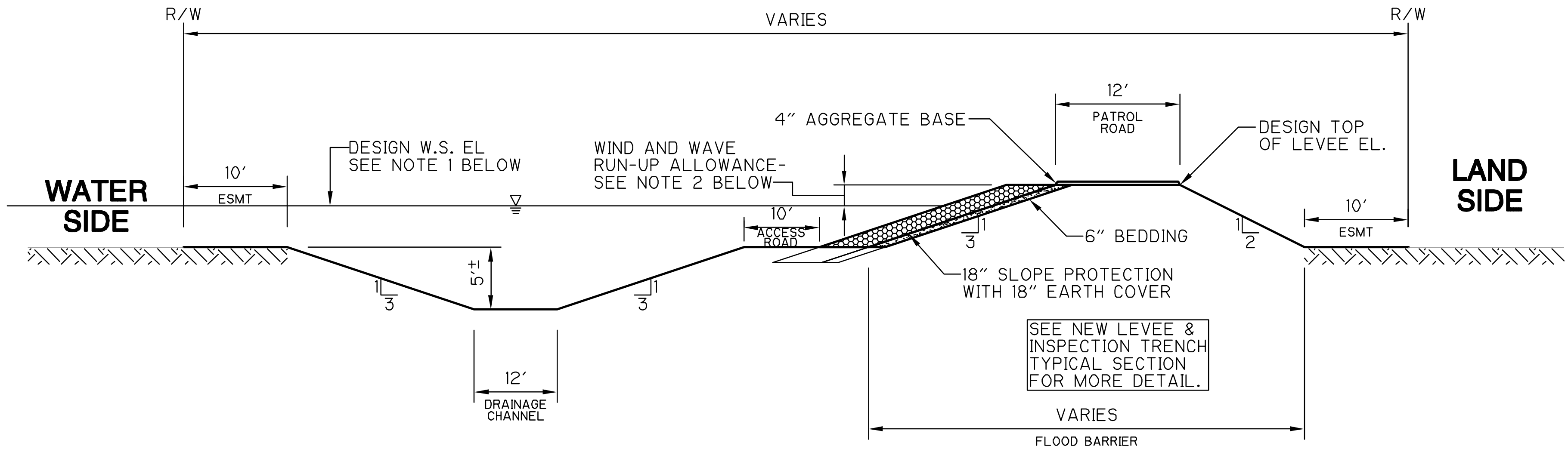
FIGURE 6-4

The height of the LCCFB levee varies from 2 feet in height near CR 96B to 18 feet in height at the west levee of the Cache Creek Settling Basin. Figure 6-2 shows the profile of the LCCFB. A 350 cfs drainage canal would be constructed on the waterside of the LCCFB to provide drainage of floodwaters ponded along the LCCFB. A 12-foot bench would separate the drainage channel from the LCCFB. Cross sections of the drainage canal and levee are provided on Figures 6-3 and 6-4. Culverts would be constructed under all roads, including I-5, SH 113, and railroads to facilitate drainage of the flood plain.

Where possible, existing roads would be raised to match the top-of-levee elevation of the LCCFB. In locations where the roads could not be raised sufficiently, stoplog structures would be constructed to close the gap in the levee. A stoplog structure would also be provided at the California Northern Railroad opening in the I-5 embankment. Stoplogs can usually be installed in 2 to 3 hours.

The portion of the west levee of the settling basin starting at the settling basin inlet south to the new inlet weir would be improved. The sideslope on west side of this levee would be flattened from 2H:1V to 3H:1V. Rock slope protection would be added north of the intersection with the LCCFB along the western slope of the west levee of the settling basin approximately 12,000 feet, continuing along the existing Cache Creek levee to CR 102. The rock slope protection would be placed on the landside of these levees for protection against wave damage. Additionally, rock slope protection, as shown in Figure 6-5, would be placed on the LCCFB (waterside only) from CR 101 to the intersection with the west levee of the settling basin for protection against wave damage during periods of ponding. Rock slope protection would also be added to the embankment of I-5 where overtopping occurs. A 40-foot-deep slurry wall was also assumed to be needed for 15 percent of the LCCFB between CR 101 and the west levee of the settling basin. Slurry walls were assumed for cost estimating purposes because geotechnical investigations/soil borings have not been completed. These investigations would be performed during the design phase of the project; see Appendix B for information on the geotechnical investigations conducted for the feasibility study.

A section of the west levee of the settling basin would be removed for the construction of a concrete weir (3,000-foot-long weir for the 78,000 cfs alternative). These facilities would drain the agricultural area west of the levee into the settling basin. Additionally, the southern 5,250-foot portion of the training levee in the settling basin would be removed to enhance the conveyance of the overflow from the flood plain through the settling basin. The height of the inlet weir would be set at elevation 45 feet msl (NAVD88) to prevent backflow from the settling basin (Plate 14). Water levels above the weir crest elevation would drain into the settling basin over the inlet weir. Water below the weir crest elevation would drain into the settling basin though a low-level drainage structure (culverts). Flapgates would be installed on the culverts to prevent backflow from the settling basin into the area west of the settling basin. Gated culverts would also be installed through the LCCFB levee to convey water to Woodland’s pumping station. The amount of water flowing through this culvert would be controlled



LOWER CACHE CREEK
FLOOD BARRIER WITH
SLOPE PROTECTION
(FROM CR 101 TO WEST LEVEE)
NOT TO SCALE

NOTES

1. REFLECTS A RISK AND UNCERTAINTY APPROACH TO DESIGN.
2. VARIES 1 TO 2.5 FEET.

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
LOWER CACHE CREEK
FLOOD BARRIER WITH
SLOPE PROTECTION

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-5

by the City of Woodland. Additional information regarding the ponding of water and drainage durations is discussed under “Operation of the Pond Outlet Facilities” later in this section.

Borrow material for construction of the LCCFB would be developed from four sources: the excavation of the proposed drainage canal, the removal of the training levee in the settling basin, the removal of a portion of the west levee of the setting basin, and a small borrow area in the settling basin. Staging areas would be required for the construction of the LCCFB. A staging area at each road crossing of the LCCFB would be required for the construction of the levee.

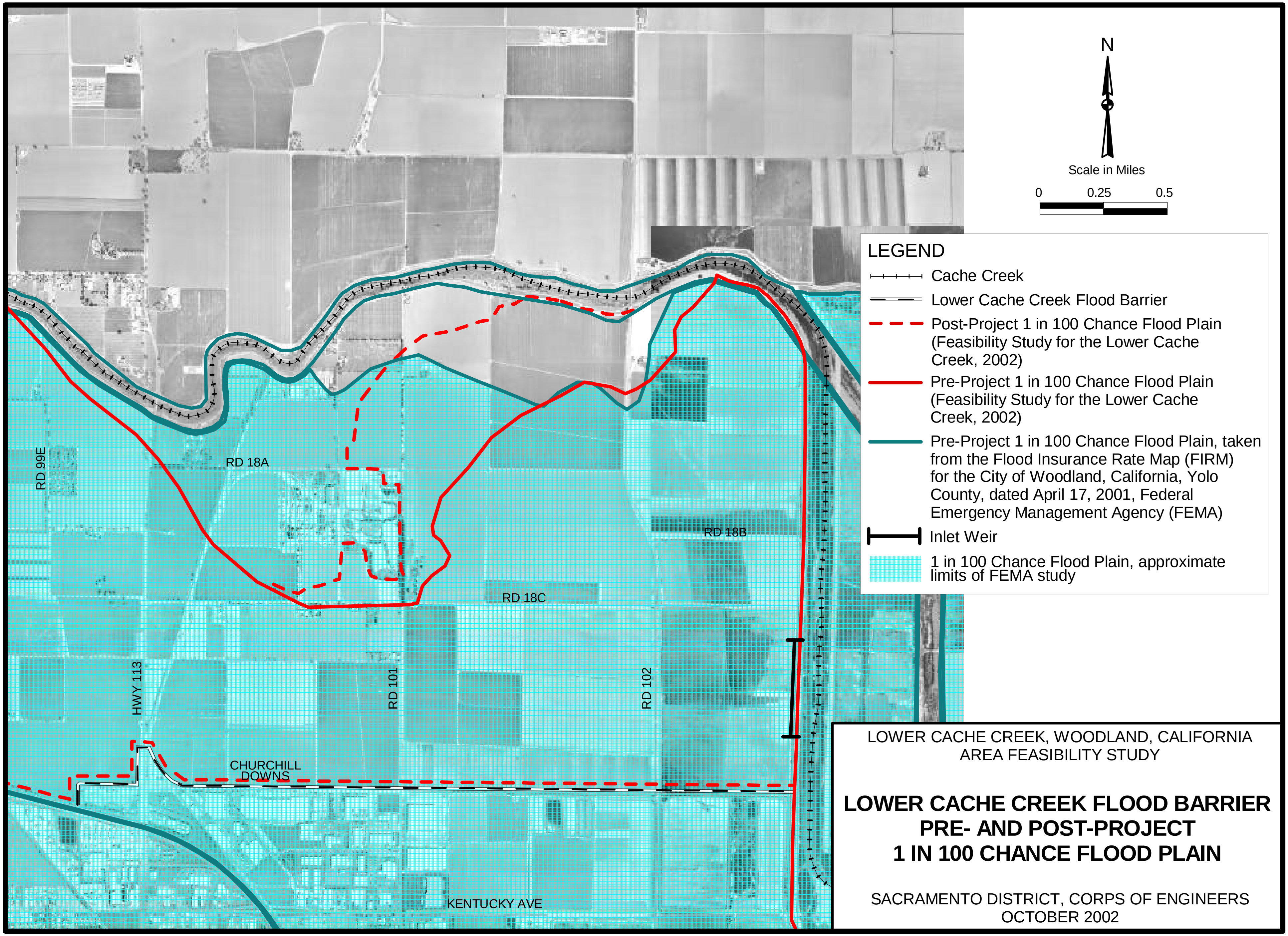
Real estate requirements for the LCCFB would be based on the footprint of the levee, the drainage canal, plus 20 feet for maintenance access (Figure 6-3). Furthermore, a flowage easement would be required for an area west of the west levee of the settling basin due to the increased depth and duration of flooding in this area; see the Real Estate Plan (Appendix F), Exhibit C.

Additionally, flowage easements would be acquired for lands that are not currently within the Cache Creek flood plain but would be subject to flooding induced by the LCCFB. Additional information on real estate requirements is discussed in the Real Estate Plan (Appendix F).

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.

Areas that are not presently within the Cache Creek flood plain but would be within the flood plain of the proposed project are shown on Figure 6-6. This figure shows the pre-project (existing conditions) 1 in 100 chance flood plain and the post-project flood plain for the LCCFB Plan for the area east of I-5. For comparison, the FEMA 1 in 100 chance flood plain is also shown. The post-project flood plain west of I-5 and north of the LCCFB would not be significantly changed from pre-project conditions.

Gross costs for floodproofing up to 25 homes have been included in the LCCFB Plan cost estimates (Appendix K, Tables K-1 to K-3). A building would be floodproofed only if floodproofing is determined to cost less than the compensation to the owner that would be required as the result of a “taking.” During detailed design of the project, elevations of individual structures will be surveyed and a takings analysis will be performed to determine which structures, if any, would be subject to a taking as a result of additional flooding. A comparison of compensation costs versus floodproofing costs



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER
PRE- AND POST-PROJECT
1 IN 100 CHANCE FLOOD PLAIN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-6

will then be performed to determine whether floodproofing is appropriate for a particular building.

ACCOMPLISHMENTS OF PLAN

The LCCFB Plan could accomplish the flood damage reduction goals of the City of Woodland by protecting the city and areas south of the LCCFB from large flood events on Cache Creek. Most of the lands north of the LCCFB are currently in the flood plain. The LCCFB would divert a portion of the floodflows that flow southeast toward Woodland and east toward the settling basin. These flows would pond temporarily against the west levee of the settling basin until drained into the settling basin. Plate 14 indicates proposed drainage facilities.

Pre-project conditions show that I-5 and SH 113 are subject to flooding. Although flooding would still occur north of the LCCFB, I-5 and SH 113 would be protected south of the LCCFB. Pre- and post-project flood plains are shown on Plate 9.

A flood warning system would be provided to increase the time to prepare for flood fighting, to evacuate citizens from flood areas, and to close the openings in the LCCFB. A river forecast at the Yolo stream gage would provide additional reliability to the flood warnings for the residents of Yolo County and Woodland . The acquisition of a storm watch system and a reverse “911” system by the local agencies would save several hours in notifying and evacuating the general public.

HYDRAULIC MITIGATION

The hydraulic effects from the LCCFB modeling indicate there would be an increase in water depths (in comparison between pre- and post-project conditions) on the flood plain north of the LCCFB and south of Cache Creek. Increases in depths range from zero to 7 feet (Plate 15). Flood depths and durations increase the most in the vicinity of the west levee of the settling basin (Plate 16). The LCCFB would also cause some additional areas south of the creek to be flooded. Plate 17 indicates the FEMA and the Corps pre- and post-project flood plains on the west side of the project. Flows in Cache Creek would not be affected by this plan. Effects to the settling basin include an increase of water depths from 0.8 foot to 2.1 feet. Hydraulic effects are presented in more detail in Appendix D.

The LCCFB Plan would involve structural changes to the settling basin. A 3,000-foot weir and low level outlet facility would be installed in the west levee. These facilities would drain floodwaters from the agricultural land to the west of the basin into the settling basin and would change flow patterns southwesterly in a portion of the settling basin.

Based on some preliminary analysis with the FLO 2D model, the impact of large, rare flood flows into the basin via the inlet weir do not appear to generate severe enough scour velocities to remove much sediment from the basin. Regarding the removal of the training levee though, there will be some impact on the deposition of sediment over the life of the basin, such as changes in the spatial deposition of sediment. Also, only a relatively small portion of suspended sediment would actually enter the settling basin via the proposed weir because most of the sediment load of flows escaping from Cache Creek would be deposited on the flood plain. Thus, the LCCFB Plan would not significantly change the sediment loading into or out of the basin.

However, because the LCCFB Plan would remove a portion of the training levee in the settling basin, the pattern of sediment deposition could be altered. The purpose of the training levee is to maintain flow velocities to prevent the premature deposition of sediments and clogging of the inlet area. The existing settling basin operations and maintenance plan already provides for the incremental removal of the training levee for the purpose of directing the deposition of sediments in the settling basin. During the planning, engineering, and design phase, the effects of the LCCFB Plan to these functions would be analyzed. Modifications to operation and maintenance requirements may be necessary to mitigate for any effects of the project. It is expected that there would not be sufficient impact to substantially change the conclusions of this feasibility study.

An analysis was also performed to determine whether the increase in peak flows exiting the settling basin could potentially affect flooding on the Yolo Bypass. A peak flow coincidence analysis was performed to determine the likelihood of simultaneous peak flows in these two bodies of water (Appendix C). The analysis compares the 10 largest floods of record for the Yolo Bypass gage near the settling basin and shows that in all 10 events, the peak flow on Cache Creek occurred 1 to 3 days prior to the peak flow in the bypass. In conclusion, the LCCFB Plan would result in a higher volume of water reaching the bypass over the length of a flood event, but should not cause an increase in the peak stage.

OPERATION AND MAINTENANCE

Once the LCCFB is completed, ownership would be transferred to the non-Federal sponsor, The Board, which would transfer this obligation to the City of Woodland. Operation, maintenance, and rehabilitation of the LCCFB would be in accordance with the operation and maintenance manual to be provided by the Corps. The Corps would have the responsibility to make certain the non-Federal entity inspects, maintains, and rehabilitates the project according to this manual to protect the Federal investment. Maintenance of the levees would include grading and graveling roadways, weed control, rodent control, drainage inspection, maintenance of slope protection, and maintenance of project mitigation features.

The LCCFB Plan would require minor changes to the operation and maintenance of the settling basin. DWR is currently operating the settling basin under an operations and maintenance manual provided by the Corps. If and when a new project is authorized, this manual and any other reports and agreements would be updated at that time.

Under the LCCFB Plan, the operation and maintenance of the existing Cache Creek levee system is expected to continue. Although it is not a part of the LCCFB Plan, by State law, operation and maintenance of the existing levee system is the responsibility of DWR.

OPERATION OF THE POND OUTLET FACILITIES

The existing Cache Creek Settling Basin, located adjacent to the Yolo Bypass, was constructed to prevent sediment being carried by Cache Creek from being deposited in the Yolo Bypass and adversely affecting the hydraulic capacity of the bypass. Flows in Cache Creek enter the northwest corner of the settling basin and exit the settling basin via structures located in the southeast corner of the settling basin.

These structures consist of a 1,740-foot concrete outlet weir and a gated, double box culvert. The crest elevation of the outlet weir is currently at approximately elevation 35 feet msl (NAVD88); therefore, when the basin fills with sediment such that the trap efficient decreases to less than 30 percent, the crest elevation of the outlet weir will be raised 6 feet to elevation 41 feet msl (NAVD88).

Floodflows escaping from Cache Creek on the south bank currently flow to the east and southeast both north of and through Woodland, eventually ponding against the west levee of the settling basin and the Yolo Bypass levees north and east of Woodland. Under post-project conditions (LCCFB Plan), Woodland would be protected by a levee along its northern urban limit line, and floodflows that overtop the existing levees or channel banks of Cache Creek on the south side would flow east and pond against the west levee of the Cache Creek Settling Basin. Figure 6-7 shows a portion of the 1 in 100 chance flood plain boundary established by FEMA and the extent of ponding under post-project conditions for various lesser flood events. The extents of ponding for each chance flood event was approximated from the hydraulic modeling presented in Appendix D. Figure 6-8 shows the depths of post-project ponding, after the floodwaters would have ceased flowing over the road embankments and the proposed settling basin inlet weir. At this point, the floodwaters would be drained primarily through the low-flow culverts, which would take a relatively long time. The depths shown are the water-surface elevations at the low point in the top of the road embankments and at the crest of the inlet weir. These depths would decrease slowly as the pond drains through the culverts. Figure 6-9 shows duration of flooding at CR 101 and 102 as a function frequency of flood event, and Figure 6-10 shows the stage hydrograph of flooding in the ponding area for the 1 in 100 chance flood event. The extent and depth of ponding, in addition to the drainage duration along the LCCFB and the west settling basin levee, depends on the hydrologic event, hydraulic capacity of the pond outlet structures, water levels in the settling basin, and the available pumping capacity of the city's North Canal Pump Station.

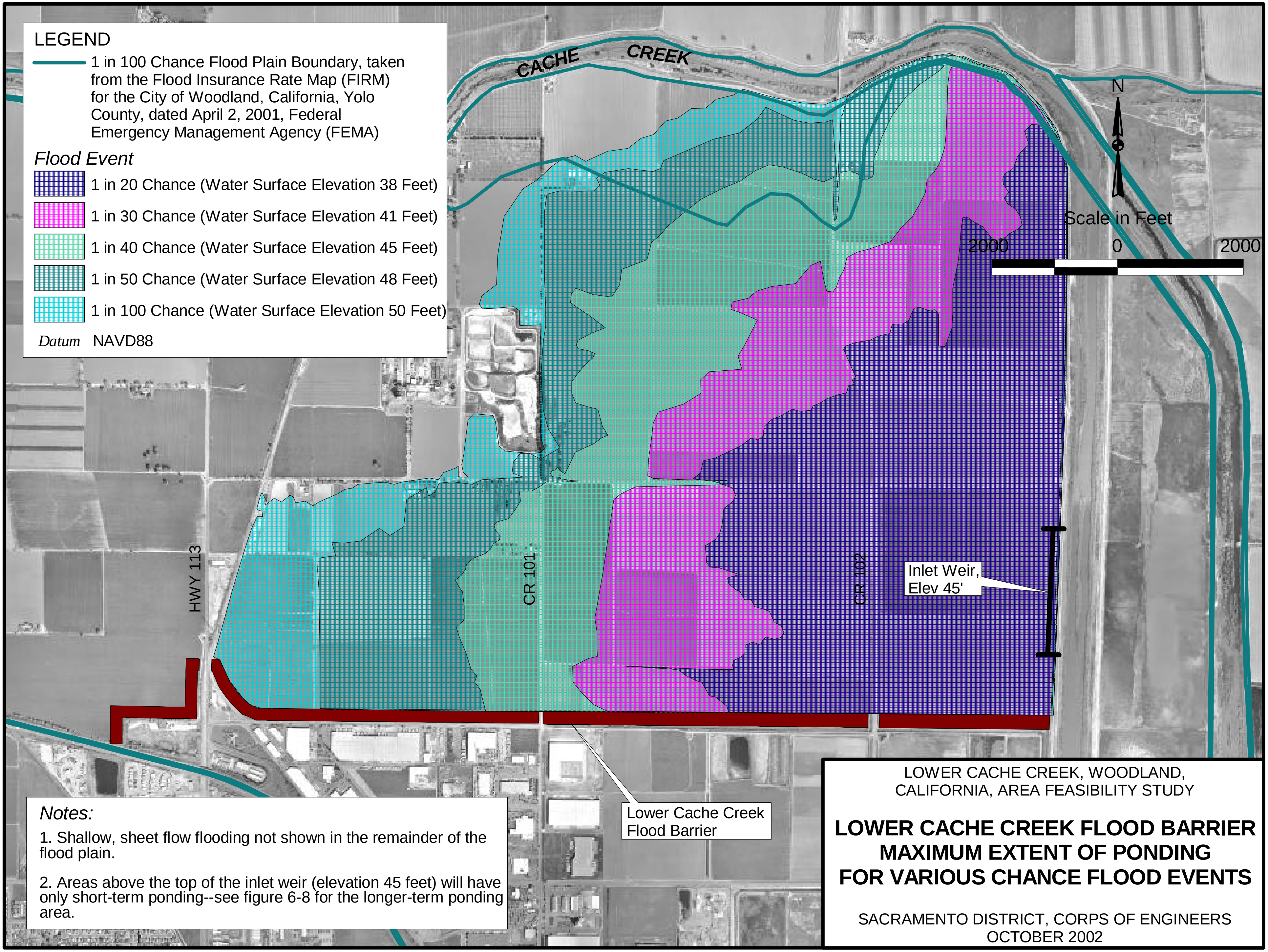
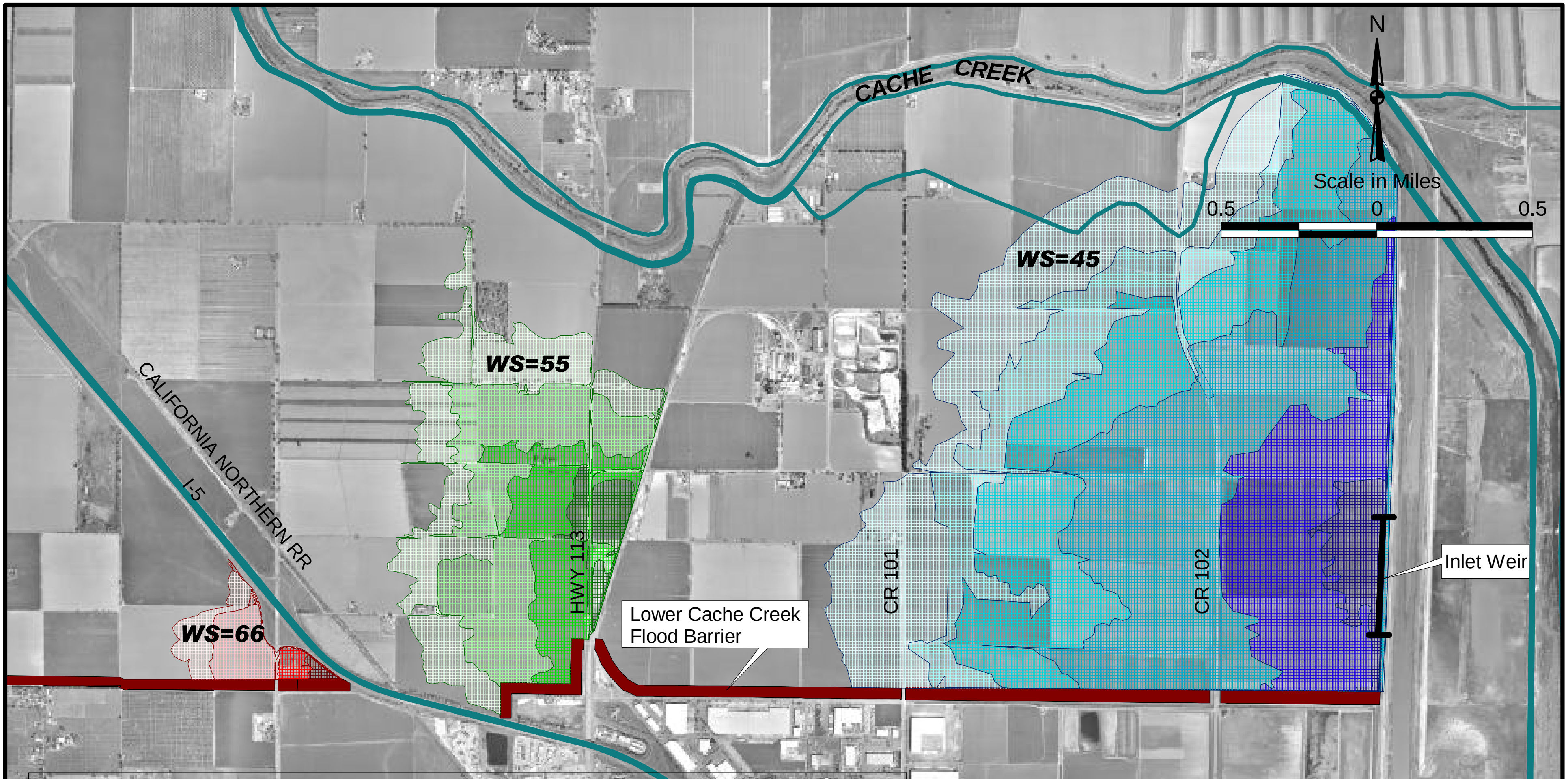

LEGEND
1 in 100 Chance Flood Plain Boundary, taken from the Flood Insurance Rate Map (FIRM) for the City of Woodland, California, Yolo County, dated April 2, 2001, Federal Emergency Management Agency (FEMA)
Flood Event
1 in 20 Chance (Water Surface Elevation 38 Feet)
1 in 30 Chance (Water Surface Elevation 41 Feet)
1 in 40 Chance (Water Surface Elevation 45 Feet)
1 in 50 Chance (Water Surface Elevation 48 Feet)
1 in 100 Chance (Water Surface Elevation 50 Feet)
Datum NAVD88
CACHE CREEK
N
Scale in Feet
2000 0 2000
HWY 113
CR 101
CR 102
Inlet Weir, Elev 45'
Lower Cache Creek Flood Barrier
Notes:
1. Shallow, sheet flow flooding not shown in the remainder of the flood plain.
2. Areas above the top of the inlet weir (elevation 45 feet) will have only short-term ponding--see figure 6-8 for the longer-term ponding area.
LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY
LOWER CACHE CREEK FLOOD BARRIER MAXIMUM EXTENT OF PONDING FOR VARIOUS CHANCE FLOOD EVENTS
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure 6-7



LEGEND

1 in 100 Chance Flood Plain Boundary, taken from the Flood Insurance Rate Map (FIRM) for the City of Woodland, California, Yolo County, dated April 17, 2001, Federal Emergency Management Agency (FEMA)

WS Pond water surface elevation (Feet above mean sea level, NAVD88)

Ponding Depths

I-5	SH113	Northeast Corner	
Approx. 6 Feet	Approx. 5 Feet	Approx. 11 Feet	3-5 Feet
4-6 Feet	3-5 Feet	9-11 Feet	< 3 Feet
2-4 Feet	1-3 Feet	7-9 Feet	
<2 Feet	<1 Feet	5-7 Feet	

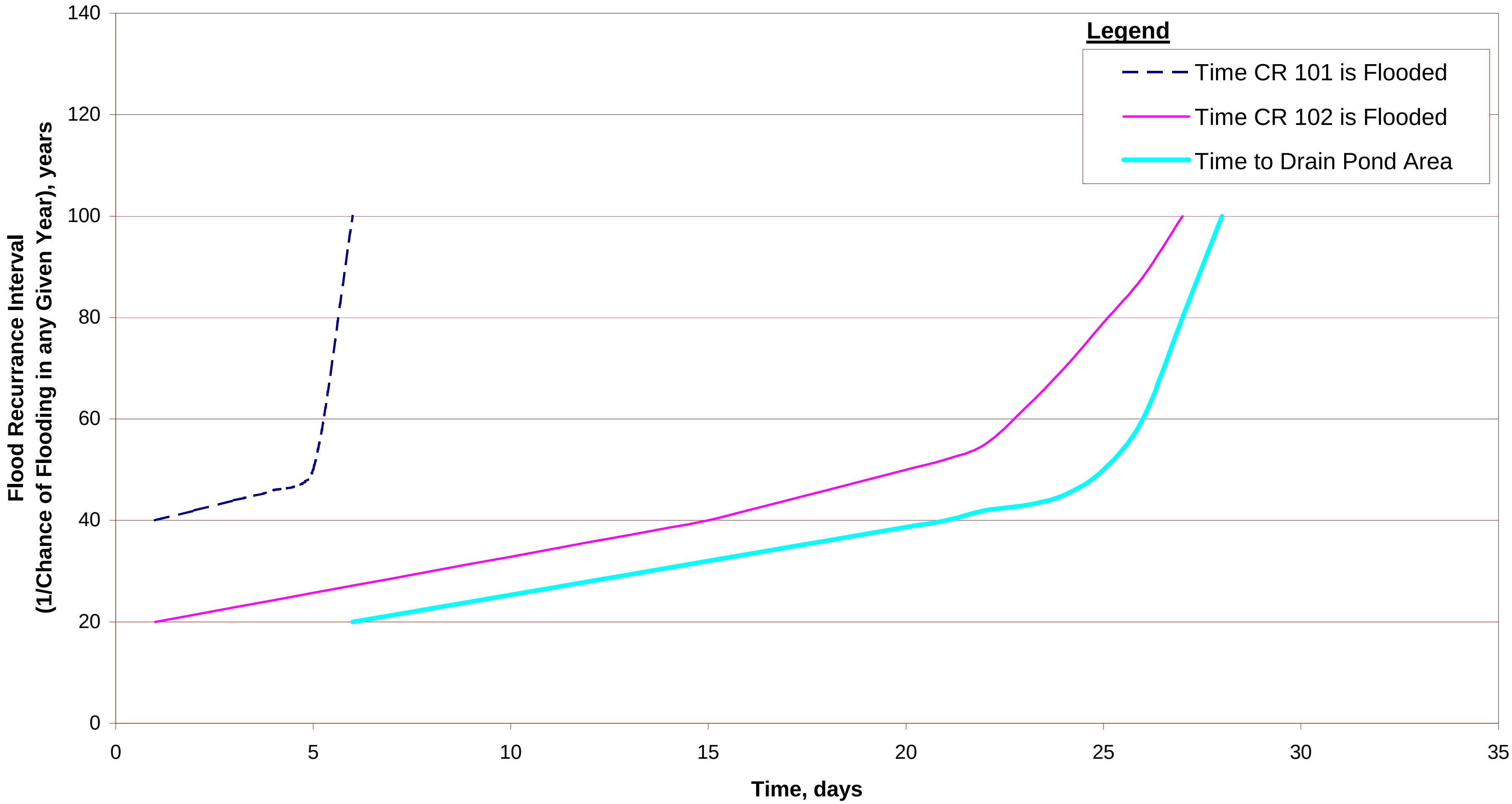
NOTE: This figure only applies to flows larger than approximately a 1 in 40 chance flood.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER LONG-TERM FLOODWATER DEPTHS IN PONDING AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Figure 6-8



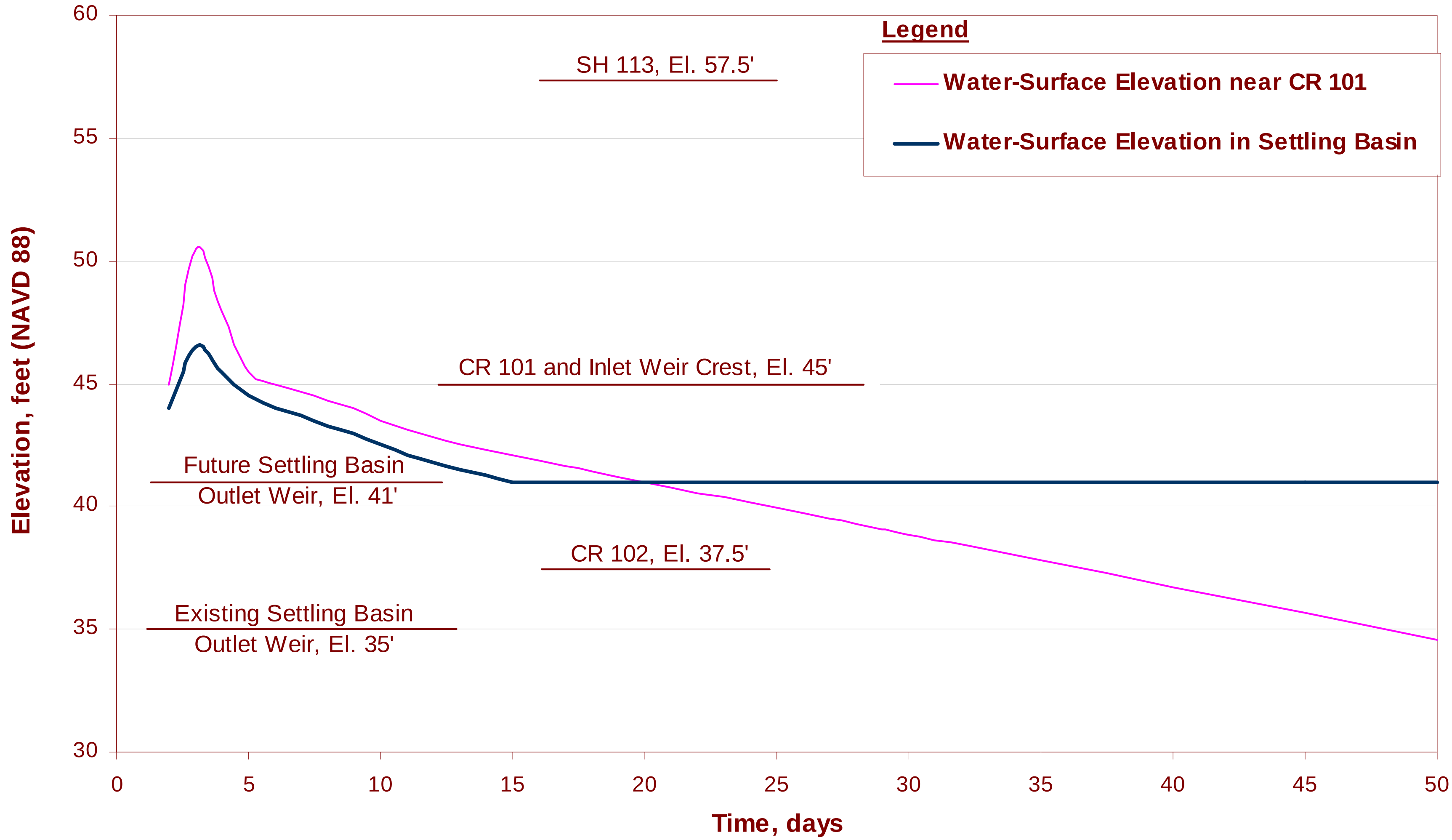
Note: Drain times are based on an outflow rate of 500 acre-feet /day.
Assumptions:
1. No additional rainfall on the south floodplain.
2. The settling basin water surface is 1 foot below the water surface of the pond.
3. The average available pump capacity is 200 acre-feet/day (North Canal Pump Station).

LOWER CACHE CREEK, WOODLAND, CALIFORNIA AREA, FEASIBILITY STUDY

DURATIONS OF FLOODING FOR VARIOUS CHANCE FLOOD EVENTS IN THE PONDING AREA AND IN THE SETTLING BASIN FOR THE LOWER CACHE CREEK FLOOD BARRIER PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER, 2002

Figure 6-9



Notes:
Lowest elevation west of the settling basin west levee is approximately elevation 34.5 feet.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

STAGE HYDROGRAHS FOR THE 1 IN 100 CHANCE FLOOD EVENT IN THE PONDING AREA AND IN THE SETTLING BASIN FOR THE LOWER CACHE CREEK FLOOD BARRIER PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER, 2002

Figure 6-10

Proposed facilities to drain the pond into the settling basin consist of the removal of a 3,000-foot section of the west levee of the settling basin and the construction of a 3,000-foot-long concrete inlet weir and a multi-barrel gated box culvert. The inlet weir would have a crest at elevation 45.0 feet msl (NAVD88) (10 feet above that of the existing settling basin outlet weir). The new inlet weir would have the capability of draining the "pond" between the settling basin and CR 101 down to approximately elevation 45 feet in a few days (about 3 days for the 1 in 100 chance event). At this water surface elevation, the pond would have a volume of about 10,500 acre-feet, and water depths would vary from zero to about 11 feet (Figure 6-8).

The proposed low-level outlet facilities (culverts) would drain the pond (below elevation 45 feet) into either the settling basin or into the North Canal and eventually to the North Canal Pump Station. The hydraulic capacity of the low-level outlet facilities would be a function of the size of the culverts provided and the water level differential ("head") across the facility. The proposed facility into the settling basin consists of a triple 3-foot by 3-foot concrete box culvert with flap gates on the east end of the culvert and slide gates in the middle of the culvert. This facility would have a hydraulic capacity of approximately 150 cfs or 300 acre-feet per day at a head differential of 1 foot.

The proposed outlet facility leading to the pump station consists of a reinforced concrete pipe culvert with a slide gate in the middle or at the upstream end of the culvert. The culvert would have a maximum hydraulic capacity of 170 cfs (the same capacity as the pump station). The slide gate would be used to control the flow to the pump station to match the available capacity of the station. If approximately 100 cfs (200 acre-feet per day) of the capacity of the pump station is available, it would take approximately 50 days to drain the pond using only this facility and assuming no additional inflow into the pond (Cache Creek flows are less than 20,000 cfs).

Under existing conditions, floodflows escaping Cache Creek will also pond against the west levee of the settling basin; however, both the depth and duration of this ponding would be less than under post-project conditions. Under existing conditions for the 1 in 100 chance event, the maximum water surface level at CR 101 (the upstream end of the pond) would be about elevation 45 feet msl (NAVD88) for the 1 in 100 chance flood event. Under post-project conditions, the maximum water level at CR 101 would be approximately elevation 50.5 feet. Under post-project conditions, the duration of this flooding is discussed above and is estimated to be 26 to 55 days (depending on hydrologic factors, described above, occurring after the flood event).

The low point of the crown of CR 101 is approximately elevation 45 feet msl (NAVD88); under post-project conditions for the 1 in 100 chance event, the duration of flooding at this location would be approximately 3 to 4 days. The low point of the crown of CR 102 is about elevation 37.5 feet in the ponding area; the duration of flooding at this location would be an additional 2 to 5 weeks. Flooding duration estimates are based on the assumption that no additional rain falls in the Woodland area during this period, that the pump station drains the pond at a rate that averages 200 acre-feet per day, and that the water levels in the settling basin are 1 foot below and drop at the same rate as the pond water level until it reaches the elevation of the outlet weir to the Yolo Bypass.

Under post-project conditions, a flood event with a peak greater than the capacity of the existing levee system would be conveyed in the following manner:

- A large flood event in lower Cache Creek either overtops the channel banks upstream from the existing levee system, flowing onto the Cache Creek flood plain, or fails a section of the existing levee system (either by overtopping or structurally failing the levee), or both. When a levee fails, it is assumed that the existing levee will be eroded down to original ground and that flows above original ground would escape through the breach onto the flood plain. Floodwaters escaping from Cache Creek on the south bank would initially flow primarily east towards the settling basin and some floodwater would flow southeast toward Woodland. Much of the floodwater flowing towards the settling basin, would be intercepted by road/railroad embankments, as described below, some of which would be diverted towards Woodland. These floodwaters flowing towards Woodland would be diverted by the LCCFB east and would eventually pond against the west levee of the settling basin until it is drained into the settling basin or to the North Canal Pump Station. Alternatively, a levee failure on the north side of the creek would flow northeast away from Woodland. If the north levee fails upstream from a break in the south levee, ponding against the settling basin would be less.

- The depth and duration of ponding (between CR 101 and the settling basin) depends on a number of factors, including the elevation of the flood event, the magnitude of the flood peak, the volume of water that escapes unto the flood plain, and if there is weir flow (events with greater flow than the 1 in 40 chance flow event). Figure 6-7 indicates pond limits for various Cache Creek flood events in the 1 in 30 to 1 in 100 chance range. Flood extents for flow events with greater chance of occurring than 1 in 50 in any given year were determined by estimating the volume escaping from the channel and calculating the area that would be flooded by this volume. Cache Creek hydrographs and flood peak frequency at CR 94B are included in Appendix C. Flow events with less of a chance than 1 in 50 were calculated by routing overbank and channel flows through the system using the FLO-2D model. (See Appendix D for additional information and for flood depths and durations at various locations and structure groups on the south flood plain.)

- Between the location where the floodwaters escape from the channel (Appendix D, Plates 12 through 15) and the settling basin, floodwaters must be conveyed over, under, or around various embankments and/or obstructions that have been constructed on or across the flood plain.

- The major embankments obstructing overbank flows are Interstate 5 and State Highway 113. When floodwaters reach an existing embankment, they pond and are diverted until the accumulated water either overtops the embankment or is conveyed under the embankment by existing and new cross drainage facilities (the drainage channel and culverts along the LCCFB).

- At I-5, floodwaters escaping from Cache Creek flow southeast along the embankment to the LCCFB. If the volume is sufficient, the water would pond in the CR 99/I-5 area and eventually overtop the freeway in one or more locations if the magnitude and duration of the event is sufficiently large.

- Any floodwaters that do not overtop flood plain obstructions (freeway, railroad, or roadway embankments) would be drained under these embankments via existing and new cross drainage facilities.

In addition to flood events that result from a levee failure or bank overtopping, local flooding along various flood plain embankments, roadways, and against the west levee of the settling basin can occur. This flooding is primarily due to insufficient capacity of the internal drainage system of the southern Cache Creek flood plain. The proposed LCCFB Plan would improve the existing internal drainage system east of I-5 by increasing the capacity of the system in this reach. West of I-5, capacity is also being increased; however, under existing conditions where floodwaters would flow into Woodland, the LCCFB would divert these flows east via the drainage channel system to the settling basin or the City pump station. Because the capacity of the flood plain's internal drainage system is being increased and the source of this flooding is not from Cache Creek, improving these existing flooding problems is not an objective of this study. These existing flooding problems have not been evaluated or specifically addressed by the LCCFB Plan and may continue to be problems.

ENVIRONMENTAL EFFECTS AND MITIGATION

The potential effects of the LCCFB Plan on environmental resources in the project area are evaluated in detail, and the results are presented in detail in the *Lower Cache Creek, Yolo County, CA, City of Woodland and Vicinity, Draft Environmental Impact Statement/Environmental Impact Report for Potential Flood Damage Reduction Project, (EIS/EIR)*, under separate cover. Potential adverse effects of the plan are identified and quantified when possible, and measures to avoid, reduce, or mitigate these effects to less than significant are presented.

Based on the results of the environmental studies, resources not affected by the LCCFB Plan are climate; topography; geology; soils; recreation; hazardous, toxic, and radiological waste; public health vectors and vector control; and fisheries. The potentially affected resources include social and economic resources, land use, agriculture, prime and unique farmlands, transportation, noise, air quality, water quality, sedimentation and the settling basin, vegetation and wildlife, special-status species, cultural resources, and esthetic and visual resources. The potential effects, mitigation, and significance for these affected resources are summarized below.

Project-induced flooding north of the LCCFB would cause a potential decrease in the value of some lands, therefore affecting social and economic resources. In addition, one home would need to be acquired. Agricultural landowners would be compensated for takings to the extent required by law, and the homeowner would be compensated for the land and home value. Implementation of these mitigation measures would reduce the potentially significant effect to less than significant.

Land use effects of the LCCFB Plan would be the conversion of 100 acres of row crop, 2 acres of orchard, and 2 acres of agricultural support lands for flood damage reduction purposes. This effect represents an incompatible land use change and is a significant effect that cannot be mitigated.

Effects on prime and unique farmland due to the LCCFB would be a loss of 100 acres of prime farmland and 2 acres of statewide-important farmland. The acreage of prime farmland converted cannot be mitigated since the qualities that distinguish prime farmland cannot be re-created. The conversion of prime and statewide-important farmland represents a significant effect.

Temporary direct transportation effects would include lane closure during road repair, roadway safety hazards, and an increase in traffic volume. The lead agency would provide a traffic management plan as a mitigation measure. Additionally, contractors would use construction easements as much as feasible when hauling materials to the construction site; traffic would be rerouted when necessary to avoid construction areas; and flaggers would be stationed to slow or stop approaching vehicles to avoid conflicts with construction vehicles or equipment. With the implementation of these mitigation measures, the effects on transportation would be reduced to less than significant.

Indirect transportation effects would include increased depth and duration of flooding on roadways traversing the project area. CR 101 would be flooded for about 1 week, and CR 102 would be flooded for 3 weeks during floods with a greater than 1 in 40 chance of occurring. These road closures could cause lengthened response times for emergency vehicles traveling to residents northeast of Woodland. However, there are several county roads close to CR 102 that could be used as alternative routes to circumvent the flooded portions of CR 102. This mitigation measure would reduce the indirect transportation effect, but not to a less-than-significant level.

Construction-related effects on noise would consist of temporary decibel levels above the significance threshold for some sensitive receptors during construction. Construction equipment would be outfitted and maintained with noise-reduction devices such as mufflers, and construction would be limited to daytime hours. The implementation of these mitigation measures would lessen the effects, but not to a less-than-significant level.

Construction-related effects on air quality would consist of temporary increases in pollutant emissions. NOx and PM_{10} emissions would exceed the significance thresholds established by the Yolo-Solano Air Quality Management District (AQMD). Sensitive receptors would also be exposed to the high levels of fugitive dust emissions. NOx mitigation measures would be incorporated into construction plans and specifications, and the lead agency would provide a dust suppression plan to lessen the effects of PM_{10}. The mitigation measures would reduce the air quality effects, but not to a less-than-significant level.

The removal of the training levee could alter the distribution of sedimentation in the settling basin. The design of the LCCFB Plan would incorporate the existing function of the settling basin, reducing any potential effects to less than significant.

Potential project-related effects on water quality would include pollutants from construction equipment and erosion at the construction site that could temporarily degrade the water quality of local runoff during construction. The lead agency would prepare a stormwater pollution prevention plan. A portion of this plan would specifically address erosion and sediment control. The lead agency would also prepare a Hazardous Substance Control and Emergency Response Plan and would comply with all requirements of the Clean Water Act. In addition, appropriate best management practices and monitoring would be implemented to preserve the quality of surface runoff. Implementation of these mitigation measures would reduce the effects on water quality to less than significant.

Project-related effects on vegetation and wildlife, as determined by the USFWS in its draft Coordination Act Report (CAR), would include the loss of 122 acres of agricultural habitat, 100 native and nonnative trees, 0.52 acre of upland habitat, and 0.28 acre of scrub shrub. Recommended mitigation for habitat loss has been outlined by the USFWS in its CAR, which is included as Appendix A with the Draft EIS/EIR. Construction-related effects would include disturbance from equipment and crews and potential disturbance of species. Mitigation for these effects include limiting construction crews to the right-of-way and confinement of disturbance to as small an area as possible and conducting nest surveys prior to the removal of any trees or scrub shrub to ensure migratory birds would not be lost during construction, pursuant to the Migratory Bird Treaty Act. Implementation of mitigation measures would reduce project-related and construction-related effects to less than significant.

Project-related effects to special-status species (Swainson’s hawk, giant garter snake, northwestern pond turtle, chinook salmon, and steelhead) would include temporary and permanent loss of habitat. Construction-related effects would include disturbance from equipment and crew and potential take of species. Mitigation for effects to special-status species would be determined through formal consultation with the

USFWS and NMFS and outlined in their Biological Opinion. Mitigation for effects to State special-status species would also be determined through formal consultation with the California Department of Fish and Game. Adherence to the mitigation measures outlined by the resource agencies would reduce the effects on special-status species to less than significant.

Appendix I of the Draft EIS/EIR includes a Habitat Mitigation Alternatives Analysis that considers alternative sites and measures to provide mitigation of project effects for both endangered species and general habitat. A habitat mitigation alternatives analysis was performed, rather than an incremental cost analysis, because it is expected that nearly all the general habitat impacts will be offset by the non-discretionary incidental take conditions resulting from formal consultations for endangered species, or by project design features. Only minimal additional measures would be required to fully mitigate the remaining general habitat impacts as recommended by USFWS. Therefore, a habitat mitigation alternative analysis was performed to identify the least-cost mitigation plan that would effectively meet both the anticipated incidental take conditions and the minor remaining general habitat mitigation recommendations. The extent to which the beneficial habitat features of the LCCFB offset its adverse impacts was considered in the analysis. The overall conclusion of the mitigation alternatives analysis is that the least cost mitigation plan would be to purchase credits at a mitigation bank to compensate for the project's net adverse effects.

Increased flooding may occur at cultural resource sites between the creek and the LCCFB, affecting the quality of the resource. Mitigation measures would be developed in consultation with the State Historic Preservation Officer and could include floodproofing some structures. If previously unidentified cultural materials and/or features are discovered during construction, all work in the immediate area would cease, and a cultural resources specialist would be immediately contacted for identification and evaluation. Additionally, if human remains are encountered, a cultural resources specialist and county coroner would be contacted in compliance with State law. Adherence to these mitigation measures would reduce potentially significant effects on cultural resources to less than significant.

The LCCFB Plan would have effects on esthetic and visual resources. The LCCFB would create a linear feature and a view block to residents. The LCCFB would be reseeded with grasses and forbs; however, this would not reduce the overall effect to a less-than-significant level.

COSTS

Construction, environmental, and real estate costs for the LCCFB Plan are shown in Tables 6-3A and 3B. The cost reflects design flows of 70,000 cfs and 78,000 cfs, respectively. The costs for the full range of design flow options are discussed below under the heading "Comparison of Plans."

Table 6-3A. Total Project Cost Summary for the LCCFB Plan, 70,000 cfs Design Flow

Feature	Cost[1] $1,000
Construction Costs (excludes environmental mitigation costs)[2]	23,028
Environmental Mitigation	
Trees	159
Scrub Shrub	2
Elderberry	0
Shaded Riparian Aquatic Habitat	0
Giant Garter Snake Habitat	1,192
Subtotal	1,353
+18% Contingency	**1,597**
Real Estate	
Levee Footprint (Flood Protection Levee Easement)	807
Ponding Area (Permanent Flowage Easement)[5]	2,265
Constructions Easements (Temporary Work Area Easements)	55
Environmental (Fee Title)[4]	0
Channel Improvements (Channel Improvement Easement)	0
Roads (Roads and Road Easements)	12
Borrow Area (Borrow Easement)	0
Structures	50
Severance	319
Contingencies (25%)	1,754
Relocation Costs	23
Non-Federal Administrative Costs	2,765
Federal Administrative Review Costs	529
Subtotal	8,577
Equipment	1,200
Cultural, Engineering and Construction Mgmt @ 21.5%	5,294
Total First Costs [3]	**39,697**
Interest During Construction	**2,701**
TOTAL INVESTMENT COST	**42,398**

[1]Includes a contingency, construction 20 percent, real estate 25 percent, and environmental 25 percent.
[2]For the 70,000 cfs design flow plan.
[3]Maintenance of the existing levees is not included.
[4]Not available at printing. Expected to be a relatively small cost.
[5]Includes some areas with a temporary work easement.

Table 6-3B. Total Project Cost Summary for the LCCFB Plan, 78,000 cfs Design Flow

Feature	Cost[1] $1,000
Construction Costs (excludes environmental mitigation costs)[2]	24,079
Environmental Mitigation	
Trees	159
Scrub Shrub	2
Elderberry	0
Shaded Riparian Aquatic Habitat	0
Giant Garter Snake Habitat	1,192
Subtotal	1,353
+18% Contingency	**1,597**
Real Estate	
Levee Footprint (Flood Protection Levee Easement)	807
Ponding Area (Permanent Flowage Easement)[5]	2,265
Constructions Easements (Temporary Work Area Easements)	55
Environmental (Fee Title)[4]	0
Channel Improvements (Channel Improvement Easement)	0
Roads (Roads and Road Easements)	12
Borrow Area (Borrow Easement)	0
Structures	50
Severance	319
Contingencies (25%)	1,754
Relocation Costs	23
Non-Federal Administrative Costs	2,765
Federal Administrative Review Costs	529
Subtotal	8,577
Equipment	1,200
Cultural, Engineering and Construction Mgmt @ 21.5%	5,520
Total First Costs [3]	**40,973**
Interest During Construction	**2,787**
TOTAL INVESTMENT COST	**43,760**

[1]Includes a contingency, construction 20 percent, real estate 25 percent, and environmental 25 percent.
[2]For the 78,000 cfs design flow plan.
[3]Maintenance of the existing levees is not included.
[4]Not available at printing. Expected to be a relatively small cost.
[5]Includes some areas with a temporary work easement.

EVALUATION OF SETBACK LEVEE PLANS

DESCRIPTION OF NARROW SETBACK LEVEE PLAN

The preliminary Setback Levee Plan was modified and developed into the Narrow Setback Levee (NSL) Plan. The NSL Plan was developed to minimize effects to landowners and agricultural operations along Cache Creek while still satisfying engineering design requirements. The plan was also developed to maximize the use of existing project facilities levees where possible.

The primary objective of the NSL Plan was to avoid houses and farm support structures (Figure 6-11 and Plate 18). The secondary objective of the NSL Plan was to reduce channel velocities, minimize the need for rock slope protection measures, and minimize hydraulic effects to the existing bridges.

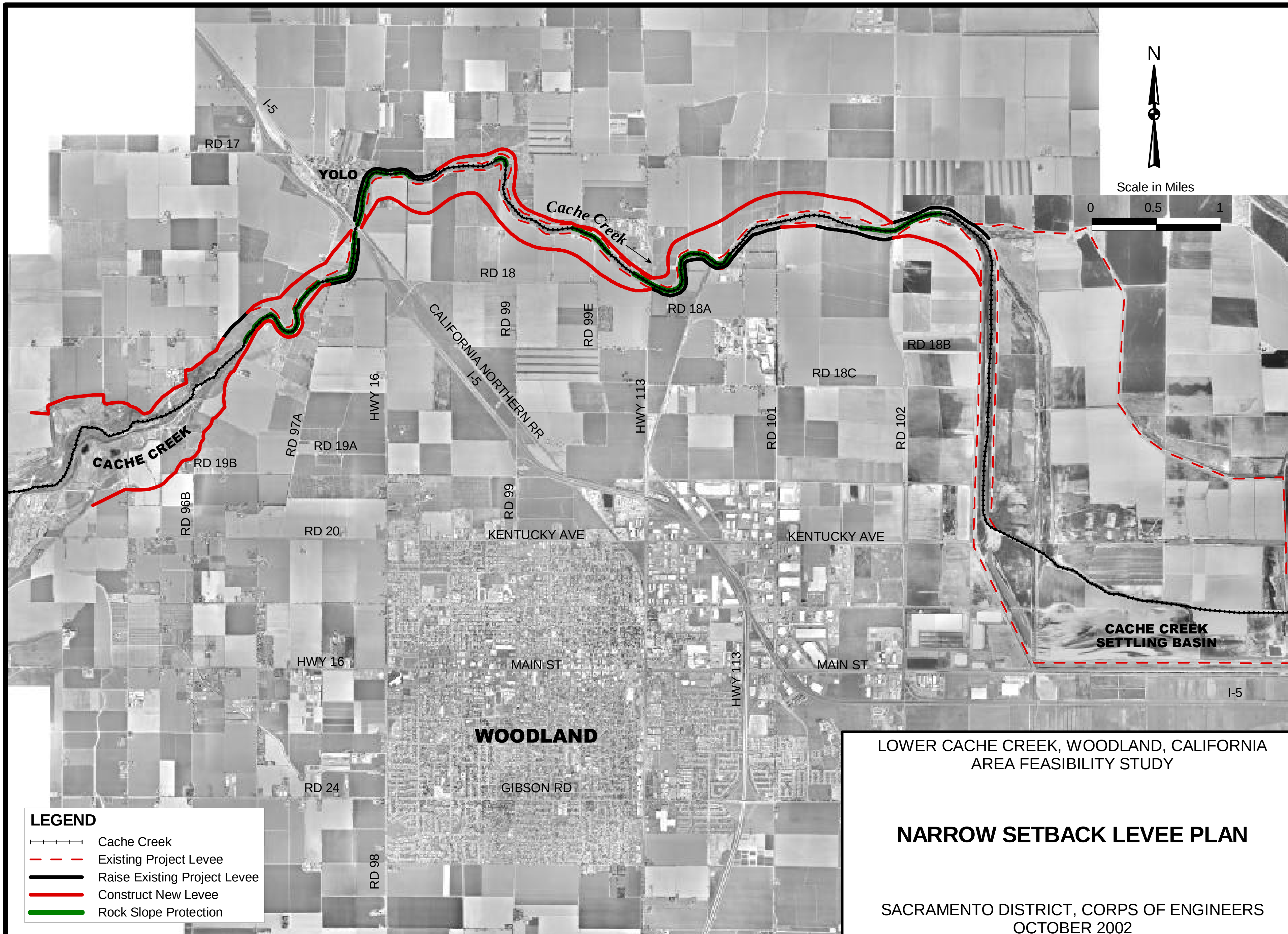
The plan was designed to protect against bank erosion and channel instability of the creek. Traditional methods of slope/erosion protection such as riprap and gabions were used to protect those bank areas subject to scouring velocities under current condition and to protect areas with bank erosion and instability problems at the existing bridges.

The NSL Plan was analyzed in detail for the three design flow rates of 50,000 cfs, 70,000 cfs, and 90,000 cfs. Other design flows of interest were also analyzed based on these more detailed analyses. This flow range provided the basis to determine the economic feasibility of the plan and to optimize the net benefits.

PHYSICAL FEATURES

The major feature of the NSL Plan would involve the construction of about 19 miles of new setback levees and modifications to the existing levees on Cache Creek. The levee system would extend from the settling basin inlet to high ground near CR 94B. Levee design, construction, and use of portions of the existing levee system would vary between the right (southern) and left (northern) levees. Typical cross sections of setback levees are shown on Figures 6-12 to 6-15, and representative modified cross sections are given on Figure 6-16.

Design levee profiles and other project features were developed based for flow rates of 50,000 cfs, 70,000 cfs, and 90,000 cfs. Maximum levee heights for levees upstream from CR 102 would be approximately 12, 15, and 16 feet for the 50,000 cfs, 70,000 cfs, and 90,000 cfs flows, respectively. Downstream from CR 102, finished levee heights would have a maximum height of approximately 18 feet for all design levels.

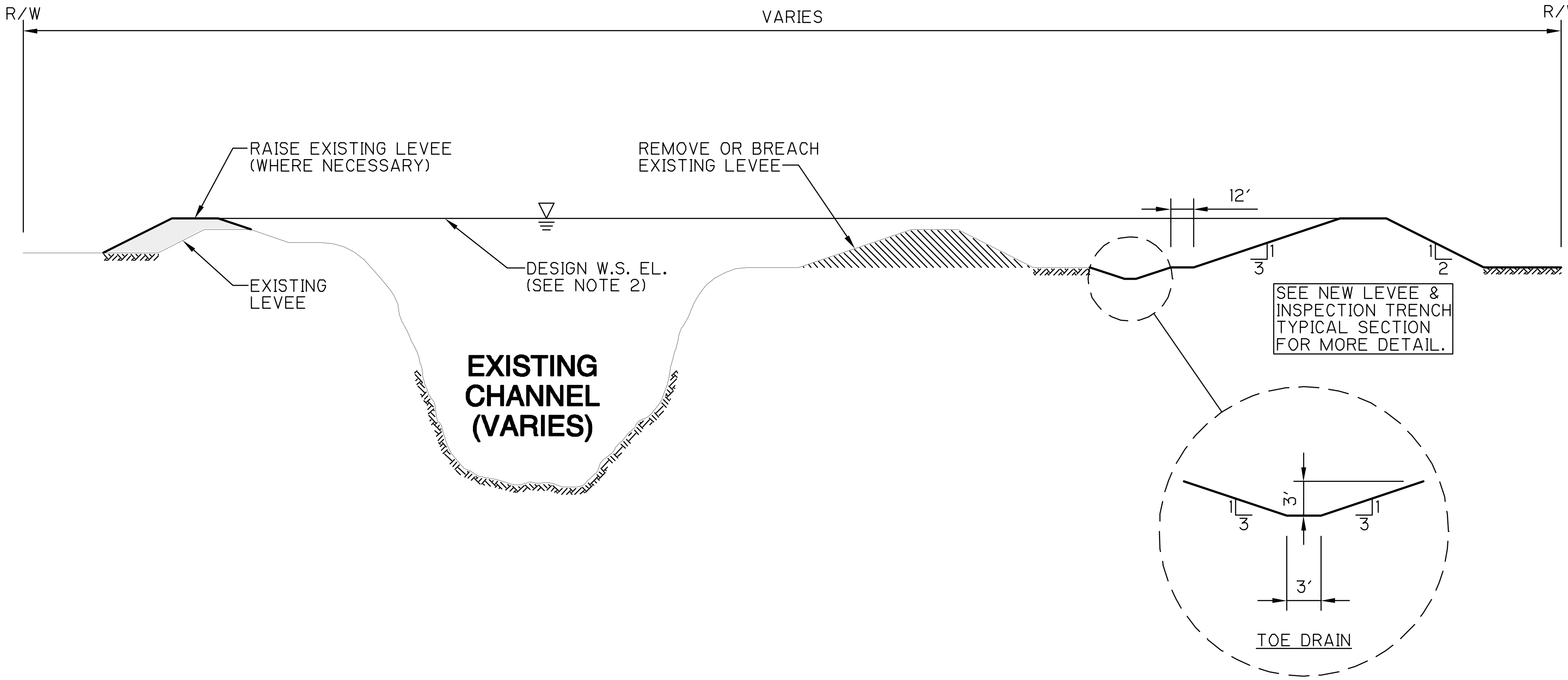


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

NARROW SETBACK LEVEE PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-11



SETBACK LEVEE

NOT TO SCALE

NOTES

1. SLOPE PROTECTION IS REQUIRED ALONG REACHES WITH VELOCITIES GREATER THAN EXISTING-CONDITIONS VELOCITIES FOR TOP-OF-LEVEE FLOWS.

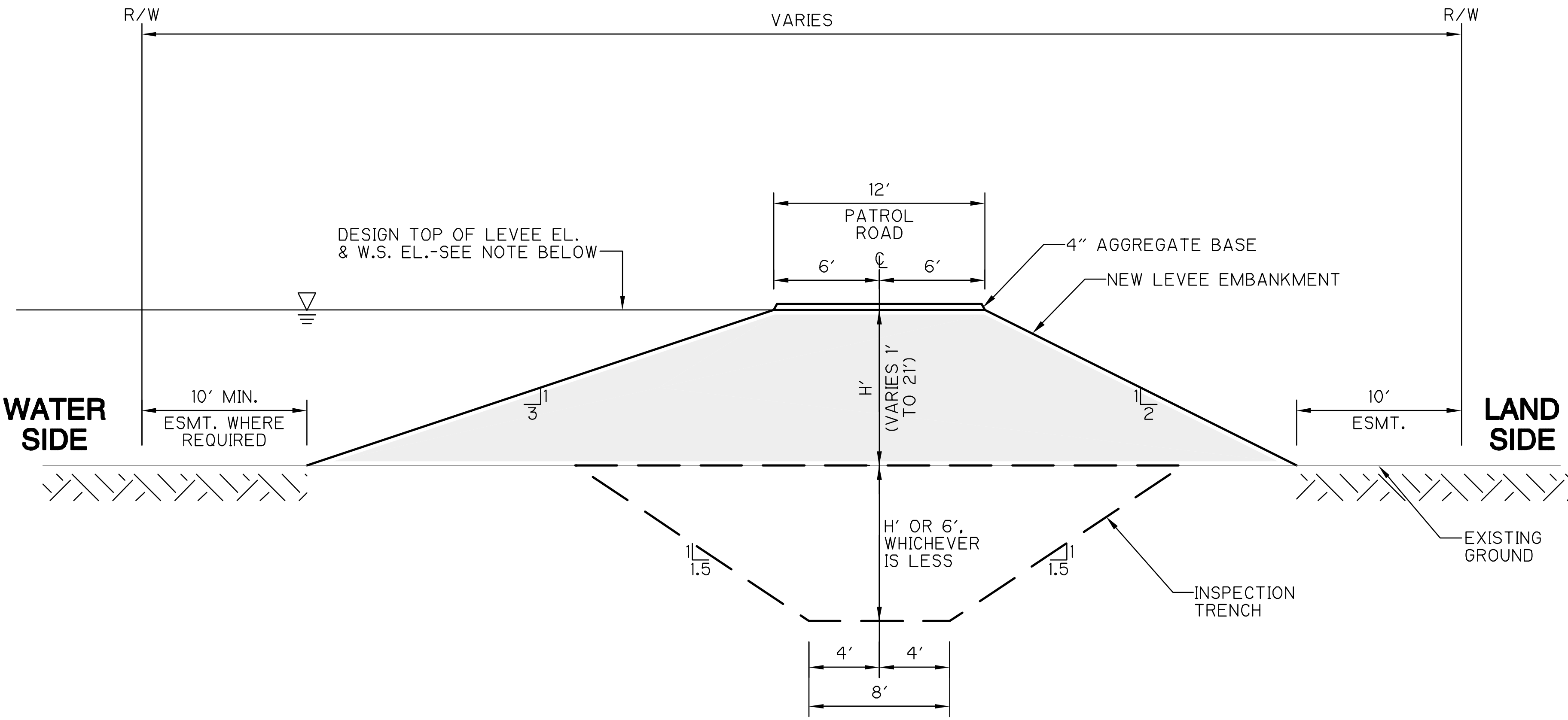
2. REFLECTS A RISK AND UNCERTAINTY APPROACH TO DESIGN.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION SETBACK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-12



NEW LEVEE & INSPECTION TRENCH

NOT TO SCALE

NOTE

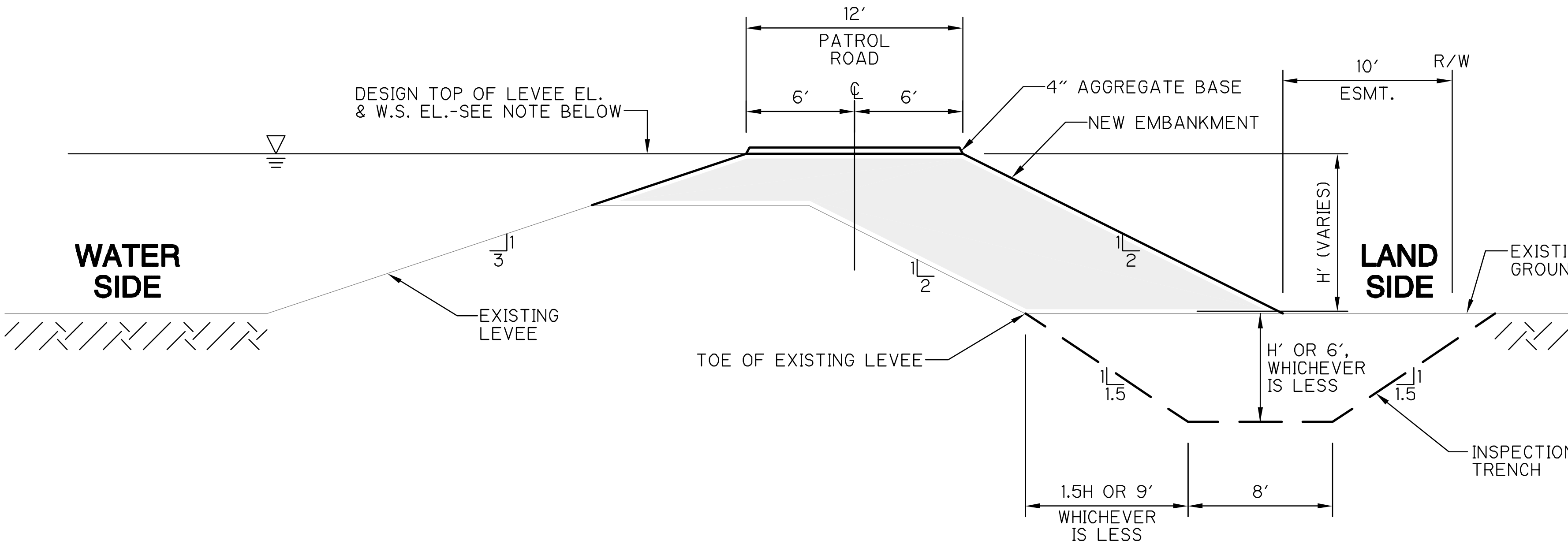
REFLECTS A RISK AND UNCERTAINTY APPROACH TO DESIGN.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION NEW LEVEE AND INSPECTION TRENCH

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-13



RAISED LEVEE & INSPECTION TRENCH

NOT TO SCALE

NOTE

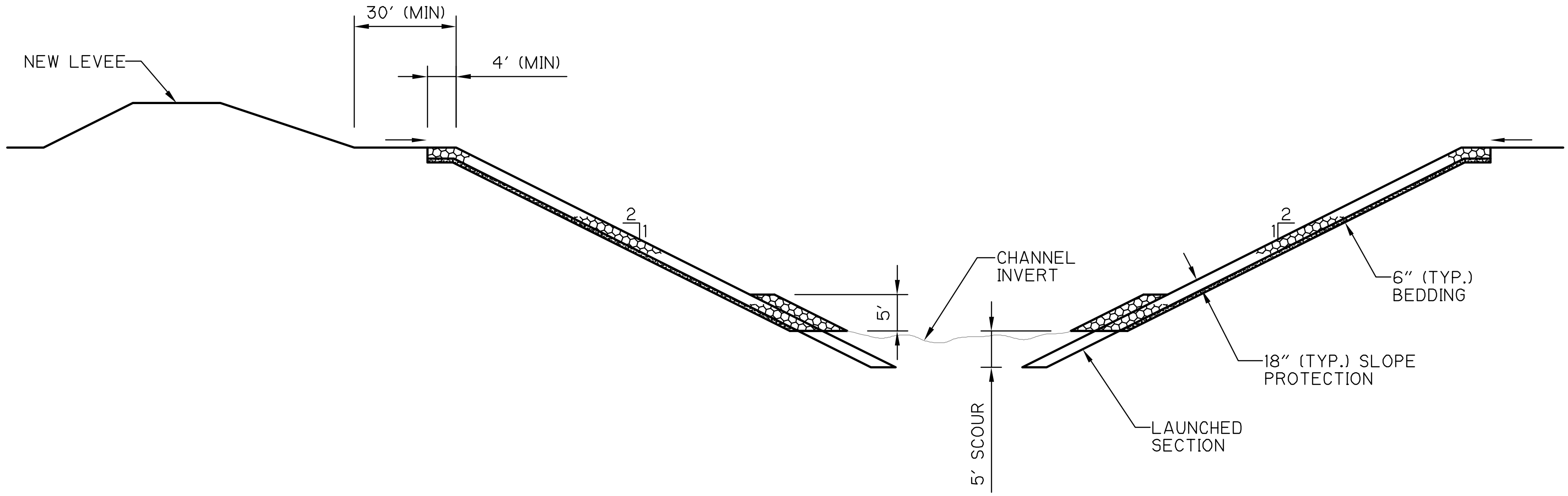
REFLECTS A RISK AND UNCERTAINTY APPROACH TO DESIGN.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION RAISED LEVEE AND INSPECTION TRENCH

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-14



SETBACK LEVEE WITH
SLOPE PROTECTION

NOT TO SCALE

NOTE

1. SET RIPRAP SLOPE PROTECTION ON A MINIMUM CHANNEL SIDE SLOPE OF 2H:1V.

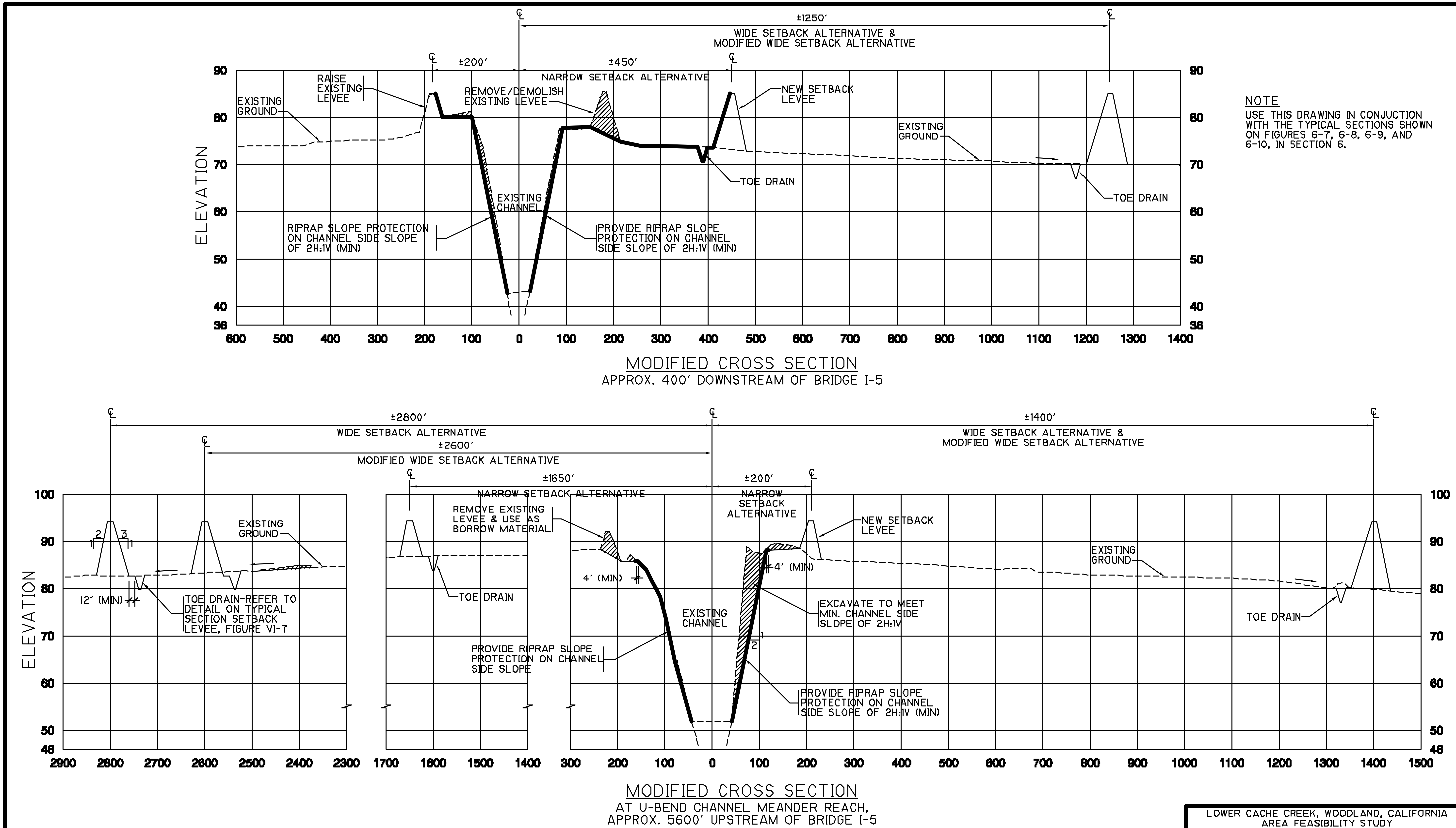
2. THE EXTENT OF RIPRAP SLOPE PROTECTION WOULD BE PROVIDED UP TO THE DESIGN TOP OF LEVEE AT PREDETERMINED UPSTREAM AND DOWNSTREAM REACHES OF THE BRIDGES AT I-5, SH 113, AND CR 102.

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
SETBACK LEVEE WITH
SLOPE PROTECTION

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-15



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

REPRESENTATIVE MODIFIED CROSS SECTIONS FOR THE SETBACK LEVEE PLANS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SEPTEMBER 2002

FIGURE 6-16

Existing levees that are incorporated into the 50,000 cfs NSL Plan would meet or exceed the design water-surface elevations and would not need to be raised. The existing levee system for the 70,000 cfs plan would need to be raised approximately 2 feet and for the 90,000 cfs design approximately 4.5 feet.

The placement of the new setback levees is in general 500 feet north and south of the creek centerline to minimize existing and future channel instability problems. Exceptions to this generalization are made at major structures, at significant topographical features, and to reduce channel velocities and the need for slope protection. In the vicinity of bridges, levees were aligned to match existing bridge openings.

A toe drain along the waterside levee toe of a newly constructed setback levee would be provided to drain the area between the creek and the levee, as shown on Figure 6-12.

Other major features of this plan include 28,500 feet of slope protection, 10,000 feet of slurry wall, and 4,000 feet of sheet piling (Plate 18). These features were included where high velocities were unavoidable, where erosion problems are known to exist, and where structures are located adjacent to the existing levee. Most of the slope protection would consist of stone revetment and gabion structures along the channel banks. A total of 700 linear feet of concrete lining would be provided through the bridges. Because geotechnical investigations have not been completed, a 40-foot slurry wall was assumed necessary for 15 percent of the total length of levees (10,600 feet). In areas with space constraints, levees would be raised with about 3,600 and 4,200 feet of sheet pile for the 70,000- and 90,000 cfs designs, respectively.

None of the existing bridges would need to be replaced for design capacities less than 70,000 cfs. The SH 113 and CF 102 bridges would need to be replaced and lengthened for design flows greater than 71,000 cfs. The railroad bridge would need to be replaced at design flows of 78,000 cfs and greater. All of the bridges, I-5 North, I-5 South, CR 99W, and California Northern Railroad, would need to be replaced and/or lengthened for the 90,000 cfs design flow.

The 70,000 and 90,000 cfs design flows include demolition of the settling basin training levee because the training levee was designed for 30,000 cfs with 2 feet of freeboard. Also, the increased design flow would cause backwater on the CR 102 bridge, requiring the bridge to be replaced. For the 90,000 cfs design, the settling basin levees would be raised a maximum of 0.9 foot.

Real estate requirements for the NSL Plan would be based on the footprint of the levee and toe drain, plus 20 feet for maintenance access (Figure 6-13). A flowage easement would be required on all lands between the levees. In addition, a temporary 40-foot-wide construction easement and a 40-foot-wide drainage easement would be necessary on the waterside of the levee. The temporary construction easement would be acquired for the duration of the construction contracts.

ACCOMPLISHMENTS OF PLAN

The main benefit of the NSL Plan is the reduced frequency of flooding from Cache Creek to Woodland. In contrast to the LCCFB Plan, this plan would also have the benefit of decreasing the frequency of flooding to lands within the county both north and south of the creek. Flooding of major interstate and State transportation routes would also be reduced.

The NSL Plan minimizes the costs of real estate because least amount of land is required. However, this plan requires extensive environmental mitigation due to slope protection required to protect existing bridges and structures.

HYDRAULIC MITIGATION

The hydraulic effects of the NSL Plan are project-induced increases in flood risk in adjacent, upstream, or downstream areas. The hydraulic effects of all the setback levee plans were evaluated for the peak floodflows of approximately 50,000 cfs, 70,000 cfs, and 90,000 cfs.

Properties on the landside of the setback levees would be protected from flooding up to the design flow. Properties on the waterside of the new levees (between the existing levees and setback levees) that are currently protected from flood events with a 1 in 10 chance in any given year would be inundated by less frequent storm events. However, the increase in flooding frequency of the affected areas would be compensated with a flowage easement.

Hydraulic effects upstream from the study area may need to be mitigated. The water-surface elevations for the peak floodflows of 50,000 cfs, 70,000 cfs, and 90,000 cfs increase from 0.4 foot to 2.3 feet just downstream from the CR 94B bridge (upstream end of the project) compared to existing conditions. These increases in water-surface elevations would cause water-surface elevations upstream from the bridge to increase as well. These effects have not been evaluated and may not increase flooding because of the large conveyance capacity upstream. These effects will need to be evaluated further if the setback levee plan is selected. Costs have been included in the real estate plan to acquire flowage easements on affected areas between the levees downstream from CR 94B.

Hydraulic effects downstream from the study area were also evaluated. The existing Cache Creek levee system was designed to contain flows of up to 30,000 cfs with 3 feet of freeboard and could potentially convey flows as great as 35,000 cfs within the existing levees. Under this existing system, flows that exceed the design flow result in a risk of levee failure and flooding in the surrounding area. Under these existing conditions, large floodflows (greater than the existing design flow) that cause levee failures, only about 25,000 cfs will be contained within Cache Creek and reach the settling basin. Under post-project conditions of this plan, flows reaching the settling basin would be substantially increased. These increased floodflows at the settling basin would cause increased water-surface elevations ranging from 1.5 feet to 3.4 feet. (See Appendix D for further information.) Consequently, at the 90,000 cfs design peak flow, the settling basin levees would need to be raised approximately 1 foot.

The NSL Plan could potentially affect the lifespan of the settling basin by containing flows up to the new design flow (greater than the existing design flow of 30,000 cfs). These higher flows would be conveyed directly into the settling basin, resulting in a higher sediment load for the storm event as compared with the existing levee system that would fail and allow overflow of sediment-laden flow onto adjacent farmland. Because the chance of these high flows is relatively low, this impact would likely not be significant when considering the 50-year lifetime of the settling basin. In terms of scour, the results from the geomorphology study indicated that the 1 in 200 chance storm would not increase the velocities to the point that significant scour would be observed.

For design flows of 70,000 cfs and higher, the training levee would need to be removed because it was only designed for 30,000 cfs with 2 feet of freeboard and because the increased design flow rates would cause backwater on the CR 102 bridge, requiring the bridge to be replaced. One of the purposes of the training levee is to maintain flow velocities near the inlet of the settling basin and to prevent premature deposition of sediments and clogging near the inlet. Also, the training levee and its incremental removal helps to direct the deposition in the basin. During the planning, engineering, and design phase, the effects of the project to these functions would be analyzed, and potential modifications and/or operation and maintenance requirements would be determined to address any effects.

An analysis was also performed to determine whether the increase in peak flows exiting the settling basin under the NSL Plan could potentially affect flooding in the Yolo Bypass. A peak flow coincidence analysis was performed to determine the likelihood of simultaneous peak flows in these two bodies of water (Appendix C). The analysis compares the 10 largest floods of record for the Yolo Bypass gage near the settling basin and shows that, in all 10 events, the peak flow on Cache Creek occurred 1 to 3 days prior to the peak flow in the bypass. In conclusion, the NSL Plan would result in a higher volume of water reaching the bypass over the length of a flood event, but should not cause an increase in the peak stage.

OPERATION AND MAINTENANCE

Ownership of the NSL project, once completed, would be transferred to the non-Federal sponsor. Operation, maintenance, and rehabilitation of the NSL project would be in accordance with the operation and maintenance manual to be provided by the Corps.

The Corps would have the responsibility to make certain that the non-Federal sponsor inspects, maintains, and rehabilitates the project according to this manual to provide an operational and a safe project.

ENVIRONMENTAL EFFECTS AND MITIGATION

A preliminary evaluation of the potential effects of the NSL Plan on environmental resources was conducted during the plan formulation process. Severe environmental effects associated with the plan were identified, which made the plan undesirable due to potentially high costs and extensive mitigation requirements. As a result, further environmental analysis on the NSL Plan was discontinued, and the setback levee plan was modified to reflect these results as discussed below.

Based on the preliminary environmental studies, resources not affected by the NSL Plan are climate; topography; geology; soils; recreation; hazardous, toxic, and radiological waste; public health vectors and vector control; and fisheries. The potentially affected resources include social and economic resources, land use, agriculture, prime and unique farmlands, transportation, noise, air quality, water quality, sedimentation and the settling basin, vegetation and wildlife, special-status species, cultural resources, and esthetic and visual resources. At the time that the NSL Plan was eliminated, analysis had been completed on the following resource categories: social and economic resources, land use, prime and unique farmlands, and special-status species. The potential effects, preliminary mitigation, and significance for these resources are summarized below.

Social and economic resources would be affected due to the relocation of 10 residences and farm support structures. Agricultural landowners would be compensated for land value effects/takings, and the homeowners would be compensated for the land and home values. Implementation of these mitigation measures would reduce the potentially significant effect to less than significant.

Land use effects of the NSL Plan would be the conversion of 161 acres of row crop, 62 acres of orchard, 123 acres of riparian, and 22 acres of agricultural support lands for flood damage reduction purposes. There is a potential conversion of an additional 1,487 acres confined by the levees. This effect represents an incompatible land use change and is a significant effect that cannot be mitigated.

Effects of prime and unique farmland due to the NSL Plan would be a loss of 223 acres of prime farmland. A total of 718 acres of prime farmland confined by the levee system has the potential of conversion due to indirect effects (inability to farm due to size, accessibility, or other factors). The acreage of prime farmland converted cannot be mitigated since the qualities that distinguish prime farmland cannot be re-created. The conversion of prime farmland represents a significant effect.

The use of rock slope protection and grading of the stream channel would cause permanent habitat loss including shaded riverine aquatic (SRA) habitat. The loss of SRA habitat would likely not be possible to mitigate due to the extent of required mitigation, 20.23 miles of SRA habitat. In-channel construction would also reduce habitat for the bank swallow, giant garter snake, northwestern pond turtle, chinook salmon, and steelhead, including designated critical habitat for the steelhead. The loss of bank swallow habitat cannot be mitigated due to the difficulty in purchasing and/or re-creating such habitat. Mitigation for the loss of snake, turtle, salmon, and steelhead habitats would be required. The overall effect on special-status species would be significant.

Onsite surveys of elderberry shrubs were conducted near road-levee intersections, where the greatest number of effects would be expected. These surveys indicated large numbers of plants with valley elderberry longhorn beetle presence. Mitigation would include transplanting shrubs with beetle presence and planting additional shrubs (approximately 286 transplanted elderberry clumps and 27,408 planted elderberry seedlings). Based on preliminary estimates, including the purchase of new plants and transporting existing plants, these mitigation measures would cost approximately $7 million.

COSTS

Construction, environmental, and real estate costs for the NSL Plan are shown in Table 6-4. The costs are for the 78,000 cfs design flow option. The costs for the full range of design flow options are discussed below under the heading “Comparison of Plans.”

Table 6-4. Total Project Cost Summary for the Narrow Setback Levee Plan, 78,000 cfs Design Flow

Feature	Cost[1] $1,000
Construction Costs (excludes environmental mitigation costs)[2]	51,819
Environmental Mitigation	
Scrub	0
Orchard	5,300
Native Trees	0
Nonnative Trees	0
Riparian	4,700
Emergent Marsh	0
Upland/Agricultural Land	0
Shaded Riparian Aquatic	10,700
Elderberry	7,100
Subtotal	27,800
+25% Contingency	**34,800**
Real Estate[1]	
Levee Footprint (Flood Protection Levee Easement)	1,209
Flowway Between Levees (Permanent Flowage Easement)[3]	8,374
Constructions Easements (Temporary Work Area Easements)	683
Environmental (Fee Title)	0
Channel Improvements (Channel Improvement Easement)	191
Roads (Roads and Road Easements)	9
Borrow Area (Borrow Easement)	677
Structures	742
Severance	1,191
Contingencies (25%)	3,274
Relocation Costs	225
Non-Federal Administrative Costs	7,513
Federal Administrative Review Costs	1,377
Subtotal	25,485
Cultural, Engineering, and Construction Mgmt @ 21.5%	18,623
Total First Costs	**130,727**
Interest During Construction	**8,893**
TOTAL INVESTMENT COST	**139,620**

[1]Includes a contingency, construction 20 percent, real estate 25 percent, and environmental 25 percent.
[2]For the 78,000 cfs design flow plan.
[3]Includes some areas with a temporary work easement.

DESCRIPTION OF WIDE SETBACK LEVEE PLAN

In contrast to the NSL Plan, where rock slope protection was required to preserve the stability of the system, the objective of the Wide Setback Levee (WSL) Plan was to further reduce environmental effects (compared to the NSL Plan) by reducing the amount of rock slope protection (Figure 6-17 and Plate 19). A second objective was to avoid affecting and replacing existing bridges. This objective was determined to be feasible only if rock slope protection could be used upstream and downstream from the bridges.

The WSL Plan was designed without any engineered rock slope protection except to protect the existing bridges. Without rock slope protection and with excessive channel velocities, channel migration would continue and most likely increase. This migration of the channel could eventually encroach into the levee prism and cause failure. To protect against this occurrence, the alignments of the levees of the WSL Plan was set 1.5 times as wide as the meander of the existing channel. Minimizing the taking of homes and land was not a primary objective in the selection of the levee alignment.

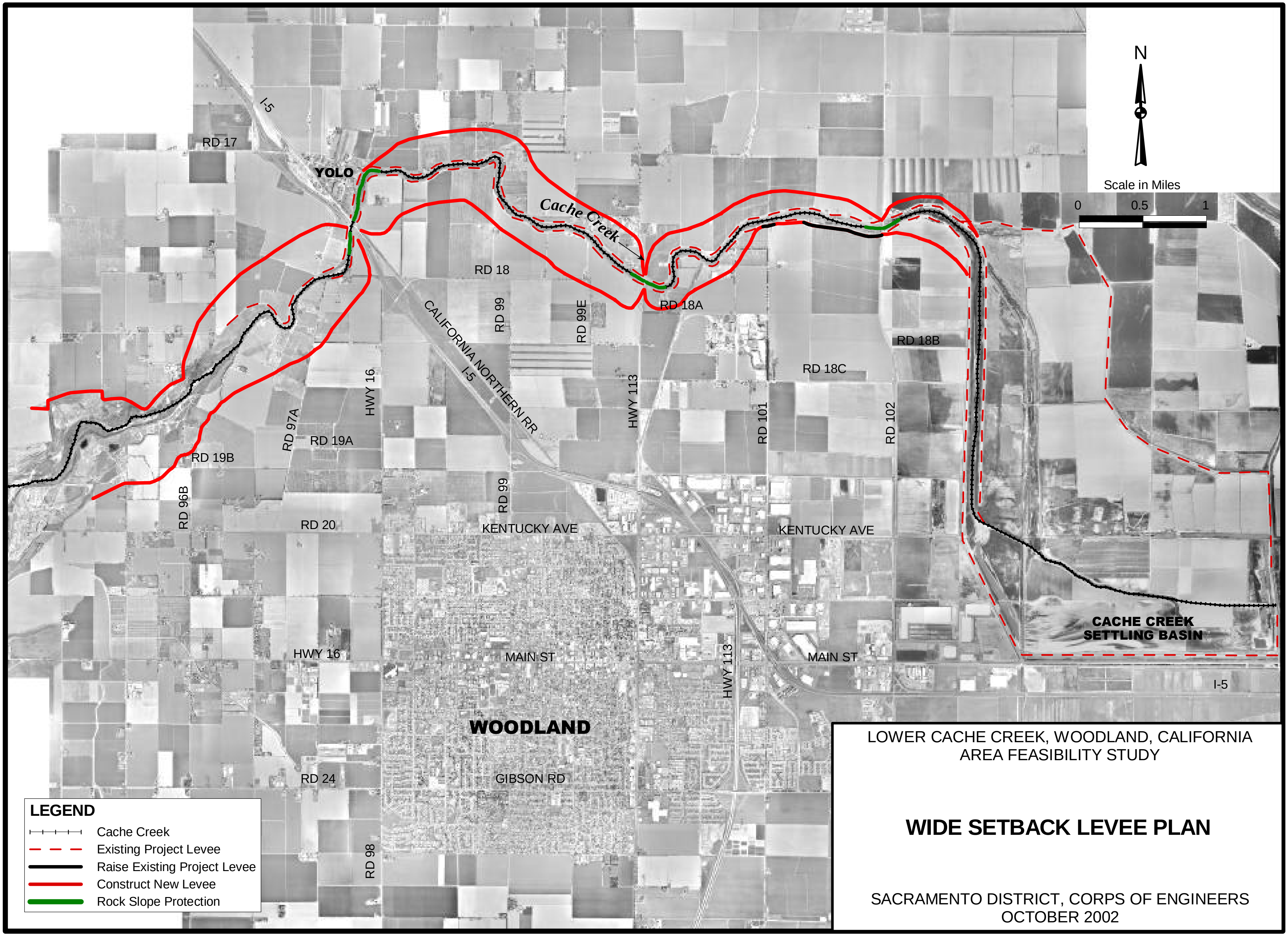
The WSL Plan was also analyzed in detail for three design flow rates of 50,000 cfs, 70,000 cfs, and 90,000 cfs. Other design flows of interest were also analyzed based on these three more detailed analyses. This flow range provided the basis to determine the size of the project that would optimize net benefits.

PHYSICAL FEATURES

Many of the features of the WSL Plan are similar to those features of the NSL Plan. The major features of the WSL Plan are described below. For other features, refer to the section under the heading “Physical Features” under the description of the NSL Plan.

The major feature of the WSL Plan is the construction of about 19 miles of levees consisting of a combination of new setback levees and the modifications to the existing levees on Cache Creek. The levees would extend from the settling basin inlet to high ground near CR 94B. Levee design, construction, and use of portions of the existing flood damage reduction system would vary between the right (southern) and left (northern) banks of Cache Creek. Typical cross sections of setback levees are shown on Figures 6-12 to 6-15, and representative modified cross sections are shown on Figure 6-16.

Flow rates of 50,000 cfs, 70,000 cfs, and 90,000 cfs were analyzed for optimization of the project. Design levee profiles and other project features were developed based on these three flow rates. Maximum levee heights would be approximately 18 feet for 50,000 cfs and 70,000 cfs flows and 21 feet for 90,000 cfs



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
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WIDE SETBACK LEVEE PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

FIGURE 6-17

flows. A portion of the right existing levee between SH 113 and CR 102 would need to be raised 2 feet for the 70,000 cfs flow and 3 feet for the 90,000 cfs flow. The 50,000 cfs flow requires a small segment only 500 feet long to be raised 3 feet between SH 113 and CR 102.

The placement of the levees of the WSL Plan west of I-5 is in general 1,000 to 1,500 feet north and south of the creek centerline, except at the bridges. East of I-5, the setback levees would both incorporate same existing levees and be closer to the creek. The levees pinch in at the vicinity of the bridges to match bridge openings. This configuration protects the roadways and bridges from flooding during most storm events. However, the 90,000 cfs design requires the replacement of CR 102, SH 113, and I-5 southbound bridges. For all three design flows, the channels would be concrete-lined under the bridges, and rock slope protection would be provided both upstream and downstream from these bridges to provide protection. To accommodate the rock slope protection, channel slopes steeper than 2H:1V would be cleared and regraded to a slope of 2H:1V. In some areas, this would be a combination of both excavation and embankment fill or rock fills.

Real estate requirements for the WSL Plan would be based on the footprint of the levee and toe drain, plus 20 feet for maintenance access (Figure 6-13). A flowage easement would be required on all lands between the footprints of the levees. In addition, a temporary 40-foot-wide construction easement and a 40-foot-wide drainage easement would be necessary on the waterside of the levee. The temporary construction easement would be acquired for the duration of the construction contracts.

ACCOMPLISHMENTS OF PLANS

The main benefit of the WSL Plan is the reduced chance of flooding in Woodland. In contrast to the LCCFB Plan, this plan would also have the benefit of decreasing the frequency of flooding to the land within the county both north and south of the creek. Flooding of major interstate and State transportation routes would also be reduced.

Compared to the NSL Plan, the amount of rock slope protection required for the WSL Plan is reduced, decreasing the amount of required streambank mitigation. However, the wide setback option would increase the real estate costs, entailing the taking of a much greater amount of agricultural land and residences.

HYDRAULIC MITIGATION

The hydraulic effects of the WSL Plan are project-induced increases in flood risk in adjacent, upstream, or downstream areas. The hydraulic effects of all the setback levee plans were evaluated for the peak floodflows of approximately 50,000 cfs, 70,000 cfs, and 90,000 cfs.

Properties on the landside of the setback levees would be protected from flooding up to the design flows, but those properties on the waterside of the new levees (between the existing levees and setback levees) that are currently protected from a 1 in 10 chance flood would be inundated by more frequent flooding events (1 in 2 annual chance of occurrence) of these areas. The increase in flooding frequency of the affected areas would be compensated with a flowage easement.

Hydraulic effects upstream from the study area may need to be mitigated. The water-surface elevations for the peak floodflows of 50,000 cfs, 70,000 cfs, and 90,000 cfs increase from zero to 0.8 foot just downstream from the CR 94B bridge as compared to existing conditions. These increases in water-surface elevations would cause water-surface elevations upstream from the bridge to increase as well. These effects have not been evaluated and are not expected to aggravate flood conditions because of the large conveyance capacity of the channel in this area. These effects will need to be evaluated if the WSL Plan is selected.

Hydraulic effects downstream from the study area were also evaluated and are discussed in the section “Hydraulic Mitigation” under the description of the NSL Plan.

OPERATION AND MAINTENANCE

Operation and maintenance of this plan would be the same as for the NSL Plan.

ENVIRONMENTAL EFFECTS AND MITIGATION

A preliminary evaluation of the potential effects of the WSL Plan on environmental resources was conducted during the plan formulation process. Severe environmental effects associated with the plan were identified, which made the plan undesirable due to potentially high social and economic effects and extensive mitigation requirements. As a result, further environmental analysis on the WSL Plan was discontinued, and the setback levee plan was modified to reflect these results.

Based on the preliminary environmental studies, resources not affected by the WSL Plan are climate; topography; geology; soils; recreation; hazardous, toxic, and radiological waste; public health vectors and vector control; and fisheries. The potentially affected resources include social and economic resources, land use, agriculture, prime and unique farmlands, transportation, noise, air quality, water quality, sedimentation and the settling basin, vegetation and wildlife, special-status species, cultural resources, and esthetic and visual resources. At the time that the WSL Plan was eliminated, analysis had been completed on the following resource categories: social and economic resources, land use, prime and unique farmlands, and special-status species. The potential effects, preliminary mitigation, and significance for these resources are summarized below.

Social and economic resources would be affected due to the relocation of 56 residences and farm support structures. Agricultural landowners would be compensated for land value effects/takings, and the homeowners would be compensated for the land and home values. Implementation of these mitigation measures would reduce the potentially significant effect to less than significant.

Land use effects of the WSL Plan would be the conversion of 246 acres of row crop, 51 acres of orchard, 51 acres of riparian, and 27 acres of agricultural support lands for flood damage reduction purposes. There is a potential conversion of an additional 2,440 acres confined by the levees. This effect represents an incompatible land use change and is a significant effect that cannot be mitigated.

Effects of prime and unique farmland due to the setback levee would be a loss of 297 acres of prime farmland. A total of 1,539 acres of prime farmland confined by the levee system has the potential of conversion due to indirect effects (inability to farm due to size, accessibility, or other factors). The acreage of prime farmland converted cannot be mitigated since the qualities that distinguish prime farmland cannot be re-created. The conversion of prime farmland represents a significant effect.

The use of rock slope protection and grading of the stream channel would cause permanent habitat loss including shaded riverine aquatic (SRA) habitat. Although the loss of SRA is substantially less than for the NSL Plan, the amount required for mitigation, 5.83 miles, may be difficult to mitigate. There would be no effects to bank swallows under the WSL Plan due to the reduction in rock slope protection as compared to the NSL Plan. In-channel construction around the bridges would impact giant garter snake, northwestern pond turtle, chinook salmon, and steelhead habitat, including designated critical habitat for the steelhead. Mitigation for the loss of these habitats would be required. The overall effect on special-status species would be significant.

Onsite surveys of elderberry shrubs were conducted near road-levee intersections, where the greatest number of effects would be expected. These surveys indicated large numbers of plants with valley elderberry longhorn beetle presence. Mitigation would include transplanting shrubs with beetle presence and planting additional shrubs (approximately 123 transplanted elderberry clumps and 22,496 planted elderberry seedlings). Based on preliminary estimates including the purchase of new plants and transporting existing plants, these mitigation measures would cost approximately $5 million.

COSTS

Construction, environmental, and real estate costs for the WSL Plan are shown in Table 6-5. The costs are for the 78,000 cfs design flow option, which corresponds to the project that has approximately the highest net benefits. The costs for the full range of design flow options are discussed below under the heading “Comparison of Plans.”

Table 6-5. Total Project Cost Summary for the Wide Setback Levee Plan, 78,000 cfs Design Flow

Feature	Cost[1] $1,000
Construction Costs (excludes environmental mitigation costs)[2]	41,780
Environmental Mitigation	
Scrub	0
Orchard	4,500
Native Trees	0
Nonnative Trees	0
Riparian	3,500
Emergent Marsh	0
Upland	0
Shaded Riparian Aquatic	3,100
Elderberry	5,300
Subtotal	16,400
+25% Contingency	**20,500**
Real Estate[1]	
Levee Footprint (Flood Protection Levee Easement)	1,632
Flowway Between Levees (Permanent Flowage Easement)[3]	22,106
Constructions Easements (Temporary Work Area Easements)[4]	0
Environmental (Fee Title)	0
Channel Improvements (Channel Improvement Easement)	62
Roads (Roads and Road Easements)	13
Borrow Area (Borrow Easement)	677
Structures	8,344
Severance	3,283
Contingencies (25%)	9,029
Relocation Costs	1,300
Non-Federal Administrative Costs	9,503
Federal Administrative Review Costs	1,666
Subtotal	57,612
Cultural, Engineering and Construction Mgmt @ 21.5%	13,390
Total First Costs	**133,283**
Interest During Construction	**9,067**
TOTAL INVESTMENT COST	**142,350**

[1]Includes a contingency, construction 20 percent, real estate 25 percent, and environmental 25 percent.
[2]For the 78,000 cfs design flow plan.
[3]Includes some areas with drainage, borrow, and temporary work easements.
[4]Temporary work easements coincide with the permanent flowage easement and are therefore included in the flowway between levees.

DESCRIPTION OF MODIFIED WIDE SETBACK LEVEE PLAN

Because the WSL Plan would require a significant amount of rock slope protection at the constrictions of the bridge, the Modified Wide Setback Levee (MWSL) Plan was developed to further reduce environmental effects at the bridges and, where possible, reduce the effects on homes that were near the proposed levee alignment. (See Figure 6-18 and Plate 20.)

Eliminating the need for rock slope protection near the bridge requires decreasing the high velocities and shear stresses caused by containing the design flows through the existing bridges. To accomplish this goal, the conveyance area must be increased through the bridge area.

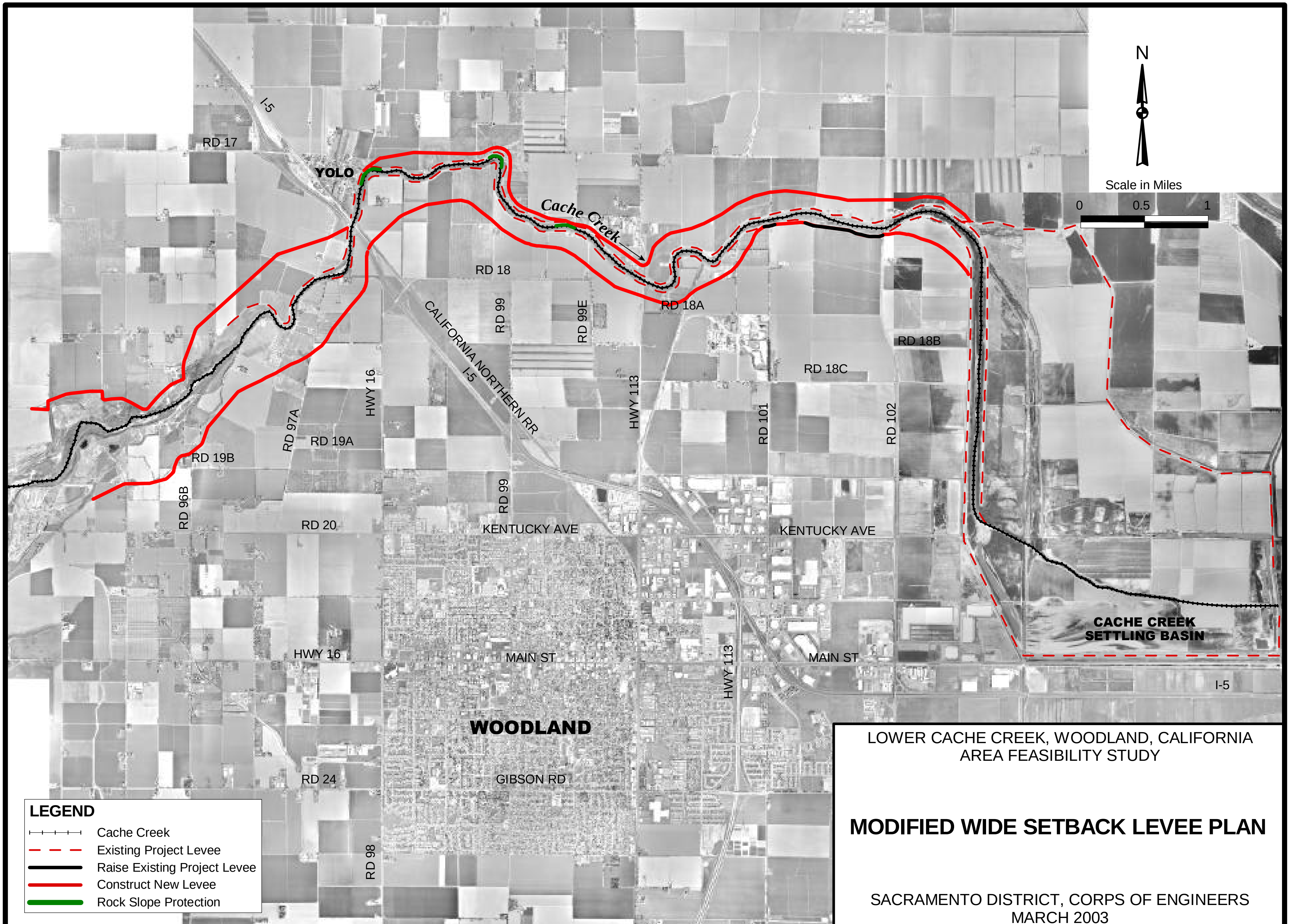
One way to increase the conveyance area is to divert some flow around the bridge opening and over the bridge approaches. This overflow could be contained by closure of the roads with closure structures. Because the existing levees would be removed and the new setbacks would tie into the road where the road ramps down, the existing approaches would need to be raised to prevent overflow of the roads by events more frequent than for existing conditions. The difference between the proposed bridge ramp elevation and the bridge soffit elevation would only be a few feet allowing for a very small hydraulic head over this overflow area. Therefore, the overflow approaches would need to be several thousand feet long to pass the high overflows and would not be practical.

Another way to increase the conveyance area of the bridge is with viaducts in the flood plain. The road in the overbank area would be raised with piles, and the overbank flow would flow under the road, like a causeway. Viaducts were incorporated into this plan.

This plan requires the modification of all the bridges (I-5 South, I-5 North, California Northern Railroad, SH 113, and CR 102) for each of the three design flows (50,000 cfs, 70,000 cfs, and 90,000 cfs), enhancing the flow capacity of the bridges with the provision of viaducts. This modification eliminates the rock slope protection that would be required at the bridges for the NSL and WSL Plans. Rock slope protection would be provided at problem locations along the left bank close to the town of Yolo. Due to the geomorphology of the stream channel configuration, riprap, gabions, and hard points would be necessary to ensure bank stability at these locations. Except for the left bank reach between I-5 and SH 113, levee alignments of this plan are similar to the WSL Plan.

PHYSICAL FEATURES

Many of the features of the MWSL Plan are similar to those features of the NSL Plan and the WSL Plan. The major features of the MWSL Plan are described below. For other



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

MODIFIED WIDE SETBACK LEVEE PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
MARCH 2003

FIGURE 6-18

features, refer to the section under the heading “Physical Features” under the description of the NSL Plan.

This description of the physical features for the MWSL Plan pertains to the 78,000 cfs design flow, which corresponds to a flood damage reduction level of a 1 in 500 chance flow. The basic features for design flows of 50,000 cfs and 90,000 cfs would be similar. The plan consists of approximately 19 miles of levees. Levee improvements would begin at the west levee of the settling basin and terminate upstream near CR 94B. Levee design, construction, and use of portions of the existing levee system would vary.

Typical cross sections of setback levees are shown on Figures 6-12 to 6-15, and representative modified cross sections are shown on Figure 6-16. The maximum levee height would be approximately 18 feet. A portion of the right existing levee between SH 113 and CR 102 would need to be raised 2 feet.

In general, the proposed alignments of the levees of the MWSL Plan are similar to the WSL Plan. A major difference in levee alignments of this plan is on the north and south banks between I-5 and SH 113. These changes in the levee alignments were made to reduce the environmental mitigation associated with the location of elderberry plants and also to reduce effects to homes and farm structures. The alignments for all three setback plans and locations of surveyed elderberry plants are represented on Plate 21. Modifications to the bridges would consist of rebuilding the bridge approaches and replacing the existing embankment approaches with viaduct approaches. These viaducts would substantially increase bridge openings and flow capacity, reducing the flow velocities and eliminating the need for rock slope protection and subsequent environmental mitigation. Concrete linings would still be necessary under bridges in the main channel for erosion and scour prevention.

Although rock slope protection is reduced at the bridges, riprap and a series of gabions would be required on a small portion of the left bank downstream from I-5. Furthermore, hard points (stone fills) would be installed at the outer bend near the vicinity of the town Yolo. Due to the geomorphology of Cache Creek in these locations, bank protection would be necessary to ensure lateral channel stability. Toe drains, acting as lateral drainage channels, would also be installed on the waterside of the levees to facilitate overbank drainage. Additionally, approximately 70 percent of the existing levee system would be removed to allow water to flow back and forth from the channel and overbank area. The other 30 percent is expected to naturally degrade over time, minimizing disturbance to the nearby elderberry shrubs, substantially reducing environmental effects.

Borrow material for construction of the new levees would be developed from several sources: the removal of the training levee in the settling basin, the removal of portions of the existing Cache Creek levees, a borrow area in the northwest corner of the settling basin, and from various borrow areas located along and adjacent to the water side of the setback levees. The five potential borrow areas along the setback levee have been tentatively selected for the purposes of preparing the Real Estate Plan and for identification of environmental effects. Construction staging areas would be located at the west end of CR 18 near the I-5/SH 16 interchange and at Highway 16 and Cache Creek. Staging areas would be located between the setback levee and the existing levee on lands being acquired as permanent flowage easements.

Real estate requirements for the MWSL Plan would be based on the footprint of the levee and toe drain, plus 20 feet for maintenance access (Figure 6-13). A flowage easement would be required on all lands between the levees. In addition, a temporary 40-foot-wide construction easement and a 40-foot-wide drainage easement would be necessary on the waterside of the levee. The temporary construction easement would be acquired for the duration of the construction contracts.

ACCOMPLISHMENTS OF PLANS

The main benefit of the MWSL Plan is the reduced flood frequency in Woodland. In contrast to the LCCFB Plan, this plan would also have the benefit of decreasing the frequency of flooding to lands within the county both north and south of the creek. Flooding of major interstate and State transportation routes would also be reduced.

Compared to both the NSL and WSL Plans, the amount of rock slope protection required for the MWSL Plan would be reduced even further, decreasing the amount of required streambank mitigation. Due to the alignment modifications from the WSL, real estate costs would be less than for the WSL Plan. However, this plan would still entail the taking of a much greater amount of agricultural land and residences than the NSL Plan. Real estate costs would be lower than the WSL Plan, yet more expensive than the NSL Plan.

HYDRAULIC MITIGATION

Properties on the landside of the setback levees would be protected from flooding up to the design flows, but those properties on the waterside of the new levees (between the existing levees and setback levees) that are currently protected from a 1 in 10 chance flood would be inundated by more frequent flood events (1 in 2 annual chance of occurrence) of these areas. The increase in flooding frequency of the affected areas would be compensated with a flowage easement.

Hydraulic effects upstream from the study area may need to be mitigated. The water-surface elevations for the peak floodflows of 50,000 cfs, 70,000 cfs, and 90,000 cfs increase from zero to 0.8 foot just downstream from the CR 94B bridge compared to existing conditions. These increases in water-surface elevations would cause water-surface elevations upstream from the bridge to increase as well. These effects have not been evaluated and may not induce flooding because of the large conveyance capacity upstream. These effects would need to be evaluated if the MWSL Plan is selected.

Hydraulic effects downstream from the study area were also evaluated and are discussed in the section "Hydraulic Mitigation" under the description of the NSL Plan.

OPERATION AND MAINTENANCE

Operation and maintenance of this plan would be the same as for the NSL Plan.

ENVIRONMENTAL EFFECTS AND MITIGATION

The potential effects of the MWSL Plan on environmental resources in the project area are evaluated in detail, and the results are presented in detail in the EIS/EIR. Potential adverse effects of the plan are identified and quantified when possible, and measures to avoid, reduce, or mitigate these effects to less than significant are presented.

Based on the results of the environmental studies, resources not affected by the MWSL Plan are climate; topography; geology; soils; recreation; hazardous, toxic, and radiological waste; public health vectors and vector control; and fisheries. The potentially affected resources include social and economic resources, land use, agriculture, prime and unique farmlands, transportation, noise, air quality, water quality, sedimentation and the settling basin, vegetation and wildlife, special-status species, cultural resources, and esthetic and visual resources. The potential effects, mitigation, and significance for these affected resources are summarized below.

Social and economic resources would be affected due to the relocation of 32 residences and up to 182 farm structures. Agricultural landowners would be compensated for land value effects/takings, and the homeowners would be compensated for the land and home values. Implementation of these mitigation measures would reduce the potentially significant effect to less than significant.

Land use effects of the MWSL Plan would be the conversion of 123 acres of row crop, 35 acres of orchard, 11 acres of riparian, and 47 acres of agricultural support lands for flood damage reduction purposes. There is a potential conversion of an additional 2,135 acres confined by the levees. This effect represents an incompatible land use change and is a significant effect that cannot be mitigated.

Effects of prime and unique farmland due to the MWSL Plan would be a loss of 158 acres of prime farmland. A total of 1,254 acres of prime farmland confined by the levee system would have the potential of conversion due to indirect effects (inability to farm due to size, accessibility, or other factors). The acreage of prime farmland converted cannot be mitigated since the qualities that distinguish prime farmland cannot be re-created. The conversion of prime farmland represents a significant effect.

Temporary direct transportation effects would include lane closure during road repair, roadway safety hazards, and an increase in traffic volume. The lead agency would provide a traffic management plan as a mitigation measure. Additionally, contractors would use construction easements as much as feasible when hauling materials to the construction site; traffic would be rerouted when necessary to avoid construction areas; and flaggers would be stationed to slow or stop approaching vehicles to avoid conflicts with construction vehicles or equipment. With the implementation of these mitigation measures, the effects on transportation would be reduced to less than significant.

Construction-related effects on noise would consist of temporary decibel levels above the significance threshold for some sensitive receptors during construction. Construction equipment would be outfitted and maintained with noise-reduction devices such as mufflers, and construction would be limited to daytime hours. The implementation of these mitigation measures would lessen the effects, but not to a less-than-significant level.

Construction-related effects on air quality would consist of temporary increases in pollutant emissions. NOx and PM_{10} emissions would exceed the significance thresholds established by the Yolo-Solano AQMD. Sensitive receptors would also be exposed to the high levels of fugitive dust emissions. NOx mitigation measures would be incorporated into construction plans and specifications, and the lead agency would provide a dust suppression plan to lessen the effects of PM_{10}. The mitigation measures would reduce the air quality effects, but not to a less-than-significant level.

The removal of the training levee could alter the distribution of sedimentation in the settling basin. The design of the MWSL Plan would incorporate the function of the settling basin, reducing any potential effects to less than significant.

Potential project-related effects on water quality would include pollutants from construction equipment and erosion at the construction site that could temporarily degrade the water quality of local runoff during construction. The lead agency would prepare a stormwater pollution prevention plan. A portion of this plan would specifically address erosion and sediment control. The lead agency would also prepare a Hazardous Substance Control and Emergency Response Plan and would comply with all Clean Water Act requirements. In addition, appropriate best management practices and monitoring would be implemented to preserve the quality of surface runoff. Implementation of these mitigation measures would reduce the effects on water quality to less than significant.

Project-related effects on vegetation and wildlife, as determined by the USFWS in its draft Coordination Act Report (CAR), would include the loss of 174 acres of agricultural habitat, 49 acres of orchard trees, 9.01 acres of riparian habitat, and 0.69 acre of shaded riverine aquatic habitat. Mitigation for habitat loss has been outlined by the USFWS in its CAR, which is included as Appendix A with the EIS/EIR. Construction-related effects would include disturbance from equipment and crews and potential disturbance of species. Mitigation for these effects include limiting construction crews to the right-of-way and confinement of disturbance to as small an area as possible, and conducting nest surveys prior to the removal of any trees or scrub shrub to ensure migratory birds would not be lost during construction, pursuant to the Migratory Bird Treaty Act. Implementation of mitigation measures would reduce project-related and construction-related effects to less than significant.

Project-related effects to special-status species (valley elderberry longhorn beetle, Swainson's hawk, giant garter snake, northwestern pond turtle, chinook salmon, and steelhead) would include temporary and permanent loss of habitat. Construction-related effects would include disturbance from equipment and crew and potential take of species. Mitigation for effects to special-status species would be determined through formal consultation with the USFWS and NMFS and outlined in their Biological Opinion. Mitigation for effects to State special-status species would also be determined through formal consultation with the California Department of Fish and Game. Adherence to the mitigation measures outlined by the resource agencies would reduce the effects on special-status species to less than significant.

Archeological and historic sites could be affected by levee construction, degradation of the present levee, and accelerated erosion. Mitigation measures could consist of avoidance; data recovery; and, for structures, recordation under the Historic American Buildings Survey/Historic American Engineering Recordation criteria. If previously unidentified cultural materials and/or features are discovered during construction, all work in the immediate area would cease, and a cultural resources specialist would be immediately contacted for identification and evaluation. Additionally, if human remains are encountered, a cultural resources specialist and county coroner would be contacted in compliance with State law. Adherence to these mitigation measures would reduce potentially significant effects on cultural resources to less than significant.

The MWSL Plan would have effects on esthetic and visual resources. The plan would include the extension of bridges and the presence of a new viewblock to numerous rural residences. Mitigation measures would include reseeding the new levees with grasses and forbs; however, this would not reduce the overall effect to a less-than-significant level.

COSTS

Construction, environmental, and real estate costs for the MWSL Plan are shown in Table 6-6. The costs are for the 78,000 cfs design flow option, which corresponds to the project that has approximately the highest net benefits. The costs for the full range of design flow options are discussed below under the heading "Comparison of Plans."

Table 6-6. Total Project Cost Summary for the Modified Wide Setback Levee Plan, 78,000 cfs Design Flow

Feature	Cost[1] $1,000
Construction Costs (excludes environmental mitigation costs)[2]	75,652
Environmental Mitigation	
Trees	1,150
Scrub Shrub	0
Elderberry	3,600
Shaded Riparian Aquatic Habitat	146
Giant Garter Snake Habitat	3,025
Subtotal	7,921
+25% Contingency	**9,901**
Real Estate[1]	
Levee Footprint (Flood Protection Levee Easement)[3]	1,808
Flowway Between Levees (Permanent Flowage Easement)[4]	19,447
Constructions Easements (Temporary Work Area Easements)	534
Environmental (Fee Title)	0
Channel Improvements (Channel Improvement Easement)	0.559
Roads (Roads and Road Easements)	9
Borrow Area (Borrow Easement)	677
Structures	5,445
Severance	2,792
Contingencies (25%)	6,980
Relocation Costs	718
Non-Federal Administrative Costs	8,713
Federal Administrative Review Costs	1,524
Subtotal	48,647
Cultural, Engineering, and Construction Mgmt @ 21.5%	18,394
Total First Costs	**152,594**
Interest During Construction	**10,381**
TOTAL INVESTMENT COST	**162,975**

[1]Includes a contingency, construction 20 percent, real estate 25 percent, and environmental 25 percent.
[2]For the 78,000 cfs design flow plan.
[3]Includes some areas with a temporary work easement.
[4]Includes some areas with drainage, borrow, and temporary work easements.

COMPARISON OF PLANS

BENEFITS

Benefits are defined as the reduction in flood damages due to the implementation of the proposed project. The without-project (No-Action Plan) damages for Lower Cache Creek are $12 million annually. The without-project flood damages represent the average annual damages that are expected under existing conditions and with the continued operation and maintenance of the existing levee system. With-project benefits are the reduction in flood damages that are expected to result from the implementation of a specific flood damage reduction project. The total annual damages and benefits estimated for the final plans are listed in Table 6-7 for the design flows of 1 in 50, 1 in 100, 1 in 200, 1 in 500, and 1 in 1,000 chance flows, approximately 53,000, 64,000, 70,000, 78,000, and 91,000 cfs, respectively.

COSTS

Costs were estimated for the four plans (NSL, WSL, MWSL and the LCCFB Plans). Three design flows for each plan were analyzed to determine the project size that would maximize the net benefits for each plan. These design flows correspond to design flows in lower Cache Creek of approximately 50,000 cfs, 70,000 cfs, and 90,000 cfs, approximately 1 in 50, 1 in 200, and 1 in 1,000 chance flows, respectively. Other design flows of interest were also analyzed based on these more detailed analyses. The estimated total investment and annual costs are listed in Table 6-8. Detailed cost estimates are presented in Appendix K.

Costs for replacing existing bridges were included in the estimate for the NSL Plan as listed in Table 6-7. Existing bridges would require replacement when peak floodflows exceed about 71,000 cfs to 81,000 cfs, approximately 1 in 200 and greater than 1 in 500 chance flows, respectively. The bridges at CR 102 and S 113 would need replacement when flows exceed 71,000 cfs, the railroad bridge would need replacement at 78,000 cfs (1 in 500 chance flow), and CR 99W and both I-5 bridges would need lengthening at 81,000 cfs.

Estimated costs for the WSL Plan for design flows requiring bridge replacement or lengthening at about 71,000, 74,000 (approximately a 1 in 350 chance flow) and 88,000 cfs (approximately a 1 in 900 chance flow) are shown in Table 6-8. These refinements were done to reflect the large increase in costs associated with replacing or lengthening a bridge and to more accurately identify the optimal design level.

Cost estimates for the MWSL in Table 6-8 included the additional design storm of 78,000 cfs and modifications to all the existing bridges for all of the design levels.

NET BENEFITS

Each plan was evaluated in terms of the costs and benefits associated with different design flows to determine the optimal design flow for each plan. The annual costs and benefits are shown in Table 6-9 and plotted on Figure 6-19 for each plan. Some of the points were interpolated from the costs and benefits curves. The net benefits were computed as the difference between the benefits and costs and are shown in Tabble 6-9 and plotted on Figure 6-20.

Table 6-7. Estimated Project Annual Damages and Benefits for Various Design Flows of the No-Action Plan, the Lower Cache Creek Flood Barrier Plan, and the Setback Levee Plans[1]

PLAN	Design Peak Flow (x 1,000 cfs)	Occurrence Frequency (chance per year)	Residual Damages ($1,000)	Annual Benefits ($1,000)
No-Action Plan—Rehabilitation of Cache Creek Levee System[2]	30	1 in 10	12,429	—
Lower Cache Creek Flood Barrier Plan	53	1 in 50	1,815	10,614
	63	1 in 100	1,269	11,160
	70	1 in 200	1,029	11,400
	78	1 in 500	888	11,541
	91	1 in 1,000	822	11,607
Narrow, Wide, and Modified Wide Setback Levee Plans[3]	53	1 in 50	6,050	6,745
	63	1 in 100	2,452	10,720
	70	1 in 200	1,347	11,940
	78	1 in 500	794	12,550
	91	1 in 1,000	323	13,070

[1]The period of analysis is 50 years, and the Federal discount rate is 6 1/8 percent. All costs are expressed in October 2001 (fiscal year 2002) price levels.
[2]No-Action Plan—The existing system operation and maintenance is a DWR responsibility. If a Setback Levee Plan is built, existing system operation, maintenance, repair, rehabilitation, and replacement would not be needed, and this would be a cost savings, or benefit.
[3]The Setback Levee Plan has essentially the same benefits for all three options.

Table 6-8. Estimated Project Investment and Annual Costs for Various Design Flows of the No-Action Plan, the Lower Cache Creek Flood Barrier Plan, and the Setback Levee Plans[1]

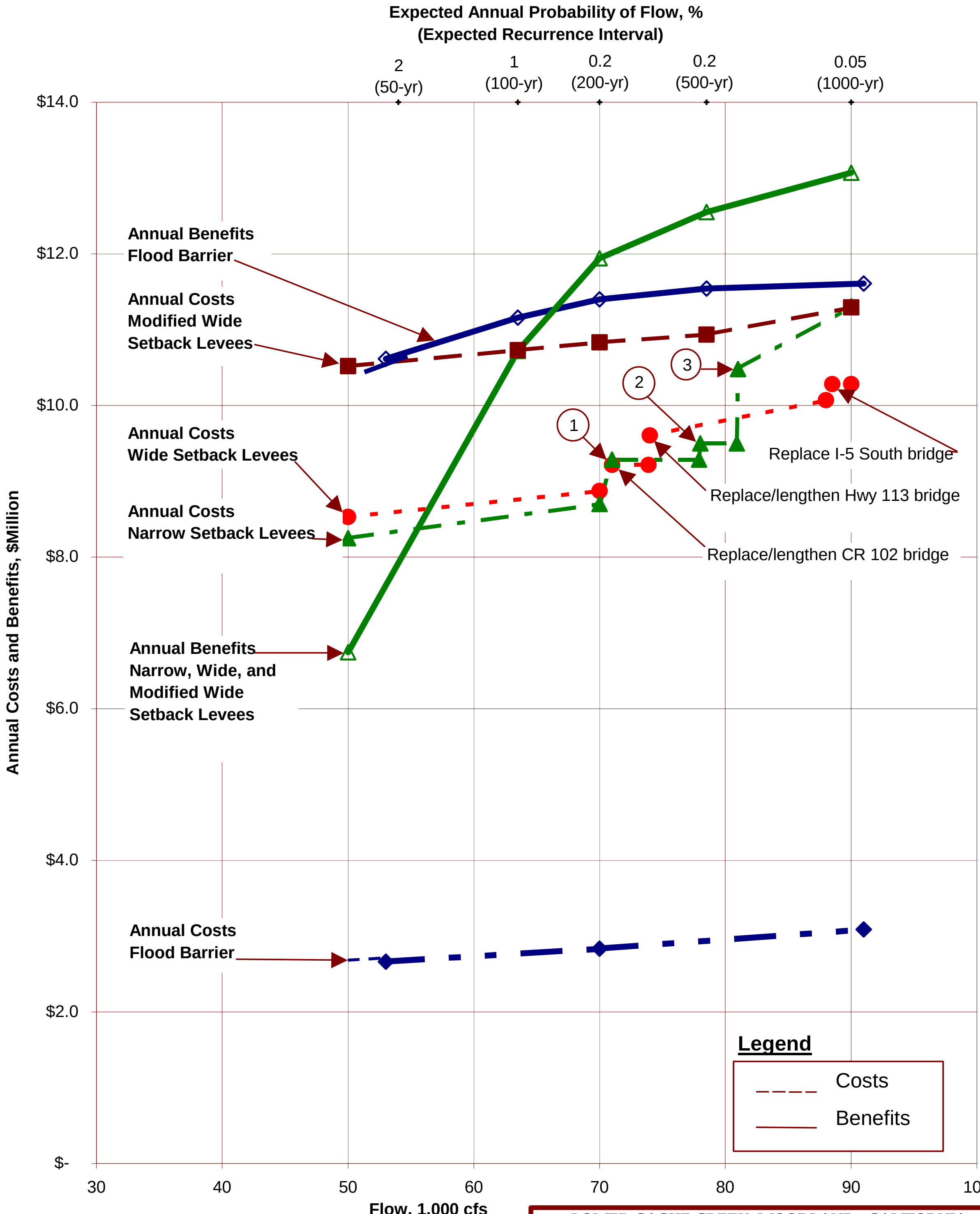
PLAN	Design Peak Flow (x 1,000 cfs)	Occurrence Frequency (chance per year)	Total Investment Cost[2] ($1,000)		Interest & Amortization ($1,000)	Operation & Maintenance Cost ($1,000)	Total Annual Cost ($1,000)
No-Action Plan—Rehabilitation of Cache Creek Levee System[3]	30	1 in 10	$9,043		$583	$350	$934
Lower Cache Creek Flood Barrier Plan	53	1 in 50	39,725		2,564	98	2,662
	70	1 in 200	42,398		2,737	98	2,835
	78	1 in 500	43,761		2,825	98	2,923
	91	1 in 1,000	46,332		2,991	98	3,089
Narrow Setback Levee Plan	50	~ 1 in 50	120,251		7,763	485	8,248
	70	1 in 200	127,287		8,217	485	8,702
Replace CR102 and SH. 113 Bridges[4]	71	~ 1 in 200	136,300		8,799	485	9,284
Replace Railroad Bridge[4]	78	1 in 500	139,620		9,013	485	9,498
Lengthen CR 99W and both I-5 Bridges[4]	81	~ 1 in 600	154,795		9,993	485	10,478
	90	~ 1 in 1,000	167,660		10,823	485	11,308
Wide Setback Levee Plan	50	~ 1 in 50	125,709		8,115	415	8,530
	70	1 in 200	131,032		8,459	415	8,874
Replace CR102 Bridge[4]	71	~ 1 in 200	136,299		8,799	415	9,214
Replace SH. 113 Bridge[4]	74	~ 1 in 350	142,350		9,189	415	9,604
Replace I-5 South Bridge[4]	88	~ 1 in 900	149,558		9,655	415	10,070
	90	~ 1 in 1,000	152,859		9,868	415	10,283
Modified Wide Setback Levee Plan	50	~ 1 in 50	156,514		10,104	415	10,519
	70	1 in 200	161,356		10,416	415	10,831
	78	1 in 500	162,975		10,521	415	10,936
	90	~ 1 in 1,000	168,508		10,878	415	11,293

[1]The period of analysis is 50 years, and the Federal discount rate is 6 1/8 percent. All costs are expressed in October 2001 (fiscal year 2002) price levels.
[2]Includes Total First Cost plus interest during 2-year construction schedule. See Appendix K for additional cost information and details.
[3]No-Action Plan—The existing system operation and maintenance is a DWR responsibility. If a Setback Levee Plan is built, existing system operation, maintenance, repair, rehabilitation, and replacement would not be needed, and this would be a cost savings, or benefit.
[4]Bridge replacements and lengthening apply to all design flows greater than the one specified.

Table 6-9. Project Costs and Benefits for Various Design Flows of the No-Action Plan, the Lower Cache Creek Flood Barrier Plan, and the Setback Levee Plans[1]

PLAN	Design Peak Flow (x 1,000 cfs)	Occurrence Frequency (chance per year)	Total Annual Costs ($1,000)	Flood Damage Reduction Annual Benefits ($1,000)	Avoided Existing System Rehab Annual Benefits ($1,000)	Total Annual Benefits ($1,000)	Net Annual Benefits ($1,000)	Benefit-to-Cost Ratio
No-Action Plan—Rehabilitation of Cache Creek Levee System[4]	30	1 in 10	934		—	—		—
Lower Cache Creek Flood Barrier Plan	53	1 in 50	2,662	10,614	—	10,614	7,952	4.0
	63	1 in 100	2,769[2]	11,160	—	11,160	8,391	4.0
	70	1 in 200	2,835	11,400	—	11,400	8,565	4.0
(NED Plan)	78	1 in 500	2,923	11,541	—	11,541	8,618	3.9
	91	1 in 1,000	3,089	11,607	—	11,607	8,518	3.8
Narrow Setback Levee Plan[6]	50	~ 1 in 50	8,248	5,811	934	6,745	(1,503)	0.8
	63	1 in 100	8,555[2]	9,786	934	10,720	2,166	1.3
	70	1 in 200	8,702	11,006	934	11,940	3,238	1.4
Replace CR102 and SH. 113 Bridges[5]	71	~ 1 in 200	9,284	11,078[3]	934	12,012	2,728	1.3
Replace Railroad Bridge[5]	78	1 in 500	9,498	11,616	934	12,550	3,052	1.3
Widen CR 99W and both I-5 Bridges[5]	81	~ 1 in 600	10,478	11,729[3]	934	12,663	2,185	1.2
	90	~ 1 in 1,000	11,308	12,136	934	13,070	1,762	1.2
Wide Setback Levee Plan	50	~ 1 in 50	8,530	5,811	934	6,745	(1,800)	0.8
	63	1 in 100	8,762[2]	9,786	934	10,720	1,958	1.2
	70	1 in 200	8,874	11,006	934	11,940	3,066	1.3
Replace CR102 Bridge[5]	71	~1 in 200	9,214	11,078[3]	934	12,012	2,798	1.3
Replace SH 113 Bridge[5]	74	~1 in 350	9,604	11,293[3]	934	12,227	2,623	1.3
	78	1 in 500	9,754[2]	11,616	934	12,550	2,796	1.3
Replace I-5 South Bridge[5]	88	~ 1 in 900	10,283	12,068[3]	934	13,002	2,719	1.3
	90	~ 1 in 1,000	10,283	12,136	934	13,070	2,787	1.3
Modified Wide Setback Levee Plan	50	~ 1 in 50	10,519	5,811	934	6,745	(3,774)	0.6
	63	1 in 100	10,730[2]	9,786	934	10,720	(10)	1.0
	70	1 in 200	10,831	11,006	934	11,940	1,109	1.1
	78	1 in 500	10,936	11,616	934	12,550	1,614	1.2
	90	~ 1 in 1,000	11,293	12,136	934	13,070	1,777	1.2

[1]The period of analysis is 50 years, and the Federal discount rate is 6 1/8 percent. All costs and benefits are expressed in October 2001 (fiscal year 2002) price levels.
[2]Interpolated/extrapolated from costs curve.
[3]Interpolated/extrapolated from benefits curve.
[4]No-Action Plan—The existing system operation and maintenance is a DWR responsibility. If a Setback Levee Plan is built, existing system operation, maintenance, repair, rehabilitation, and replacement would not be needed, and this would be a cost savings, or benefit.
[5]Bridge replacements and lengthening apply to all design flows greater than the one specified.
[6]The Narrow Setback Levee Plan at a design flow of 70,000 cfs has the highest net benefits for all of the Setback Levee Plans, however, it has severe adverse environmental effects and mitigation costs are expected to be prohibitive.



Notes:

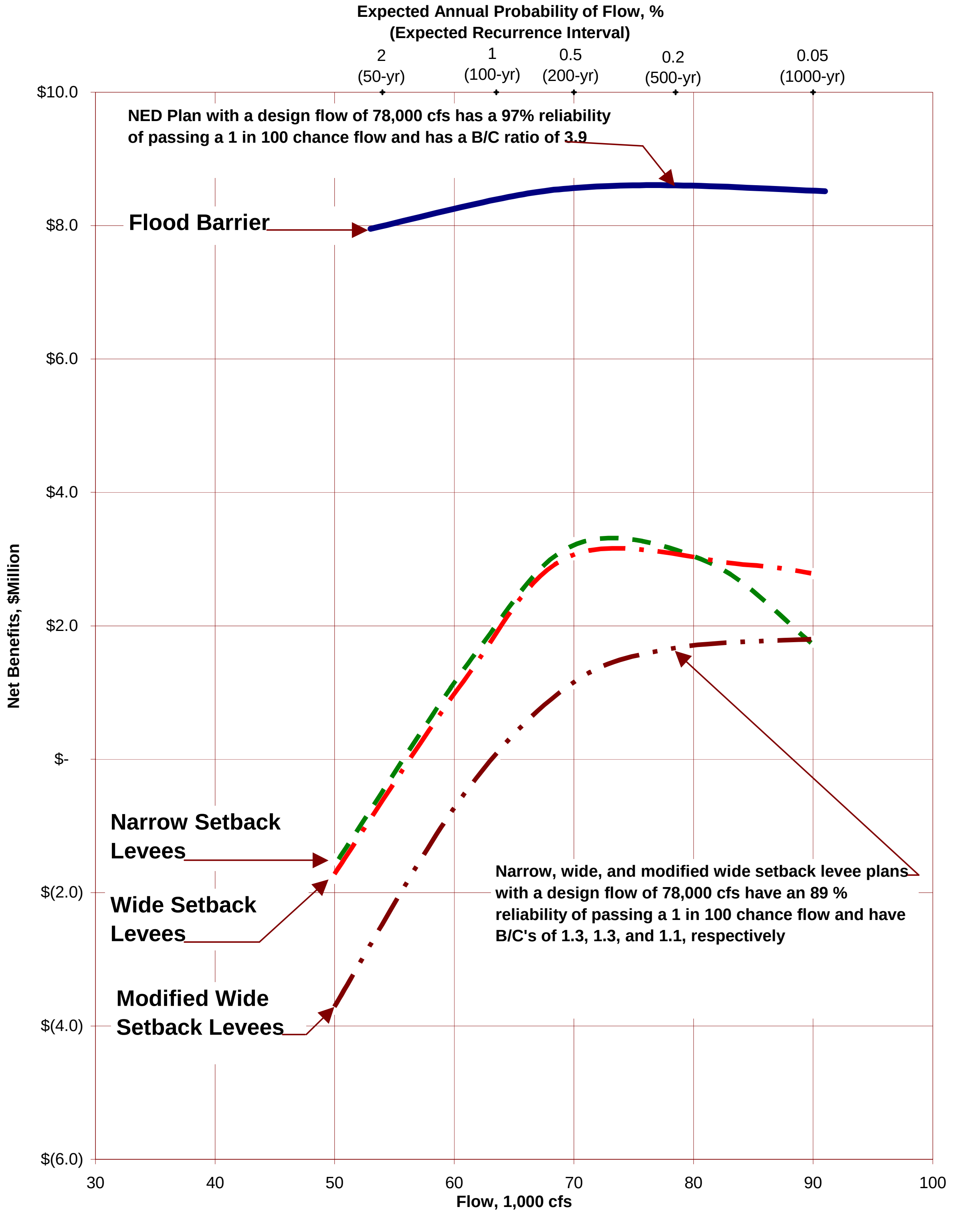
1. Replace and lengthen CR 102 and SH 113 bridge.
2. Replace railroad bridge.
3. Lengthen CR 99W and both I-5 bridges.
4. Annual benefits for the three Setback Levee Plans include approximately a $1.0 million credit for avoiding future existing-system repairs.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA,
AREA FEASIBILITY STUDY

ANNUAL COSTS AND BENEFITS FOR THE NARROW, WIDE, AND MODIFIED WIDE SETBACK LEVEE PLANS AND FOR THE LOWER CACHE CREEK FLOOD BARRIER PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER, 2002

Figure 6-19



Notes:

1. Net benefits for the three Setback Levee Plans include approximately a $1.0 million credit for avoiding future existing-system repairs.
2. A generalized curve is drawn through the net benefits for the three Setback Levee Plans.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA,
AREA FEASIBILITY STUDY

NET ANNUAL BENEFITS FOR THE NARROW, WIDE, AND MODIFIED WIDE SETBACK LEVEE PLANS AND FOR THE LOWER CACHE CREEK FLOOD BARRIER PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER, 2002

Figure 6-20

Figure 6-20 indicates that the net benefits for all three of the Setback Levee Plans are substantially less than those associated with the LCCFB Plan. The NSL Plan and the WSL Plan have higher net benefits than the MWSL Plan. However, as discussed previously, there would be potentially severe adverse environmental effects associated with the NSL and WSL Plans and mitigation requirements are expected to be prohibitive.

The Modified Wide Setback Levee Plan was selected as the Setback Levee Plan. The MWSL Plan optimizes at a design flow of 91,000 cfs (1 in 1,000 chance flow). However, the MWSL Plan selected for further analysis is the 78,000 cfs plan (1 in 500 chance event), with a benefit-to-cost ratio of 1.1, because the substantial increase in the total project cost for the 91,000 cfs plan is not warranted by the relatively small increase in net benefits. Also since the LCCFB Plan optimizes at a design flow of 78,000 cfs it is believed that the public would view selecting a much larger design flow for the Setback Levee Plan is an unfair portrayal of the cost of this plan.

The LCCFB Plan optimizes at a design flow of 78,000 cfs (1 in 500 chance flood event), with a benefit-to-cost ratio of 3.9, and was identified as the NED Plan because it has the highest net benefits.

The net benefits for the LCCFB Plan are relatively constant. The reason is that the LCCFB Plan provides very reliable flood protection to Woodland where most of the damages would occur, in any size flood event. Due to the large flood plains remaining under the LCCFB Plan, there are relatively small differences in flood stages/levee heights between different chance flood events. Thus, both cost and net benefit curves are relatively flat.

POTENTIAL ENVIRONMENTAL EFFECTS

The LCCFB and MWSL Plans would have significant effects on some of the existing resources in the study area. The draft CAR’s habitat evaluation procedure and the Special-Status Species Technical Appendix Impact assessment provided the acreages of affected wildlife and special-status species habitat. Mitigation alternatives for the LCCFB Plan were developed based upon this information, and a Habitat Mitigation Alternatives Analysis was prepared to identify the most cost-effective alternative, which is the basis for the mitigation cost estimate. The EIS/EIR provides further detail on the effects of the proposed plans and describes mitigation measures that could be used to minimize or offset adverse effects. Effects for the LCCFB and MWSL Plans are listed in the following paragraphs:

LCCFB Plan

Significant effects include:

- A loss of 100 acres of prime farmland and 2 acres of statewide important farmland due to construction of the levee and drainage ditch.

- Indirect transportation effects would include increased depth and duration of flooding on roadways traversing the Cache Creek floodplain. CR 101 would be flooded for about 1 week and CR 102 would be flooded for 3 weeks. Flooding would result in road closures and would lengthen response times for emergency vehicles traveling north of Woodland.

- Construction of the LCCFB Plan would temporarily produce decibel levels above the significance threshold for some sensitive receptors during construction.

- NO_x and PM_{10} emissions would exceed the significance thresholds established by the Yolo-Solano Air Quality Management District. The exceedence would be a temporary effect during construction.

- The LCCFB levee would create a new linear feature and a view block to residents.

Effects that would be reduced to less than significant with mitigation include:

- Loss of land value due to effects/takings.
- Traffic effects associated with road closures during road repair, roadway safety hazards, and increased traffic volume.
- Pollutants from construction equipment and erosion at the construction site could temporarily degrade the water quality of local runoff during construction.
- Loss of 122 acres of agricultural habitat, 100 native and nonnative trees, 0.52 acre of upland habitat, and 0.28 acre of scrub shrub.
- Project-related effects to special-status species (Swainson’s hawk, giant garter snake, northwestern pond turtle, chinook salmon, steelhead) would include temporary and permanent loss of habitat.
- Increased flooding may occur at cultural or historic sites between the creek and LCCFB.

Modified Wide Setback Levee Plan

Significant effects include:

- A loss of 158 acres of orchard and row crop farmland (all prime farmland) as a result of the levee footprint, and potential isolation of up to 1,254 acres of farmland between the levees (all prime farmland).
- Construction of the setback levees would temporarily produce decibel levels above the significance threshold for some sensitive receptors during construction.
- NO_x and PM_{10} emissions would exceed the significance thresholds established by the Yolo Solano Air Quality Management District. The exceedence would be a temporary effect during construction.
- The extension of bridges and the presence of a new viewblock to numerous rural residences.

Effects that would be reduced to less than significant with mitigation include:

- Loss of land value due to effects/takings, including loss of 32 residences and up to 182 farm structures.
- Traffic effects associated with road closures during road repair, roadway safety hazards, and increased traffic volume.
- Pollution from construction equipment and erosion related to construction activities could potentially degrade the water quality of local runoff.
- Loss of 174 acres of agricultural habitat, 49 acres of orchard trees, 9.01 acres of riparian habitat, and 0.69 acre of shaded riverine aquatic habitat.
- Project-related effects to special-status species (valley elderberry longhorn beetle, Swainson’s hawk, giant garter snake, northwestern pond turtle, chinook salmon, steelhead) would include loss of habitat.
- Archeological and historic sites could be affected by levee construction, degradation of the present levee, and accelerated erosion.

ACCOMPLISHMENTS OF PLANS

All flood damage reduction plans could reduce flood damages to Woodland. Other accomplishments are as follows:

The LCCFB Plan:

- Provides a high degree of flood damage reduction to Woodland and has the highest net benefits.

- Is a very reliable system due to the amount of storage that is available on the flood plain. Larger flood events only cause a small increase in flood stages.
- Meets the FEMA 95 percent reliability criteria for the 1 in 100 chance flood event.
- Meets 90 percent reliability criteria for the 1 in 200 chance event for the 78,000-cfs design flow plan.
- Reduces peak floodflows entering the settling basin.

The MWSL Plan:

- Meets the FEMA 90 percent reliability criteria for the 1 in 100 chance flood event.
- Has 78 percent reliability for the 1 in 200 chance event for the 78,000-cfs design flow plan.
- Protects the area between the setback levee and the LCCFB levee.
- Protects areas north of Cache Creek that would not be protected by the LCCFB Plan.
- Protects roadways on the flood plain that are not protected by the LCCFB Plan.

TENTATIVELY RECOMMENDED PLAN

Based on currently available data, it appears that the LCCFB Plan with the 1 in 500 chance event, 78,000-cfs design flow is the NED Plan and the Tentatively Recommended Plan. Table 6-10 summarizes how well each plan meets the objectives of the feasibility study. The benefits and costs indicated in this table also show that the net benefits for the LCCFB Plan are significantly higher than for all of the Setback Levee Plans.

RATIONALE FOR SELECTION OF RECOMMENDED PLAN

The LCCFB Plan was selected as the recommended plan on the basis that this plan is the least environmentally damaging plan and the plan with the highest net benefits.

Table 6-10. Comparison of Ability of the No-Action Plan, the Lower Cache Creek Flood Barrier Plan, and the Setback Levee Plans to Meet the Objectives and Constraints of the Feasibility Study

	No-Action	LCCFB Plan	Narrow Setback Levee Plan	Wide Setback Levee Plan	Modified Wide Setback Levee Plan
OBJECTIVES/CONSTRAINTS					
Protect Woodland	Poor	Good	Good	Good	Good
Protect Agricultural Areas North of Woodland	Poor	Poor	Good	Good	Good
Protect Major Transportation Facilities	Poor	Moderate	Good	Good	Good
Minimize Project Impact on Homes	N/A	Good	Good	Poor	Poor
Minimize Biological Effects	N/A	Good	Poor	Poor	Good
Minimize Effects on Agricultural Operations	N/A	Moderate	Moderate	Poor	Poor
FLOOD DAMAGE REDUCTION BENEFITS[1] (Average Annual, $ Millions)	N/A	$11.5	$11.6	$11.6	$11.6
PROJECT COSTS[1] ($ Millions)					
Total Investment Cost	N/A	$43.8	$139.6	$142.4	$163.0
Annual Operation and Maintenance		$0.1	$0.5	$0.4	$0.4
O&M and Rehab. of Existing Cache Creek System by DWR	$0.94	$0.94	$0	$0	$0
BENEFIT-TO-COST RATIO[1]	N/A	3.9	1.3	1.3	1.1
NET BENEFITS ($ Millions)	N/A	$8.6	$3.0	$2.8	$1.6

[1]Costs and benefits are presented for the 78,000-cfs design flow.

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Chapter 7

CHAPTER 7
PUBLIC INVOLVEMENT

Levee break (right, middle) near County Road 102 (background) in 1983.

CHAPTER 7
PUBLIC INVOLVEMENT

Levee break (right, middle) near County Road 102 (background) in 1983.

CHAPTER 7

PUBLIC INVOLVEMENT

Throughout the study, the Corps has closely coordinated with the non-Federal cost-sharing sponsor, the Reclamation Board of the State of California (Board). On September 13, 2000, the lower Cache Creek feasibility study team, consisting of representatives from the cost-sharing partners, began meeting weekly to discuss major management decisions in accordance with the Feasibility Cost Sharing Agreement.

On March 23, 1999, the City of Woodland Public Works staff recommended creating an advisory body to assist in the evaluation of flood effects, flood damage reduction plans, and methods of funding improvements to assist in dealing with Woodland's flood threats. The task force is composed of members of the Woodland City Council, City Mayor and Deputy Mayor, an Association of General Construction member, a member of the Cache Creek Conservancy, two Woodland Chamber of Commerce members, and three citizens at large. The City of Woodland Flood Plain Task Force helped identify measures for the initial screening process. On February 8, 2001, task force members were presented with the evaluation of the five preliminary plans.

The project team, composed of representatives from the Board, the Corps and the City of Woodland, began meeting on February 9, 2000, and continued monthly meetings to discuss design and project feasibility. The Corps and the Board held various meetings to coordinate concerns of Yolo County Calfed, the gravel mining industry, the Central Valley Regional Water Quality Control Board, the California Northern Railroad, Caltrans, National Marine Fisheries Service, Yolo County Farm Bureau, Sacramento Valley Farm Credit Bureau, and individual stakeholders.

Agency and public involvement and coordination is indicated in Chapter 5 of the EIS/EIR.

PUBLIC INTEREST

The Corps published a Notice of Intent (NOI) to prepare the draft EIS in the Federal Register on May 5, 2000. The Board delivered a Notice of Preparation to the California State Clearinghouse on June 11, 2000.

On May 30, 2000, the City of Woodland, the Board and the Corps hosted a public meeting to solicit public input on flood damage reduction, environmental, and cultural resources issues along lower Cache Creek. The same hosts organized another public meeting on May 31, 2001, to discuss FEMA flood maps and the Corps' flood damage reduction plans and to invite public participation in the flood management process.

The Corps and the Board met numerous times with public and private parties to identify and discuss concerns, tailor actions, and expand insight into the flood management process. Public and private entities included private landowners, a private gravel mining company, and Sacramento and Yolo County Farm Bureaus.

This project was heard at a public meeting before the Board on December 21, 2001. Members of the public, as well as other public and private entities, were invited to express concerns during the proceedings.

COMMENTS ON THE EIS/EIR

A Notice of Intent (NOI) for a Draft Environmental Impact Statement for a Proposed Flood Reduction Investigation in Yolo County, California, was published in the Federal Register on May 5, 2000. Also, a Notice of Preparation (NOP) of a Draft Environmental Impact Report was submitted to the Office of Planning and Research, State Clearinghouse, on June 11, 2000. No comments were received on either the NOI or NOP.

A notice of availability of the Draft EIS/EIR was published in the Federal Register on March 21, 2003. The draft was distributed for public review on March 21, 2003. A public workshop was also held during the 45-day review period to provide additional opportunities for comment on the Draft EIS/EIR. All comments received by May 6, 2003 were incorporated into the Final EIS/EIR, as appropriate.

RESPONSES TO FREQUENTLY ASKED QUESTIONS

INTRODUCTION

During the process of identifying, screening, and evaluating potential measures to reduce flood damages to the Woodland area, a number of questions have been asked by interested parties, members of the community, and public agencies. Questions that are of a general nature and that may be of interest to affected parties are listed below with a short response. Answers to the listed questions have been prepared to provide readers with readily available answers to some of the more frequently raised questions that have been asked during the course of investigations.

EXTENT OF FLOODING AND EFFECTS

Questions and Answers

1. What is the likelihood of flooding under current conditions?

The existing Cache Creek levee system was designed to safely handle a flow with about a 1 in 10 chance of occurring in any year (a 10-year flood event of about 30,000-cfs), but historically the system has handled up to 36,000 cfs (about 1 in 20 chance event), so the existing system is believed to contain a flood with a frequency of about 1 in 10 to 1 in 20.

2. Why is this flood protection project necessary; Woodland has never been flooded.

Although the city of Woodland has never been flooded from floods on Cache Creek, a portion of what is now part of Woodland was flooded in 1983 due to a levee *break, and in 1955, overflow from Cache Creek came within one block of the city. Also, it has been determined that portions of the city are at risk of being flooded from storms having a greater flow than one having a 1 in 20 chance of occurring in any given year. FEMA, the Corps, the City, and others have conducted studies that have concluded that portions of the city are at risk of flooding from events above the capacity of the existing levee system.*

3. What does 100-year protection mean?

The 100-year flood is a flood that has an average annual recurrence frequency of 1 in 100, 0.01, or a 1 percent chance of occurrence in any year. FEMA and the Corps have determined that a project that reliably contains a 1 in 100 chance flood would provide 1 in 100 chance protection.

4. Would Woodland be out of the FEMA 1 in 100 chance flood plain over the project life?

There is a high likelihood that the Lower Cache Creek Flood Barrier Plan or the Modified Wide Setback Levee Plan would continue to be certified to contain the 1 in 100 chance FEMA flood throughout the project life. It is possible, but unlikely, that climate change, very unusual weather patterns, or a significant change in FEMA policy could cause the projects to become uncertified.

5. What flood effects would result from the construction of the LCCFB Plan on the agricultural lands north of the flood barrier?

The results from hydraulic analysis show that the effect varies from no effect in the west to significant effect in the east. The western area is subject to shallow flooding, and the LCCFB Plan would not change that condition. Areas near the LCCFB would experience an increase in flood depth, but no significant increase in duration. The eastern area near the settling basin would experience a significant increase in depth and duration of flooding. See Chapter 6 for more detail.

6. Would the LCCFB Plan create a "de facto bypass" over the 5,000 to 6,000 acres of land between the LCCFB levee and Cache Creek?

No. A flood bypass such as the Yolo Bypass is designed to flood frequently. The area north of the LCCFB would not flood frequently, and over the vast majority of this area, no changes to frequency of flooding are planned as part of this project.

7. How often would ponding occur in the area just west of the settling basin – the area called the "pond" area?

No change to the frequency of ponding is anticipated. Heavy rains cause local runoff ponding under current conditions, and this project would not change that. If a severe rainstorm causes the existing Cache Creek levee system to fail or be overtopped, depending upon the volume of water that escapes from the creek, ponding could occur in the "pond" area. It is believed that the frequency of this occurring has about a 1 in 10 to

1 in 20 chance of happening in each year. Under post-project conditions, the spatial extent of ponding will change, and some areas along the fringe of the ponding area will experience a change in the frequency of flooding.

8. How does the LCCFB operate in a flood event?

In a major flood event such as a 1 in 50 chance flood, water would be expected to escape from the existing Cache Creek levee system at the upper end of the system near the gravel mines and CR 97A and flow toward the east. After flowing across the area north of the LCCFB, the water would collect just west of the settling basin. When the floodwater reaches the elevation of the inlet weir to the settling basin (45 feet msl [NAVD88]), it flows into the basin and then through and out into the Yolo Bypass. The water would reach a maximum pond elevation of about 50.5 feet during the 1 in 100 chance/year flood event, see Figure 6-10. Once the main floodflow has drained out over the weir, ponded water would remain for an extended period of time. The pond would eventually be drained through the settling basin via low-level culverts (a box culvert draining into the settling basin) and a pipe culvert draining into the North Canal that leads to one of the City's pump stations. See Chapter 6 for more detail.

9. Why does the LCCFB Plan not attempt to enhance the flood protection of the areas north of Cache Creek? In addition to agricultural land, the town of Yolo is in this area.

Flood damage reduction projects are planned primarily on economic principles. Agricultural land, low density of structures, and very small towns do not incur as much total economic loss as would a city such as Woodland. Woodland, having a large number of structures at risk of flooding, justifies a greater investment in flood protective measures than low density and agricultural areas.

10. How often would I-5 be flooded with the LCCFB Plan?

There would be no change of I-5 flooding from existing conditions. I-5 has a 1 in 10 to 1 in 20 chance of flooding now and would have the same risk with the LCCFB Plan. It is important to note that under post-project conditions, I-5 would only be inundated for a relatively short duration following large flood events. Under existing conditions, I-5 east of Woodland would be flooded for extended periods of time.

11. What are the velocity and erosion effects of the LCCFB Plan on agricultural land north of the LCCFB?

There should be no significant change in flow velocities or erosion on agricultural lands north of the LCCFB. Water in some areas would pond deeper, but not move faster.

12. Would a project on Cache Creek with a 1 in 40 or 1 in 50 chance design flow remove Woodland from the FEMA 1 in 100 chance flood plain?

No. Levee would still fail during a 1 in 100 chance flood.

PROPOSED FLOOD CONTROL STRUCTURES

Questions and Answers

1. Why can't the Cache Creek channel just be cleaned out and widened as necessary to allow more water to flow through?

If the channel is cleaned out and all vegetation removed, the capacity would still not be sufficient to convey major floodflows such as the 1 in 100 chance flow. Also, environmental regulations make clearing of the channel a very difficult and costly plan.

2. If the LCCFB Plan were chosen, would DWR continue to maintain and repair the existing levee system?

Yes, the existing levee system would not be removed or deauthorized if the LCCFB is constructed. DWR would continue to maintain the system as required by law and agreements with the Corps.

3. What is the plan for the settling basin when it fills up with sediment?

Prior to the settlling basin filling with sediment, the outlet weir will be raised to maintain sediment trap efficiency, and the settling basin should continue to operate as designed for the remainder of its project life. The settling basin is only a temporary solution; therefore, the long-term future of the settling basin is unknown. Future planning will be needed to determine what will be done after the current settling basin's life cylce is exceeded.

ENVIRONMENTAL ISSUES

Questions and Answers

1. It is mentioned that Cache Creek has relatively high levels of mercury-laden sediments and boron. How much of these sediments would be deposited on the agricultural area if the LCCFB Plan is implemented? Would this pose a significant health threat?

In regard to mercury, no significant change from pre-project conditions is expected as a result of the LCCFB Plan. The land would flood regardless of whether the LCCFB is constructed. Although the LCCFB Plan would still allow deposition of mercury-containing sediments on the flooded agricultural land, the primary health concern is the incorporation of the substance into high tropic level (high on the food chain) fish species. Mercury deposition on agricultural land would not pose a significant health risk. Mercury deposition on agricultural lands has not been an issue in the settling basin where ponding occurs almost annually.

2. If a significant amount of debris and sediments are deposited on private property during flooding conditions, what sort of compensation would be given? Who is going to finance and be responsible for removing debris and sediments?

It is expected that this would be the responsibility of the respective landowners on which such materials are deposited. Since the LCCFB would prevent floodwaters and debris from entering lands south of the LCCFB, it would to some extent increase the amount of debris that is deposited on the lands north of the LCCFB. It is expected that most of the debris would be deposited in the area between CR 101 and the west settling basin levee. However, the LCCFB Plan would not increase the frequency of floodwaters escaping from the creek; hence, in comparison to pre-project conditions, this plan is not expected to significantly change the amount of debris or other substances deposited. Acquisition of a flowage easement in the area subject to significant ponding has been included in the plan and provides compensation for increased flooding and debris deposition.

REAL ESTATE AND MITIGATION

Questions and Answers

1. In other areas of Sacramento, project sponsors have been required to fully mitigate for any adverse change in existing conditions along, and upstream or downstream, from the project. Would the Corps be taking this approach for the Cache Creek project?

Mitigation of upstream and downstream changes is a complex and ever-changing issue that is highly dependent on the parties involved and the specifics of each case. Corps, DWR, and SAFCA projects have frequently included mitigation measures that address to "some extent" upstream and downstream effects of proposed projects. The primary purpose of the EIS/EIR is to identify and define project effects and mitigation measures. The Corps is doing this in both the Feasibility Report and Draft EIS/EIR, which are expected to be issued for agency and public review and comment in the fall of 2002.

2. What is being proposed to mitigate effects on prime farmland? Does the proposal meet Yolo County's farmland preservation plans?

Various project plans have been identified and evaluated. These plans have different significant effects on prime farmlands (acreages, specific farms, and types and severity of effects). No specific mitigation measures are presently included in the final two plans (LCCFB Plan and Modified Wide Setback Levee Plan) being evaluated that specifically address effects to prime farmlands or the county's preservation plans.

3. Is the LCCFB Plan causing or increasing the flooding of existing structures? Should the plan include flood proofing of these structures?

The LCCFB Plan does include the flood proofing of some structures deemed to be significantly affected and where such flood proofing is cost effective. When flood proofing is not effective or the cost of flood proofing is excessive, significantly affected structures would be purchased.

4. What compensation would landowners north of the LCCFB receive for aggravation of existing flooding conditions, loss of development opportunities, loss of property values, increased farming costs, damages to orchards, or loss in productivity?

Compensation would be provided when affected properties and/or improvements are deemed to be of such an extent as to constitute a "takings" in terms of applicable law. See Appendix F.

5. Who would be responsible for making flood protection modifications to the houses? How would it be determined which homes would be protected?

The Corps and the project sponsors (DWR and the City of Woodland) would make decisions as to which properties would be considered as candidates for this particular form of mitigation. During the design of the project, the existing structures would be surveyed to determine the floor elevations, etc. This information would be used to identify which structures are at risk and need to be raised or protected from aggravated flooding. The landowners would be consulted and their wishes accommodated as much as possible in this process.

6. What is the process for resolving differences between whatever the Corps determines to be fair compensation and what property owners believe to be fair compensation for effects or loss of value?

Briefly, the process is as follows: DWR appraises the property, estimates the effects, and then negotiates price with the property owner. If these negotiations fail to determine an agreeable price, the acquisition would proceed into a condemnation process and a review board or State court process would decide on the price. More details are available at the following website: http://wwwdlrw.water.ca.gov

7. Would the Corps require flowage easements to be obtained from all flood plain landowners? What other types of easements would the Corps require the local sponsors to obtain?

The Corps is currently proposing to acquire occasional flooding easements from those property owners that would experience a significant adverse change in the depth, frequency, or duration of flooding. Easements for levees, channel improvements, permanent flowage, drainage facilities, and temporary construction activities would also be acquired from affected properties.

8. If the Modified Wide Setback Levee Plan is selected, portions of farmland between the levees would be lost. Would this land be purchased? Can farmers still farm the remainder of their land inside the levee? What if the farmer does not want to sell the land?

The land between the setback levees would be acquired as a permanent flowage easement (due to the increased depth, frequency, and flow velocities) and as an environmental easement. Currently, it is estimated that these lands would be acquired at full market value by DWR and would be used for environmental mitigation to some *extent. It is possible that a leaseback agreement could be included in some settlement agreements under some situations. If there is an unwilling seller and it is determined that a portion of his property is required for public purposes, then the courts would determine what compensation is required.*

9. How much agricultural land is taken out of production with each plan? What is the definition of "taken out of production?" Does it include land inside the setback levee, or just levee footprints?

The land required for the various plans is indicated in Appendix F. Levee footprints as well as the lands between the setback levees are regarded as being taken out of production (the latter is due to aggravated flood conditions).

10. Would flooding associated with the LCCFB Plan negatively affect a landowner's ability to borrow money for farm operations?

It is the opinion of the Corps that farming viability would not be significantly affected by the LCCFB Plan. Thus, no effect on agricultural operations, including financing, is anticipated.

11. Would an occasional flowage easement be acquired over the 5,000 to 6,000 acres of land north of the flood barrier?

No. A flowage easement would be acquired only for the lands (approximately 1,800 acres) that could experience a significant amount of ponding. These lands must be sufficiently affected to constitute a "takings." See Appendix F for a discussion and definition of these terms. The criterion that is currently being proposed regarding the definition of a "taking" involves an evaluation of the frequency, depth, and duration of flooding at the property in question. Compensation would be provided to the owners of all lands that would be encumbered by flowage easements. This is usually a percentage of the current fair market value of the property.

12. Shallow flooding in the Yolo Bypass is more damaging than deeper flooding and requires releveling fields and rebuilding furrows. Would farmers be compensated for this effect?

Currently, no mitigation for this effect has been included in the project cost estimates. This effect would still occur under existing conditions (whenever floodflows escape from Cache Creek).

PLAN SELECTION

<u>Questions and Answers</u>

1. What are the NED and LPP plans, and how are they cost shared?

The NED Plan, or National Economic Development Plan, is the plan that is determined to be the plan with the greatest net benefits. It is the basis for cost sharing by *the Federal Government. The LPP, or Locally Preferred Plan, may be the same as the NED Plan, or it might be a different plan. The Federal cost share is limited to the cost share determined for the NED Plan. The manner in which cost would be shared (under the current congressional authorization) depends on a number of classifications and definitions. However, most of the construction costs would be shared approximately between the Corps (65 percent), DWR (24.5 to 17.5 percent), and the City (10.5 to 17.5 percent). Lands, easements, and relocations would be a non-Federal cost and could range up to 50 percent of the cost.*

2. Doesn't Congress authorize plans that are not the NED Plan? If so, why can't the Modified Wide Setback Levee Plan be authorized as the LPP?

Plans other than the NED Plan have been authorized in the past, and it is possible that Congress could authorize full cost sharing for a more expensive plan.

3. Was upstream storage (a multiuse flood control and water supply facility) considered, and why was it not selected?

Upstream dams have been considered several times in the past, but have never been found to be cost effective. Water, power, and flood damage reduction dams on Cache Creek would be much more expensive than the levee plans proposed.

4. Have legal costs for lawsuits been included in the cost of the project?

The costs for the acquisition of the lands and rights-of-way needed to construct, operate, and maintain the project have been included in the contingencies in the real estate costs of the project. These costs include an allowance for legal actions that may be needed to acquire the easements for the project.

5. Have the flood benefits north of the creek been included in the Modified Wide Setback Levee Plan?

The flood reduction benefits of the Modified Wide Setback Levee Plan for the area north of Cache Creek have been included in the Draft Feasibility Report. These benefits increase the total benefits of this plan and were not included in the earlier drafts of the report.

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Chapter 8

CHAPTER 8
PLAN IMPLEMENTATION, CONCLUSIONS AND RECOMMENDATIONS

Levee boil in 1995.

CHAPTER 8
PLAN IMPLEMENTATION, CONCLUSIONS AND RECOMMENDATIONS

Levee boil in 1995.

CHAPTER 8

PLAN IMPLEMENTATION, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes the procedures and cost-sharing requirements for implementing either of the plans.

IMPLEMENTATION REQUIREMENTS

DRAFT REPORT REVIEW AND PLAN SELECTION

This Draft Feasibility Report and the Draft EIS/EIR shall be available for a minimum period of 45 days for review by Federal, State, and local agencies as well as various groups and individuals.

FINAL REPORT AND APPROVAL

The final District report (Final Feasibility Report) will be completed based on the recommendations from the non-Federal sponsor and comments received on this Draft Feasibility Report. It will then be coordinated and submitted for Washington-level review and will be made available for a 30-day State and Federal agency review. At the same time, interested individuals and organizations will be able to provide comments on the Final Feasibility Report. The Washington-level reviewers will coordinate the public comments and make a recommendation to the Chief of Engineers. The recommended plan and proposed cost-sharing will be reviewed by the Assistant Secretary of the Army for Civil Works for consistency with current Federal policies and budgetary priorities. The Chief of Engineers will then submit the report to the Assistant Secretary of the Army (Civil Works), who will, in turn, submit the report to Congress. At this point, the project would be ready for Congressional authorization, which normally occurs as part of the biannual Water Resources Development Act legislation.

PROJECT FUNDING

Once the final report is approved and the project is authorized, construction funds will be requested. The project will be considered for inclusion in the President's budget based on national priorities, economic feasibility, level of local support, willingness of the non-Federal sponsor to fund its share of the project cost, and budgetary constraints that may exist at the time of funding. Budget recommendations will be based on evidence of support by the Reclamation Board of the State of California and its ability and willingness to provide its share of project costs. Once Congress appropriates the Federal share of funds for the project, the Assistant Secretary of the Army (Civil Works) and the non-Federal sponsor will sign a formal project cooperation agreement. This agreement will obligate the non-Federal sponsor to participate in implementing, operating, and maintaining the project according to requirements established by Congress and the Administration.

COST-SHARING REQUIREMENTS

In accordance with the Water Resources Development Act of 1986, as amended, the non-Federal sponsor's obligations for this project would include the following:

- Provide all lands, easements, rights-of-way and borrow and disposal areas needed for project construction and operation.
- Perform relocations and alterations of buildings, utilities, roads, highways, bridges (except railroad bridges), sewers, and other facilities required for construction of the project.
- Provide, during construction, a cash contribution of 5 percent of total project costs.
- If the total value of the above requirement is less than 35 percent of total flood damage reduction project cost, provide an additional cash payment during the period of construction to make the total non-Federal cost equal to 35 percent of total project costs.
- The total non-Federal first cost of the NED Plan will not exceed 50 percent of total project first cost.
- Operate, maintain, replace, repair, and rehabilitate the project after construction.
- If the selected plan is a Locally Preferred Plan (LPP) that is not fully Federally supportable, pay 100 percent of the additional cost of the LPP.

A letter specifying the non-Federal sponsor's willingness to meet these obligations will be included in the Final Feasibility Report. However, the non-Federal funds will not have to be provided until after Congress authorizes the project and appropriates construction funds and a project cooperation agreement is signed. Payment of the funds is to be made at intervals during construction as specified in the Project Cooperation Agreement.

COST APPORTIONMENT

GENERAL

As shown in Table 6-9, both the LCCFB Plan and the Modified Wide Setback Levee Plan are economically feasible. Neither plan includes uneconomic increments. The plan formulation analysis also demonstrates that the plans are independent of one another; that is, neither could be incrementally added to the other. Therefore, the basic cost-sharing apportionment methodologies apply to both plans. Tables 8-1, 8-2, 8-3, and 8-4 present the cost-sharing breakdown for the two plans.

Table 8-1. First Costs and Annualized Costs for the LCCFB Plan, Tentatively Recommended Plan ($1,000)[1]

Summary of First Cost	
Lands and Damages	8,577
Relocations	5,466
Channels and Canal	3,871
Levees and Floodwalls	10,718
Roads	233
Flood Control and Diversion Structures	3,801
Operating Equipment	1,200
Fish and Wildlife Mitigation	1,597
Cultural Resources Preservation[2]	257
Planning, Engineering & Design	3,081
Supervision and Administration	2,182
Total First Cost	40,973
Interest During Construction	2,787
Total Investment Cost	43,761
Summary of Annual Costs	
Interest and Amortization	2,825
Operation and Maintenance	98
Total Annual Cost	2,923

[1]The period of analysis is 50 years, and the Federal discount rate is 6 1/8 percent. All costs are expressed in October 2001 (fiscal year 2002) price levels.
[2]It is assumed that no cost will be required for cultural resources data retrieval.

Table 8-2. Cost-Sharing Breakdown for the LCCFB Plan, Tentatively Recommended Plan ($1,000)[1]

Summary of First Cost	**Federal**	**Non-Federal**	**Total**
Lands		8,577	8,577
Relocations		5,466	5,466
LERRD Total		14,043	14,043
Cash Contribution	24,881	2,049	26,930
Total First Cost	24,881	16,092	40,973
Percent of First Cost	61%	39%	100%

[1]All costs are expressed in October 2001 (fiscal year 2002) price levels.

Table 8-3. First Costs and Annualized Costs for the Modified Wide Setback Levee Plan ($1,000)[1]

Summary of First Cost	
Lands and Damages	48,647
Relocations	43,308
Channels and Canal	4,980
Levees and Floodwalls	19,530
Railroad Modifications	6,753
Roads	1,081
Fish and Wildlife Mitigation	9,901
Cultural Resources Preservation[2]	856
Planning, Engineering & Design	10,266
Supervision and Administration	7,272
Total First Cost	152,594
Interest During Construction	10,381
Total Investment Cost	162,975
Summary of Annual Costs	
Interest and Amortization	10,521
Operation and Maintenance	415
Total Annual Cost	10,936

[1]The period of analysis is 50 years, and the Federal discount rate is 6 1/8 percent. All costs are expressed in October 2001 (fiscal year 2002) price levels.
[2]It is assumed that no cost will be required for cultural resources data retrieval.

Table 8-4. Cost-Sharing Breakdown for the Modified Wide Setback Levee Plan ($1,000)[1]

Summary of First Cost	**Federal**	**Non-Federal**	**Total**
Lands		48,647	48,647
Relocations		43,308	43,308
LERRD Total		91,955	91,955
Cash Contribution	60,639	91,955	152,594
Cost Share Adjustment	-35,758	35,758	
Total Fist Cost	24,881	127,713	152,594
Percent of First Cost	16%	84%	100%

[1]All costs are expressed in October 2001 (fiscal year 2002) price levels.

COST SHARING

The non-Federal sponsor is responsible for all lands, easements, rights-of-way, relocations, disposal areas (LERRDs) required for the project and the Operation, Maintenance, Replacement, Repair, and Rehabilitation (OMRR&R) in perpetuity/project life. This is shown in the breakout of costs for the individual features of each project. In addition, the sponsor must provide a cash contribution equal to 5 percent of the construction first costs, shown in Table 8-2. This is the first adjustment shown in the tables. The 5 percent cash contribution is required irrespective of the total cost of the LERRDs provided by the sponsor. In accordance with cost-sharing requirements, the sponsor must provide a minimum of 35 percent of the total construction costs. Because the Modified Wide Setback Levee Plan would be more expensive than the anticipated federally supportable NED Plan (LCCFB Plan), the additional costs of the Modified Wide Setback Levee Plan would be 100 percent non-Federal. That adjustment is the Cost Share Adjustment shown in Table 8-4. Based on this analysis, the Federal share of the first cost for the LCCFB Plan is \$24.9 million, and the non-Federal sponsor's share is \$16.1 million. For the Modified Wide Setback Levee Plan, the Federal share is \$24.9 million, and the non-Federal sponsor's share is \$127.7 million.

Detailed pre-construction, engineering, and design (PED) studies will be initiated as soon as funding becomes available. The results of these studies will be used to prepare plans and specifications for project construction. The non-Federal sponsor is required to provide 25 percent of the cost of the PED work. Credit will be given for the non-Federal sponsor's participation on the Design Coordination Team and activities related to records maintenance and auditing. The remainder of the share of non-Federal PED costs must be provided in cash at the start of PED studies. Adjustments will be made during construction so that the PED cost is shared in accordance with the authorized construction cost sharing for the project.

COST ESTIMATE

Costs presented are first costs at October 2001 price levels. The estimate accounts for future inflation and is based on the current first costs, the schedule at which contracts will be awarded, and assumed annual inflation percentages. The cost estimate represents the actual costs that Congress will need to appropriate and the local sponsors will provide in the future to construct the project. The cost estimate for the LCCFB Plan is \$41.0 million: \$24.9 million paid by the Federal Government and \$16.1 million paid by the sponsors. The estimate for the Modified Wide Setback Levee Plan is \$152.6 million: \$24.9 million paid by the Federal Government and \$127.7 million paid by the sponsors.

FINANCIAL ANALYSIS

The City of Woodland and the State of California, through the California Department of Water Resources (DWR), would jointly provide the non-Federal funding requirements for the project.

DEPARTMENT OF WATER RESOURCES

Financing Plan

Any plan involving funding from the DWR would be dependent on completion and approval of necessary planning and environmental documents and an appropriate cost-sharing agreement among participants.

DWR would pay its share of the Lower Cache Creek Flood Control Project from the general California State Fund for the payment of lands, easements, rights-of-way, relocations, disposal, planning, engineering, design, and construction of the project.

The City of Woodland is investigating ways to finance its portion of the project.

PROJECT COOPERATION AGREEMENT

Before construction is started, the Federal Government and non-Federal sponsor will execute a project cooperation agreement. This contract will define responsibilities of the Federal Government and the non-Federal sponsor for project construction and operation.

ESTIMATED PROJECT SCHEDULE*

• 45-Day Public Review and Comment Period for Draft Feasibility Report and Draft EIS/EIR	21 Mar – 6 May 2003
• Respond to Comments on Draft Documents, Prepare and Process Final and Draft EIS/EIR	7 May – Sep 2003
• Division Engineer's Public Notice of Final Report Availability	Oct 2003
• 30-Day Public Review and Comment Period for Final Feasibility Report and Final EIS/EIR	Oct – Nov 2003
• Chief of Engineers' Report Signed and Forwarded	Feb 2004
• Record of Decision for EIS by Assistant Secretary of the Army (ASA) for Civil Works (CW)	Apr 2004
• Notice of Decision for EIR and Project Approval by the Reclamation Board	Apr 2004
• ASA (CW) Coordination with OMB, OMB Clearance, ASA (CW) Transmittal to Congress	Feb - Oct 2004
• Congressional Authorization (assumed via a Water Resources Development Act in 2004)	Oct 2004
• President Signs Legislation Authorizing Project	Nov 2004
• Corps and Non-Federal Sponsor Sign Agreement for Pre-Construction, Engineering, and Design (PED) Phase	Oct 2003
• Initiate PED Phase, including Plans and Specifications (may begin after publication of Division Engineer's Public Notice)	Nov 2003
• Sign Project Cooperation Agreement (PCA)	Mar 2005
• Complete Plans and Specifications	Jul 2005
• Begin Project Construction/Implementation	Aug 2005
• Physical Construction Completed/Begin Operation of Project	Dec 2007
• Establishment Period for Mitigation Vegetation Completed	Dec 2010

* It is recognized that this schedule is subject to change due to availability of funding, potential delays in review and approval processes by Federal and non-Federal partners and concerned agencies, and public input (affected stakeholders, groups, persons).

CONCLUSIONS

The major conclusions drawn from the lower Cache Creek feasibility study are:

- There is a significant risk of flooding to Woodland and the surrounding area from Cache Creek.
- There are two plans identified in this study that could substantially reduce the flood risk.
- The LCCFB Plan, at a first cost of $41.0 million, is the less expensive plan, but leaves the unincorporated area north of the city at risk from flood events greater than the design capacity of the existing levee system.
- The Modified Wide Setback Levee Plan, at a first cost of $152.6 million, is much more expensive and has a marginal benefit-to-cost ratio. However, this plan reduces flood risk for both the city and unincorporated area. The Modified Wide Setback Levee Plan also has greater environmental effects, has a greater potential for ecosystem restoration along the creek, and takes more agricultural land out of production.

RECOMMENDATIONS

The tentatively recommended plan is the LCCFB Plan, and this plan also appears to be the least environmentally damaging plan. It is likely that this plan will be recommended by the Corps in the Final Feasibility Report.

The estimated first cost of the LCCFB Plan is $41.0 million, and the estimated average annual OMRR&R cost is $100,000. Once the Division Engineer's Public Notice is distributed, a Design Agreement is signed with the sponsor, and funding is available the Corps will initiate pre-construction, engineering, and design studies.

NON-FEDERAL RESPONSIBILITIES

The non-Federal partner shall, prior to implementation, agree to perform the following items of local cooperation:

1(a) Provide a minimum of 35 percent, but not to exceed 50 percent, of total project costs assigned to structural flood protection, as specified below:

- Enter into an agreement which provides, prior to construction, 25 percent of the pre-construction, engineering, and design (PED) costs;

- Provide any additional funds needed to cover the non-Federal share of PED costs;

- Provide, during construction, a cash contribution equal to 5 percent of the total NED project costs;

- Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations, except railroads, determined by the Government to be necessary for the construction, operation, and maintenance of the project;

- Provide or pay to the Government the cost of providing all retaining dikes, waste weirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

- Provide, during construction, any additional costs as necessary to make its total contribution equal to at least 35 percent of the total project costs.

2(a) Provide and maintain necessary access roads, parking areas, and other public use facilities open and available to all on equal terms.

(b) For as long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

(c) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land that the local sponsor owns or controls for access to the project for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(d) Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating the project or completed functional portions of the project, including mitigation features, without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments. Operations and maintenance will include protecting the channels and other flood protection works from future encroachment or obstruction, including sedimentation and vegetation, that would reduce their flood-carrying capacity or adversely affect the proper functioning or efficient operation and maintenance of the project works. Monitor the status of completed mitigation and provide periodic reports on its condition, and provide repairs and replacement if needed, pursuant to the project Mitigation and Monitoring Plan, after the establishment period.

(e) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project, or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(f) Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

(g) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

(h) Perform, or cause to be performed, any investigations for hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of way necessary for the construction, operation, and maintenance of the project, except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

(i) Assume complete financial responsibility for all necessary cleanup and response costs for any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

(j) Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, replace and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

(k) Prevent future encroachments on project lands, easements, and rights-of-way that might interfere with the proper functioning of the project. Ensure that construction and maintenance of any non-Federal flood protection features do not diminish the flood protection provided by the authorized project plan.

(l) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policy Act of 1970 (Public Law 91-646), as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100- 17), and the Uniform Regulations contained in 49 CFR part 24 in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connections with said act.

(m) Comply with all applicable Federal and State laws and regulations including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and the Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

(n) Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 USC 70lb-12), which requires a non-Federal interest to have prepared a flood plain management plan within 1 year after the date of signing a project cooperation agreement. The plan shall be designed to reduce the effects of future flood events in the project area, including, but not limited to, addressing those measures to be undertaken by non-Federal interests to preserve the level of flood protection provided by the project. Provide an information copy of the plan to the Government upon its preparation.

(o) Publicize flood plain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

(p) Monitor city and county adherence to drainage master plans and performance and operations of detention basins or other facilities built to manage flows.

(q) Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation that are in excess of 1 percent of the total amount authorized to be appropriated for the project in accordance with the cost-sharing provisions of the agreement.

(r) Participate and comply with applicable Federal flood plain management and flood insurance programs.

(s) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

(t) Inform affected interests, at least annually, regarding the limitations of the protection afforded by the project.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the partner, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Michael J. Conrad, Jr.
Colonel, Corps of Engineers
District Engineer

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

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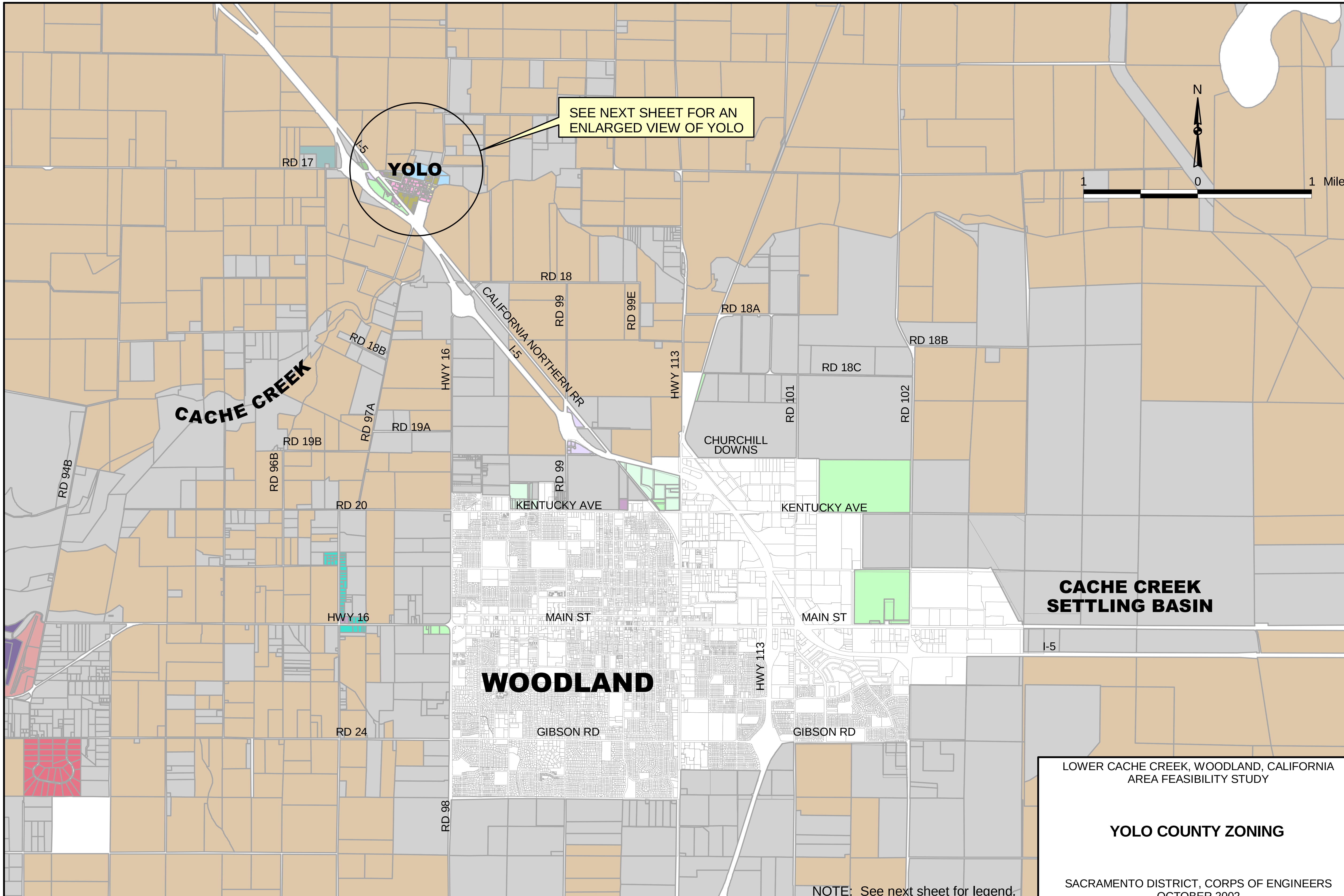
LOWER CACHE CREEK, YOLO COUNTY, CA
CITY OF WOODLAND AND VICINITY

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Plates

PLATES



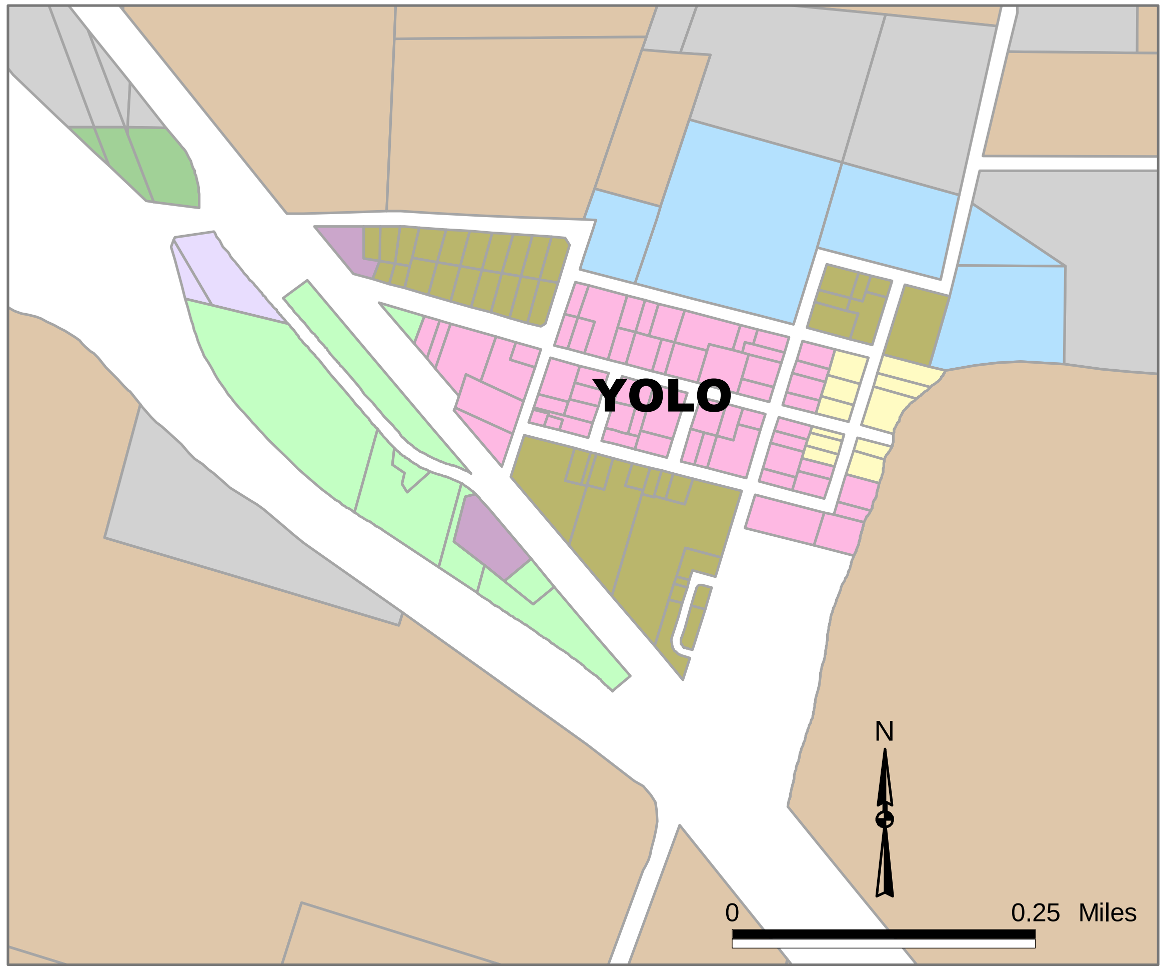
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

YOLO COUNTY ZONING

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Source: Yolo County Planning and Public Works Department

PLATE 1, SHEET 1 OF 2



LEGEND

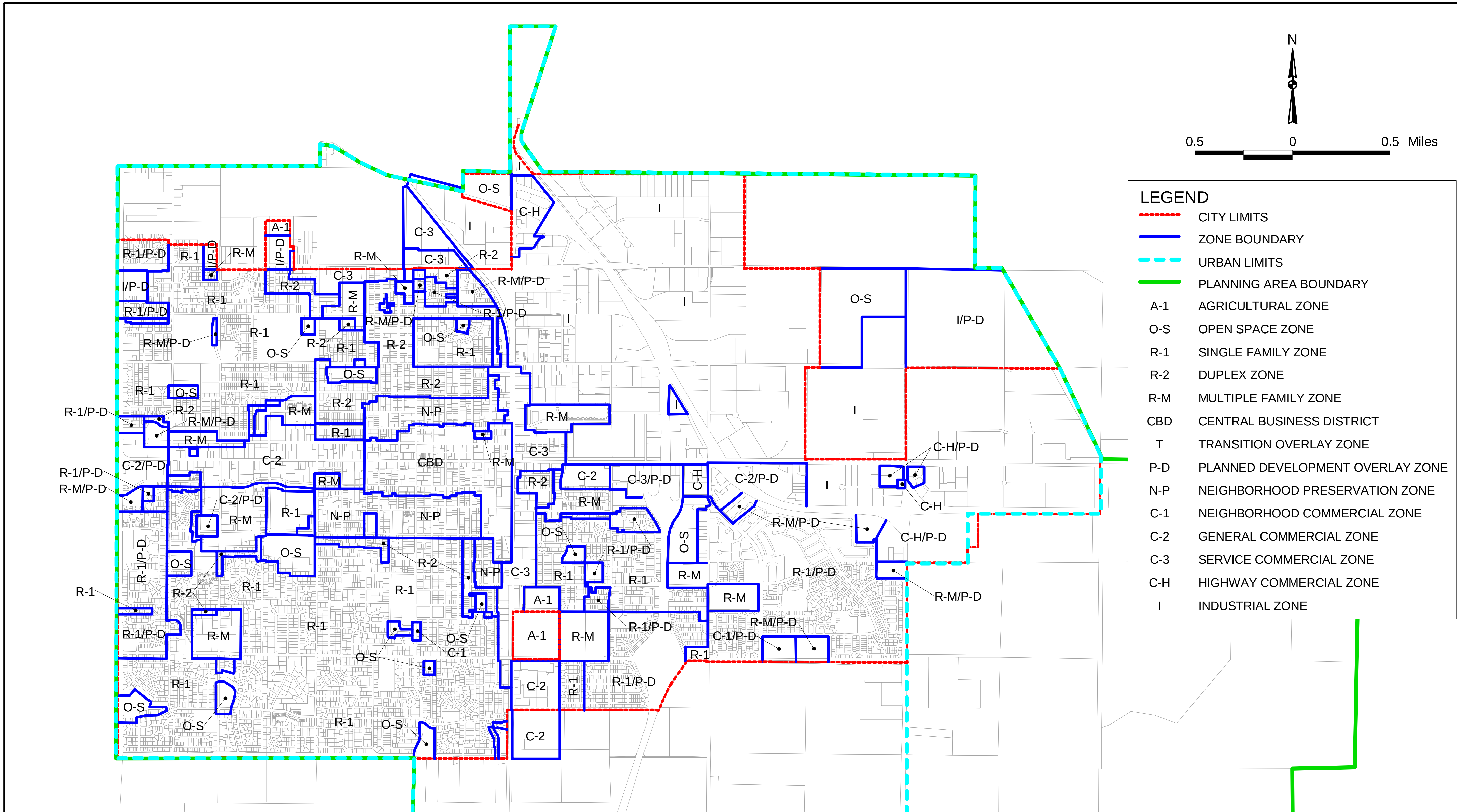
A-1	Agricultural General (Ag. Gen.)
A-E	Agricultural Exclusive
A-P	Agricultural Preserve
A1/CH	Ag. Gen/Highway Service Commercial
AV	Airport
C1	Neighborhood Commercial
C2	Community Commercial
CH	Highway Service Commercial
M1	Light Industrial
M2	Heavy Industrial
PD-45	Planned Development 45
R1-PD	Residential, One Family-Planned Development
R2	Residential, One Family or Duplex
R2-B28	Residential, One Family or Duplex: 28,000 sf minimum parcel
R3	Residential, Multi-Family
RS	Residential, Suburban
RS-B130	Residential, Suburban; 130,000 sf minimum parcel

LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

YOLO COUNTY ZONING

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Source: Yolo County Planning and Public Works Department

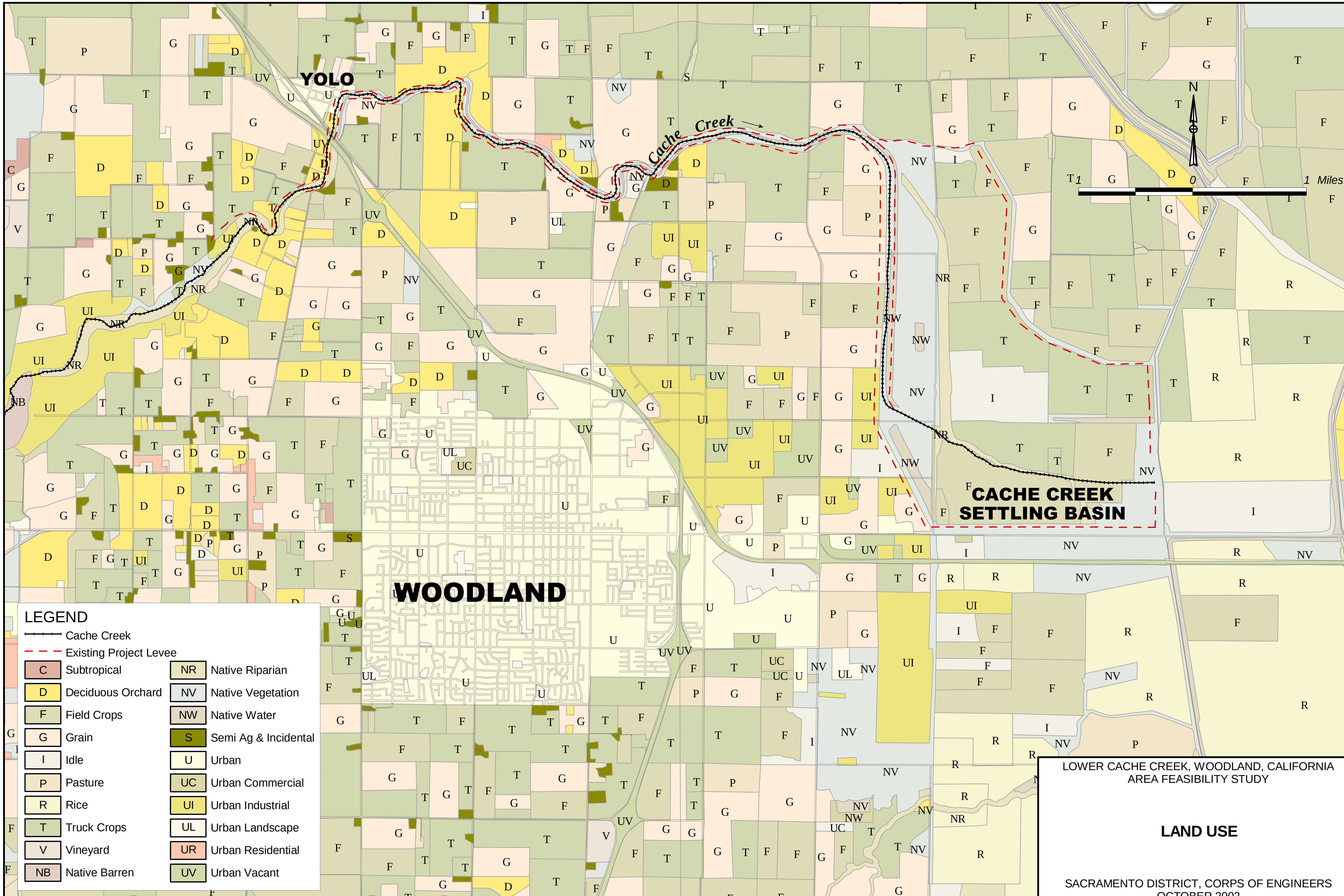


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

CITY OF WOODLAND ZONING

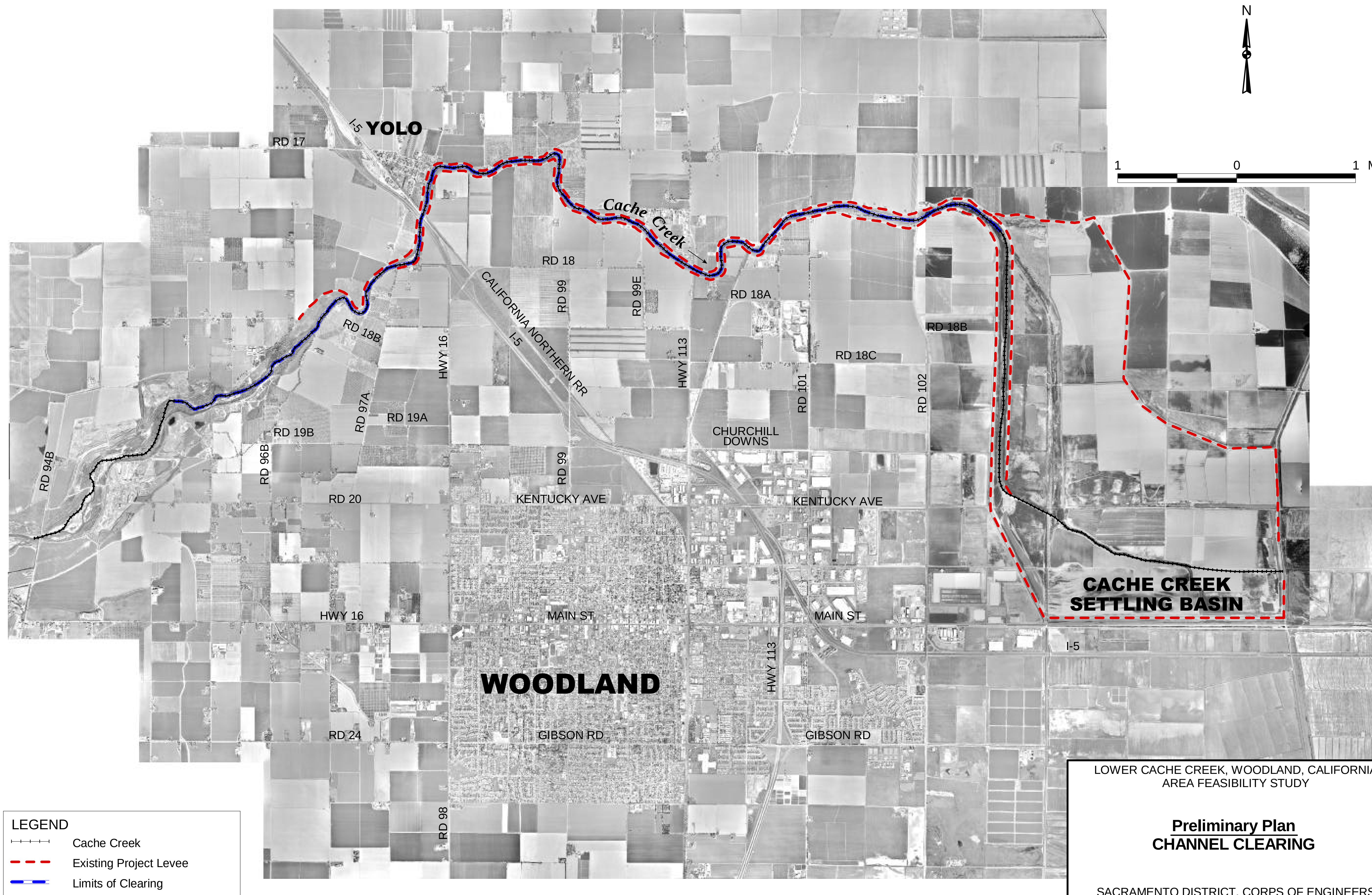
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

Source: City of Woodland



Source: California Department of Water Resources, 1997

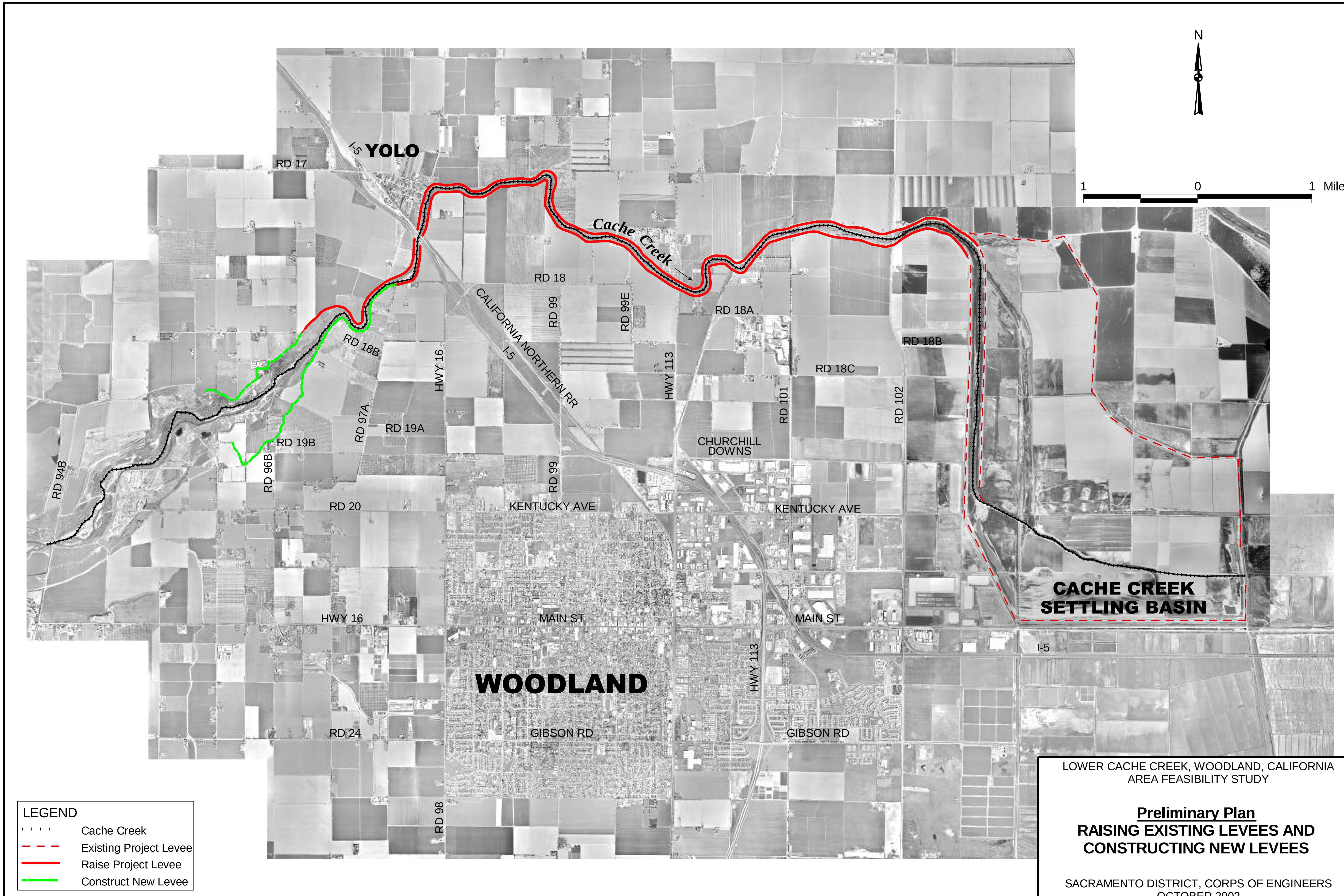
PLATE 3



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan
CHANNEL CLEARING

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

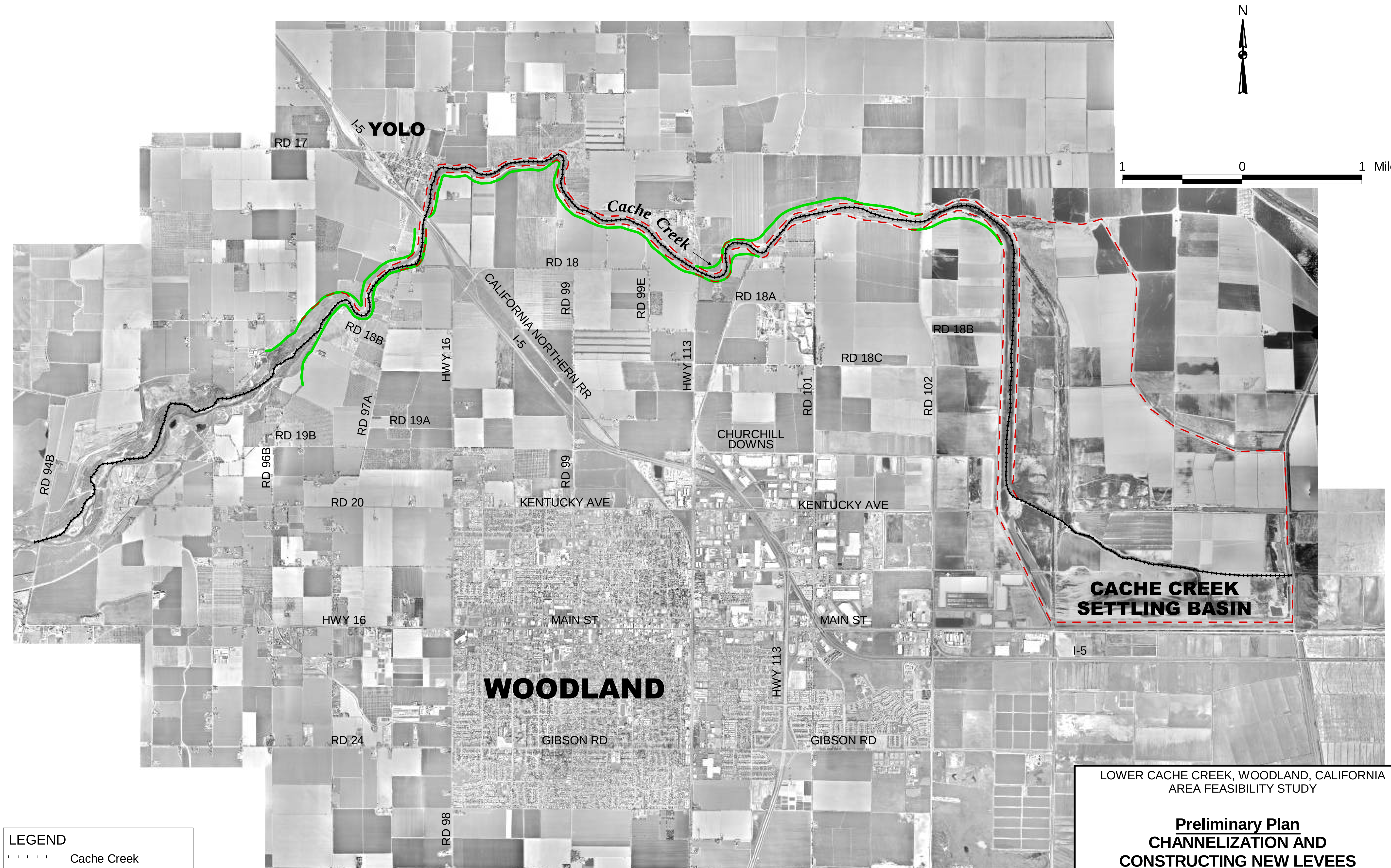


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan

RAISING EXISTING LEVEES AND CONSTRUCTING NEW LEVEES

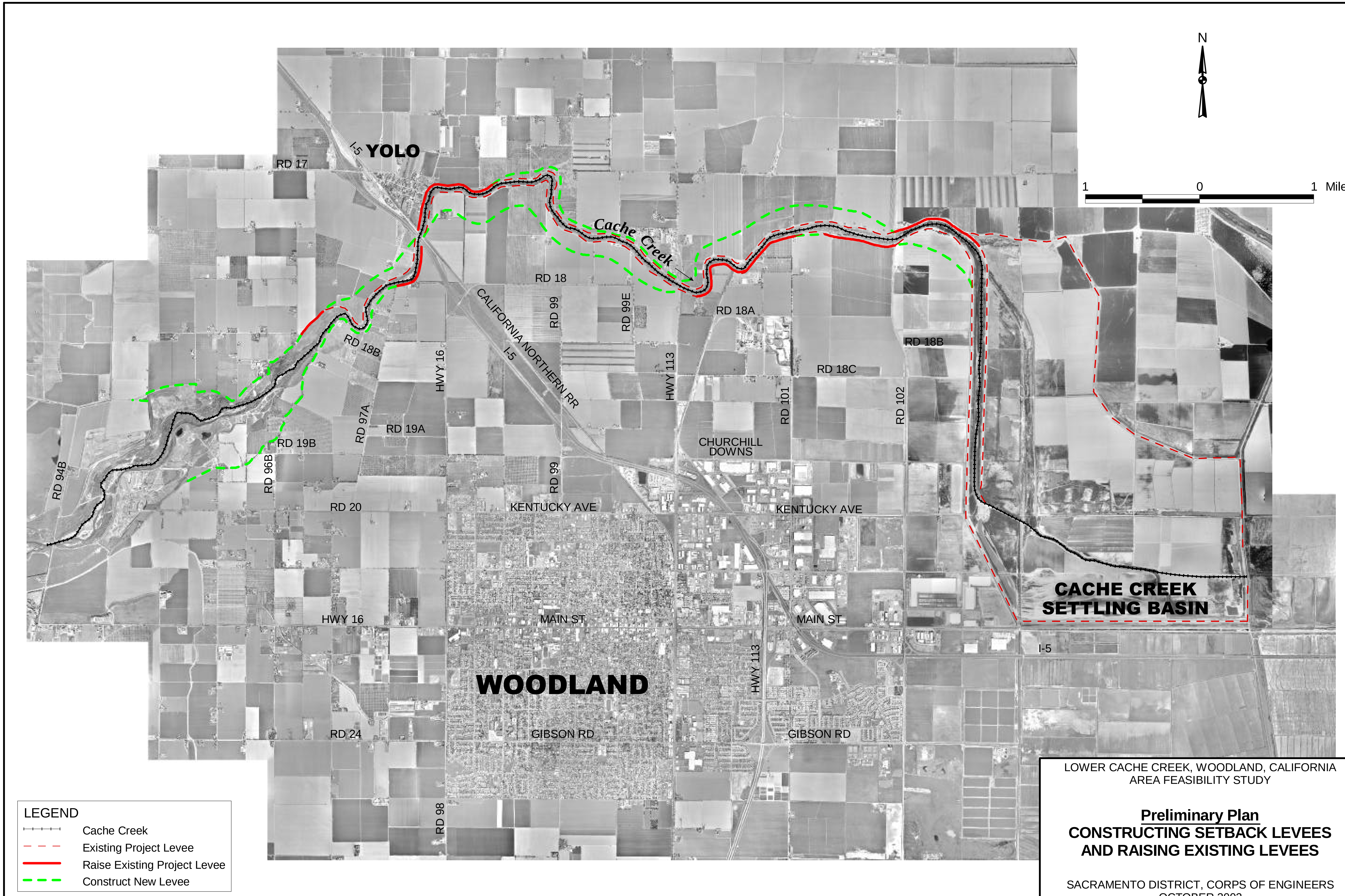
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan
CHANNELIZATION AND CONSTRUCTING NEW LEVEES

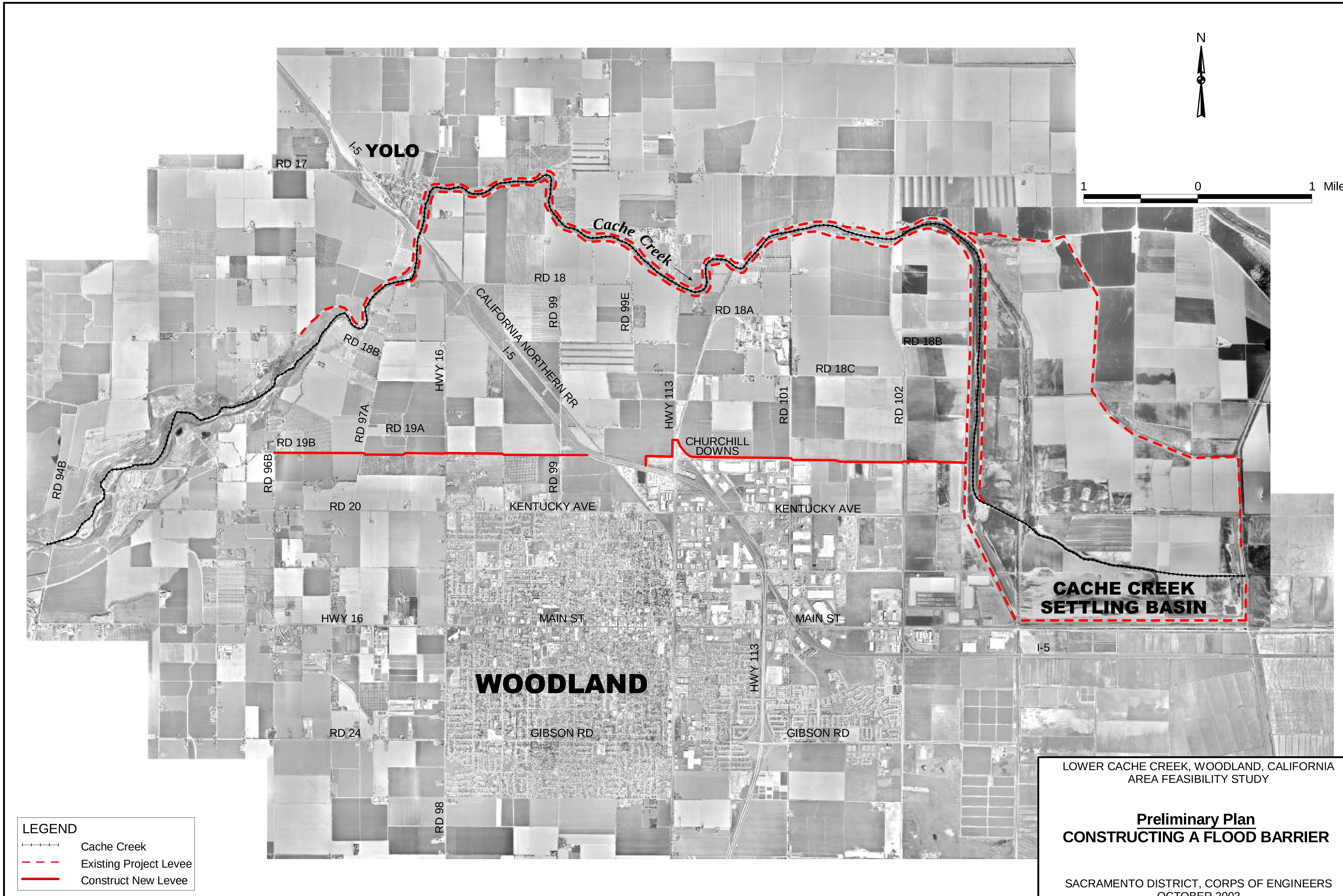
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan
CONSTRUCTING SETBACK LEVEES AND RAISING EXISTING LEVEES

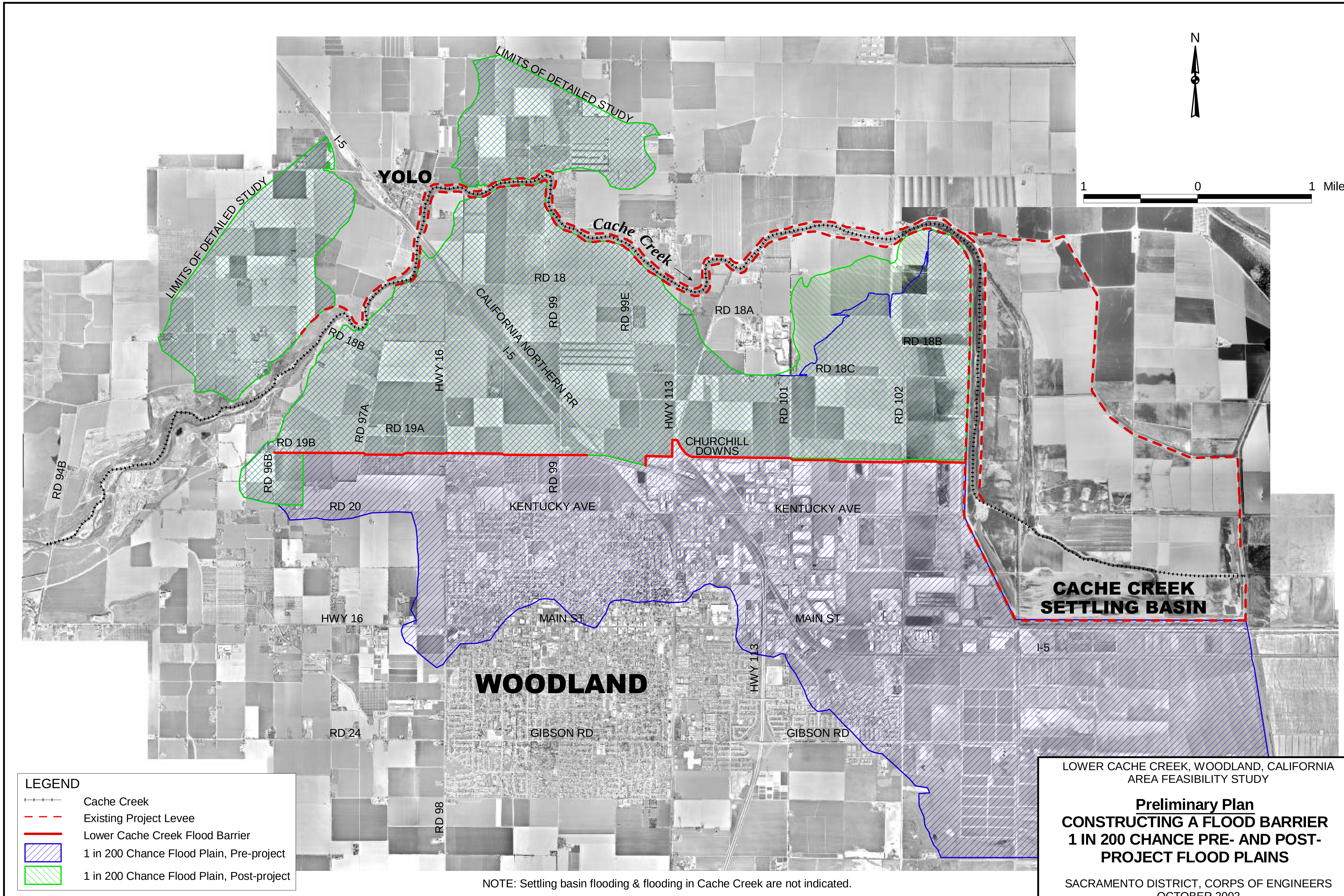
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan
CONSTRUCTING A FLOOD BARRIER

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

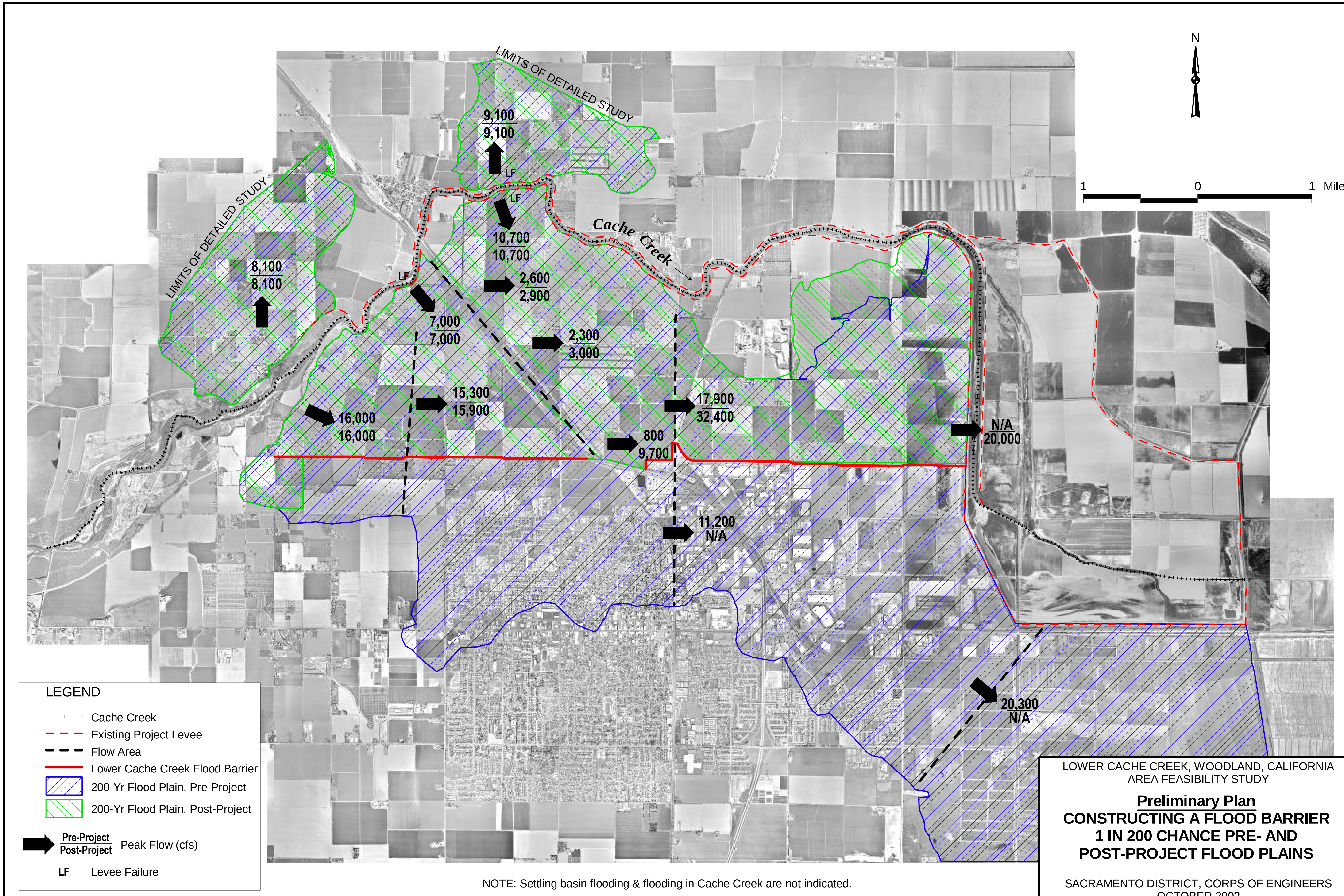


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan

CONSTRUCTING A FLOOD BARRIER
1 IN 200 CHANCE PRE- AND POST-PROJECT FLOOD PLAINS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



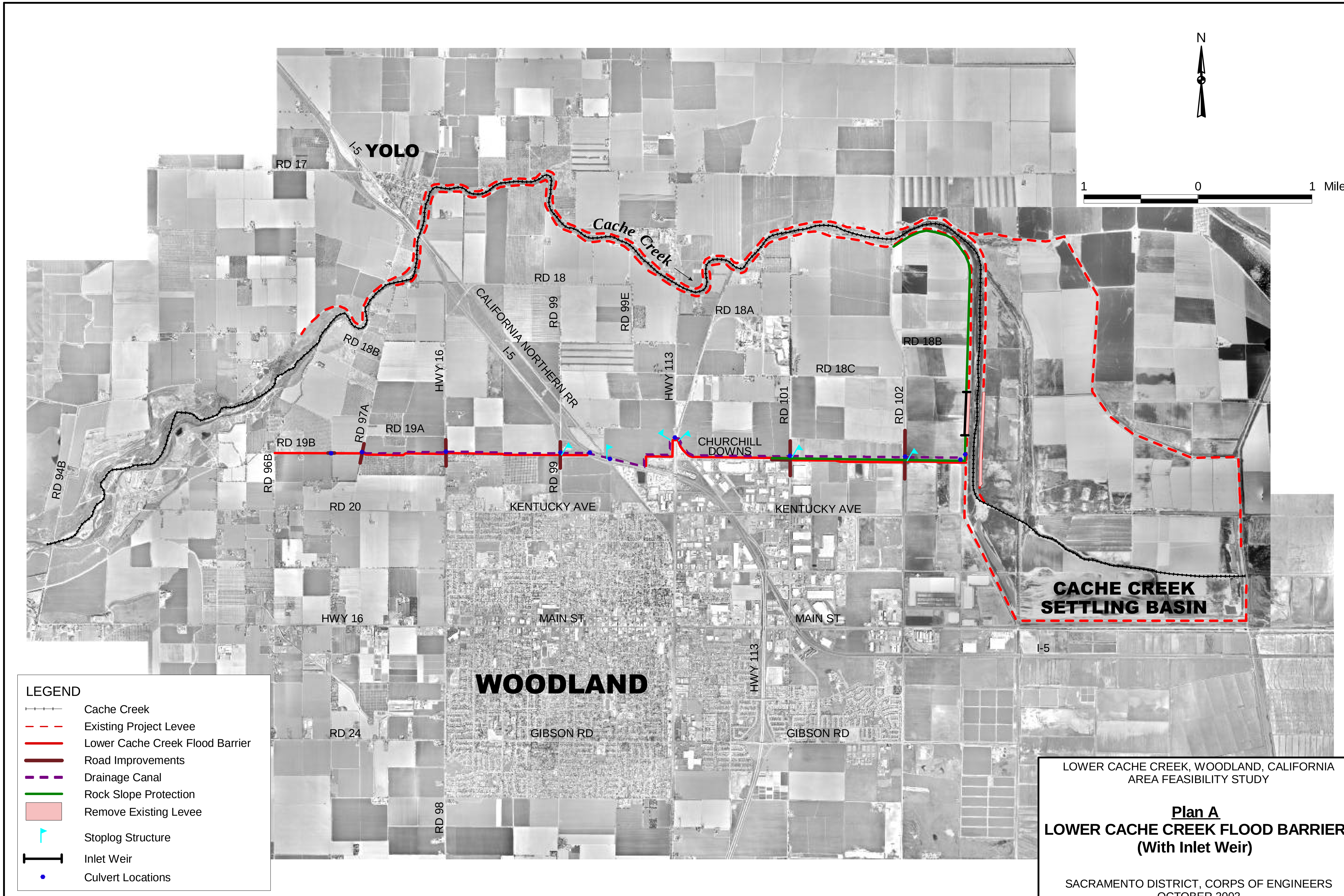
NOTE: Settling basin flooding & flooding in Cache Creek are not indicated.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Preliminary Plan

CONSTRUCTING A FLOOD BARRIER
1 IN 200 CHANCE PRE- AND
POST-PROJECT FLOOD PLAINS

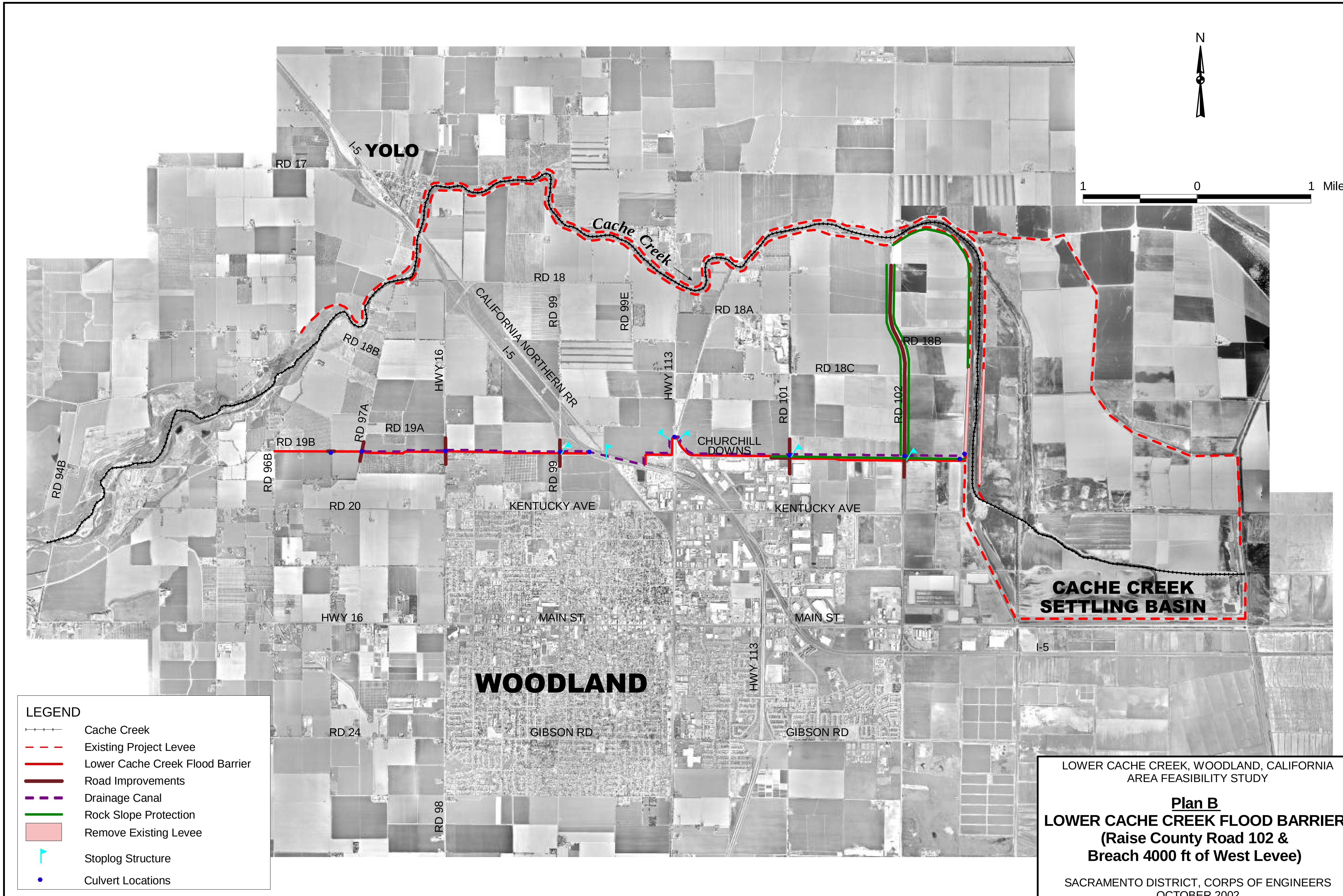
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Plan A
LOWER CACHE CREEK FLOOD BARRIER
(With Inlet Weir)

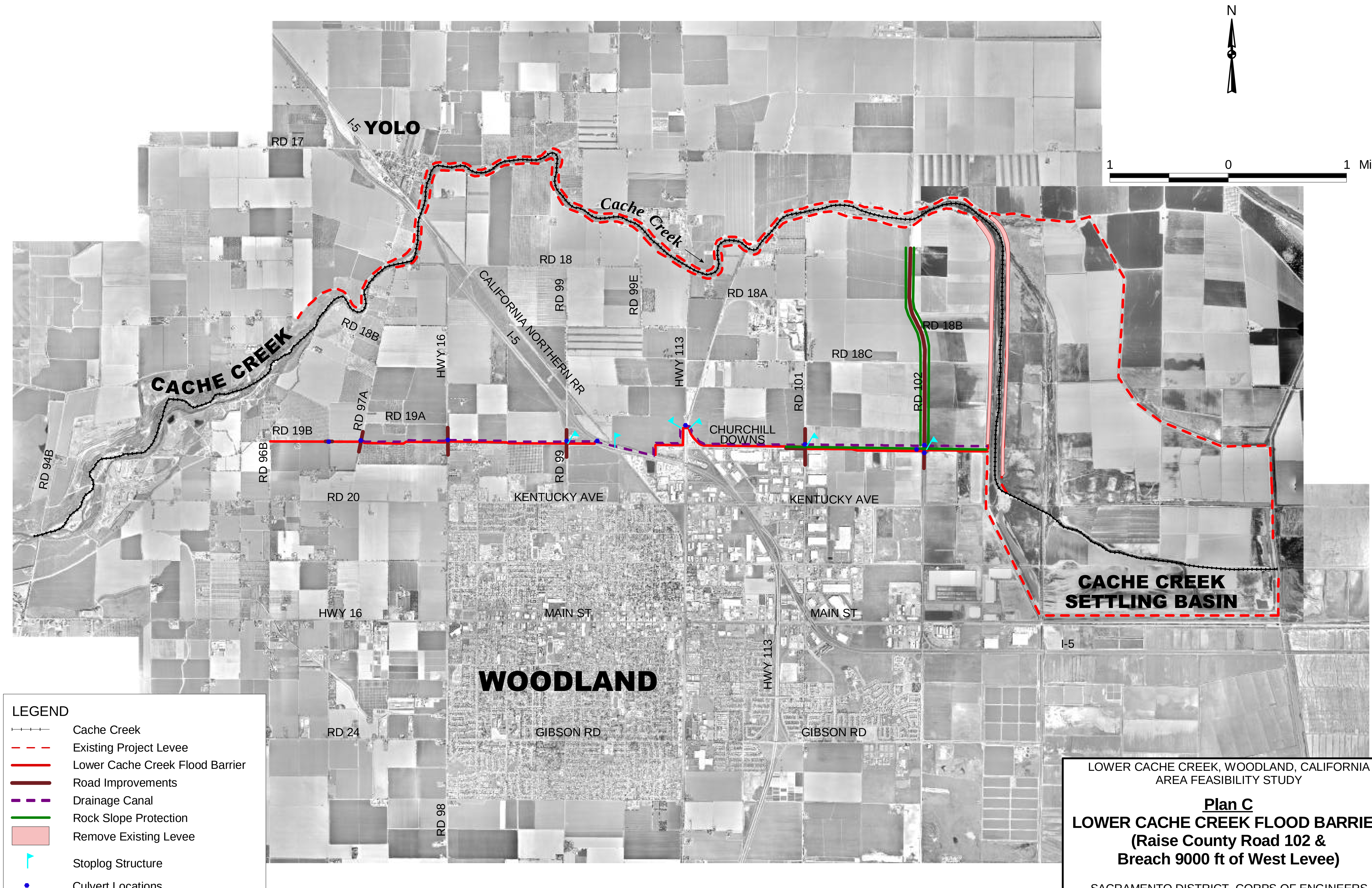
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Plan B
LOWER CACHE CREEK FLOOD BARRIER
(Raise County Road 102 &
Breach 4000 ft of West Levee)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

Plan C

LOWER CACHE CREEK FLOOD BARRIER
(Raise County Road 102 &
Breach 9000 ft of West Levee)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

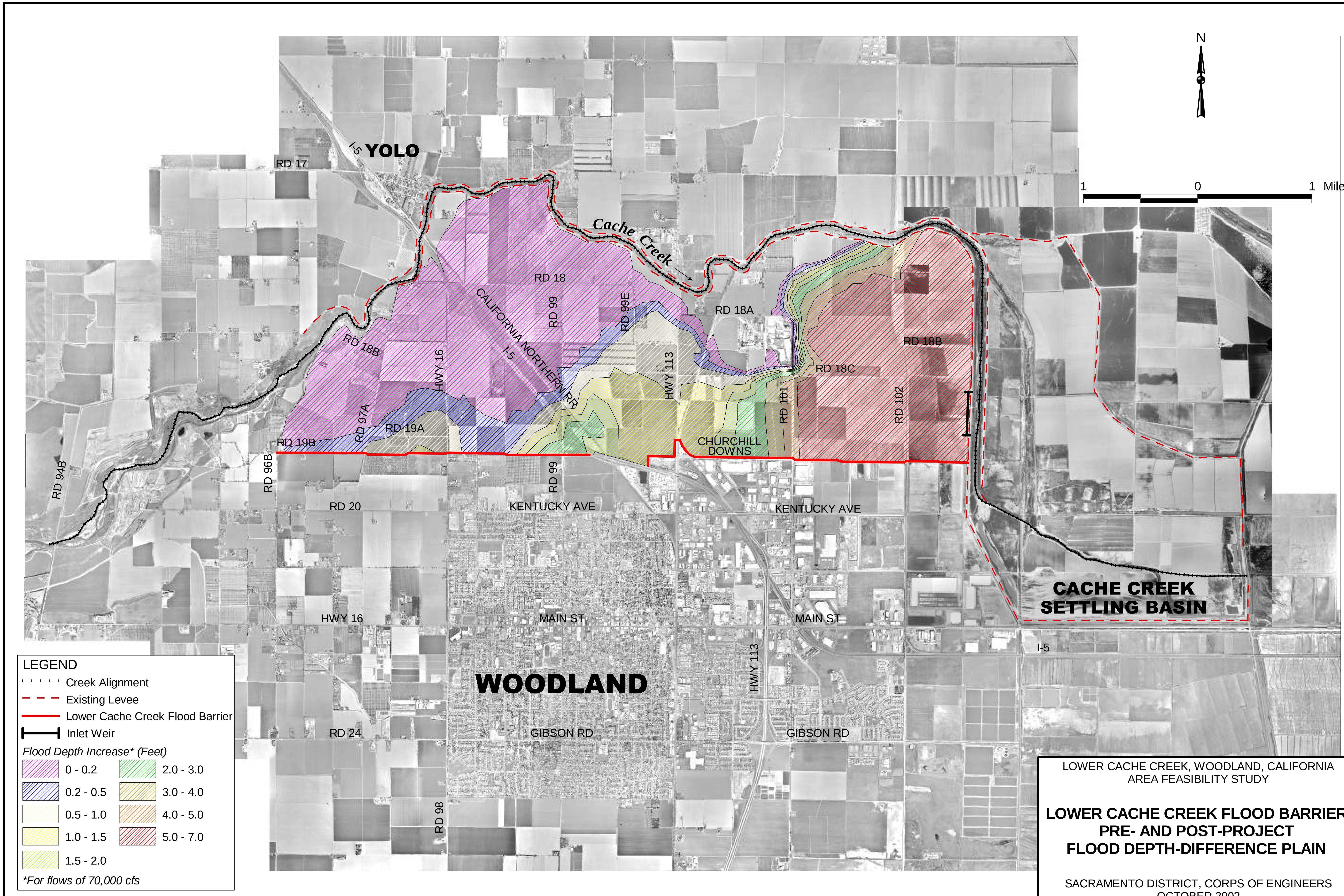
NOTES

1. REMOVE EXISTING WEST LEVEE.
2. CONSTRUCT 3000' CONCRETE WEIR.
3. REMOVE 5250' OF EXISTING TRAINING LEVEE.
4. EXISTING DITCH TO REMAIN.
5. TEMPORARY HAUL ROAD.
6. REMOVE EXISTING CULVERT.
7. INSTALL TRIPLE 3' X 3' BOX CULVERTS WITH SLIDE & FLAP GATES.
8. INSTALL NEW CULVERT.
9. INSTALL NEW STOPLOG STRUCTURE.
10. RELOCATE EXISTING DITCH TO THE WEST.
11. FILL/ABANDON EXISTING DITCH.

LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER FEATURES AT INLET WEIR

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

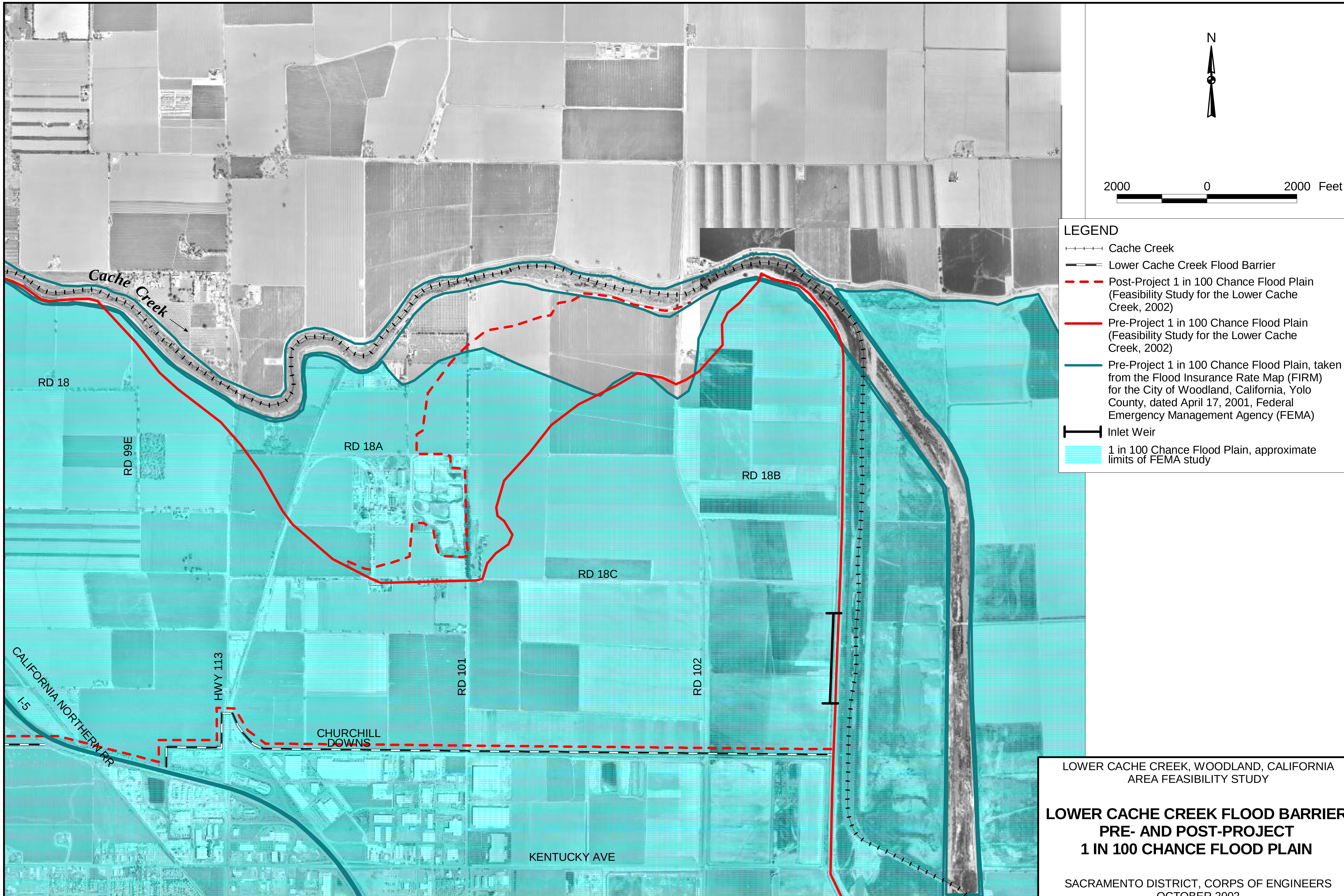


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER
PRE- AND POST-PROJECT
FLOOD DEPTH-DIFFERENCE PLAIN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

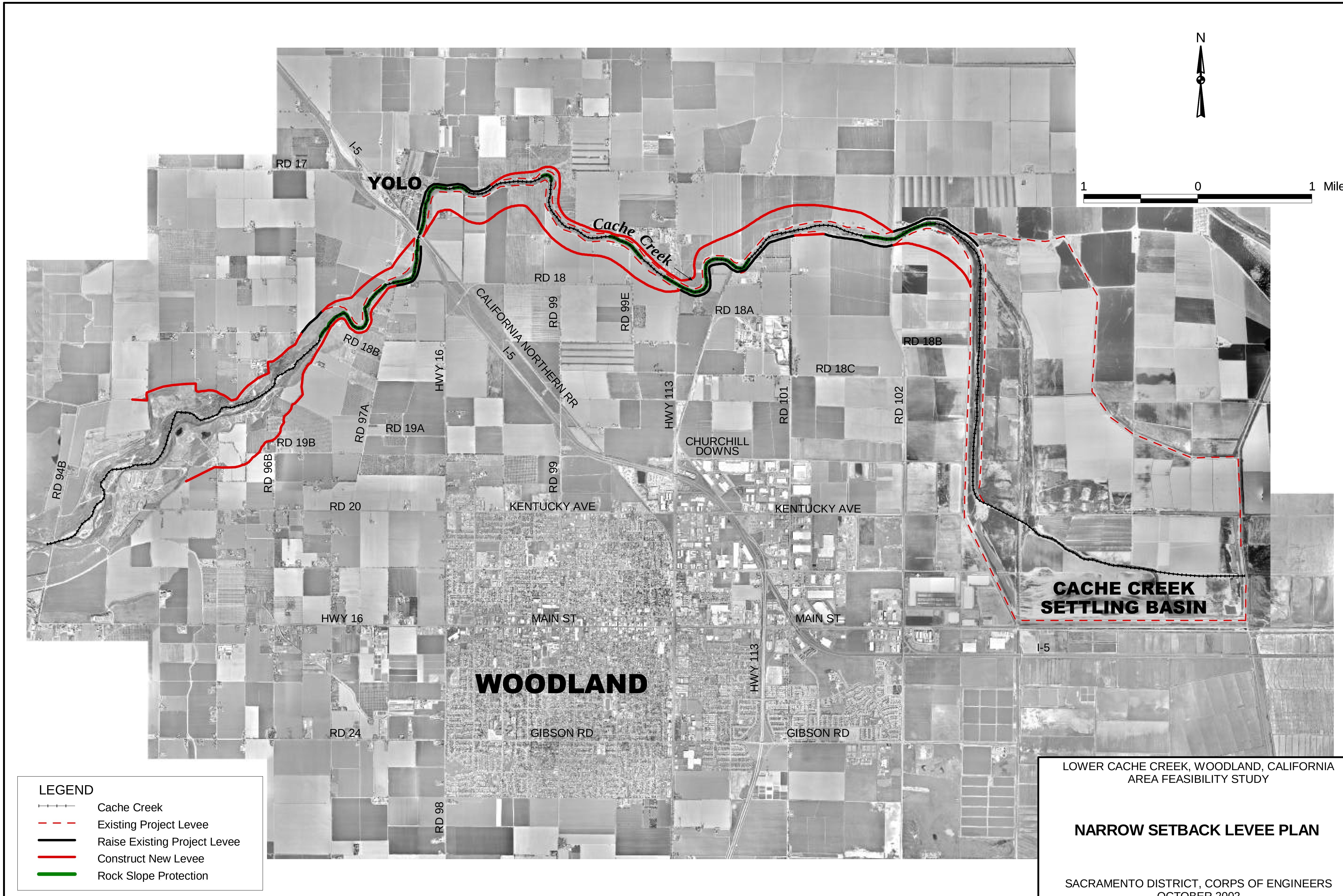

N
1 0 1 Miles
LIMITS OF DETAILED STUDY
DEPTH (ft)
TIME (hrs)
LEGEND
Cache Creek
Existing Project Levee
Flood Depth, Pre-Project Conditions (Feet)
Flood Depth, Post-Project Conditions (Feet)
Inlet Weir
1 in 200 Chance Flood Plain, Pre-project
1 in 200 Chance Flood Plain, Post-project
NOTE: For more detailed information, see Plate 30 of Appendix D.
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY
LOWER CACHE CREEK FLOOD BARRIER
1 IN 200 CHANCE PRE- AND POST-
PROJECT FLOOD PLAIN
DEPTH-DURATION CURVES
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK FLOOD BARRIER
PRE- AND POST-PROJECT
1 IN 100 CHANCE FLOOD PLAIN

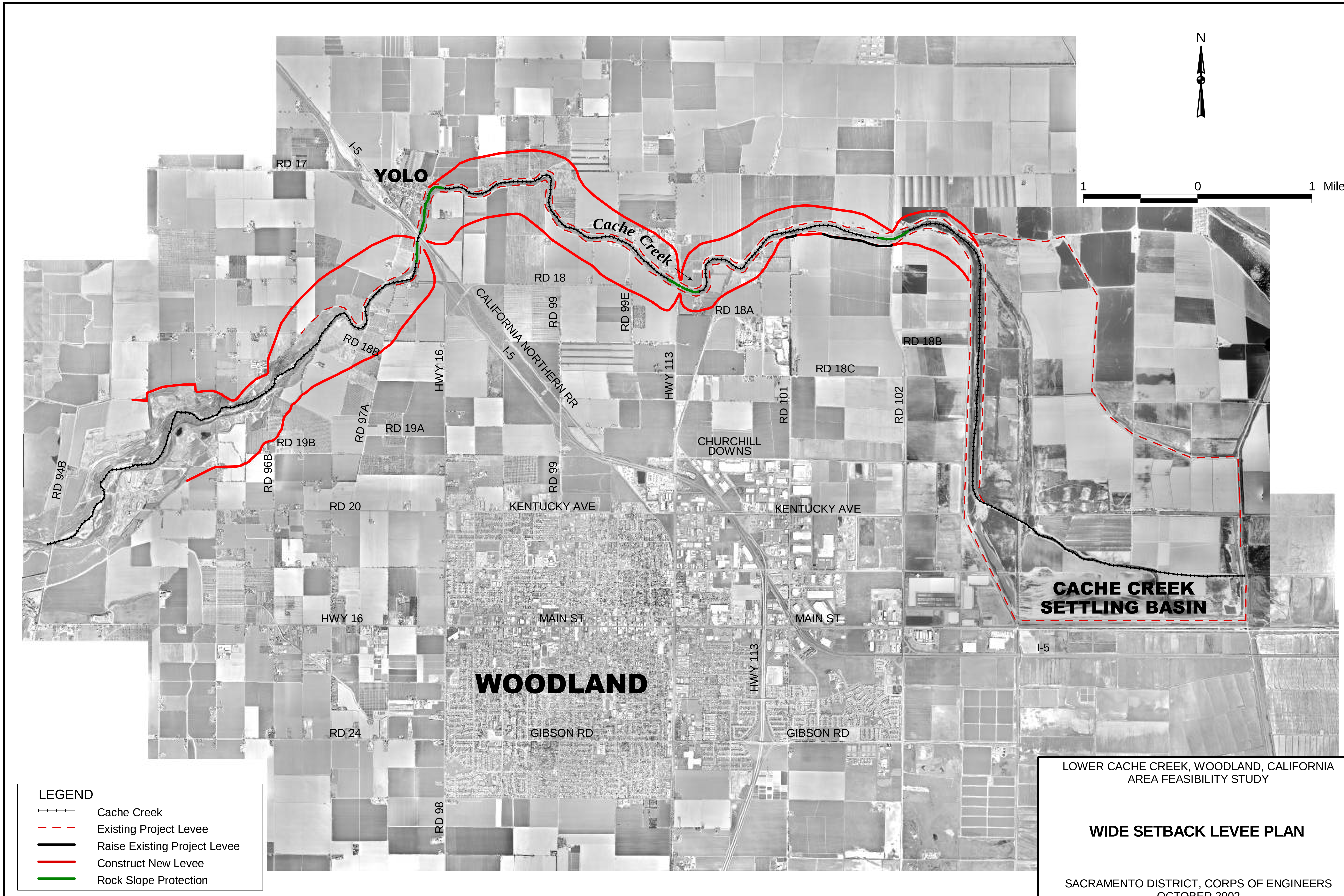
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

NARROW SETBACK LEVEE PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

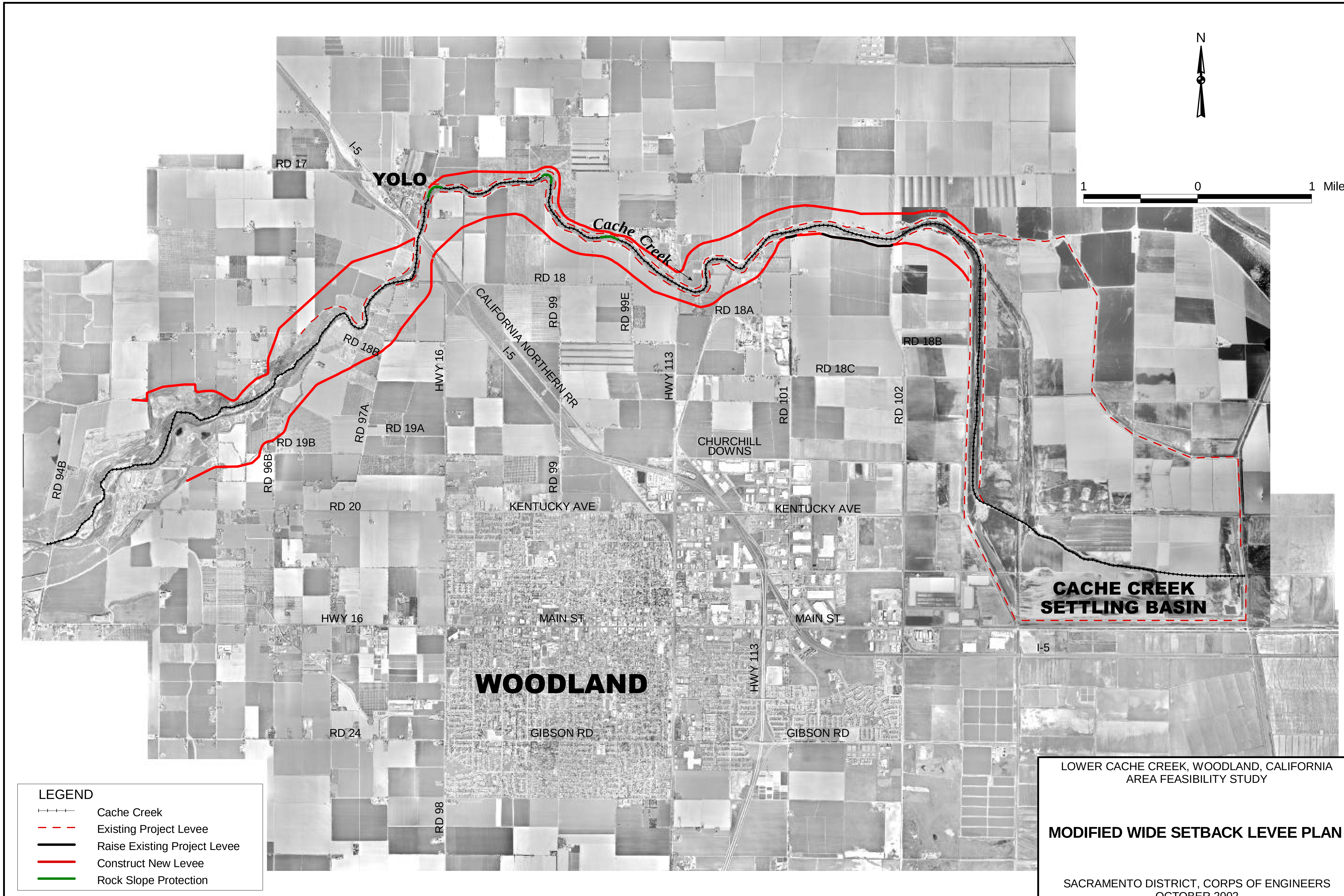


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

WIDE SETBACK LEVEE PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

PLATE 19

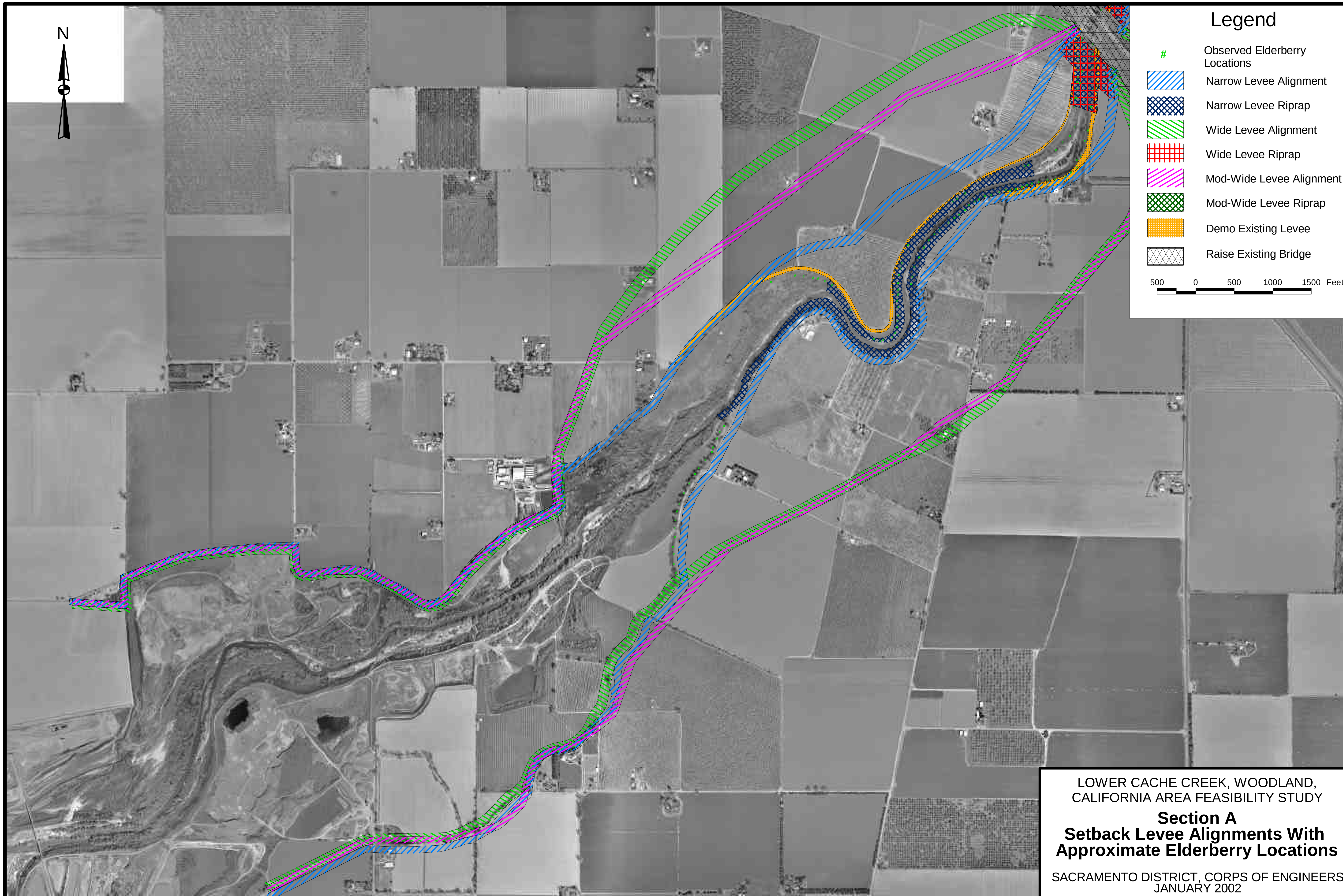


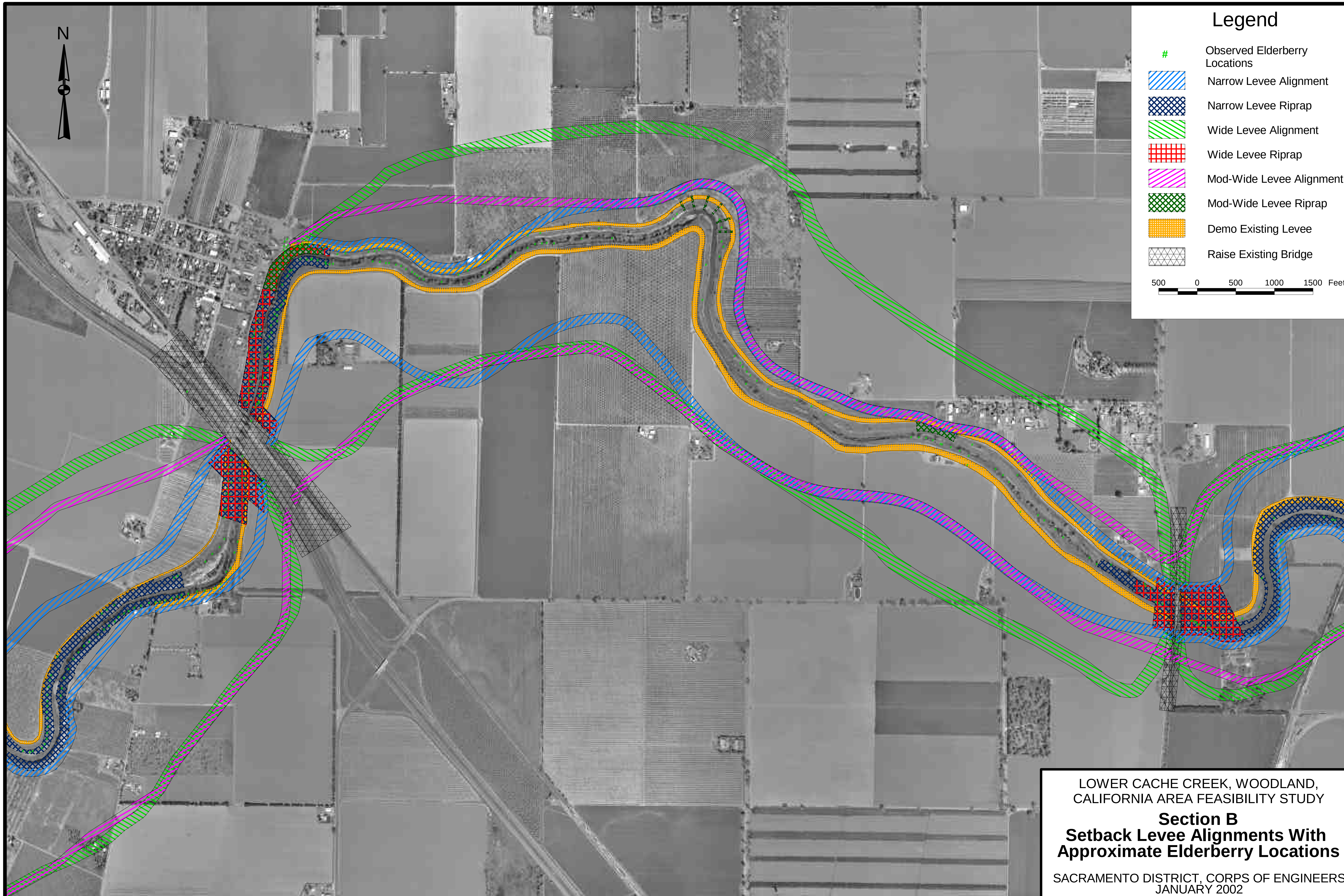
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

MODIFIED WIDE SETBACK LEVEE PLAN

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

PLATE 20


N
Legend
Observed Elderberry Locations
Narrow Levee Alignment
Narrow Levee Riprap
Wide Levee Alignment
Wide Levee Riprap
Mod-Wide Levee Alignment
Mod-Wide Levee Riprap
Demo Existing Levee
Raise Existing Bridge
500 0 500 1000 1500 Feet
LOWER CACHE CREEK, WOODLAND, CALIFORNIA AREA FEASIBILITY STUDY
Section A
Setback Levee Alignments With Approximate Elderberry Locations
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA AREA FEASIBILITY STUDY

Section B
Setback Levee Alignments With Approximate Elderberry Locations

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 2002


N
Legend
Observed Elderberry Locations
Narrow Levee Alignment
Narrow Levee Riprap
Wide Levee Alignment
Wide Levee Riprap
Mod-Wide Levee Alignment
Mod-Wide Levee Riprap
Demo Existing Levee
Raise Existing Bridge
500 0 500 1000 1500 Feet
LOWER CACHE CREEK, WOODLAND, CALIFORNIA AREA FEASIBILITY STUDY
Section C-D
Setback Levee Alignments With Approximate Elderberry Locations
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 2002

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendixes

APPENDIXES

A	**Basis for Design for Evaluation of Selected Alternatives**
B	**Geotechnical Risk-Based Analysis**
C	**Hydrology**
D	**Hydraulic Analysis**
E	**Environmental Site Assessment**
F	**Real Estate Plan**
G	**Economics**
H	**(Not Used)**
I	**Qualitative Geomorphologic and Channel Stability Assessment of Lower Cache Creek**
J	**(Not Used)**
K	**Cost Estimates**
L	**Evaluation of Potential Flooding from Cache Creek**

LOWER CACHE CREEK, YOLO COUNTY, CA
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Appendix A

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APPENDIX A

Basis for Design
for
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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.

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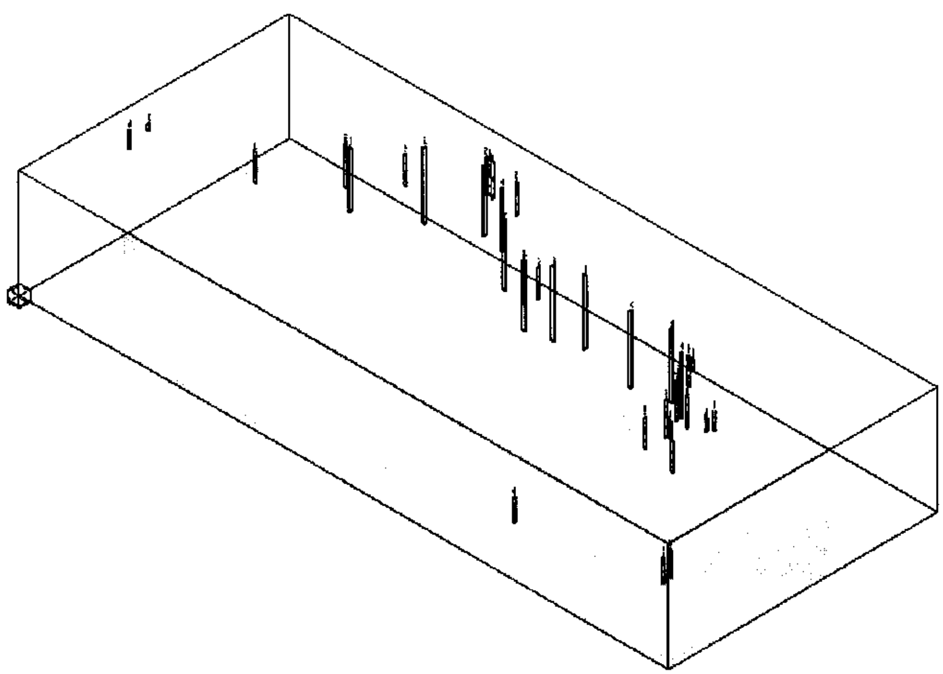
APPENDIX B

Geotechnical Risk-Based Analysis

LOWER CACHE CREEK
FEASIBILITY STUDY

GEOTECHNICAL RISK-BASED ANALYSIS



SEPTEMBER 2000

U. S. ARMY CORPS OF ENGINEERS
SOUTH PACIFIC DIVISION - SACRAMENTO DISTRICT
GEOTECHNICAL BRANCH - SOIL DESIGN SECTION

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Cover Illustration: 3-D Isometric View of Explorations along Cache Creek.

Tables

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Figures

Sheets

Abbreviations

2H:1V - 2 Horizontal to 1 Vertical Slopes

BOD - Basis of Design

CPT - Cone Penetrometer Test

DS - Downstream

ΔH - change in hydraulic head

E[x] - Expected value of x

ETL - Engineering Technical Letter (COE)

FS - Factor of Safety

GW - groundwater

i - hydraulic gradient

i_{crit} - critical hydraulic gradient

i_e - hydraulic exit gradient

k_b - top blanket permeability

k_f - substratum permeability

k_h - horizontal permeability

k_v - vertical permeability

ln - natural logarithm

$N_{1(60)}$ - SPT blow counts corrected for overburden and energy

PFP - Probable Failure Point

PNP - Probable Nonfailure Point

Pr(f) - Probability of Failure

psf - pounds per square foot

q_T - normalized tip friction

R_f - Friction ratio

$\sigma[x]$ - standard deviation of x

SPT - Standard Penetration Test

t/ft^2 - tons per square foot

TOL - top of levee

USGS - United States Geological Survey

w/s - with some

US - Upstream

Var[x] - Variance of x

V(x) - coefficient of variation of x

z_b - top blanket thickness

z_f - substratum thickness

1.0 Introduction.

The purpose of this report is to present the results of the geotechnical risk based analysis. The risk-based analysis is conducted according to U. S. Army Corps of Engineers publication ETL 1110-2-556, "Risk-Based Analysis in Geotechnical Engineering for Support of Planning Studies," 28 May 1999. Reported PFP (probable failure point) and PNP (probable nonfailure point) values derived from probability of failure [Pr(f)] curves are given for the existing levees based on the results of field reconnaissance, engineering analysis, and judgement. This report is expected to be followed-up with a Geotechnical Basis of Design (BOD) report once the "selected plan" has been identified and further explorations are conducted.

2.0 Explorations.

CPT (cone penetrometer test) explorations were performed at the levee crowns with the approximate locations given in Table 2.1. A plan view of the CPT explorations are also shown in Figure 2.1 on a USGS quadrangle map.

Table 2.1
Location of CPT Explorations.

CPT #	Northing[1] (ft)	Easting[1] (ft)	Depth (ft)	Location
1	2,080,450	385,850	52.5	levee crown, right bank
2	2,078,500	386,950	59.7	levee crown, left bank
3	2,075,600	386,050	61.5	levee crown, right bank
4	2,071,300	386,100	59.7	levee crown, left bank
5	2,069,650	384,900	60.4	levee crown, right bank
6	2,067,900	383,950	56.9	levee crown, left bank
7	2,064,000	386,050	55.9	levee crown, right bank
8	2,061,650	388,150	50.0	levee crown, left bank
9	2,059,550	388,600	56.1	levee crown, right bank
10	2,055,450	387,150	60.5	levee crown, left bank
11	2,052,850	382,900	51.5	levee crown, left bank
12	2,041,750	375,300	5.2	levee crown, right bank
13	2,041,350	373,900	14.9	levee crown, right bank

[1] NAD 27, possible error (+-) 300 feet.

Classification of materials based on CPT explorations are shown in Figures 2.2 through 2.7. Where possible, CPT explorations were compared to the original field logs based on actual sampling of materials which were conducted for the original 1958 project. The original field logs (unaltered) are shown in Sheet B1.0. A comparison between the locations of the CPT explorations and the original field explorations are shown in Table 2.2.

Table 2.2
Location proximity between the CPT explorations
and the original 1958 explorations.

CPT # or Drill Hole (Left Bank)	Proximity	CPT # or Drill Hole (Right Bank)	Proximity
2F-8-10	>	CPT-1	>
CPT-2	2000' US of -10	CPT-3	>
CPT-4	>	CPT-5	1500' DS of –9
CPT-6	500' DS of –8	2F-8-9	>
2F-8-8	>	CPT-7	>
CPT-8	1000' DS of –7	CPT-9	>
2F-8-7	>	2F-8-3	>
2F-8-6,5,4	>	>	>
CPT-10	>	>	>
CPT-11	1500' DS of –2	>	>
2F-8-2	>	>	>

">" = greater than 2000' from nearest hole

When comparison is made between CPT-6 and 2F-8-8, it can be seen that the general pattern is the same but that the CPT generally characterizes the material slighter coarser than the 1958 explorations.

Plots of CPT tip resistance (q_T) and correlated blow counts ($N_{1(60)}$) versus depth are shown in Figures 2.8 through 2.13. Most holes were driven to specified depths except CPT-12 and -13 which were driven to 6 and 16 feet respectively, and were stopped due to the presence of large particles, estimated to be mostly gravels to cobbles. The cone penetrometer device could not penetrate these large particles without significant damage. Both CPT-12 and -13 were located at the Teichert Gravel Pit levees. The data from CPT-1 was found to be unreadable but should be similar to that of CPT-2 and -3.

Groundwater depths were determined by pore pressure dissipations for CPT's 2, 7, 8, and 11 and were found to be at 20, 35, 42, and 42 feet below the ground surface, respectively.

Levee geometry and cross-sections are shown in Table 2.3 and Figure 2.14. Surveys of the sections were performed by approximate methods and represent only relative geometries.

Table 2.3
Cross-Sectional Properties

Section	Waterside Height (feet)	Landside Height (feet)	Waterside Slope __H:1V	Landside Slope __H:1V
CPT-1	11	12	3.2	2.6
CPT-2	6	9	2.4	2.1
CPT-3	9	7	3.3	2.1
CPT-4	10	7	4.0	3.0
CPT-5	3.5	4	2.75	2.15
CPT-6	4	5	3.5	2.35
CPT-7	8	9	4	2.5
CPT-8	6	6	3	2.7

3.0 Engineering Properties of Explored Materials.

Major engineering properties include soil classification, shear strength, density, and permeability. Interpolation of CPT results was an extremely iterative and complex process that lead to the results shown in Table 3.1. Soil classification methods based on the R_f zone (Robertson and Campanella, 1983) were found to most closely match the 1958 field logs although the CPT correlations tend to be slightly coarser. Unit weights were determined by the correlations established by the CPTINT program developed by R. G. Campanella (Version 4.0, 12/20/91). Shear strengths were based on table correlations with tip resistance (q_T). Undrained shear strengths were interpolated from material types and blow count value correlations (Campanella), and correlated with the values listed in Terzaghi and Peck (1993), along with engineering judgement and experience with materials in the area.

Permeabilities were based on soil classification and correlations with standard engineering charts and tables, and engineering judgement. The estimated permeabilities based on soil classifications are listed in Table 3.2.

Table 3.1
Engineering Properties of Materials Based on CPT Explorations

CPT #	Depths (feet)	Soil Classification	In-situ Unit Weight (lb/ft^3)	Effective Friction Angle (degrees)	Undrained Shear Strength (psf)
2	00 - 22	silty sand to sand w/s silt	123	33	
	22 - 30	clayey silt	120	-	600
	30 - 42	clay to silty clay	125	-	2000
	42 - 60	clayey silt to silty sand	125	33	
3	00 -07	silty sand to fine sand	121	33	
	07 - 14	sand w/s silt to fine sand	123	37	
	14 - 24	silty sand to sand w/s silt	121	33	
	24 - 48	clay	124	-	1250
	48 - 56	clayey silt to silty sand	123	-	600
	56 - 60	clay	125	-	1250
4	00 - 10	clayey silt to silty sand	123	33	
	10 - 15	silty sand to sand w/s silt	122	33	
	15 - 25	clay to clayey silt	122	-	1250
	25 - 35	clay	122	-	1500
	35 - 55	silty clay to clayey silt	124	-	1500
	55 -60	sand w/s silt to sand	125	37	
5	00 - 06	silty sand to sand w/s silt	122	33	
	06 - 10	clayey silt to silty sand	122	33	
	10 - 20	sand w/s silt	121	33	
	20 - 24	sand	124	37	
	24 - 32	clay to silty clay	122	-	1250
	32 - 44	silty clay to clayey silt	121	-	600
	44 - 60	clay to clayey silt	125	-	1500
6	00 - 05	clayey silt to silty sand	124	33	
	05 - 10	clayey silt	122	-	800
	10 - 20	sand w/s silt to sand	124	37	
	20- 30	clay	122	-	1250
	30 - 56	clay to clayey silt	123	-	1000
7	00 - 12	silty sand to sand w/s silt	121	33	
	12 - 20	silty sand	121	30	
	20 - 35	clay	124	-	1500
	35 - 56	sand to gravelly sand	126	42	

Table 3.1 (cont.)
Engineering Properties of Materials Based on CPT Explorations

CPT #	Depths (feet)	Soil Classification	In-situ Unit Weight (lb/ft^3)	Effective Friction Angle (degrees)	Undrained Shear Strength (psf)
8	00 - 10	clayey silt to silty sand	124	33	
	10 - 30	silty sand to sand w/s silt	122	33	
	30 - 42	clay to silty clay	124	-	2000
	42 - 50	fine sand to gravelly sand	125	42	
9	00 - 22	sand w/s silt	121	33	
	22 - 30	clay to silty clay	121	-	1250
	30 - 38	clay	125	-	2000
	38 - 46	silty clay to clayey silt	122	-	800
	46 - 56	clay to silty clay	123	-	1250
10	00 - 05	clayey silt to sand w/s silt	123	33	
	05 - 10	clay	124	-	2000
	10 - 18	silty sand to sand w/s silt	121	33	
	18 - 32	silty clay to clayey silt	122	-	1250
	32 - 36	sand to gravelly sand	126	42	
	36 - 52	clay to silty clay	123	-	1250
	52 - 60	clayey silt	122	-	1000
11	00 - 03	clayey silt to silty sand	124	33	
	03 - 05	clay	124	-	2000
	05 - 11	silty sand	121	30	
	11 - 16	clayey silt	122	-	800
	16 - 40	sand w/s silt to fine sand	124	37	
	40 - 42	clayey silt	121	-	600
	42 - 52	sand to gravelly sand	129	42	
12	00 - 05	sand to gravelly sand	123	42	
13	00 - 06	fine sand	125	33	
	06 - 14	sand	125	37	
13A	00 - 07	fine sand	125	33	
13A was attempted adjacent to 13					

Table 3.2
Estimated Soil Permeabilities.

Soil Classification	Vertical Permeability k_v (ft/day)	Horizontal Permeability k_h (ft/day)	Ratio (k_h / k_v)
Clay	0.0003	0.0018	6
Silty clay	0.003	0.018	6
Clayey silt	0.03	0.18	6
Silty sand	0.3	1.2	4
Sand with some silt	1	4	4
Fine sand	10	40	4
Sand	100	200	2
Gravelly sand	1000	1000	1

4.0 Risk Based Analysis.

Risk-based analysis was performed according to the methods outlined in ETL 1110-2-556, "Risk-Based Analysis in Geotechnical Engineering for Support of Planning Studies," 28 May 1999. Cross-sections used for the analysis are shown in Figure 2.14. Due to the approximate nature of the surveyed sections, if the section for the 1954 template had steeper slopes and narrower crest widths, this section was used for the seepage and slope stability analyses.

Seepage analysis was completed using the computer program GMS/SEEP2D. Each section was analyzed to determine the results of through-seepage and underseepage using a steady-state seepage condition. Where a soil layer was classified as a range (clay to silty clay), the soil with the greatest permeability was used for the analysis (silty clay). It can be seen in Figures 4.1 through 4.4 that the sections that most likely present an underseepage problem are sections CPT-4, -6, and -8 where the exit gradient (i_e) with full hydraulic head is equal to 0.5. Sections CPT-2 and -6 were used for the probability of failure [Pr(f)] analysis and it can be seen in Figures 4.5 and 4.6 that with full hydraulic head, the Pr(f) for underseepage is equal to 3 and 26 percent respectively. The coefficients of variation for permeability ratio (k_f/k_b), top stratum thickness (z_f), and blanket thickness (z_b) were equal to 40, 50, and 30 percent respectively. An example of the Pr(f) calculation for CPT-6 is shown in Table 4.1.

Table 4.1
Underseepage Pr(f) Analysis for CPT-6 with full hydraulic head

Run	k_f/k_b	z_f (ft)	z_b (ft)	i	Variance	% of Total
1	6667	10.0	5.0	0.56		
2	10000	10.0	5.0	0.56		
3	4000	10.0	5.0	0.52	4.00E-04	1%
4	6667	15.0	5.0	0.56		
5	6667	5.0	5.0	0.52	4.00E-04	1%
6	6667	10.0	6.5	0.42		
7	6667	10.0	3.5	0.74	2.68E-02	97%
				Total:	0.0276	100%

E[i]	0.56	E[ln i]	-0.62201
Var[i]	0.02761		
σ[i]	0.166161	σ[ln i]	0.29048
V(i)	29.67%		

i_{crit}	0.65	$\ln(i_{crit})$	-0.43078	Pr(f)=	0.2552
					26%

f-substratum b-top blanket

Slope stability analysis was completed using the computer program WINUT3/UTEXAS3 (WES, Wright, 1992). The coefficients of variation used for the effective friction angle and the undrained shear strength were 10 and 40 percent respectively. Sections CPT-2 and -6 were analyzed and it can be seen in Figures 4.5 and 4.6 that with full hydraulic head (at the crown) the Pr(f) for slope stability is equal to 24 and 1 percent respectively. The computer program computes the expected values (E[FS]) and variance (Var[FS]) so that the number of manual calculations are slightly less than for the underseepage analysis, but nevertheless the calculations for CPT-2 are shown in Table 4.2.

Table 4.2
Slope Stability Pr(f) Analysis for CPT-2 with full hydraulic head

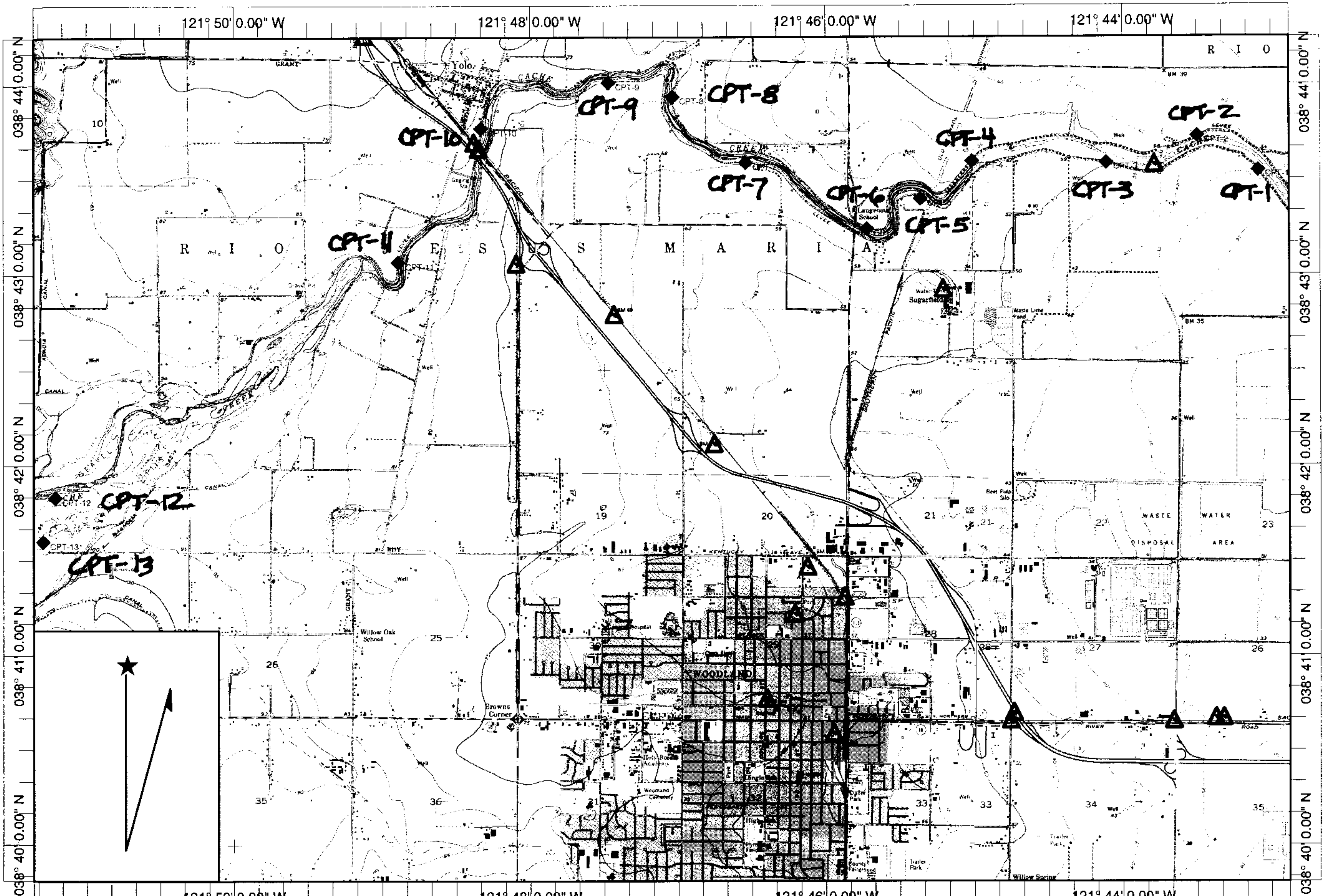
Water @ TOL		E[FS], Var[FS], Data from WINUT3	
E[FS] =	1.100	E[ln FS] =	0.087390
Var[FS] =	0.019320		
σ[FS] =	0.138996	σ[ln FS] =	0.125860
V_{FS} =	12.64%		
FS_{crit} =	1.0	Pr(f) =	0.243735
			24%

5.0 Conclusions.

Based on slope stability and underseepage analysis it was found that CPT-2 and -6 were the most critical or representative sections respectively. The probability of failure curves for CPT-2 and -6 are shown in Figures 4.5 and 4.6 respectively. Due to the possibility that not all cross-section (stratigraphy) types can be captured by a few explorations, the curves for CPT-2 and -6 representing the worst cases for slope stability and underseepage respectively, were developed into a composite graph, and using the same judgement values for each, the combined curve was calculated as shown in Figure 4.7. It can be seen from the combined curve of Figure 4.7 that the PNP (15% chance of failure) is located 2 feet below the top of levee, and that the probability of failure at the top of levee is approximately equal to 50 percent. The combined probability curve from Figure 4.7 should be used for any subsequent analysis.

The levees at the Teichert gravel pit were unable to be explored with CPT equipment, which was highly suspected. Further explorations using larger equipment or backhoes may be required depending on the selected design. Generally, in order for the relatively highly permeable levees to be safe when considering the effects of heavy seepage and seepage induced slope failures, the crest would have to have a minimum width of 30 feet with landside slopes no steeper than 2H:1V. The levees observed at the pit seemed to have these minimum dimensions but will be subject to further verification in the next phase of the analysis.

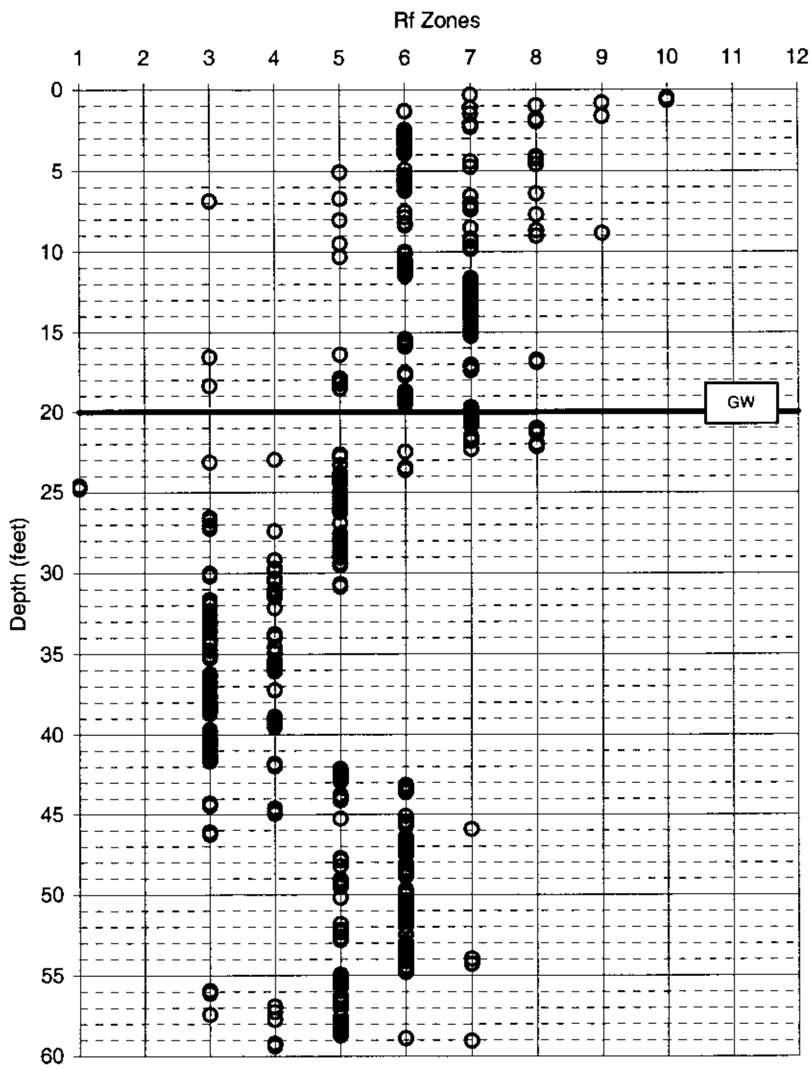
APPENDIX A
FIGURES



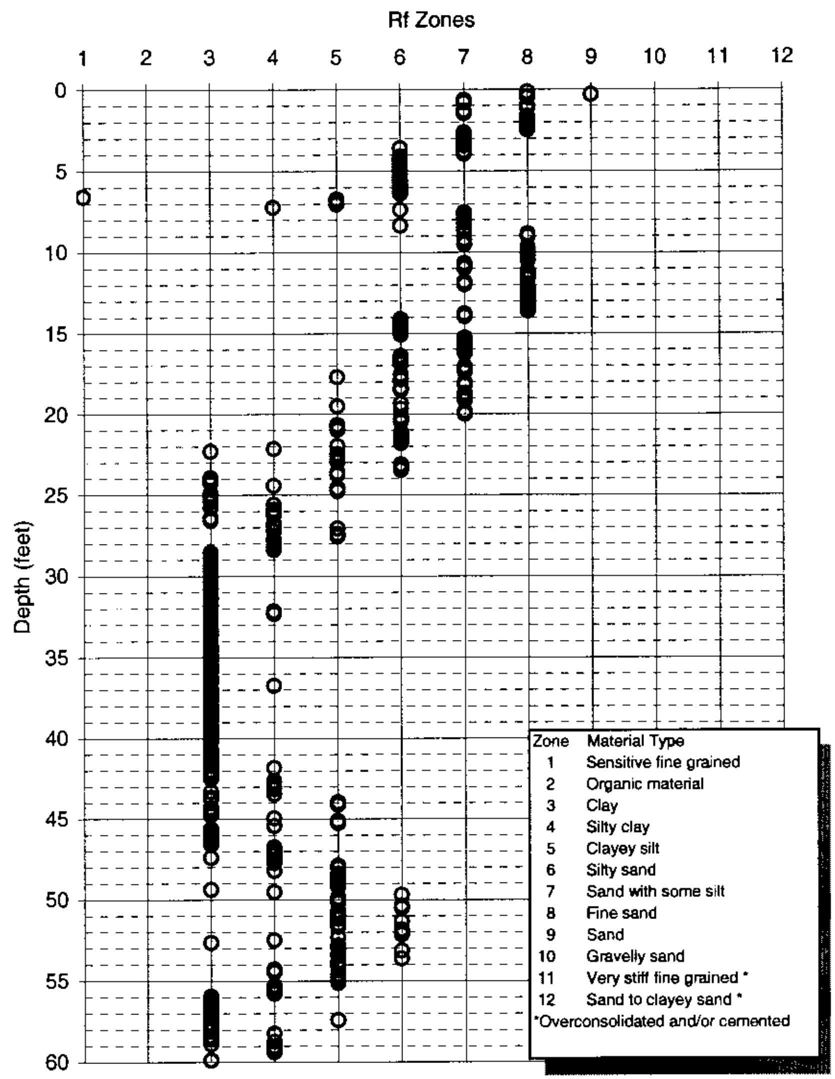
Name: WOODLAND
Date: 7/3/2000
Scale: 1 inch equals 4000 feet

Location: 038° 42' 01.7" N 121° 47' 07.2" W
Caption: Figure 2.1 Location of CPT Explorations [wt drk, lay lrg, lay info off, rulr on, nrth arro on, 1" tic off]

CPT Soil Classification - CPT 2

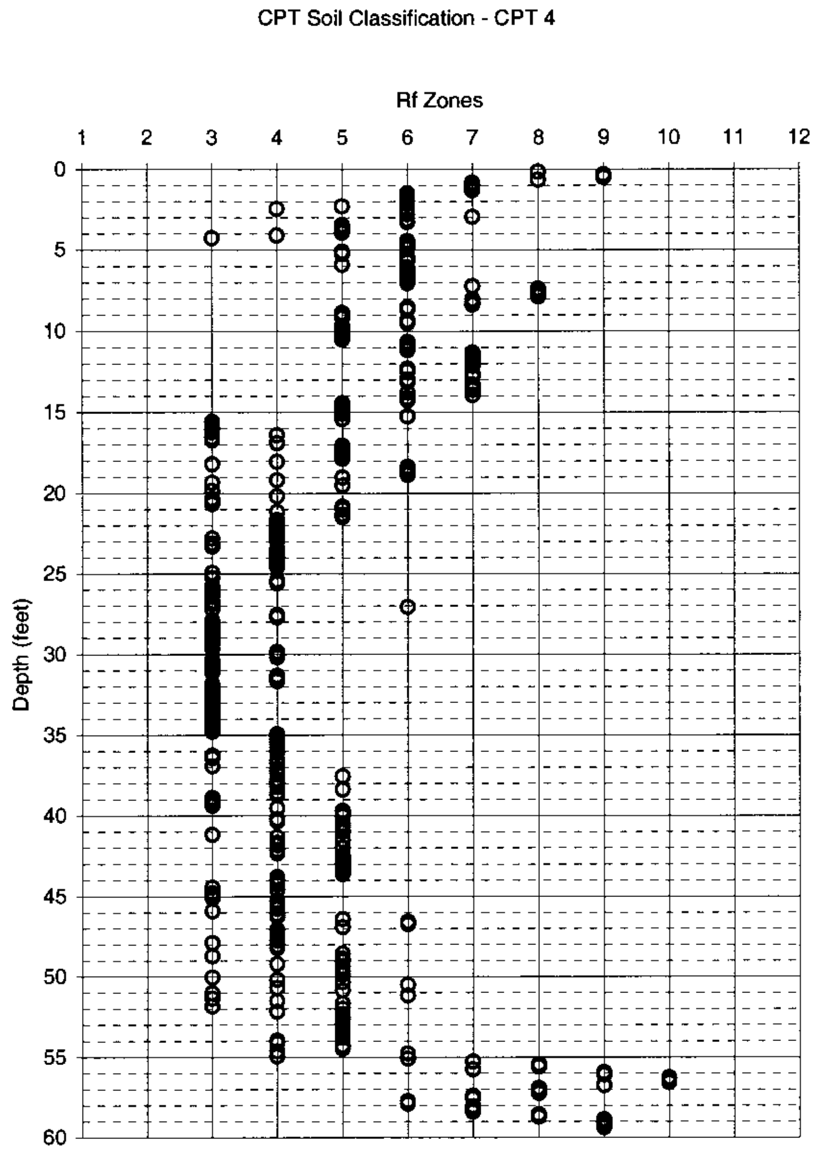


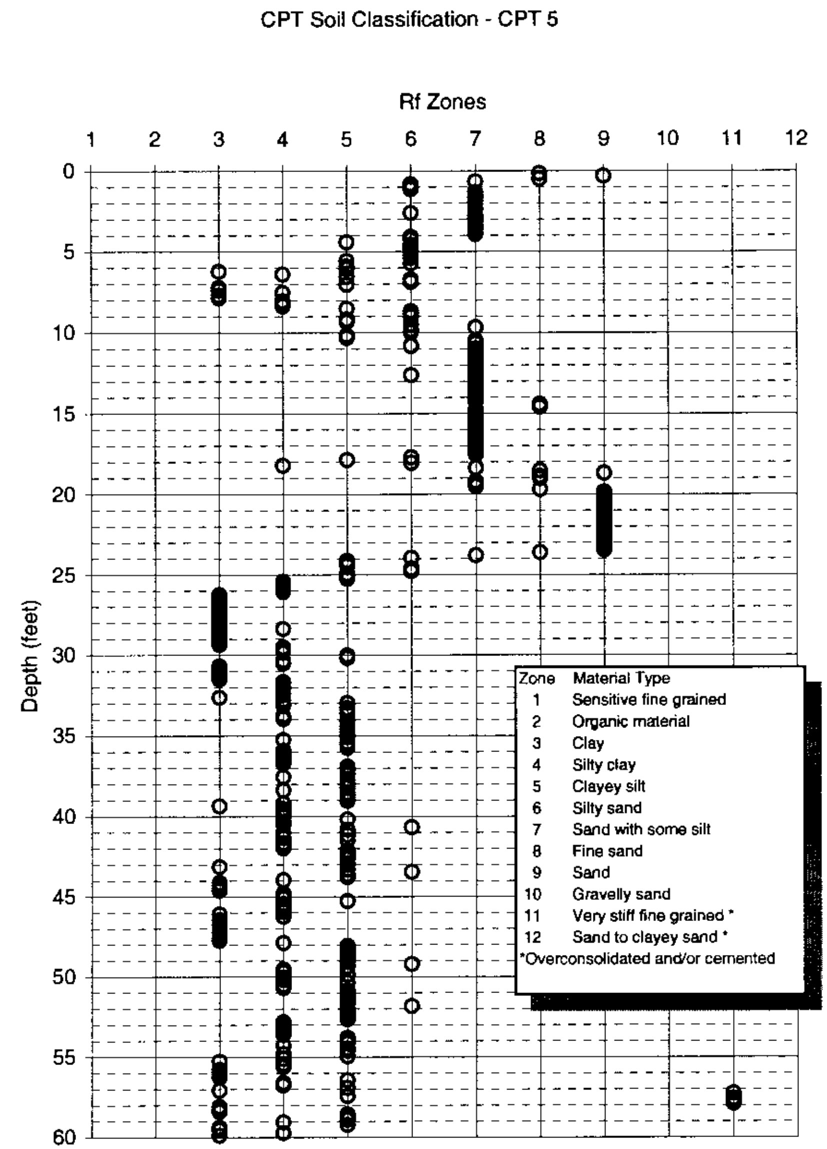
CPT Soil Classification - CPT 3



[08/28/2000 3:07 PM cptint1.xls]

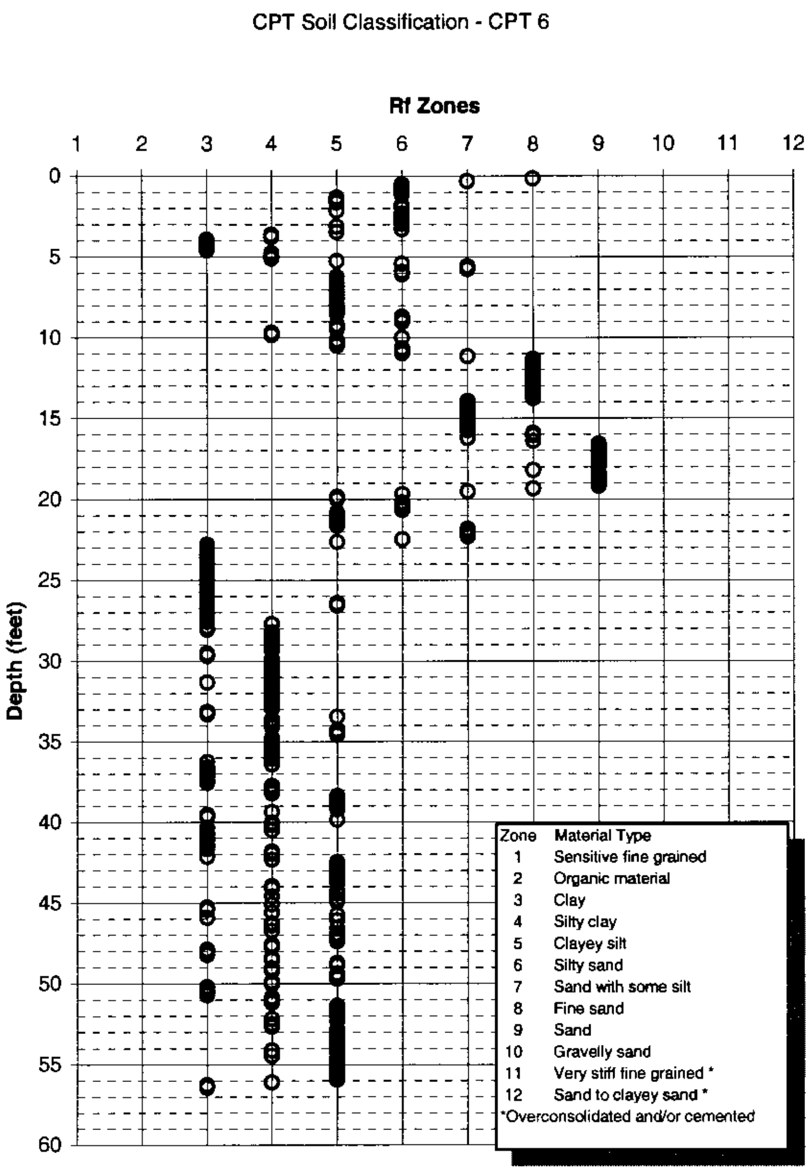
Figure 2.2

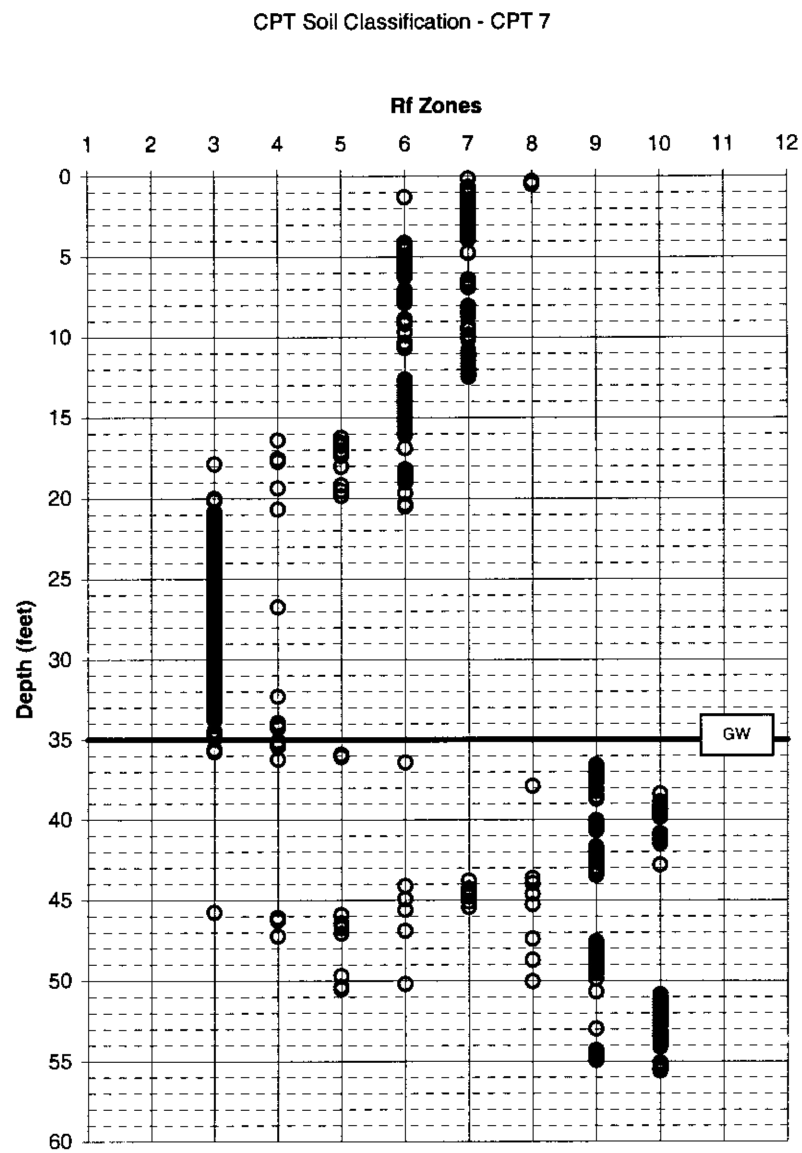




[08/28/2000 3:07 PM cptint1.xls]

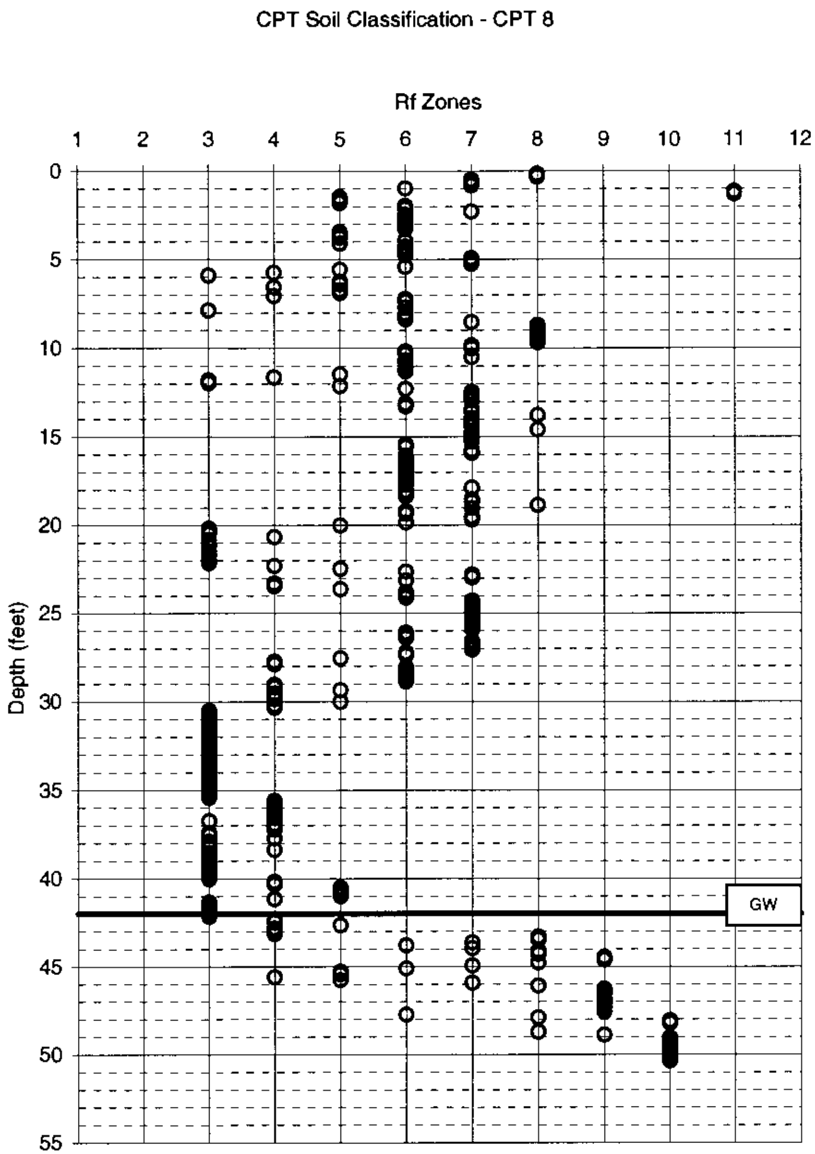
Figure 2.3

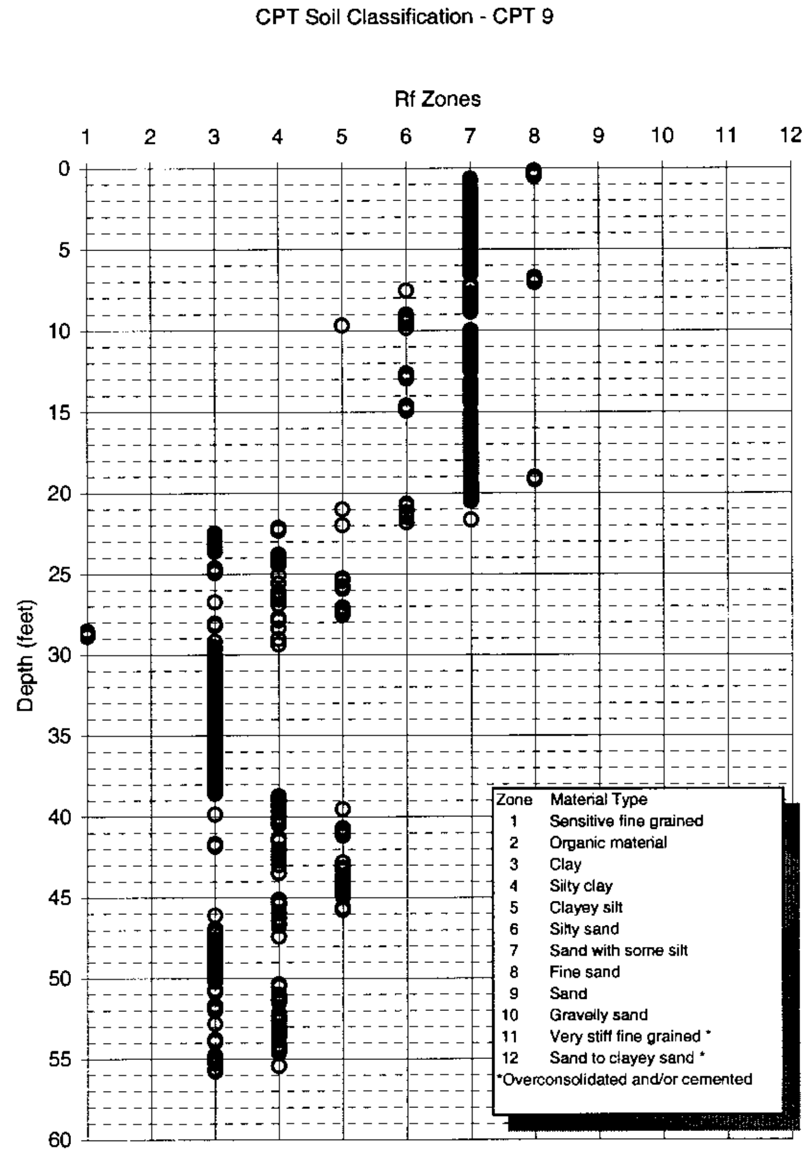




[08/28/2000 4:08 PM cptint1.xls]

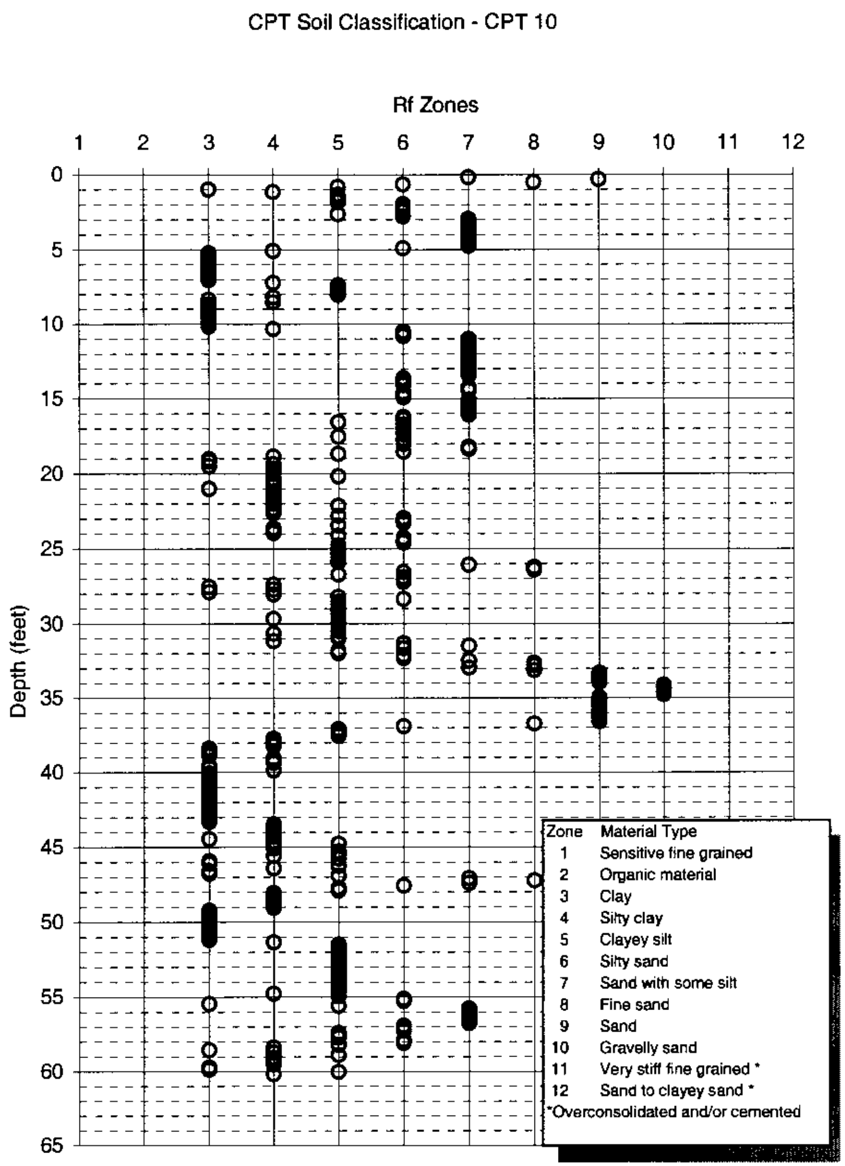
Figure 2.4





[08/28/2000 3:09 PM cptint2.xls]

Figure 2.5


CPT Soil Classification - CPT 10
Rf Zones
Depth (feet)
Zone Material Type
1 Sensitive fine grained
2 Organic material
3 Clay
4 Silty clay
5 Clayey silt
6 Silty sand
7 Sand with some silt
8 Fine sand
9 Sand
10 Gravelly sand
11 Very stiff fine grained *
12 Sand to clayey sand *
*Overconsolidated and/or cemented

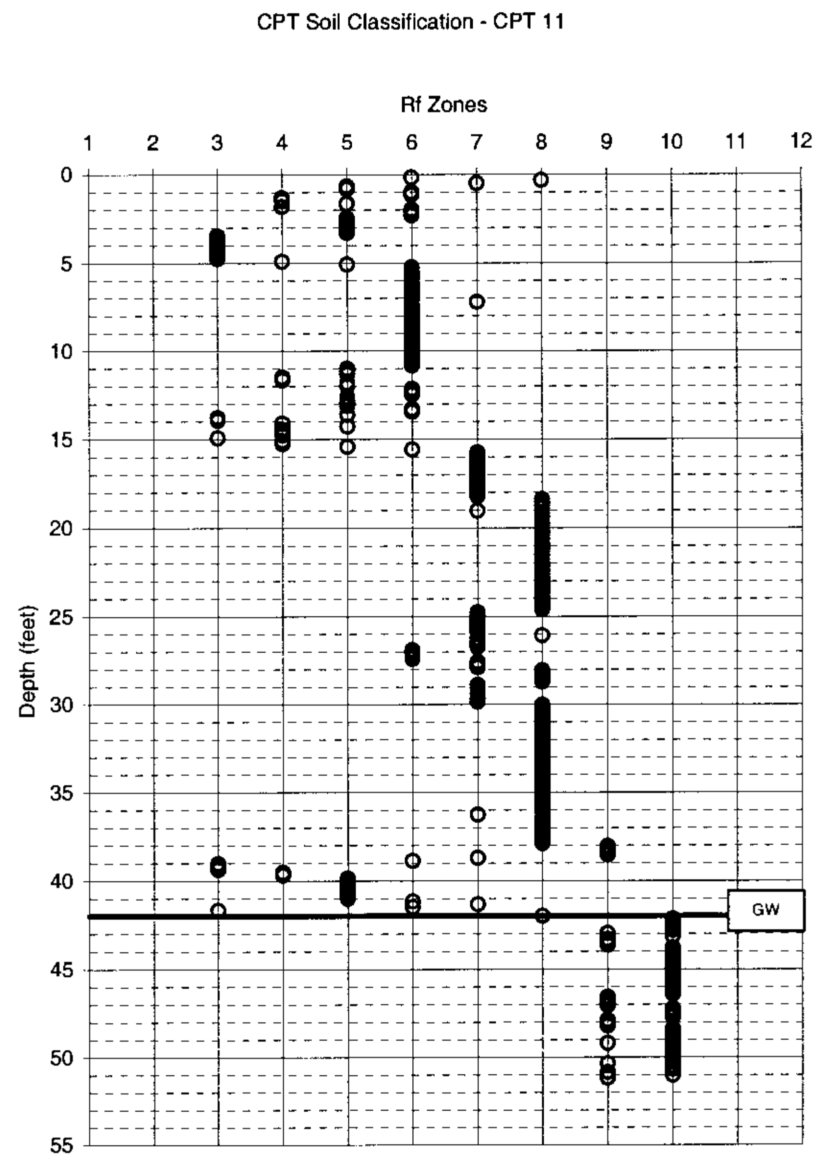
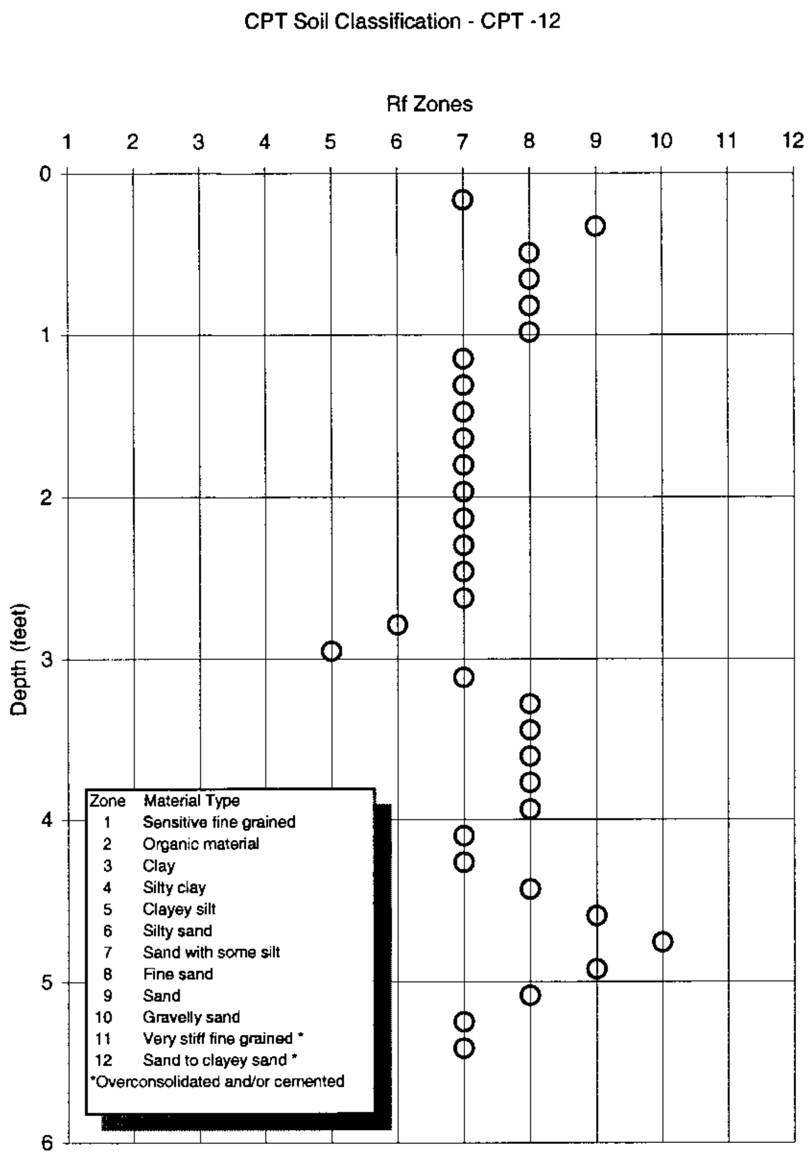
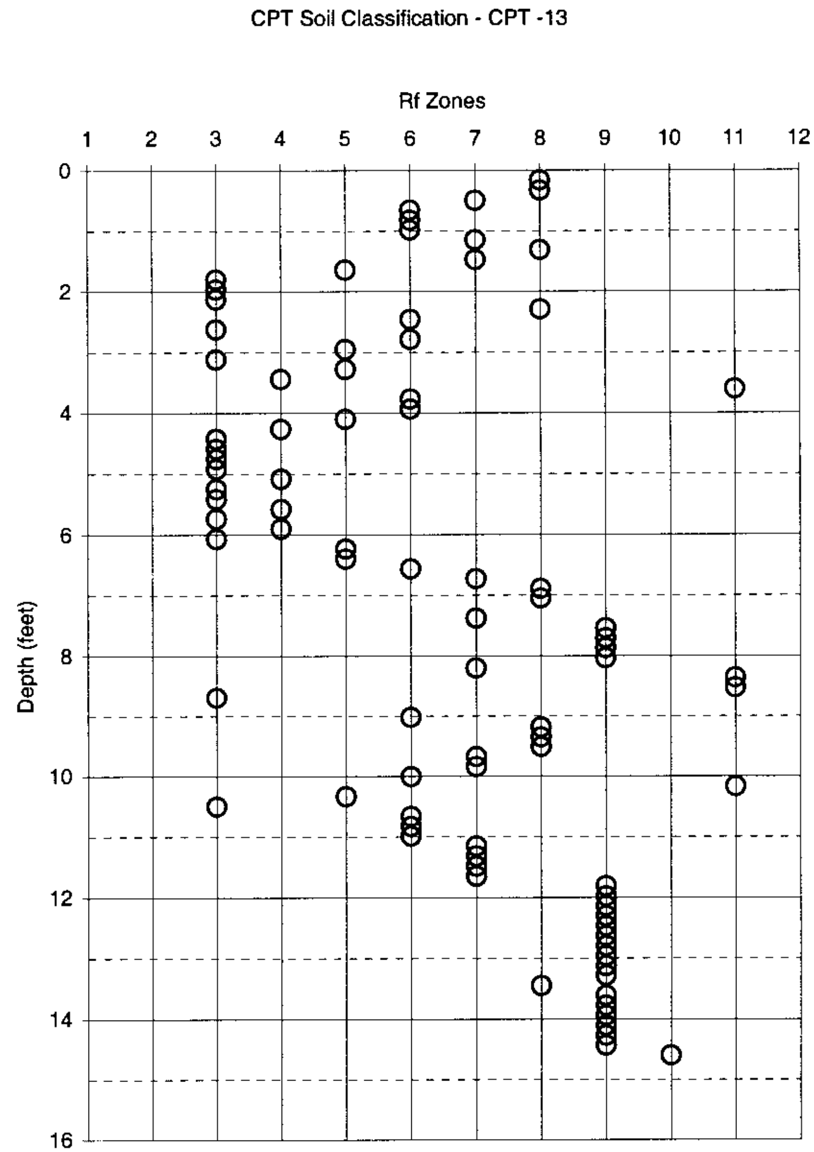

CPT Soil Classification - CPT 11
Rf Zones
Depth (feet)
GW

Figure 2.6

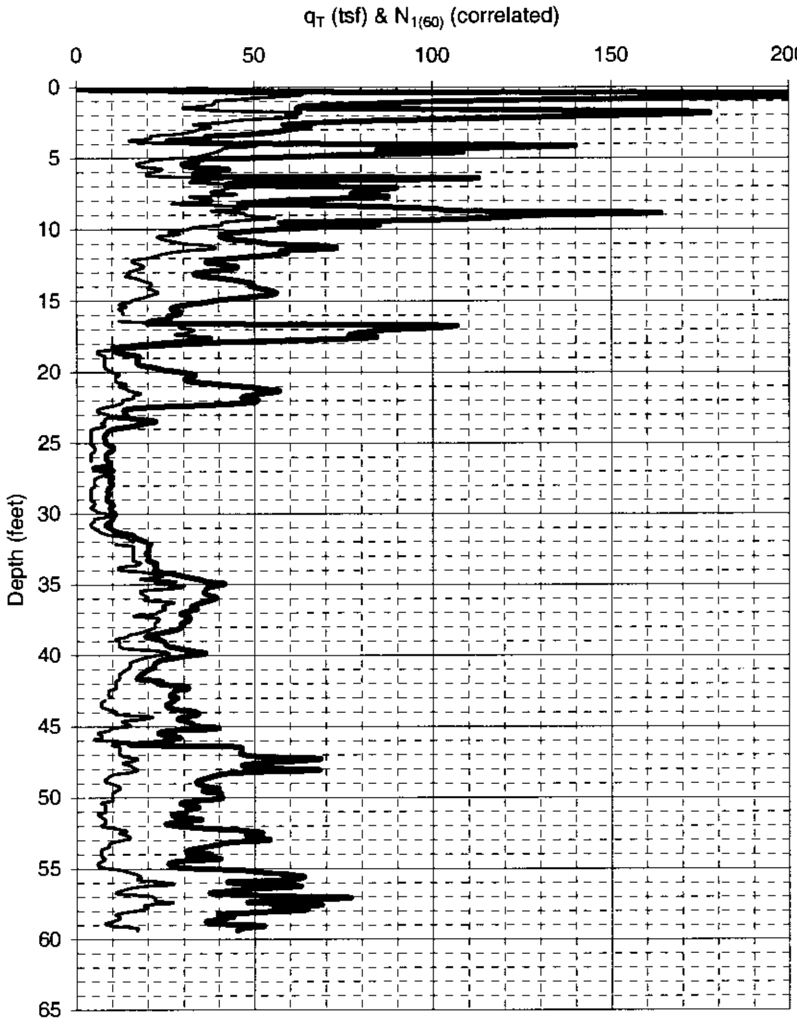




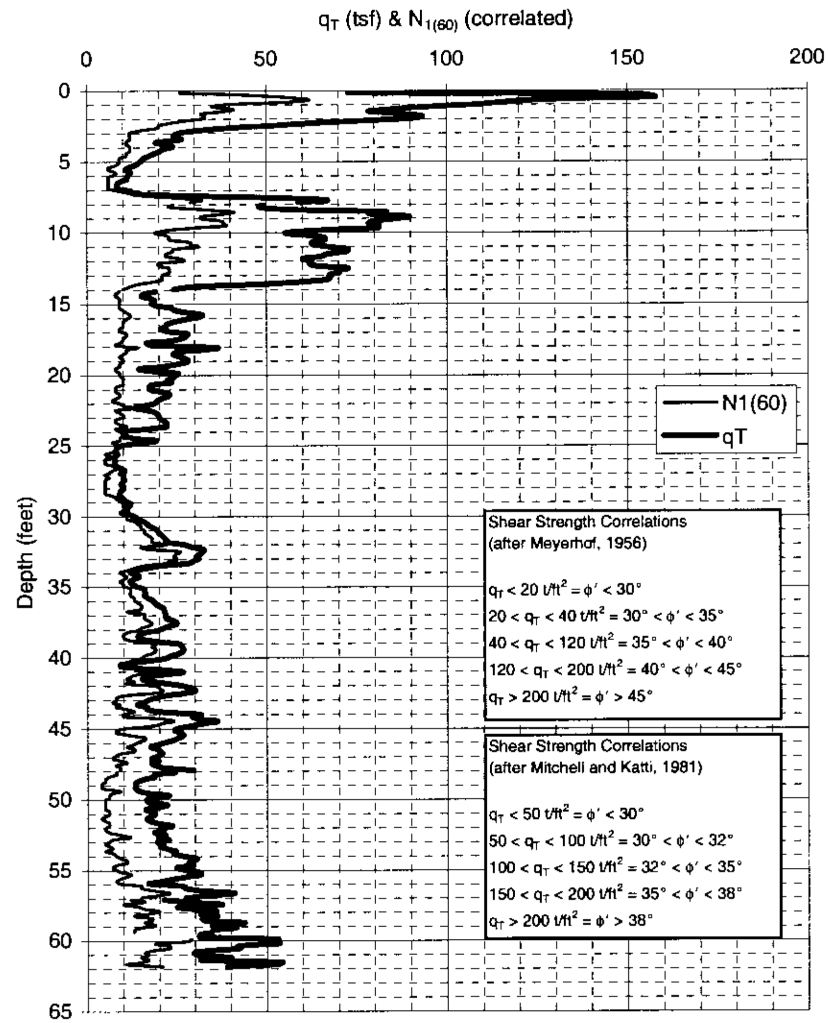
[08/28/2000 4:09 PM cptint2.xls]

Figure 2.7

Cache Creek CPT -2



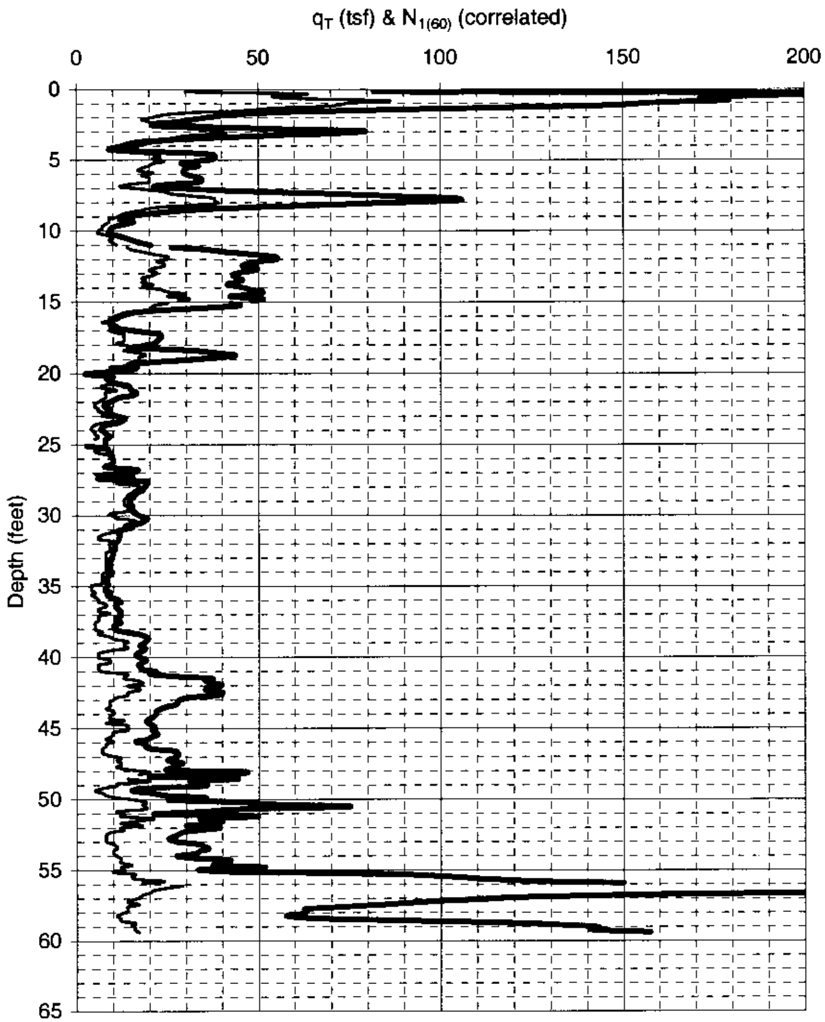
Cache Creek CPT -3



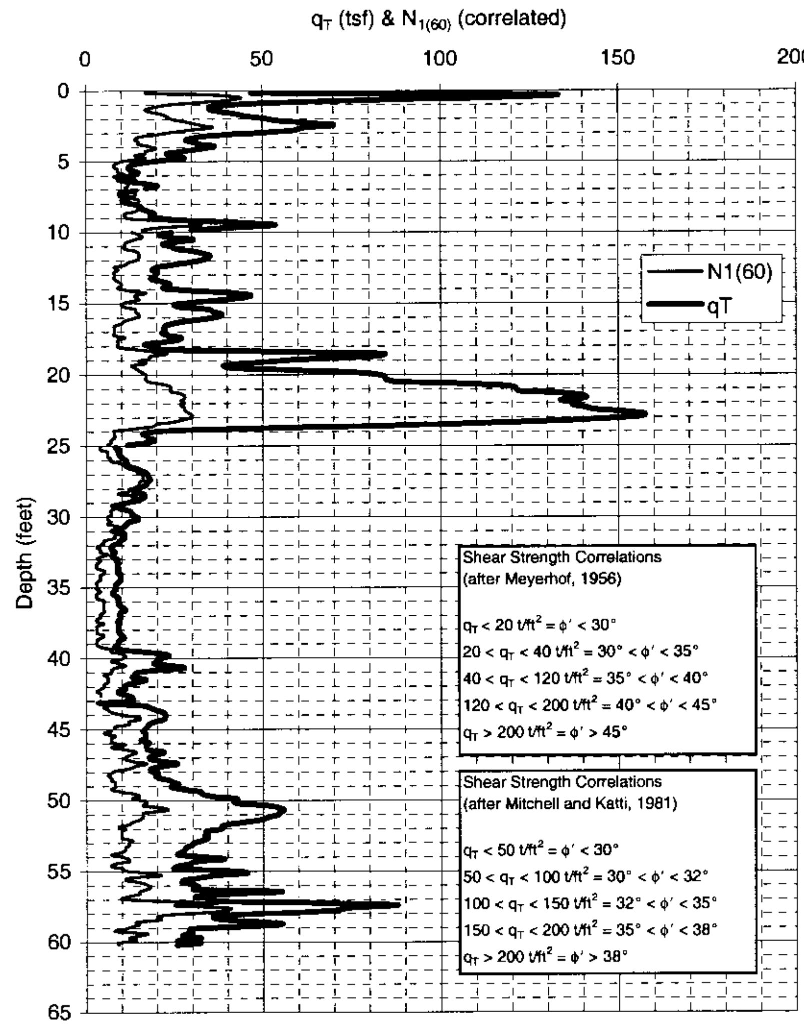
[08/28/2000 3:12 PM cptint1.xls]

Figure 2.8

Cache Creek CPT -4

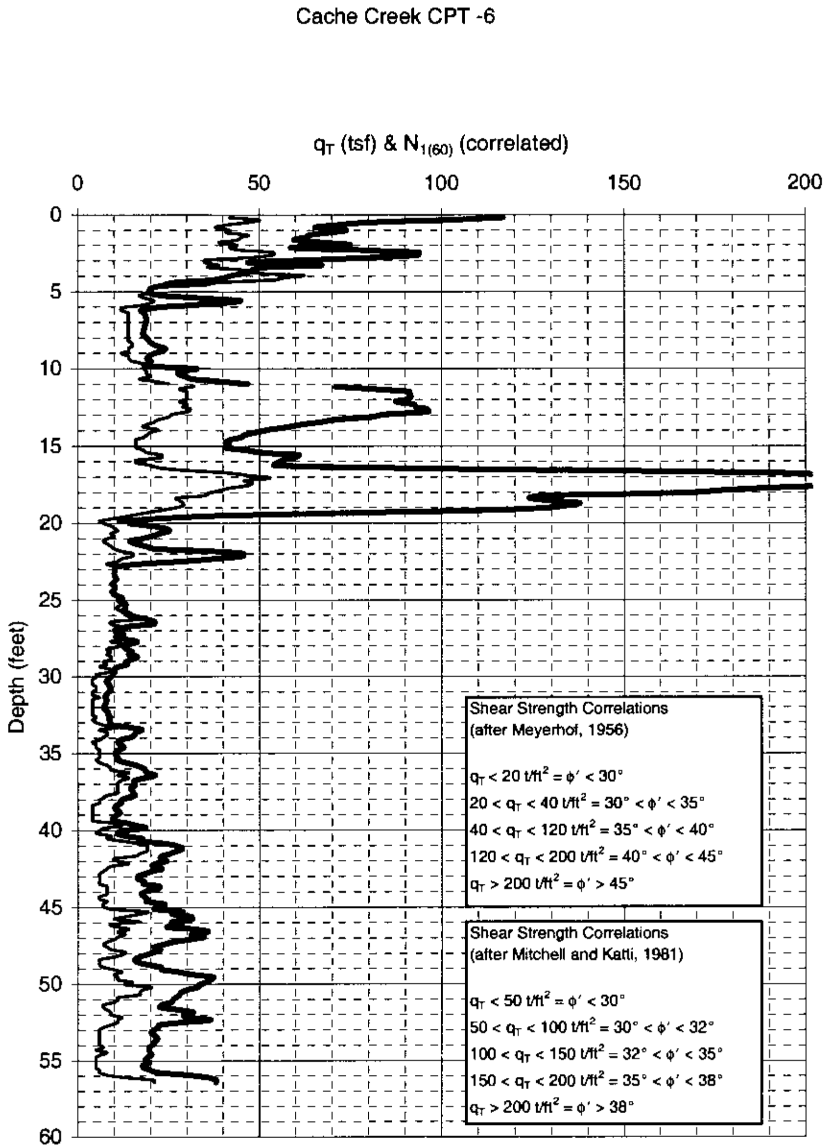


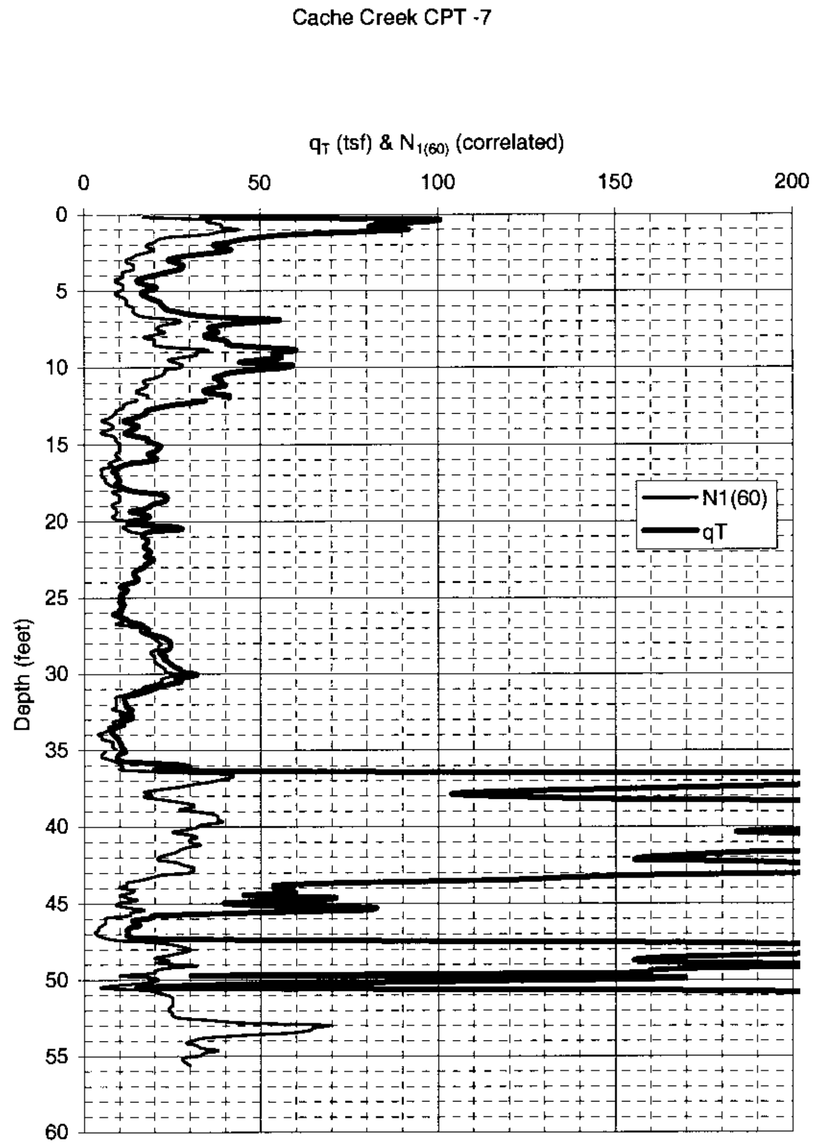
Cache Creek CPT -5



[08/28/2000 3:13 PM cptint1.xls]

Figure 2.9

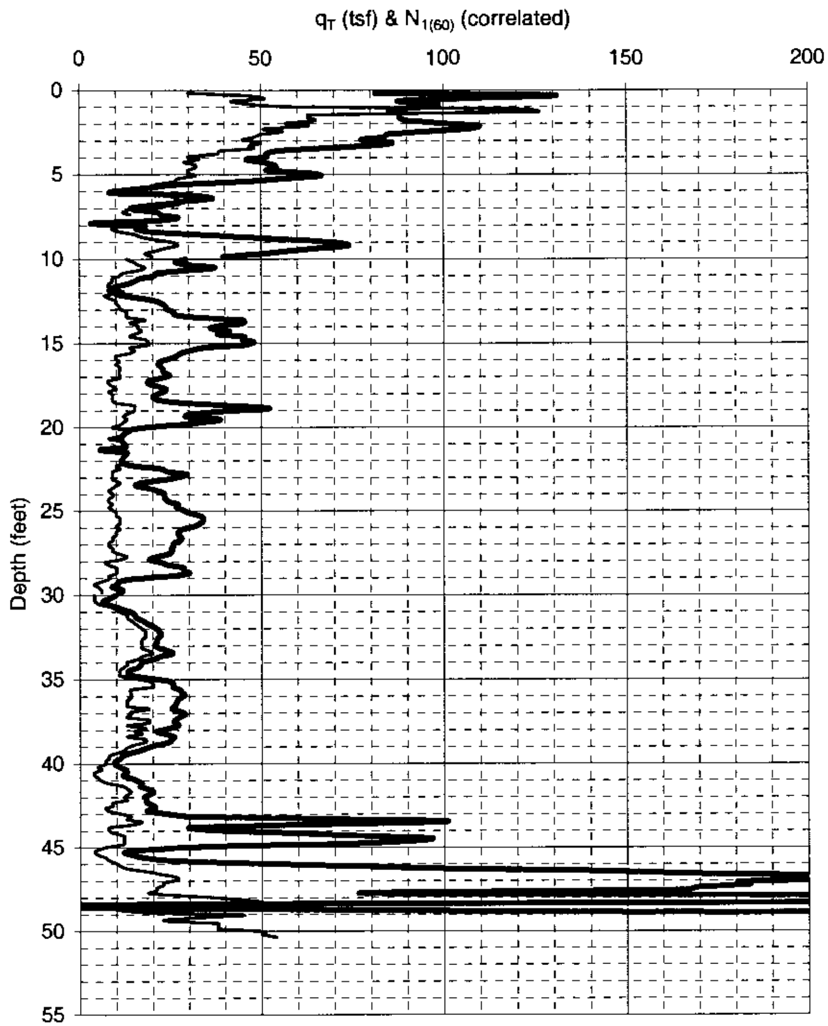




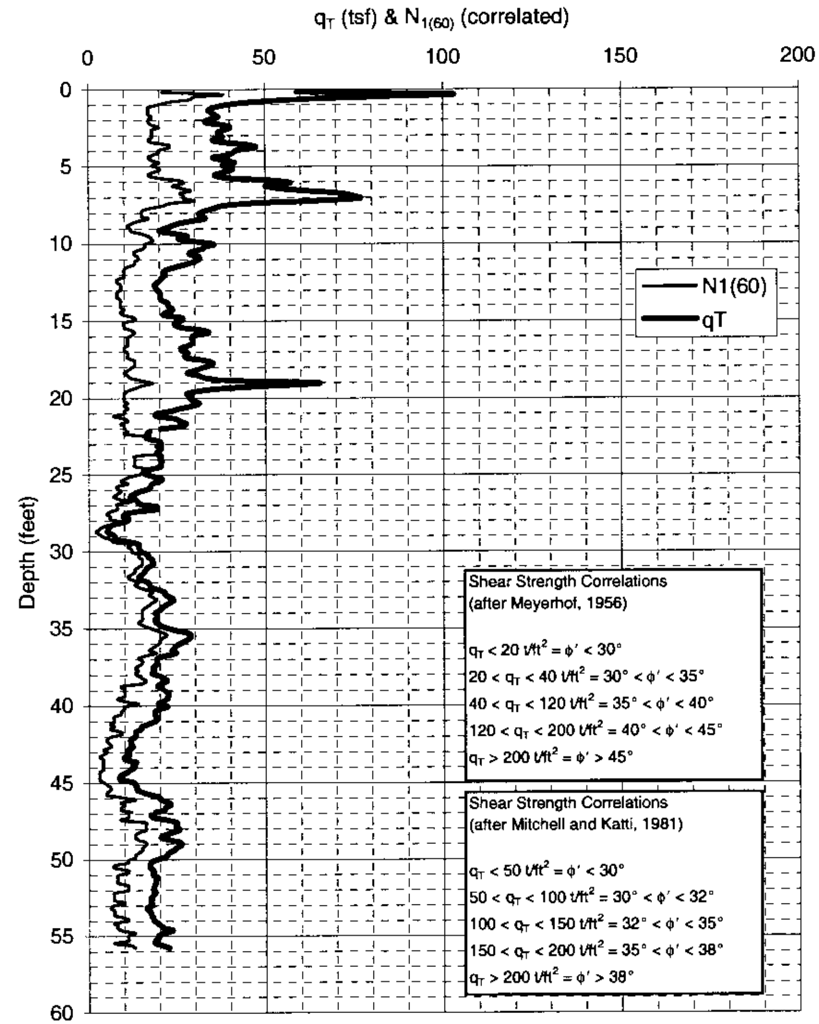
[08/28/2000 3:18 PM cptint1.xls]

Figure 2.10

Cache Creek CPT -8

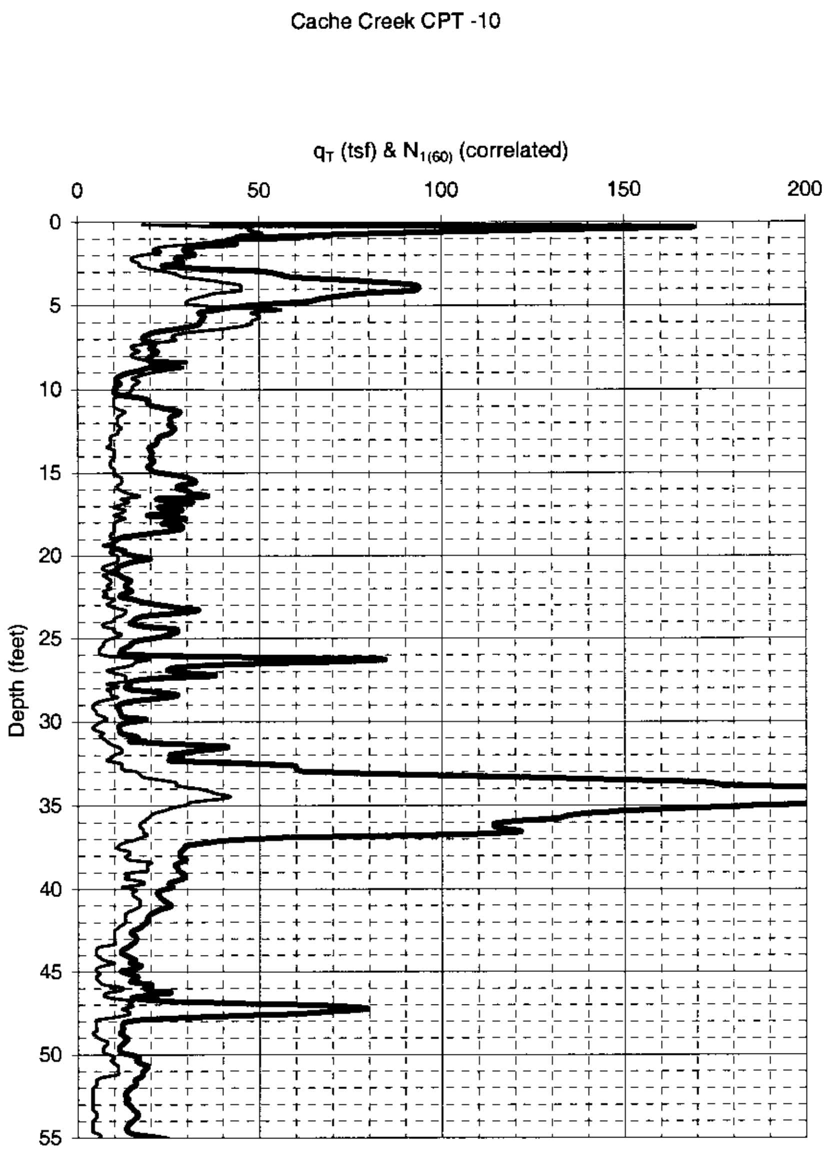


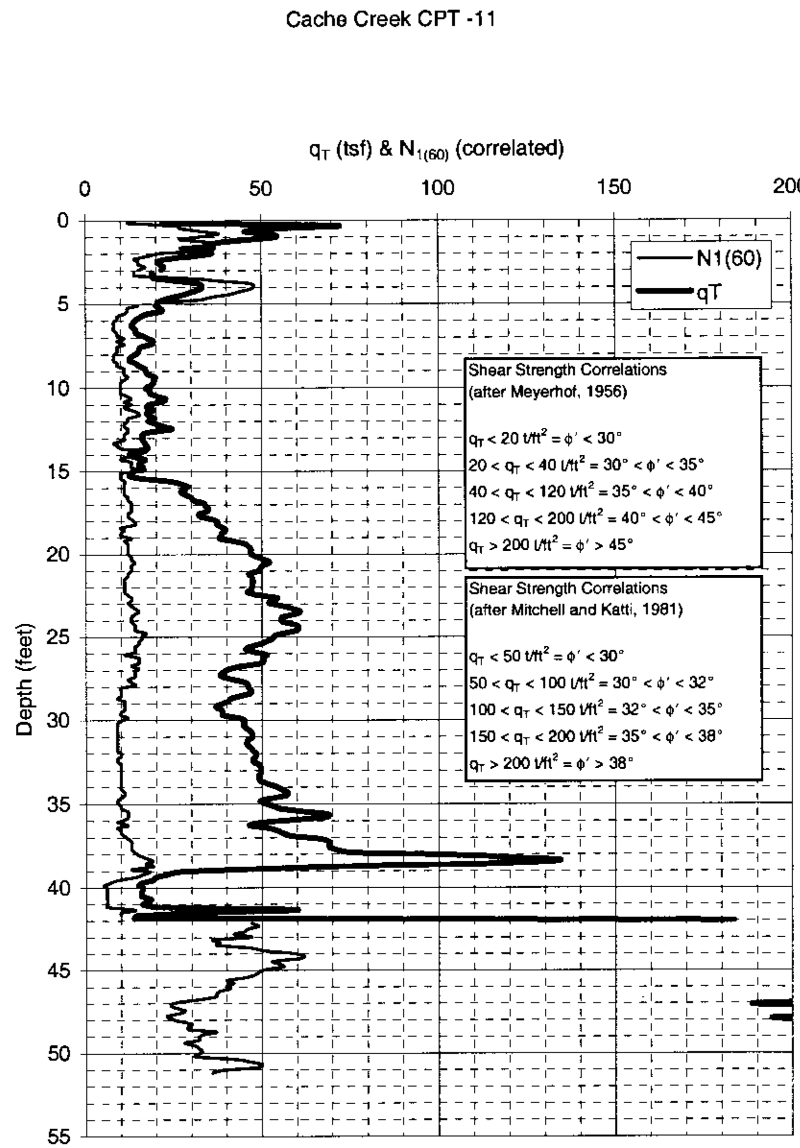
Cache Creek CPT -9



[08/28/2000 3:14 PM cptint2.xls]

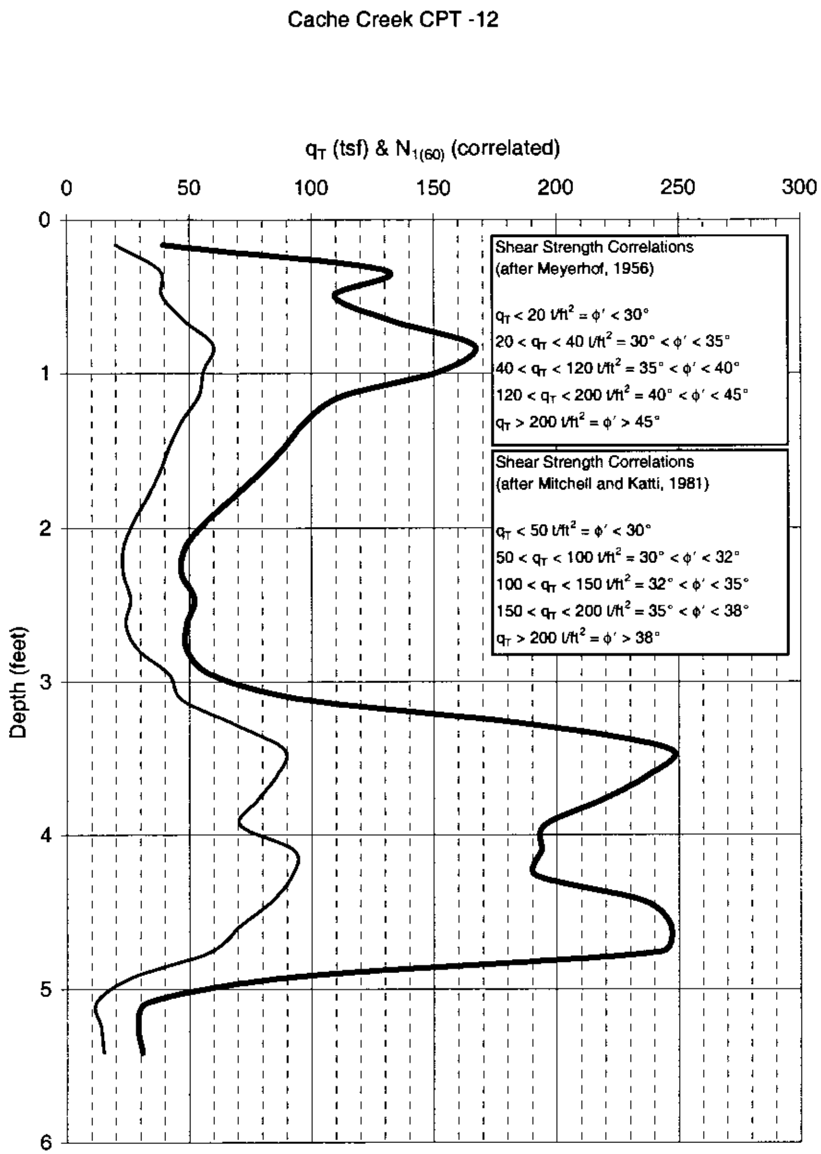
Figure 2.11

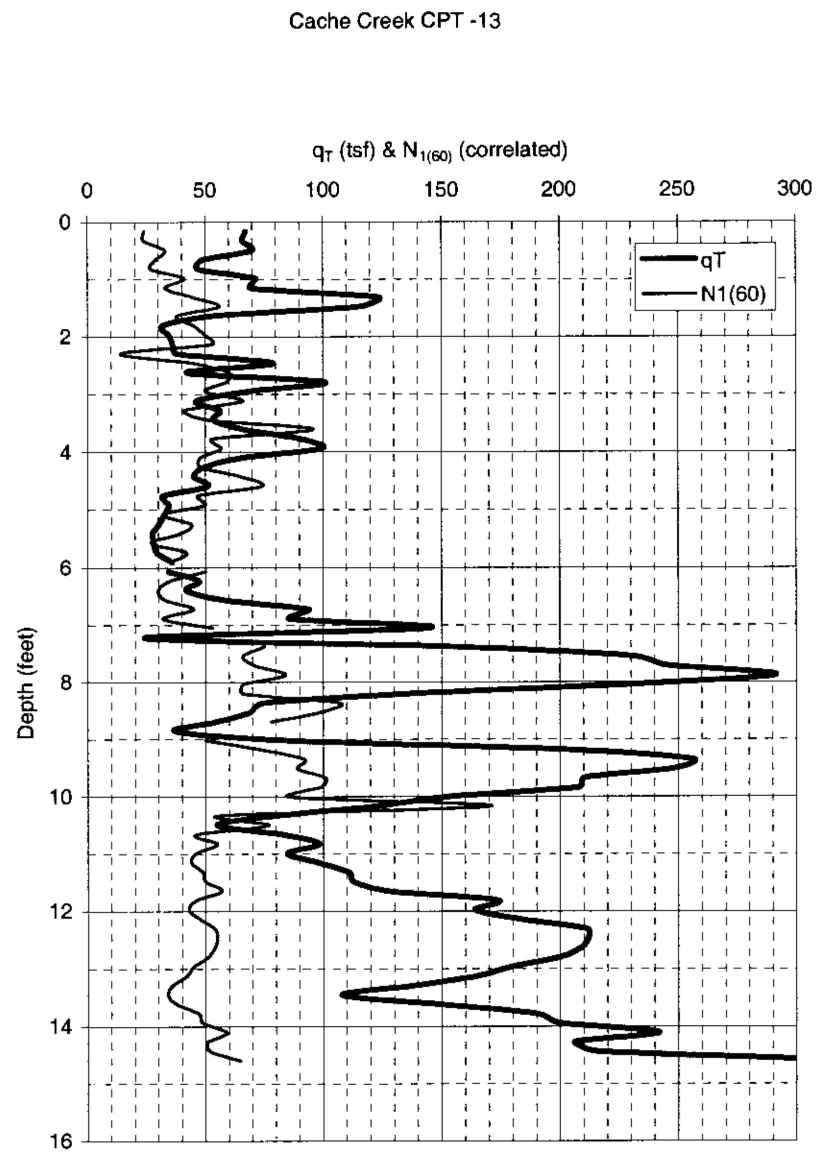




[08/28/2000 3:15 PM cptint2.xls]

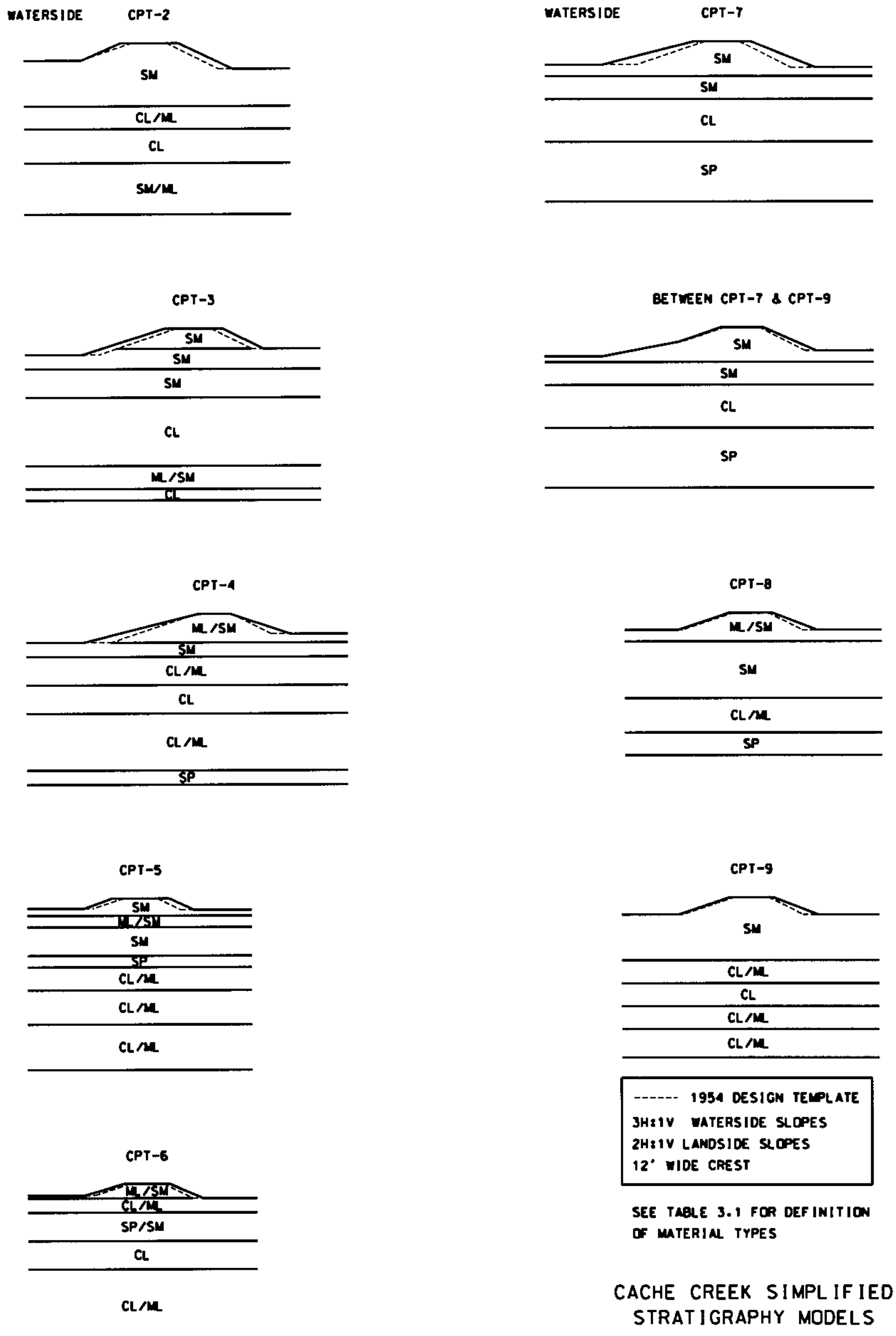
Figure 2.12





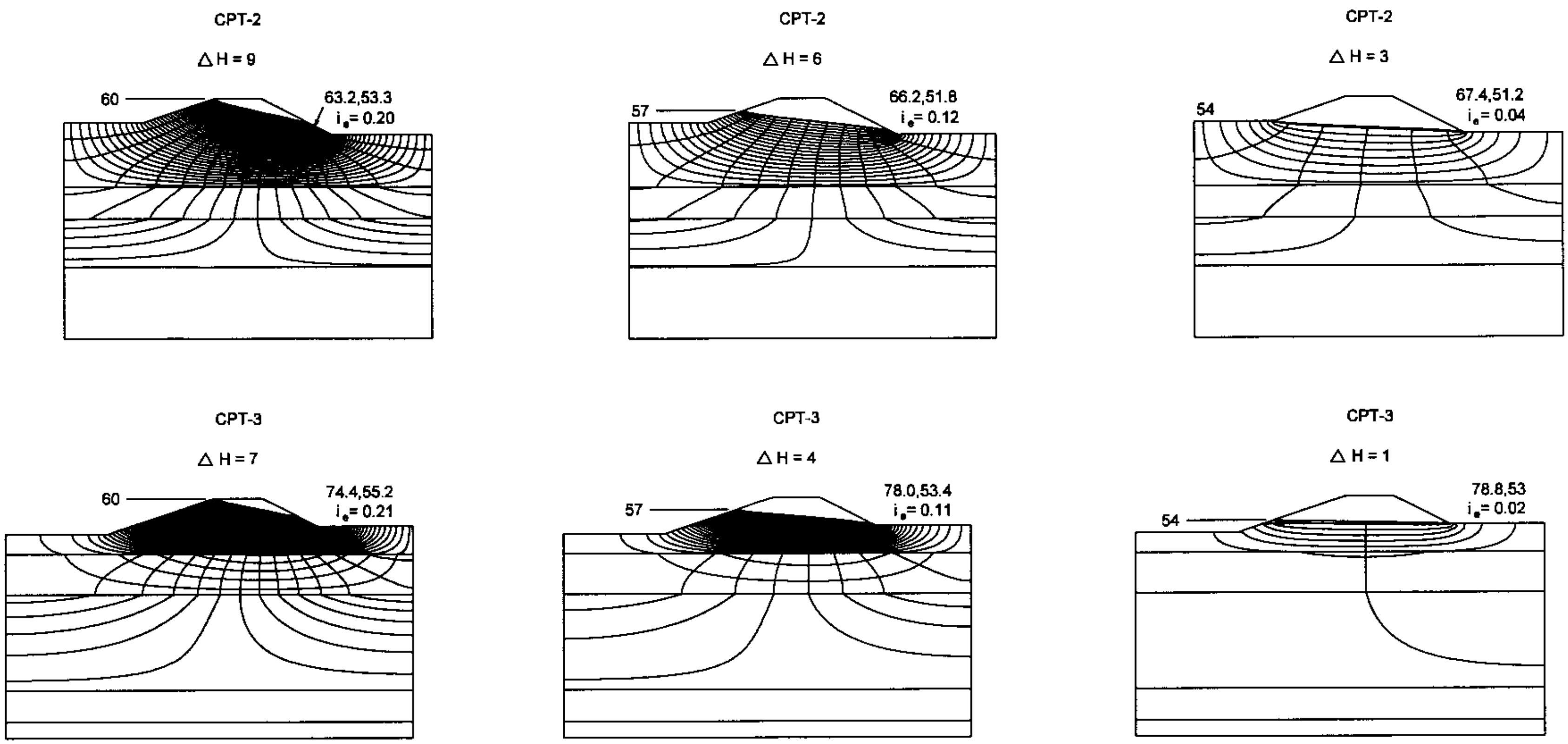
[08/28/2000 3:16 PM cptint2.xls]

Figure 2.13



CACHE CREEK SIMPLIFIED STRATIGRAPHY MODELS

FIGURE 2.14

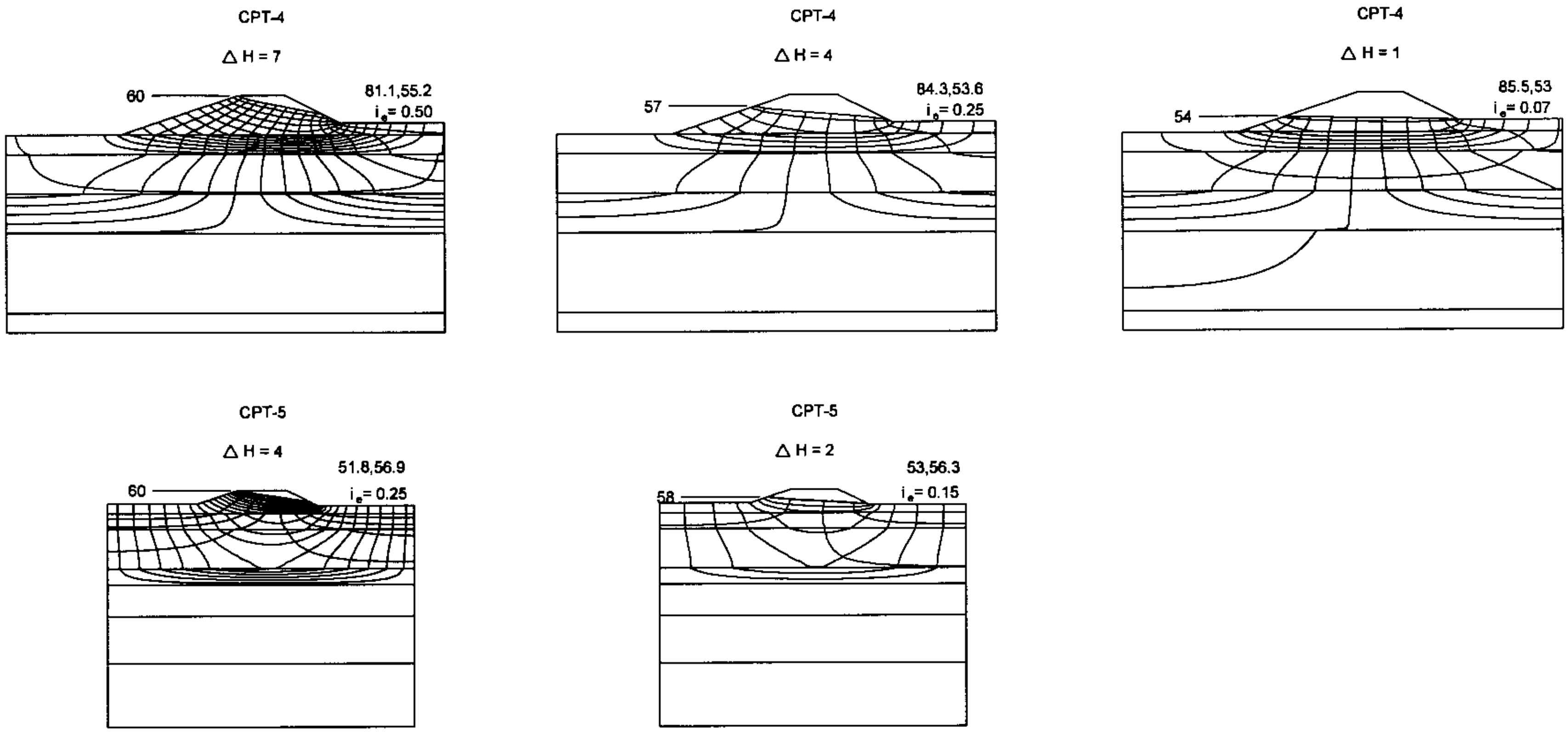


CACHE CREEK CPT'S 2 AND 3
RISK-BASED SEEPAGE ANALYSES

NOTES:
1) COORDINATES SHOWN ARE NOT ELEVATIONS

FIGURE 4.1

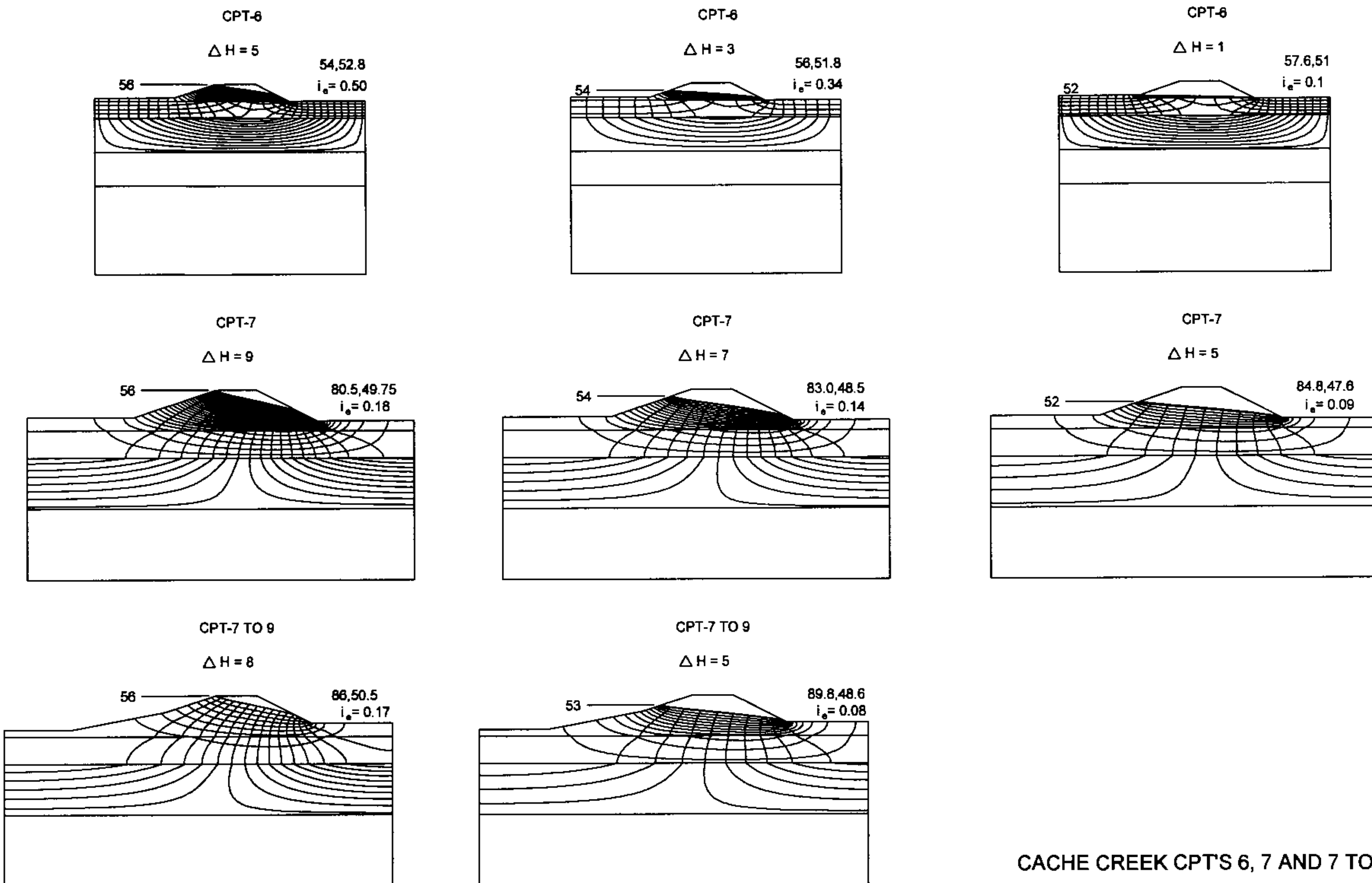
...\westside tribs\flownets2.dgn Aug. 28, 2000 15:28:47



CACHE CREEK CPT'S 4 AND 5
RISK-BASED SEEPAGE ANALYSES

NOTES:
1) COORDINATES SHOWN ARE NOT ELEVATIONS

FIGURE 4.2

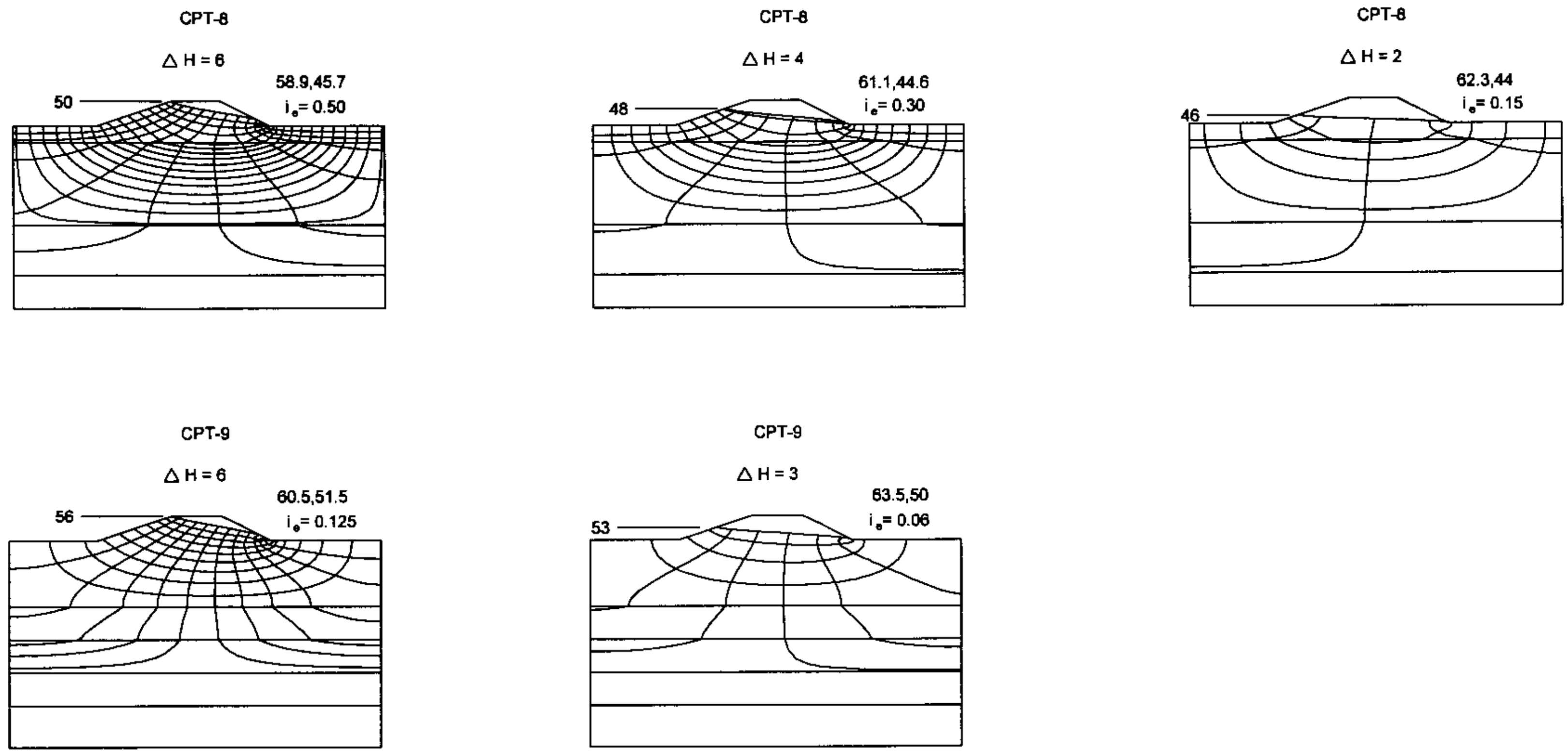


CACHE CREEK CPT'S 6, 7 AND 7 TO 9
RISK-BASED SEEPAGE ANALYSES

NOTES:
1) COORDINATES SHOWN ARE NOT ELEVATIONS

FIGURE 4.3

...\westside tribs\flownets2.dgn Aug. 28, 2000 15:29:01



CACHE CREEK CPT'S 8 AND 9
RISK-BASED SEEPAGE ANALYSES

NOTES:
1) COORDINATES SHOWN ARE NOT ELEVATIONS

FIGURE 4.4

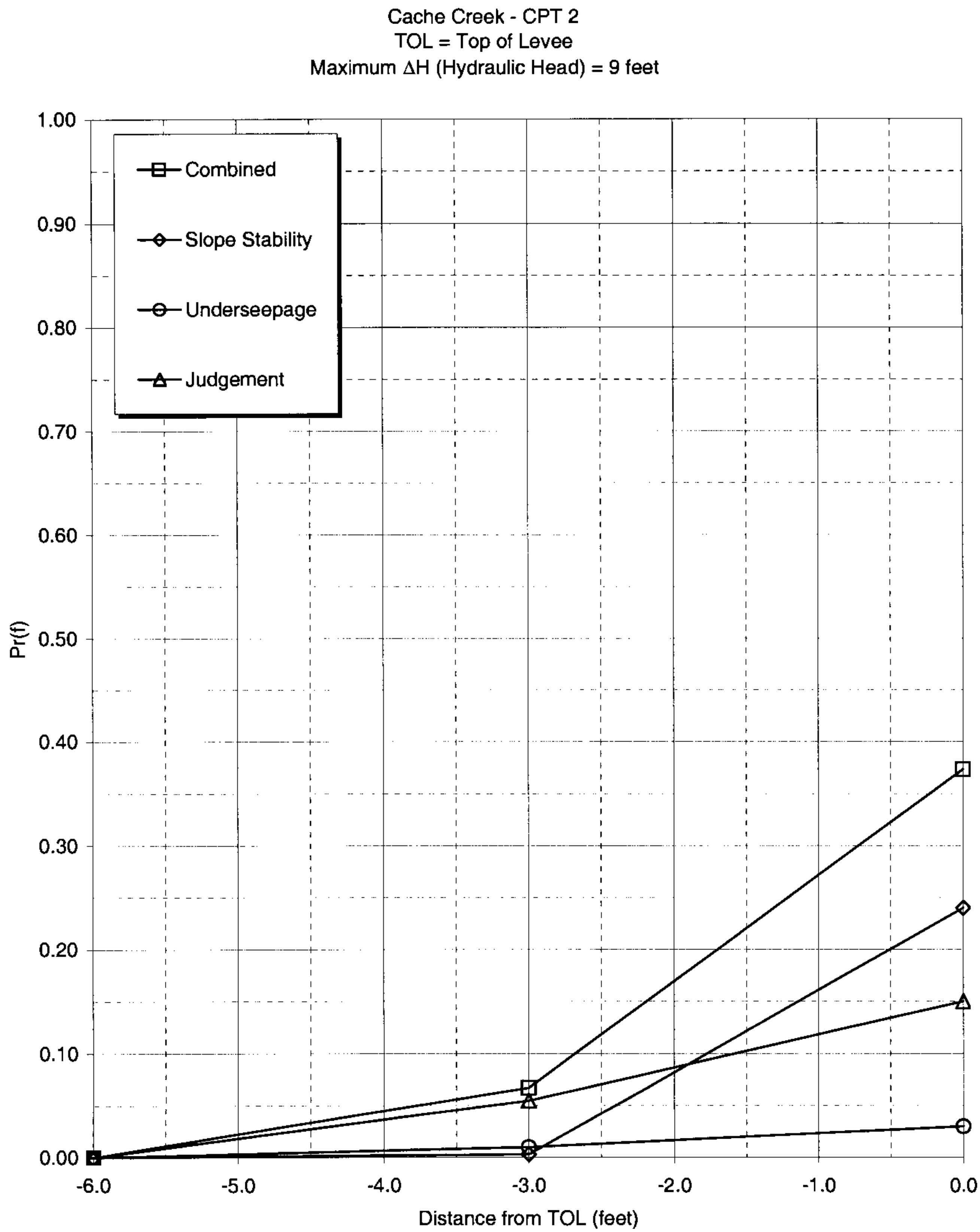

Cache Creek - CPT 2
TOL = Top of Levee
Maximum ΔH (Hydraulic Head) = 9 feet
Combined
Slope Stability
Underseepage
Judgement
Pr(f)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-6.0
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
Distance from TOL (feet)

Figure 4.5

Cache Creek - CPT 6
TOL = Top of Levee
Maximum ΔH (Hydraulic Head) = 5 feet

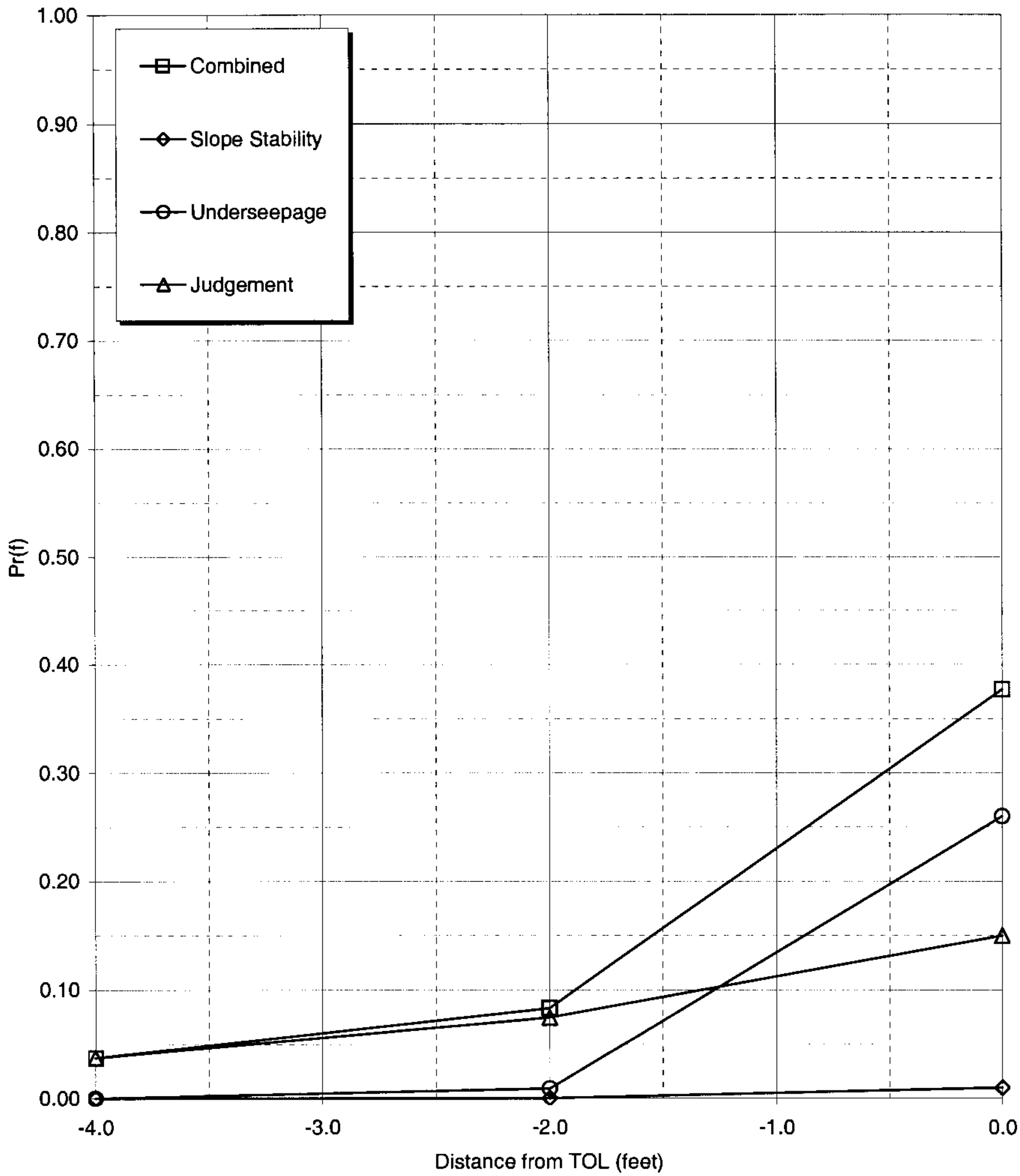
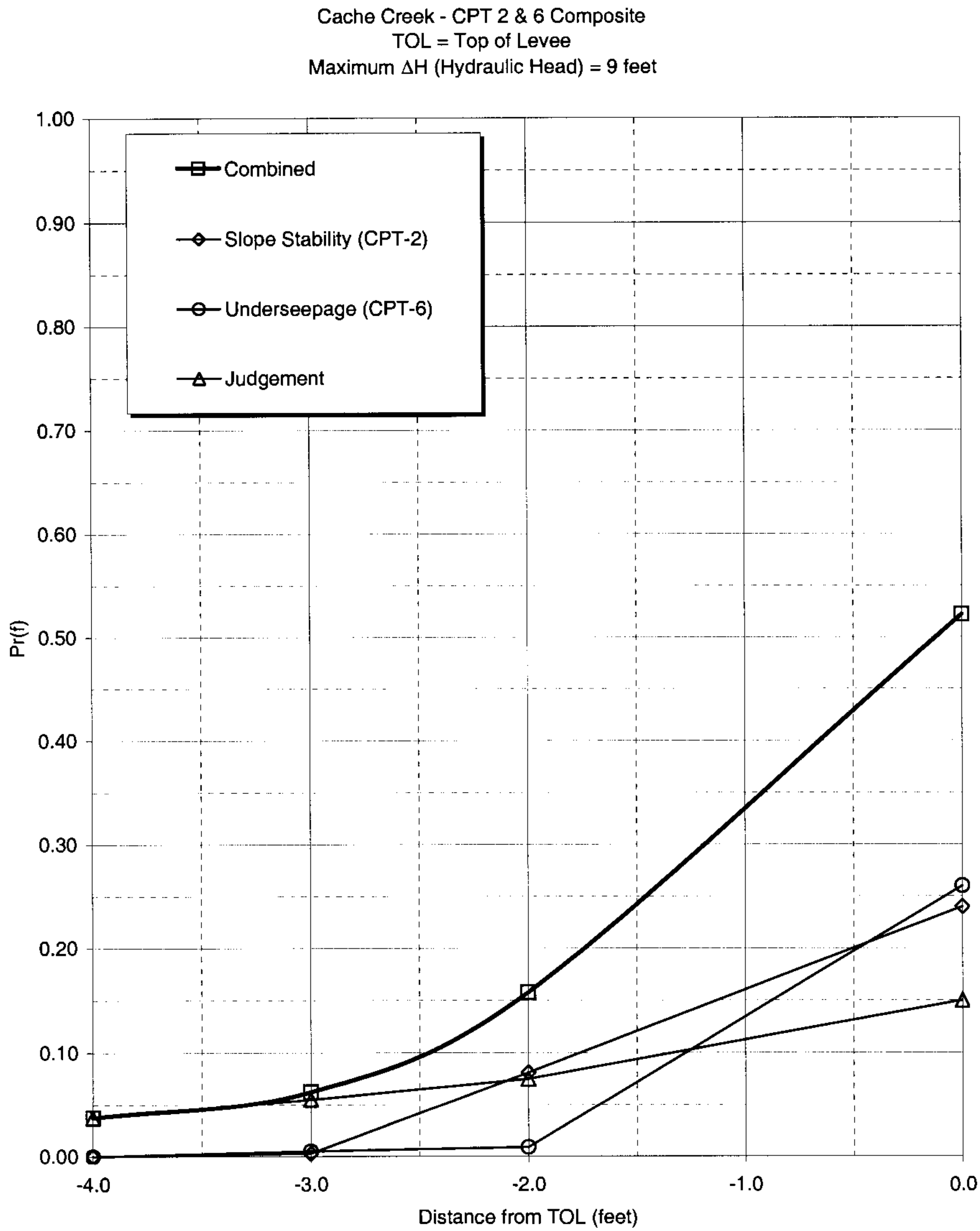


Figure 4.6



Cache Creek - CPT 2 & 6 Composite
TOL = Top of Levee
Maximum ΔH (Hydraulic Head) = 9 feet
Combined
Slope Stability (CPT-2)
Underseepage (CPT-6)
Judgement
Pr(f)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-4.0
-3.0
-2.0
-1.0
0.0
Distance from TOL (feet)

Figure 4.7

REDRAWN FROM 1958 ORIGINAL

2F–8–1
Elev. 90.0

DEPTH 0.0 – 25.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		2	98		NP	21	SILT
ML		13	87		NP	32	SANDY SILT
ML		43	57		NP	26	
SM	37	49	14		NP	4	SILTY GRAVELLY SAND
SP	46	47	7		NP	4	GRAVELLY SAND
GP	57	39	4		NP	3	SANDY GRAVEL
SP	44	51	5		NP	5	GRAVELLY SAND
SP		94	6		NP	8	SAND
							WATER JUNE 58
SP	33	61	6		NP	11	GRAVELLY SAND

2F–8–2
Elev. 92.0

DEPTH 0.0 – 35.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		17	83		NP	14	SANDY SILT
CL		8	92	37	16	28	CLAY
CL		11	89	35	13	24	
SM		68	32		NP	10	SILTY SAND
SM		81	19		NP	9	
CL		22	78	31	12	22	SANDY CLAY
CL		6	94	42	21	19	CLAY
CL		5	95	39	20	18	
CL		10	90	41	20	23	
CL		8	92	42	21	26	
CL		11	89	39	17	28	

2F–8–3
Elev. 87.1

DEPTH 0.0 – 25.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		17	83		NP	12	SANDY SILT
ML		9	91		NP	13	SILT
ML		16	84		NP	11	SANDY SILT
ML		6	94		NP	18	SILT
SM		51	49		NP	12	SILTY SAND
SM		67	33		NP	12	
CL		30	70	30	11	25	SANDY CLAY
CL		8	92	44	21	27	CLAY
CL		14	86	42	20	24	SANDY CLAY

2F–8–4
Elev. 83.8

DEPTH 0.0 – 30.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		28	72		NP	8	SANDY SILT
SM		50	50		NP	12	SILTY SAND
ML		37	63		NP	17	SANDY SILT
ML		47	53		NP	12	
ML		4	96		NP	35	SILT
ML		21	79		NP	29	SANDY SILT
CL		20	80	41	18	28	SANDY CLAY
ML		35	65		NP	19	SANDY SILT
CL		15	85	34	12	26	C SANDY CLAY
CL		15	85	36	15	27	

2F–8–5
Elev. 83.5

DEPTH 0.0 – 30.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		37	63		NP	10	SANDY SILT
ML		39	61		NP	18	
SM		59	41		NP	11	SILTY SAND
CL		24	76	31	11	23	SANDY CLAY
CL		4	96	35	11	33	CLAY
CL		19	81	40	19	26	SANDY CLAY
CL		29	71	30	12	20	
CL		10	90	37	13	28	C CLAY
CL		10	90	44	20	26	

2F–8–6
Elev. 83.4

DEPTH 0.0 – 30.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		42	58		NP	7	SANDY SILT
ML		35	65		NP	18	
ML		17	83		NP	21	
ML		30	70		NP	20	
ML		5	95		NP	32	SILT
ML		10	90		NP	35	
ML		32	68		NP	18	SANDY SILT
CL		10	90	36	15	28	CLAY

2F–8–7
Elev. 75.9

DEPTH 0.0 – 27.5'

Class	GR	SA	FI	LL	PI	MC	Description
SP		96	4		NP	4	SAND
SP		95	5		NP	3	
SM		82	18		NP	8	SILTY SAND
SP		95	5		NP	3	SAND
SM		65	35		NP	9	SILTY SAND
SM		56	44		NP	10	
SM	24	58	18		NP	12	SILTY GRAVELLY SAND
SP	34	62	4	26	10	4	GRAVELLY SAND
CL		23	77	37	19	11	SANDY CLAY

2F–8–8
Elev. 67.0

DEPTH 0.0 – 35.0'

Class	GR	SA	FI	LL	PI	MC	Description
CL		25	75	30	12	12	SANDY CLAY
CL		16	84	32	12	15	
SM		58	42		NP	10	SILTY SAND
ML		48	52		NP	18	SANDY SILT
SP	9	86	5		NP	3	SAND
SM	39	48	13		NP	6	SILTY GRAVELLY SAND
ML		3	97	35	10	36	SILT
CH		8	92	53	28	30	FAT CLAY
CL		16	84	39	21	20	SANDY CLAY
CL		26	74	33	16	24	
CL		25	75	29	10	27	

2F–8–9
Elev. 70.3

DEPTH 0.0 – 25.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		25	75		NP	13	SANDY SILT
ML		36	64		NP	15	
ML		47	53		NP	13	
ML		5	95		NP	29	SILT
ML		33	67		NP	20	SANDY SILT
SP	17	76	7		NP	10	GRAVELLY SAND
SP	5	74	11		NP	10	
SM		51	49		NP	22	SILTY SAND
CH		19	81	53	26	38	SANDY FAT CLAY

2F–8–10
Elev. 50.4

DEPTH 0.0 – 24.0'

Class	GR	SA	FI	LL	PI	MC	Description
ML		16	84		NP	23	SANDY SILT
ML		17	83		NP	24	
CL		29	71	28	10	19	SANDY CLAY
SP	15	80	5		NP	6	GRAVELLY SAND
ML		36	64		NP	30	SANDY SILT
SM	17	71	12		NP	6	SILTY GRAVELLY SAND
							WATER MAY 58
SM		86	14		NP	18	SILTY SAND
CH		4	96	54	28	37	FAT CLAY

LEGEND

GP Poorly-graded Gravels, Gravel-Sand mixtures, little or no fines.
SP Poorly-graded Sand, Gravelly Sand, little or no fines.
SM Silty Sand, Sand-Silt mixtures.
SC Clayey Sand, Sand-Clay mixtures.
ML Inorganic Silt and very fine Sand, Rock flour, Silty or Clayey fine Sand or Clayey Silt with low plasticity.
CL Inorganic Clay of low to medium plasticity, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay.
CH Inorganic Clay of high plasticity, Fat Clay.
GR Gravel.
SA Sand.
FI Fines.
LL Liquid Limit.
PI Plasticity Index.
MC Moisture Content.
C Cemented material.
N.P. Nonplastic.

NOTES

1. All classifications are laboratory classifications in accordance with the C. of E. "Unified Soil Classification System".
2. All holes were drilled to specified depth except holes 2F-8-7, 2F-8-10, 2F-8-11 and 2F-8-13 wwhere refusal was met due to caving sand and gravels.
3. Elevations are referred to C. of E. datum 3.0 feet below mean sea level.

GRAPHIC SCALE

1"=5' 0 1' 2.5' 5' 10' 15' 20' 25'

US Army Corps of Engineers
Sacramento District

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

CACHE CREEK CALIFORNIA
FLOOD CONTROL PROJECT
LEVEE CONSTRUCTION
YOLO BYPASS TO HIGH GROUND
LOGS OF EXPLORATIONS
2F-8-1 THROUGH 2F-8-10

Soil Design Section Sheet No.: 1 of X

Reference - Exploration Log file no.: XXX-01-XXX

Sheet reference number: B1.0

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix C

APPENDIX C

HYDROLOGY APPENDIX FOR
LOWER CACHE CREEK FEASIBILITY STUDY
YOLO COUNTY, CALIFORNIA
OCTOBER 2002

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

AN EXECUTIVE SUMMARY FOR CACHE CREEK HYDROLOGY

This paper presents a summary of some main points presented in the Hydrology Appendix. It describes the watershed, streamgage records, historic flooding, and a discussion of past and present hydrologic studies.

Basin Description: The Cache Creek Basin drains 1139 mi^2 of land upstream of the Highway 5 Bridge. The watershed contains two major reservoirs, Clear Lake and Indian Valley Dam. Almost half of the entire watershed (528 mi^2) drains into Clear Lake. The Clear Lake outlet consists of a narrow channel, which meanders about 5 miles before reaching Clear Lake Dam. Within this narrow channel is a natural constriction called the Grigsby Riffles, which typically restricts the outflow from Clear Lake to about a maximum of 5,000 cfs during the largest floods. The Grigsby Riffles makes Clear Lake a natural flood control structure that greatly reduces the amount of flooding on lower Cache Creek. Excluding the Clear Lake drainage area, Cache Creek consists of 611 mi^2 of drainage. Within this 611 mi^2, Indian Valley Dam on the North Fork of Cache Creek, regulates 121 mi^2 or 20% of the area. The bulk of the water that causes flooding on lower Cache Creek comes from the 490 mi^2 of unrestricted watershed below Clear Lake and Indian Valley Dam. The Rumsey streamgage, a key analysis point in this study, has a total drainage area of 960 mi^2, of which 311 mi^2 is unregulated. The Rumsey gage is therefore effected by 63% of the drainage area (311 mi^2/490 mi^2) that contributes unregulated flow to County Road 94B.

Streamgage Records: Important streamgages on lower Cache Creek include the Rumsey gage (36 miles upstream of Highway 5, 1961 - present), Capay gage (20 miles upstream of Highway 5, 1942 – 1976), and the Yolo gage (located at the Highway 5 Bridge crossing, 1907 – present). The Yolo gage information is somewhat useless for analyzing floods that exceed 36,000 cfs (flow rate that overtops the existing channel banks). Overbank flow and flooding, in locations between Road 94B and the Highway 5 bridge, cause this gage to measure less than the total runoff for large events. Storms that have exceeded this flow include the years 1958, 1965, 1983, 1995 and 1997. When comparing historic flood events, it is important to note that Indian Valley Dam did not start operation until June of 1974. This causes the period of record of some gages to be non-homogenous. Recorded flow measurements can be viewed on Table 4, page 6, of Appendix C.

Floods: The City of Woodland was incorporated in 1871 and has never been flooded. There are several explanations for this fact: 1) A likely reason is that lower Cache Creek has not experienced a 1% chance exceedence flood since the city was built. It is possible that a 1% chance exceedence flood (1/100 probability of occurrence each year) may not occur within a hundred-year period. Statistically, there is only a 63% chance that a flood of this magnitude will occur in any given century. 2) Another reason is that conditions on the creek and in the City of Woodland have changed over the years. The city of Woodland had a smaller footprint in the past and areas once vacant are now developed.

Areas that flooded in the past (1983) are now inside the city limits. It is also theorized that in the early part of the century, flows might have overtopped the channel farther upstream and followed a path that took it away from the City of Woodland – like the drainage path of the Willough Slough to the south (from reference #1 in Hydrology Appendix, page 12). Gravel pit mining and streambed erosion have increased the carrying capacity of the creek so that more water reaches lower Cache Creek during big storms than occurred in the past. It is also known that the first half of this century was relatively dry while the last half has been relatively wet. While out-of-bank flows just upstream of Yolo used to flow eastward into the Yolo Bypass, they are now partially diverted south into the City of Woodland by Interstate 5. Additionally, out-of-bank flows that reach the Cache Creek Settling Basin are forced south into the east side of the city by the new (1990) west levee of the settling basin. 3) The potential for flooding in Woodland has occurred numerous times. The fact that it hasn't is partly due to circumstance and flood-fighting efforts. Despite intense flood-fighting and sandbagging efforts, the January 1983 flood caused the south levee to break to the east of Road 102. Six hundred acres of farmland were flooded to the east of the city, but the damages might have been worse if the levee had failed farther upstream, putting the water in a more direct path towards the City of Woodland. The March 1995 flood overtopped the levee upstream of the Interstate 5 Bridge and resulted in the city declaring a State of Emergency and advising voluntary evacuation of properties north of Woodland Avenue. The water moved south along Highway 5, flooding hundreds of acres before the water came to a stop at the edge of a developed portion of the city. The extent of flooding would have been worse if the south levee had failed rather than just being overtopped because this would have decreased channel capacity from 36,000 cfs to between 20,000 - 25,000 cfs (as determined by MBK Engineers). In addition, while the peak flow at Road 94B had a 2.5% chance exceedence (40-year return period), the 72-hour volume was determined to only be a 5% chance (20-year return period). More volume would have resulted in Woodland being flooded.

Past Studies: Studies conducted by the Corps on Lower Cache Creek include reports published in 1974, 1985, 1994, and 1995. A table comparing the results of each study is shown in Table 1 for the Capay gage location. The hydrology has changed very little since the 1985 Study.

Table 1. Example Flow- and Volume-Frequency Values at Capay Gage Site

Study	2% chance (50-yr) **peak**	1% chance (100-yr) **peak**	0.2% chance (500-yr) **peak**	2% chance (50-yr) **72-hour**	1% chance (100-yr) **72-hour**	0.2% chance (500-yr) **72-hour**
1974[1] Study	42,000	47,000	58,000	Not in report	Not in report	Not in report
1985 Study[2]	51,000	58,000	75,000	25,000	28,500	37,500
1994 Westside Tributaries	55,500	62,000	79,000	30,500	34,000	43,000
1995 Re-Evaluation	55,000	61,000	74,000	30,000	34,500	44,500
2002 Feasibility	51,500	61,500	75,000	25,500	32,500	42,500

Notes:
- Capay gage was discontinued in 1976. Values shown in table may be calculated by means other than a frequency curve (such as a rainfall-runoff simulation model).
- All values in this table include effects of Indian Valley Dam operation. Capay is downstream of the dam.
(1) The 1974 Study used a rainfall-runoff model with a storm centered above Indian Valley Dam. Studies after 1983 have used a storm centered over the unregulated area below Clear Lake and Indian Valley Dam - similar to the Jan. 1983 storm. Modeling determined that this centering causes higher peak flows on Lower Cache Creek.
(2) Volume-frequency values from the 1985 Study are 3-day values from a frequency analysis using mean daily flows, not 72-hour values.

Two recent studies by private engineering firms include the following: 1) Hydrology Report, Flood Insurance Restudy, Cache Creek, October 1997, A&M Consultants of California. This study analyzed previous Corps of Engineer studies and concluded that the 1995 Corps hydrology was acceptable for use by FEMA to create floodplain maps. 2) In 2000, an engineering firm (Norman S. Braithwaite, Inc.) determined the 1% chance exceedence peak flow for the design of a new Road 99 Bridge near Yolo should be 67,000 cfs.

Corps of Engineer studies included the use of a computer-based rainfall-runoff model of the entire basin. Model parameters such as soil loss rates were adjusted by calibrating the model to observed storms (large storms in which rainfall and the corresponding runoff were recorded). The Rumsey and Capay gages were important calibration points. After calibration, hypothetical rainfall of a given frequency like the 1% chance exceedence storm is input into the model to produce runoff in the form of hydrographs

(graphs of flow rate versus time). Flow frequency curves, based upon a statistical analysis of streamgage records, are used to verify the results of the model at specific locations in the watershed.

Feasibility Study: In this latest study, the analysis included a review of previous studies, the generation of new frequency curves at Rumsey, and modification of model parameters for subbasins downstream of the Rumsey gage. A new family of unregulated flow frequency curves was derived for the Rumsey gage using the latest available information (including the January 1997 storm). Unregulated flow data allows the generation of statistical frequency curves – useful for the prediction of rare floods. The new curves were used to verify the model hydrographs produced at Rumsey. Only the 2% event needed adjustment. Farther downstream, the Capay gage, discontinued in 1976, had no new data available for a new frequency curve. The creation ofa frequency curve at Yolo is not useful since the gage does not record all the runoff during large floods exceeding 36,000 cfs. Model parameters downstream of Rumsey were re-evaluated using overlapping recorded events for the Rumsey, Capay and Yolo gages. The analysis included the development of regression equations that predict the relative increase in volume of water (upstream to downstream) during a storm. Channel bed loss rates were added and constant rainfall loss rates increased for these areas when the analysis indicated that the model was producing too much volume. Muskingum flow routing parameters, which affect the timing and peak of the hydrograph as it moves downstream were revised based on a review of historic attenuation in this reach. Finally, the reservoir operation of Indian Valley Dam was put back into the HEC-1 model to get hydrographs representing existing conditions. The model changes resulted in a 1% chance exceedence event that has the same approximate peak flow and 6% less volume (72-hour volume) than the 1995 Study (comparison at the Capay index point). Although no gage exists at Road 94B, a regulated frequency curve was generated for this location since it represent the point of input of the HEC-1 design hydrographs into MBK Associates UNET model (hydraulic model for routing flows to determine areas of levee overtopping and failure). The HEC-1 model produces a 1% chance flood at Road 94B that has a peak of 63,500 cfs and a maximum 72-hour volume of approximately 217,000 acre-feet.

In conclusion, studies conducted by the Corps since 1985 have not resulted in significant changes to the hydrology. Floods threatened the City of Woodland in 1983 and 1995 and this threat still exists. It is believed that the hydrology presented in the Hydrology Appendix is sufficient for the design of proposed alternatives with the purpose of protecting the City of Woodland and surrounding areas from flooding.

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1. Purpose of Report

The purpose of this appendix is to provide a feasibility level analysis of the hydrology for Lower Cache Creek, Yolo County, California. The study reach extends from Cache Creek at Road 94B down to the Cache Creek Settling Basin, where Cache Creek has its confluence with the Yolo Bypass of the Sacramento River, about 17 river miles. Key products of the analysis include: a) a family of regulated frequency curves for Cache Creek at Road 94B, and b) synthetic hydrographs of the 2%, 1%, 0.5%, and 0.2% chance exceedence flows on Cache Creek at Road 94B.

2. Discussion

2.1 General. The Lower Cache Creek Feasibility Study will analyze proposed project alternatives designed to reduce the flood risk to property and communities within the study reach, including the City of Woodland. Hydrographs of the 2%, 1%, 0.5%, and 0.2% (1 in 50, 1 in 100, 1 in 200, and 1 in 500) chance exceedence events were produced for the index point called 'Cache Creek at Road 94B' using a calibrated rainfall-runoff model (HEC-1). The hydrologic analysis for the Feasibility Study included: 1) review of previous hydrology reports for this watershed, 2) creation of updated unregulated flow frequency curves, 3) review and modification of the existing Corps of Engineers HEC-1 model for Cache Creek, 4) creation of design hydrographs for specific frequencies, and 5) creation of regulated frequency curves.
It is important to understand that the probability of a certain size flood is independent of what happened in previous years. The 1% chance exceedence flood has a 1 in a 100 chance of happening this year, even if a flood of similar size occurred last year.

2.2 Previous Studies. Many studies have been done either on portions or on the entire Cache Creek watershed, which is over 1,000 square miles in area. The following studies are listed for reference:

1. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Standard Project Floods," May 1974.

2. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Feasibility Report and Environmental Statement for Water Resources Development," February 1979.

3. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Hydrology Review Report," March 1985.

4. U.S. Army Corps of Engineers, Sacramento District, "Final General Design Memorandum, Cache Creek Basin (Outlet Channel)," California, July 1990.

5. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Feasibility Report and Environmental Statement for Water Resource Development," February 1992.

6. U.S. Army Corps of Engineers, Sacramento District, "Westside Tributaries to Yolo Bypass, California," Reconnaissance Report, June 1994

7. U.S. Army Corps of Engineers, Sacramento District, "Hydrology for Cache Creek, Yolo County, California," August 1995.

8. A&M Consultants of California, San Diego, CA, "Hydrology Report for Yolo County, California and City of Woodland, California," February 1997.

3. Basin Description

3.1 General. Cache Creek basin is located about 100 miles northeast of San Francisco in the coastal mountain ranges. Clear Lake, the prominent feature of the basin, is the largest natural body of fresh water entirely within the State of California. Cache Creek drains about 1,139 square miles. See Chart 1 for a general map. The outlet of Clear Lake is the origin of Cache Creek, which flows generally northeast about 8.5 miles to the confluence with its North Fork, through Capay Valley, south to the irrigation dam at Capay, north past the town of Yolo, and east and south into the Cache Creek settling basin before finally flowing into the Yolo Bypass. The watershed contains many diversion dams and reservoirs of various sizes. Clear Lake Reservoir and Indian Valley Dam contain the two largest bodies of water in the watershed and have a significant influence on the flows on Lower Cache Creek. A more detailed description of the operation of the two reservoirs is explained in Section 4.4.

3.2 Vegetation and Land Use. Vegetation in upper Cache Creek consists mainly of deciduous trees and brush, such as blue oaks and chaparral. In middle elevations, riparian forest and valley oaks predominate. Irrigated crops, orchards, and vineyards occupy the lower elevations. Most of the basin is undeveloped. Primary land use includes national forest, recreation, grazing and agriculture. Future development of the watershed is not expected to be significant.

3.3 Topography. The topography of the basin varies from steep, rugged hill slopes of the Coast Ranges to the gentle slopes of the valley floor, beginning near Capay, located on the western edge of a large alluvial plain. The elevation ranges from 6,120 feet at Goat Mountain on the northern basin perimeter to nearly sea level near Yolo. Chart 2 shows the topography of the basin. Chart 3 shows the channel profile.

3.4 Geology. The geology of the basin consists of the Franciscan formation, which forms the core of much of the Coast Ranges. Rock outcrops of this formation can only be found in the upper part of Cache Creek Basin and consist of marine sedimentary and volcanic rock. To the east of Clear Lake and in the central portion of the basin, rocks are predominantly of massive sandstone with imbedded conglomerates and silty shales. Continental deposits in the lower portion of the basin consist of clay, sand, and gravel, and occur as discreet units and heterogeneous mixtures. The younger overlying alluvium is similar and generally not as coarse as the continental deposits. Underground aquifers underlie the valley portion of the basin downstream from Rumsey. The size and extent of these aquifers are not known. Intensive agriculture, and to a lesser degree the seasonal recreation industry, comprise the main economic features of the basin. State Highways 16, 20, 29, 53 and Interstate Highway 5 are the main traffic arteries.

Climate. The climate of the Cache Creek Basin is characterized by cool wet winters and hot dry summers. Temperatures range from slightly below freezing in winters to highs of over 100 degrees Fahrenheit at times during the summer. The climatological stations "Lakeport," "Clear Lake Highlands," and "Brooks Farnham Ranch" are representative of the Lower Creek watershed. The following table (Table 1) from Reference 3 shows the average temperature and precipitation at those stations.

Table 1. Cache Creek Basin Climatic Data

	Station					
	Lakeport El 1347 ft.		**Clearlake Highlands** El 1365 ft.		**Brooks Farnham Ranch** El. 294 ft.	
Years record	27 yrs	71 yrs	9 yrs	18 yrs	45 yrs	51 yrs
Month	Ave Temp F	Ave Precip Inches	Ave Temp F	Ave Precip Inches	Ave Temp F	Ave Precip Inches
Jan	41.2	6.18	41.8	5.85	44.8	4.06
Feb	46.7	4.90	45.0	4.46	48.5	4.10
Mar	53.7	3.36	48.1	2.13	52.9	2.63
Apr	52.4	2.03	51.5	1.84	58.2	1.31
May	61.7	0.88	60.2	0.50	65.3	0.60
Jun	69.8	0.45	67.3	0.19	72.4	0.20
Jul	75.0	0.04	73.5	0.01	78.4	0.01
Aug	74.8	0.05	73.3	0.17	75.8	0.02
Sep	65.3	0.24	66.5	0.37	72.1	0.19
Oct	56.7	1.74	57.5	1.29	63.4	0.96
Nov	47.2	2.88	48.6	3.35	52.6	1.75
Dec	38.4	5.87	41.4	4.61	46.0	4.17
Annual		28.52		24.77		20.00

Normal annual precipitation varies from a minimum of about 17 inches near the community of Yolo, and averages about 32 inches over the watershed. The major portion of the annual rainfall occurs from October through April. Snowfall is very rare and has no significant effect on the streamflow in the basin. See Chart 4 for a normal annual precipitation map.

Table 2. Normal Annual Precipitation and Maximum Observed Daily Rainfall, Selected Stations and Dates, Cache Creek and Vicinity

Station	Elevation (ft)	N.A.P.(1) (in)	Maximum Daily Rainfall (in) (4)(5) Feb 1958	Jan 1965	Jan 1983	Feb 1986
Bartlett Springs	2600	40.5(3)	Na	Na	Na	7.01 *
Brooks Farnham Ranch	294	23.0(2)	2.55 19th	1.50 6th	1.35 24th	Na
Capay 4W	300	22.5(3)	3.64 *	1.85 *	3.86 *	2.38
Lakeport	1343	28.7(3)	2.02 26th	2.37 5th	Na	3.97 17th
Potter Valley PH	1084	44.8 (3)	3.83 24th	2.87 5th	2.42 26th	5.09 17th
Williams	90	15.5(3)	2.24 19th	1.09 3rd	1.43 26th	1.91 13th
Woodland 1 WNW	68	17.4 (3)	2.30 19th	0.95 6th	2.04 27th	1.61 19th

(1) N.A.P. = Normal Annual Precipitation.
(2) From Cache Creek Basin, California, Hydrology Review Report, Sacramento District Corps of Engineers, March 1985.
(3) From Depth-Duration-Frequency analysis by Jim Goodridge, retired State Climatologist, State of California.
(4) Depending on type of gage, rainfall totals may be one of the following:
a. Recording gage: maximum 24-hour precipitation ending any time on day indicated, or,
b. Non-Recording gage: daily observation of rainfall from gage read one time each day, at a specified time; total for previous 24-hour period.
(5) January 10, 1995 Daily Rainfall at Capay 4W = 3.01 in.

* Day of observation not investigated.
Na = not available

4. Runoff

4.1 Terminology used to describe flood frequency. The magnitude or size of a flood event is often described in terms of its probability of occurrence in any year (percent chance exceedence). For example, the 1% chance exceedence peak flow at Cache Creek at Road 94B is given as 63,500 cfs (Table 9). This means that this flow rate has a 1% (1 in a 100) chance of being "equaled or exceeded" in any given year at this location. Large flows that exceed channel capacity and cause flooding occur infrequently (low probability). A rule of thumb is that the larger the flood, the smaller the chance that it will occur. For example, a 1% chance exceedence flood (probability of 1 in 100 each year) is larger than a 5% chance exceedence flood (probability of 5 in 100 or 1 in 20). In this appendix, flows and/or floods will be described in terms of percent chance exceedence. A list of commonly referenced events and their associated probability in terms of 1 in "n" chance is listed below.

Table 3. Exceedence Frequency

Percent chance exceedence	Probability of occurrence each year
50%	1 in 2 chance
10%	1 in 10 chance
5%	1 in 20 chance
2%	1 in 50 chance
1%	1 in 100 chance
0.2%	1 in 200 chance
0.5%	1 in 500 chance

4.1 Cache Creek Basin. Streamflow and lake stage records were obtained from the U.S. Geological Survey (USGS) and the California Department of Water Resources (DWR) for stream gages listed in the following table.

Table 4. Cache Creek Basin Stream Gaging Stations [(a)]

Location	Drainage Area (mi2)	Period of Record Used	Length of Record (yrs)	Ave Annual Runoff (ac-ft)	Station Operator
Clear Lake at Lakeport [(b)]	528.0	1913 - 1984	72	5 [(b)]	USGS
Cache Creek near Lower Lake	528.0	1944 - 1991	47	256,000	USGS
North Fork Cache Creek at Hough Springs near Lower Lake	60.2	1971 – 1991	20	67,900	USGS
North Fork Cache Creek near Lower Lake [(c)]	197.0	1930 – 1981	52	136,500	USGS
Bear Creek near Rumsey [(c)]	100.0	1958 – 1980	23	35,760	DWR, CA
Cache Creek above Rumsey [(c)]	955.0	1961 – 1986	19	541,200	DWR, CA
Cache Creek at Rumsey Bridge	~960.0	1987 – present	13	Not available	DWR, CA
Cache Creek near Capay [(c)]	1044.0	1942 – 1976	35	556,900	USGS
Cache Creek at Yolo	1139.0	1903 – 1991	89	378,900	USGS

(a) Pertinent data for each stream gaging station were adapted to reflect the latest data available.
(b) Average annual lake stage in feet above datum of gage, 1,318.65 feet.
(c) Stream gage recorder discontinued.

4.2 Flood Problems. General rainstorms produce the largest flood events on Cache Creek. Local cloudburst storms have not produced any major recorded events.

4.3 Historical Flooding. The following are descriptive accounts of flood events and a table of peak flows and 3-day volumes, where available:

a. January 26, 1983. This flood had the highest peak flow of record at Rumsey since construction of Indian Valley Dam was completed in 1974. The peak flow at Rumsey was estimated to be 53,500 cfs (a 2% or 1 in 50 chance exceedence). No estimate of the peak flow at Capay is available. The peak flow at the Yolo gage was 33,000 cfs. Due to the large difference between the peak at Rumsey and at Yolo, it is hypothesized that overbank flow occurred in areas upstream of the Yolo gage. Flood-fighting efforts were undertaken including protective measures to save the town of Yolo. Early in the morning of the 27th, the south levee of Cache Creek failed to the east of Road 102 (about 2 miles east of Woodland) and north of Interstate 5. Following the break, 12 flood fighters were stranded for a few hours between the break site and the stub end of the levee system. A California Highway Patrol Helicopter rescued the flood crews. The water from the break flowed in a southern direction toward the Cache Creek Settling Basin and flooded about 600 acres of agricultural land. If the levee had broken upstream of Highway 5, it would have threatened Woodland since the embankment of the freeway would have directed the flow southeast towards the city. At Rumsey, the 1983 event is estimated to have produced about 25% more runoff than the March 9th, 1995 event (comparison of 3-day volumes).

b. March 9, 1995. High flows in January were followed by an even larger event in March. The estimated peak flows at Rumsey were 33,000 and 52,000 cfs in January and March, respectively. This was the 2nd largest peak flow of record at Rumsey since Indian Valley Dam was built. Heavy bank erosion and debris endangered the Capay Bridge and buildings along the creek. Rock was dumped at the bridge to stabilize the banks. Farther downstream, sandbagging and bank protection measures were used to protect the Cache Creek levees. In this event, overbank flow is estimated to have started at 36,500 cfs. The levees were originally designed to convey about 30,000 cfs (not including the additional levee freeboard). Although the levees did not fail, overtopping did occur upstream of the Highway 5 Bridge on both the north and south sides of the levee. Water overtopping the south levee flowed southeast along the freeway embankment, eventually inundating it and stopping traffic in both directions. The City of Woodland declared a State of Emergency and advised voluntary evacuation of properties north of Woodland Avenue. Floodwaters continued south and came to a stop at the edge of the developed portion of the city. As in 1983, hundreds of acres of land were flooded. Flooding of the city would have been more likely if the south levee had failed rather than being overtopped. The failure of the levee would have decreased channel capacity from 36,000 cfs to about 20,000 – 25,000 cfs (as determined by MBK Engineers). The volume of water in this flood was also a factor. The peak flow at Road 94B was determined to have a 2.5% chance exceedence (1 in 40). The 72-hour volume of the hydrograph, however, was much smaller – only about a 5% chance exceedence (1 in 20). Had the frequency of the hydrograph volume been similar to its peak flow, worse flooding would have occurred. The following table provides historical peak flow and volume data for Cache Creek gages.

Table 5. Peak Flow and Volume Data, Cache Creek Basin

Location	Date	Flood Peak (cfs)	3-Day Flow Volume (ac-ft)
Cache Creek near Lower Lake (1944 – 1991)	24 Feb 58	8,000	30,550
	22 Dec 64	(a)	(a)
	5 Jan 65	5,320	23,720
	23 Jan 70	6,320	26,620
North Fork Cache Creek at Hough Springs near Lower Lake (1971 - 1991)	26 Jan 83	6,220	19,400
North Fork Cache Creek near Lower Lake [(b)] (1930 – 1981)	24 Feb 58	13,500	31,860
	22 Dec 64	19,700	61,800
	5 Jan 65	15,700	40,060
	23 Jan 70	16,000	37,410
Bear Creek near Rumsey [(b)] (1958 - 1980)	22 Dec 64	6,820	10,680
	5 Jan 65	9,720	12,710
	23 Jan 70	5,900	10,400
Cache Creek at/above Rumsey (1961 – present)	5 Jan 65	59,000 [(c)]	--
	24 Jan 70	43,400	--
	26 Jan83	53,500	102,730
	9 Mar 95	52.000	75,530
Cache Creek near Capay[(b)] (1942 - 1976)	24 Feb 58	51,600	98,980
	23 Dec 64	32,400	84,350
	5 Jan 65	44,500	96,620
	24 Jan 70	36,200	92,230
Cache Creek at Yolo --> (1903 - Present)	Channel capacity restrictions upstream of this gage prevent it from recording the full amount of runoff generated during large events. Therefore, this data is not included in the table.		

(a) Data is unavailable.
(b) Station discontinued.
(c) Value seems unreasonably high possibly due to the extension of the low-flow rating table and slope-area measurements.

Reservoir Regulation in the Watershed. Clear Lake is the largest natural body of fresh water entirely within the state of California. The outlet of the lake is the start of Cache Creek and is a narrow, confined channel that winds a distance of about 5 miles before reaching the Clear Lake Dam. Clear Lake Dam began to store water in 1915. Even before the dam was built, the outflow from Clear Lake had always been limited to less than 10% of the potential Clear Lake inflow, due to a natural "weir-like" structure called the Griggsby Riffles. This shallow, hardened portion of the streambed in the narrow channel that leads to the dam acts as a weir. During large inflows, the constrained outflow causes the shallow lake to rise rapidly, sometimes resulting in flooding along the rim of the lake.

Clear Lake Dam can release more water than can physically pass over the riffles. The riffles control the volume of water that can reach the dam and, therefore, long-duration maximum outflow. The maximum flow passing over the riffles during large floods has been about 5,000 cfs. Laws regulate the maximum stage that Clear Lake can reach during the winter months before mandatory flood releases have to be made from the dam to keep the lake from rising further. The lake level will exceed this maximum stage when inflow is excessively high. The regulating affect of Clear Lake Dam during large floods can be modeled in HEC-1 with a stage-rating curve for the Griggsby Riffles. Since the Griggsby Riffles has been a feature in the Cache Creek watershed since recorded history, Clear Lake Dam regulation was not removed from the computation of the "unregulated" frequency curve for the Rumsey gage. The starting elevation used for Clear Lake in the HEC-1 model was the same elevation that occurred just one day prior to the March 9, 1995 storm (one of the two largest floods of record on Lower Cache Creek since 1941, assuming no regulation from Indian Valley Dam). The Clear Lake stage was unusually high at the start of this event.

The Yolo County Flood Control and Water Conservation District operates Indian Valley Dam. It began to store water in June of 1974. The reservoir serves dual purposes for both irrigation supply and flood control. Flood control releases are made in accordance with rules and regulations determined by the U.S. Army Corps of Engineers in the authorized Water Control Manual. The total volume of space set aside for flood control is 40,000 ac-ft. For the HEC-1 model used in this study, the starting storage at Indian Valley Dam was set to the bottom of the flood control space (260,000 ac-ft). The reservoir was designed to control a 2% chance exceedence (1 in 50) flood centered above the dam. Controlled releases from the gates are not allowed to cause the Rumsey gage to exceed 20,000 cfs. A simplified discussion of the operation of Indian Valley Dam is described below.

> "If rainfall gages in the vicinity of the basin show an accumulated rainfall of 0.5 inches or more in the last 8 hours, and the downstream Rumsey gage exceeds 5,000 cfs and is increasing, the outflow is reduced to 10 cfs (fish release) at the rate of 2,500 cfs per 2-hour period. If inflow to the reservoir causes the pool to rise above elevation 1485 feet, increase release by 5,000 cfs per hour until outflow equals inflow. Once the pool elevation has dropped below 1485 feet, reduce outflow by 2,500 cfs per 2-hour period until the minimum flow of 10 cfs has been reached. The minimum outflow should be maintained until the flow at Rumsey has dropped below 10,000 cfs and is decreasing, and less than 0.5 inch of rainfall has occurred in the last 12 hours. Then, outflow should be increased to the lesser of 10,000 cfs or the maximum rate of inflow during the current event. As much as possible, releases are not allowed to cause the Rumsey gage to exceed 20,000 cfs."

The regulation by Indian Valley Dam during rare events can be simulated in an HEC-1 model.

5. Hydrologic Analysis

5.1 Introduction. This section of the report presents a synopsis of the Cache Creek Hydrologic Analysis.

5.2 General. The Corps of Engineers uses a document called "Bulletin #17B, Guidelines for Determining Flood Flow Frequency" (revised September 1981 by the Interagency Advisory Committee on Water Data) to define the methodology by which it studies flood frequency in watersheds (Reference # 6). Bulletin 17B recommends three procedures for analysis of watersheds 1) statistical analysis of streamgage records, if available, 2) comparisons with similar watersheds, and 3) flood estimates from precipitation. All three methods were used in the study.

5.3 HEC-1 Model Development. The existing HEC-1 model has been developed and modified during several different studies. In 1979, a hydrologic analysis was done for the Cache Creek Basin California Feasibility Study. Following that study, a major storm hit Cache Creek in January of 1983 that caused a levee downstream of the Highway 5 Bridge to fail. The storm was centered over the ungaged area between Clear Lake Dam and Rumsey. Following this event, another study was performed. Rainfall and streamflow data from this event were used in calibrating the existing Cache Creek HEC-1 rainfall-runoff model in a 1985 review of Cache Creek hydrology (Reference 3). Model unit hydrographs, losses, and routing parameters were verified or updated. See Reference 3 for a breakdown of subareas and isohyetal patterns used for this storm event. HEC-1 subbasins are shown on Chart 5. The Clear Lake drainage area is further divided into numerous subbasins as shown in Chart 6 (derived from a detailed HEC-1 model created in a prior Corps study).

In 1994, a Reconnaissance Study of the watershed (Reference 5) used the latest HEC-1 model hydrographs as input to a hydraulics model to generate floodplains. In January and March of 1995, two more large storms occurred within the watershed. The March flood caused extensive flooding of land from overtopping of the levees. The two 1995 floods provided additional hydrologic data to use in model calibration, and the hydrology was re-studied after these events (Reference #8). The principal change to the model in the 1995 recalibration was the development of a new unit-hydrograph for a 127 square mile subarea above Rumsey, referred to as "Rumsey Local," or Subarea 805. Although less rainfall data was available for the analysis than was desired, the revised model reproduced the 1983 and 1995 storm hydrographs well at the Rumsey gage. Among the conclusions of the 1995 Study were: 1) the floodplains produced in the 1994 Study did not need revision, 2) the model worked well at the Rumsey gage, and 3) model hydrographs between Rumsey and the Yolo gage needed further analysis, due to the lack of flow data for calibration in this reach. The model reproductions of the three events are shown on Charts 7 - 9.

Although peak and daily flow were produced at the Capay gage (1943 to 1976), hourly hydrograph data is not available. The Yolo gage at the Interstate 5 Bridge has hourly data but does not capture all of the flow during large events, due to channel capacity restrictions farther upstream. Channel capacity is estimated to be between 36,000 to 38,000 cfs for both the channel reach upstream of the levees and for the levees themselves. During large floods, such as occurred in January 1983 and March of 1995, out-of-bank flow farther upstream caused the Yolo gage to record only the flow remaining in the channel. Once the flow leaves the main channel or overtops the levees, it does not return to the creek.

For this feasibility study, a new family of frequency curves for the "without Indian Valley Dam regulation" condition were created for the Rumsey gage. The curves incorporated the latest available data up to water year 1999. Simulations of the 2%, 1%, 0.5%, and 0.2% chance floods were run with the HEC-1 model (modified to remove the affect of Indian Valley regulation). The hydrographs generated at Rumsey were compared to the new frequency curves. Except for the 2% chance event, the peak, 24-, and 72-hour flows produced by the model had a good match with the frequency curves (peak, 1-, and 3-day durations). The peak 24-hour flow in each event hydrograph was about 15% higher than the corresponding 1-day curve value. This is to be expected. Since the USGS measures the daily flow at a gage from midnight to midnight, a portion of the peak 24-hour flow in a hydrograph is often cut off from the computation (especially when the peak occurs in late evening). Over the long run, the difference between the maximum 24-hour flow and the 1-day frequency curve for a given frequency is expected to be around 15%. As mentioned before, the HEC-1 hydrograph for the 2% chance event (1 in 50) had too much volume when compared to the frequency curve. For the 2% chance event, the constant loss rates for two subareas upstream of the Rumsey gage called "Long Valley" and "Local Rumsey" were each increased by 0.02 inches/hr so that the HEC-1 hydrograph and the frequency curves matched for the peak through 3-day durations.

After verifying that the model was producing accurate hydrographs at the Rumsey gage index point, the lower reaches of the model were studied closely. A frequency curve for the Yolo gage was not created, because the gage record is affected by out-of-bank flow upstream. Cache Creek at Road 94B is the most important index point in the HEC-1 model. The Road 94B hydrographs were input into a hydraulic design model for floodplain delineation and alternatives analysis. Road 94B is upstream of the section of Cache Creek in which channel capacity is limited.

The increase in volume between the Rumsey, Capay, and Yolo gage locations was evaluated for observed events in which gage records overlapped. As a result of this analysis, it was determined that HEC-1 generated hydrographs (for all modeled events) had too much volume for the reaches below Rumsey. The analysis included the development of regression equations that predicted the increase in the 1-day and 3-day volume between gages. To reduce volume, two things were done: First, the constant rainfall loss rates for the subareas below Rumsey were increased. Secondly, channel losses were incorporated into the model, which matched those described in the Cache

Creek Basin Standard Project Floods Study (Reference 1). These loss rates are shown in Table 6 of Section 5.7.

There are 8 years of overlapping peak flows between the Rumsey and Capay gages. The attenuation in peak flow from Rumsey to Capay ranges from a 4% to 39% decrease. The average attenuation is a 19% decrease. Further investigation showed that the peak tended to decrease only by a small percentage when the hydrograph shape was 'fat' (well-balanced volume across the various durations). In addition, there was not much attenuation between Rumsey and the Yolo gage in similar situations. Using this information as a guide, the original HEC-1 muskingum "x coefficients" of 0 (zero) were modified to 0.1 to 0.2 for this part of the model.

5.4 Baseflow. The baseflow information is unchanged from that presented in the 1979 feasibility report (Reference 3). Baseflow was estimated in the reproductions of the 1964, 1965, and 1970 floods on North Fork Cache Creek near Lower Lake, and Bear Creek near Rumsey. Baseflow was estimated to be equal to the flow at the beginning of the floods, increasing uniformly until it intercepted the extension of the recession limb of the observed hydrographs. Baseflow is difficult to determine accurately for the gages at Rumsey, Capay, and Yolo, as high sustained outflows from Clear Lake and loosing stream reaches obscure the actual baseflow. A loosing reach contributes to the groundwater, while a gaining reach is partially fed by groundwater. In some cases, a stream reach may be seasonally gaining during periods where the groundwater table is high.

5.5 Unit Hydrograph. The basic procedure used for developing unit hydrographs in this report is outlined in the Department of the Army's Technical Bulletin 5-550-3, "Flood Prediction Techniques," and in the Corps' Engineering Manual 1110-2-1405, "Flood Hydrograph Analyses and Computations." This procedure involves using the physical dimensions of the basin measured from topographic maps, an estimated average channel and basin hydraulic factor (Manning's "n") obtained by field observation, lag relationships, and summation curves (S-curves) obtained from unit hydrographs developed from reproduction of recorded floods. See References 1, 2, and 4 for additional unit hydrograph information and example unit hydrographs.

Table 6. Cache Creek Watershed Characteristics

Location	D.A. (2) (mi²)	Channel Length (mi)	Lca(3) (mi)	Channel Slope (ft / mi)	$\bar{n}$
Bear Cr nr Rumsey	100	31.2	13.8	72	0.06
Cache Cr Local at Diversion Dam(1)	34	11.7	7.6	243	0.06
Cache Cr Local nr Capay(1)	92	24.7	11.1	101	0.06
Cache Cr Local nr Rumsey(1)	127	21.0	10.6	130	0.06
Cache Cr Local nr Yolo(1)	61	24.7	16.7	63	0.06
Cache Cr at Rumsey Bridge	~960	--	--	--	--
Cache Cr nr Capay	1,044	--	--	--	--
Cache Cr nr Yolo	1,139	--	--	--	--
Clear Lk at Lakeport	528	--	--	---	
Copsey Cr nr Lower Lake	13.2	6.4	2.3	126	0.10
N. Fork Cache Cr at Hough Springs (nr Lower Lake)	76	17.6	8.4	180	0.06
N. Fork Cache Cr - Indian Valley Res.	121	27.0	13.8	107	0.06

(1) Channel Length, Lca, and Slope adjusted for Cache Creek subbasins bisected by mainstem Cache Creek, due to hydraulic efficiency of channel.
(2) D.A. = Drainage Area.
(3) Length of channel from basin outlet to centroid of basin.

5.6 Routing Parameters. Muskingum routing is the principal channel routing method used in the Cache Creek HEC-1 model. Muskingum coefficients used for Cache Creek below the Grigsby Riffles are based on present channel characteristics and velocities observed during the January 1983 flood. Velocities observed in 1983, ranging from 10 to 16 feet per second, were much higher than previously modeled. Some routings in the upper watershed were not changed from Tatum to Muskingum routing, if the Tatum routing performed well. Where storage effects were significant, Modified Pulls routing was used. Routing parameters for the reaches between the Rumsey gage and Road 94B were modified in this study. The muskingum "x coefficients" were modified to 0.2 instead of the original zero. Muskingum Routing parameters for the basin are shown on Chart 10.

5.7 Rainfall. A 96-hour storm was used for the analysis. General rainflood events cause the highest peak flows and volumes in this watershed. In this part of California, intense thunderstorm cells are typically embedded within long duration general storms. These embedded cells can be just as intense as a short duration summer thunderstorm. A stacked rainfall was developed such that the design storm has the same return period for all durations, that is, the 1-, 6-, 24-, 48-, and 96-hour rainfall depths all have the same frequency of occurrence.

Subarea rainfall was developed from 1% chance point rainfall from 19 gages in the region for which depth-frequency relationships were available. The depth-duration-frequency analyses were derived using methods found in Bulletin #195, Rainfall Analysis for Drainage Design, Vol. I & II, Short-Duration and Long-Duration Precipitation Frequency Data, CA Department of Water Resources, Oct. 1976. An isohyetal map of 1% chance point rainfall was developed by plotting the 1%, 96-hour rainfall amounts from the 19 stations on a map, and drawing lines of equal depth between stations.

Different centerings were computed by using depth-area reduction methods found in HMR 58. Using the HEC-1 model, it was determined that centering the storm in the subarea above the Rumsey gage and below Clear Lake and Indian Valley Dam caused the highest peak flows and volumes on Lower Cache Creek. This was the centering chosen for this study. Both rainfall depth and distribution vary by subarea. Cells of intense rainfall will not cover an entire basin (or occur at the same time basin-wide); therefore a different distribution must be used at the storm center than elsewhere on the basin. Depth-area-reduction relationships from the Midcoast California Region were used to develop subarea rainfall distributions. Areal reduction factors are greatest for the short duration rainfall. The rainfall was temporally sequenced according to Sacramento District's Standard Project Storm Criteria. This Standard Project Storm distribution was balanced (reshaped) with the 1% chance, 1-, 6-, 24-, 48-, and 72-hour rainfall for areas of 100 and 1,000 square miles. The distribution and depths for the 100 square mile area was applied to the Rumsey Local subarea (at the storm center), while the 1,000 square mile distribution and depth was applied to the remaining subareas. For 100 square miles, the basin average 1-hour rainfall is 85% of the maximum point rainfall. The 72-hour rainfall for 100 square miles, however, is 95% of the maximum point 72-hour rainfall. Therefore the subarea-wide rainfall distribution is flatter than the point rainfall distribution. For 1,000 square miles, the maximum 1-hour rainfall is 62% of the maximum point rainfall, or flatter still.

For frequency events, basin average precipitation was developed from point 1% chance rainfall depths and depth-area relationships. Point 1% chance rainfall from 19 gages was used to develop isohyets of point rainfall across the watershed. Each subbasin was given an average 96-hour point rainfall depth. In centering the storm over the Rumsey Local subarea, the basin average rainfall for a basin of this size (127 square miles) was determined from the depth-area relationships. That amount of rainfall is then subtracted from the total volume of rainfall for the entire 1,100 square mile watershed, leaving the coincident rainfall volume for the remaining 973 square miles.

Additional subareas totaling 176 square miles, between Clear Lake and Rumsey (below Indian Valley Dam), were added to the Rumsey Local subarea, and coincident rainfall was distributed on these subareas based upon the depth-area relationship for 303 square miles. This process was repeated 2 additional times until all subbasins were given 1% chance rainfall. In this way, the basin average rainfall depth is appropriate for both the local subarea, and the entire watershed. The 2%, 0.5%, and 0.2% chance ninety-six hour rainfall at gages in the region were found to be consistently 92%, 108%, and 119% of the

1% rainfall, respectively. The 2%, 0.5%, and 0.2% chance events were modeled using the 1% chance event distribution and the respective depth for each event.

5.8 Loss Rates. Extensive model calibration was performed in the 1985 and 1995 hydrology studies (references 3 and 8). Uniform loss rates for the January 1983 flood reconstitution primarily ranged from 0.15 inches/hr for the Cache Creek Basin above Clear Lake to 0.06 inches/hr in the lower portions of the Cache Creek Basin. An exception was a loss rate of 0.03 inches/hr for the Rumsey Local subbasin. Unusually low loss rates were required to reproduce observed hydrographs at the Rumsey gage. The model reproduced the 1995 events well using the same loss rates developed in 1983. For this feasibility study, loss rates for subbasins upstream of the Rumsey gage remained unchanged (except for the 2% chance event HEC-1 model). For this frequency, the constant rainfall loss rates in the subareas called "Long Valley" and "Local Rumsey" were increased by 0.02 inches/hour in order to get the hydrograph at Rumsey to match the points on the new frequency curve for that location. It is often necessary to change the rainfall loss rates for more frequent events. The largest, historical floods in many of California's watersheds have typically occurred when a large storm system follows after a previously significant rainfall event (which left the soil highly saturated).

An analysis of overlapping flow data for rainfall events at the Rumsey, Capay, and Yolo gages indicated that the model was producing too much volume in the reaches below Rumsey. The analysis included the development of regression equations that predicted the increase in the 1-day and 3-day volume between gages. To study the increase in volume at the Yolo ga ge, only events in which out-of-bank flow did not occur were studied. To correct the model, two actions were taken: Uniform rainfall loss rates for subbasins below Rumsey were increased from the 1995 Study (originally 0.06 inches/hr., changed to 0.08 to 0.15 in/hr.). Secondly, channel losses (percolation into alluvial aquifers) for the lower reaches were added to the model. The channel loss rates were determined for the Standard Project Flood analysis (Reference 1). The following percolation rates were presented:

Table 7. Channel loss rates between Rumsey and Yolo

Flow Rate (ft^3/s per hour)	Seepage (ft^3/s per hour)
2000	510
3000	670
5000	850
10,000	1220
20,000	1740
70,000	3290
90,000	3780

The channel loss rates listed above were incorporated into the HEC-1 model for this study. The channel loss rates were most likely derived from a study done by the

California Department of Water Resources (DWR). For this feasibility study, DWR was contacted for information about streamgage measurements and channel characteristics. DWR employees have been making streamflow measurements on Cache Creek for decades. The reach between Capay and Yolo has been described in another report (Reference 9) as sandy and alluvial in nature. During the warmer months, losses between Rumsey and the Yolo gage may be even higher than those given in table 6. For example, an observation of 1,000 cfs flow at Rumsey and almost zero flow at the Yolo gage has been reported during flow measurements in spring.

To model the various frequency events, only rainfall and loss rates were changed. Large historical floods in this area typically occur during wet periods when the ground has been highly saturated by previous rainfall events. Extremely rare events typically have low loss rates. More frequent events have higher loss rates.

6. Flow Frequency

6.1 Flow Frequency Analysis. Flow records for Cache Creek at Capay remained unchanged since the gage was discontinued in 1976. Therefore, no new data is available since the graphical peak flow-frequency curve was developed for the 1985 report (Reference 3). Chart 11 shows the original frequency curve for Capay created in the 1985 Study. A new family of frequency curves was generated for Cache Creek at Rumsey (for without Indian Valley Dam regulation) from the latest available flow data. Unregulated flow is produced by taking the incremental "change in storage" at Indian Valley Dam (converted to cfs), routing it to the gage, and adding it to the observed flow. Hourly change in storage is not available at Indian Valley Dam (except for a few large events such as 1997). Since Indian Valley Dam has regulated the watershed since 1974, peak unregulated flow at Rumsey after 1974 could only be calculated for the three floods for which data is available (1983, 1995, and 1997 events). However, these were the three biggest floods since regulation began and therefore the most important values needed for the analysis. Daily change in storage records for Indian Valley Dam are available since regulation began. The Griggsby Riffles (a natural, weir-like structure below Clear Lake) has controlled the rate of release from the dam since 1915. Consequently, Clear Lake Dam regulation was not removed from the "unregulated frequency curve" for Rumsey. The Rumsey frequency curve was used to check the HEC-1 model hydrograph at Rumsey for the "Without Indian Valley Dam" condition.

Measurements of peak flow on lower Cache Creek are difficult, due to the soft alluvial nature of the streambed. During significant flows, the streambed is constantly changing (eroding during the peak and gaining in height from deposition during the recession of the hydrograph). The present site of the Rumsey gage is on the Highway 16 Bridge. DWR employees are unable to make hand measurements when the flow exceeds 20,000 cfs due to overbank flow moving around the bridge. Consequently, an extrapolation of the discharge-rating curve must be done for big floods. DWR officials say that confidence in the estimated peak flow for big floods on Lower Cache Creek is "low."

For the frequency analysis in this study, the peak flow for two events at Rumsey was revised to be different from the official record of the Department of Water Resources.

a. January 26, 1983 Flood. A peak flow of 53,500 cfs at Rumsey was used for the analysis. This was the original estimate for the January 26, 1983 flood. This value was cited in the report "Hydrology Review Report, Cache Creek Basin, California," March 1985, by the U.S. Army Corps of Engineers (Reference 3). A hydrograph with this peak was also used for calibration of the HEC-1 model in the 1985 and 1995 studies conducted by the Corps. It appears that DWR revised the original peak flow estimate at least several years after the event to 74,800 cfs. A peak of 74,800 cfs equates to a 0.25% chance (1 in 400) event on the frequency curve derived in the 1995 Study. DWR officials were contacted to research the reason for the revision. According to DWR employees contacted, Rating Cur ve #30 was used for the revision. The curve was generated from one measurement taken in 1983 and many measurements taken in 1985 and 1986. The 74,800 cfs peak was derived by extending the rating curve well beyond any measured values. Strangely, the official start date for Rating Table #30 is 01 October 1986, almost 4 years after the 1983 flood. DWR employees spent many hours trying to find documentation on the 1983 event. However, after many days of research, it was determined that more detailed records may have been archived and cannot be easily retrieved. DWR did not know who performed the revision or why it was done. The Capay gage was not in operation at this time. Adding further doubt to the accuracy of the DWR revision is that the peak flow at the USGS operated Yolo gage was lower than the peak for the 1995 and 1997 floods. The 1983 flood did cause a levee to fail, but the failure was downstream of the Yolo gage and the Highway 5 Bridge. For these reasons, the original peak flow estimate of 53,500 cfs was used for the frequency analysis.

b. March 9, 1995 Flood. A peak flow of 52,000 cfs at Rumsey was used for this event. DWR official records give the peak flow for this event as 42,000 cfs. A reconstruction of the event using an HEC-2 and UNET model did not verify DWR's estimate. MBK Engineers in Sacramento provided research on this issue. An HEC-2 model run determined a peak of 48,500 cfs was needed to match a high water mark observed at Road 94B during this event. Furthermore, a UNET Model of the reach determined that it was necessary to have a hydrograph with a peak of 52,000 cfs at the Capay Diversion Dam (routed to Road 94B) to match the high water mark. Overlapping records for the Rumsey and Capay gages have shown that the peak at Capay is usually equal or less than the peak at Rumsey. Therefore, the peak flow of 52,000 cfs that was cited in the 1995 Corps Study was used for the frequency analysis in this study. In the 1995 Study, a hydrograph with a peak flow of 52,000 cfs for the March 9, 1995 storm at Rumsey was used to calibrate the Corps HEC-1 model for Cache Creek.

The historical record length for the Rumsey gage was lengthened by regression with the flow for the Capay gage. The plotting positions of the Rumsey gage flows were changed based upon the regression with Capay. The values derived by regression were not plotted on the frequency curve. Chart 12 shows the resulting frequency curve for "Without Indian Valley Dam" conditions. A regulated frequency curve for Lower Cache Creek was computed from the HEC-1 model hydrographs as described in Section 6.2

6.2 HEC-1 Model Results. For each modeled frequency, only the rainfall and loss rates were modified. Except for the 2% chance event model, none of the subareas above Rumsey were modified in the latest HEC-1 model. Therefore, except for the 2% chance event, the HEC-1 model results at Rumsey remain identical to those of the 1995 Reevaluation. The 2% chance event peak flow was decreased by 6% and the 72-hour volume by 15% in order to match the frequency curve. Farther downstream at the Capay gage site, the peak flows for the modeled frequencies (except the 2% chance event) changed only slightly if at all. For the 1%, 0.5%, and 0.2% chance exceedence events at Capay, the 24-hour and 72-hour maximum flow was decreased by an average of 5%. See Table 7 and 8 for the latest flow-frequency results for the Rumsey and Capay gage sites compared to previous studies.

Table 8. Example Flow- and Volume-Frequency Values at Rumsey

STUDY	PEAK Percent Chance Exceedence			72-HOUR Percent Chance Exceedence		
	2%	1%	0.2%	2%	1%	0.2%
1985 Study[1]	52,000	58,500	75,000	24,500	28,000	37,500
Westside Tributaries[2]	51,500	58,000	73,500	26,000	29,000	36,500
1995 Reevaluation	56,000	62,000	74,500	23,500	27,000	35,500
2001 Feasibility Study	52,000	62,000	74,500	20,500	27,000	35,000

(1) Volume-frequency values are 3-day values from a frequency analysis using mean daily flows, not maximum 72-hour values.
(2) Flow- and Volume-frequency values unpublished at this location.

Table 9. Example Flow- and Volume-Frequency Values at Capay Gage Site.

STUDY	PEAK (Percent Chance Exceedence)			72-HOUR (Percent Chance Exceedence)		
	2%	1%	0.2%	2%	1%	0.2%
1985 Study[1]	51,000	58,000	75,000	25,000	28,500	37,500
Westside Tributaries[2]	55,500	62,000	79,000	30,500	34,000	43,000
1995 Reevaluation	55,000	61,000	74,000	30,000	34,500	44,500
2001 Feasibility Study	51,500	61,500	75,000	25,500	32,500	42,500

(1) Volume-frequency values are 3-day values from a frequency analysis using mean daily flows, not maximum 72-hour values.
(2) Flow- and Volume-frequency values unpublished at this location.

Table 10. Flow Frequency Curve for Road 94B

	2% chance exceedence	1% chance exceedence	0.5% chance exceedence	0.2% chance exceedence
Peak	53,000	63,500	70,000	78,500
Peak 24-Hour Flow	43,500	54,500	62,000	72,500
Peak 72-Hour Flow	29,500	36,500	41,500	48,000

7. Risk and Uncertainty Analysis

The Corps of Engineers now uses a Risk and Uncertainty Analysis in its determination of project performance. For the analysis, the hydrologist is asked to provide a frequency curve along with statistics. If no statistics are available for the curve, the hydrologist may provide a "period of record" which describes the uncertainty in the curve. More confidence is given to a longer period of record. The uncertainty described by the period of record is used to create confidence limits for the frequency curve. Since the frequency curve at Road 94B is derived from hydrographs generated by HEC-1, the curve has no statistics. The following discussion describes how the period of record for the frequency curve was derived.

The HEC-1 model hydrographs at Rumsey were verified using a "without Indian Valley Dam regulation" frequency curve for the Rumsey gage. After some adjustment, the output and the frequency curves matched well. The Rumsey gage has 34 years of record (1961 to the present except for some missing years). Another gage called Cache Creek at Capay (1943 to1976) existed 17 miles downstream of Rumsey. This gage has good correlation with the Rumsey gage. Using regression, the Rumsey gage period of record was extended back to 1943 with the March 1995 flood being the largest flood of record (after adjusting the gage record for Indian Dam Regulation).

Prior to 1943, the previous big flood occurred in 1940. A peak flow of 38,700 cfs was recorded at the Yolo gage and a levee broke downstream of the gage causing flooding. This peak flow is close to the 38,000 and 36,400 cfs peak measured for in-channel flow in the 1958 and 1995 events.

During the 1940 event, a gage downstream of the present site of Indian Valley Dam (called North Fork Cache Creek near Lower Lake) recorded a peak flow of 20,000 cfs for its 197 square mile drainage area. At the same time, Clear Lake Dam was releasing approximately 4,500 to 5,000 cfs during the peak of the storm. No gage recorded the flow on Lower Cache Creek for this event (other than the Yolo gage). This leaves over 400 square miles of drainage area that was not measured. Since out-of-bank flow almost certainly occurred upstream of the Yolo gage, there is no available method to determine the actual peak flow that occurred farther upstream. Putah Creek is an adjoining watershed to Cache Creek. The 1940 flood caused the highest peak flow for the gage Putah Creek at Winters (for the unregulated period prior to building of Monticello Dam).

The gage, which has a drainage area of 547 mi2, recorded a peak flow of 81,000 cfs. Therefore, for the purposes of the Risk and Uncertainty Analysis, the period of record was determined to be 60 years of record (water years 1941 to 2000).

8. Interaction Between Cache Creek and the Yolo Bypass

Cache Creek is a tributary to the Yolo Bypass. The main purpose of this section is to address the concern that proposed alternatives (which involve an improved levee system) could increase the risk of flooding downstream. More specifically, could post-project conditions result in a higher peak stage in the Yolo Bypass as compared to pre-project conditions during a major flood on the Sacramento River? The following paragraphs describe the analysis that was performed to quantify this effect. The impact of the Yolo Bypass on Cache Creek is discussed at the end of this section.

The Yolo Bypass serves as a safety valve for the City of Sacramento when large flows occur on the Sacramento River. High stages on the Sacramento River enable water to spill over a series of weirs that pass water into the Yolo Bypass, thus preventing the Sacramento River from overtopping its levees. See Chart 15. The Yolo Bypass is an extremely wide channel with a capacity of approximately 350,000 cfs at the confluence with Cache Creek. The Yolo Bypass flows north to south towards the Sacramento-San Joaquin River Delta. The bypass is extremely flat. When the Sacramento Weir gates are open (about 8 miles downstream), it can cause a backwater effect and raise the stage in the bypass near Woodland. Flow entering the bypass from Cache Creek would be similar to water entering a reservoir. The water would immediately move both upstream and downstream, quickly attenuating the peak flood wave from Cache Creek. Since contributing volume from Cache Creek (as opposed to peak flow) is the factor that raises the stage in the bypass, the analysis was performed using daily flow (as opposed to hourly values).

Under existing conditions, the Cache Creek levees begin to overtop at 36,000 cfs. In the case of levee failure, channel capacity is further reduced to about 20,000 - 25,000 cfs. Flow in excess of channel capacity spills out onto the floodplain adjacent to the creek. Normally, the overbank flow does not return to the creek and will not enter the bypass. In this Feasibility Study, overbank flow modeled for the 2% chance and 1% chance floods ended up ponding against the landside of the Yolo Bypass levees. Two of the proposed project alternatives involve improved levees that are capable of conveying a higher peak flow to the Cache Creek Settling Basin and ultimately the Yolo Bypass. For the purpose of this analysis (based upon preliminary Risk and Uncertainty calculations), the improved levee capacity is assumed to be 80,000 cfs.

A streamgage called "Yolo Bypass near Woodland (gage i.d. 114530) was chosen for the analysis. The gage is located in the Yolo Bypass on the upstream side of the Interstate 5 Bridge. It is close to the Cache Creek confluence with the bypass. The gage has a period of record of 1939 to present. Chart 15 shows the location of the gage. The ten largest floods of record for the Yolo Bypass near Woodland gage were examined. In all ten events examined, the peak flow on Cache Creek occurred 1 to 3 days prior to the peak flow in the bypass. Lower Cache Creek typically experiences the peak flow of a storm hydrograph within 15 hours of the most intense rainfall. For this analysis, the recorded peak flow at the Cache Creek at Yolo gage could not be used to represent Cache Creek discharges. This is due to limited channel capacity in this reach (36,000 cfs) that has resulted in some water being lost to overbank flow (not measured). The peak instantaneous flow that occurred at the Cache Creek at Rumsey gage or Cache Creek at Capay gage was assumed to be the peak flow that would reach the bypass (no attempt was made to route or attenuate the hydrograph). Historically, significant attenuation often occurs as the hydrograph moves downstream (average of 19% from Rumsey to Capay). Secondly, an even more conservative assumption was made that the peak flow lasted for a full 24-hour period (flat hydrograph). This results in a much higher volume of flow than historically occurred. For a few of the 10 events studied, the maximum peak flow on Cache Creek occurred during a storm which was separate from that which caused the peak in the bypass. In these cases, the maximum peak recorded on Cache Creek for that water year was adopted for use. For each event analyzed, the channel capacity of 36,000 cfs was subtracted from the peak instantaneous flow to derive the 24-hour value to add to the flow recorded in the bypass. This 24-hour flow was added to the recorded daily flow in the bypass on the day in which the peak occurred at the gage called Cache Creek at Yolo (about 6 miles upstream of the Cache Creek Settling Basin). The result of the analysis was that the maximum daily flow recorded in the bypass at the gage near Woodland was never exceeded. In addition, for several of the flood events analyzed, Cache Creek did not experience flows above existing channel capacity (36,000 cfs).

In summary, it is the conclusion of this analysis that the levee alternatives being considered in this Feasibility Study will not cause higher stages in the Yolo Bypass during major floods on the Sacramento River. Furthermore, the largest floods on Cache Creek do not always coincide with the largest events on the Sacramento River. The two largest recorded floods on Cache Creek occurred in January of 1983 and March of 1995 (for unregulated conditions). The January 1983 event did not rank in the top ten events for the Yolo Bypass and the March 1995 event ranked as the 8th largest. The proposed levee alternatives will result in a higher volume of water reaching the bypass over the length of a flood event but should not cause an increase in the peak stage.

The levee alternatives being proposed could increase the frequency of flooding to rice farmers growing crops in the Yolo Bypass. This can occur when a storm centered on Cache Creek causes significantly high flows (above existing channel capacity of 36,000 cfs) and when flows in the Yolo Bypass are minimal. However, these farmers typically plant crops in the spring and harvest in October. Since only large general rainstorms occurring from November through March cause flooding on Lower Cache Creek, impact to the farmers is expected to be minimal.

The Comprehensive Study routed 15 different 1% chance exceedence storm centerings down the Sacramento River and the Yolo Bypass. The maximum stage that occurred among all the centerings was then defined as the official 1% chance stage. The spillway invert of the Cache Creek Settling Basin is 32.5 feet (NVGD 1929). The Comprehensive

Study computed a 1% chance stage in the Yolo Bypass at the Cache Creek confluence as 31.25 feet (NVGD 1929). In addition, the latest FEMA floodmap appears to show the same 1% chance stage at this location. Therefore, a 1% chance exceedence flow in the Yolo Bypass will not prevent flows on Cache Creek from exiting the Settling Basin. The Comprehensive Study 0.5% chance (1 in 200) stage is 33.2 feet (NVGD 1929) therefore this event could overtop the settling basin. The spillway invert is scheduled to be raised another six feet in the year 2017 to compensate for storage loss due to sediment deposition.

9. Summary

A 96-hour balanced hyetograph (balanced meaning that the 1-, 6-, 24-, 48- and 96-hour duration rainfall had the same frequency of occurrence) was produced for every subbasin in the HEC-1 model, with the most intense rainfall cell being centered over the subarea that ends at the Rumsey gage (127 square miles). The 1985 Study determined this to be the most critical storm centering for producing the highest flows on Lower Cache Creek. In the 1995 Study, the model was calibrated to three large storms (January 1983, January 1995, and March 1995) using recorded precipitation, reservoir inflow, and streamgage data.

For this study, a family of frequency curves for the Cache Creek at Rumsey Bridge gage (adjusted for without Indian Valley Dam regulation) was produced using the latest flow records available up to the year 2000. The HEC-1 model was run for various frequency events (without Indian Valley Dam) and the hydrographs at Rumsey were compared with the frequency curve. After a few modifications to the 2% chance model, the HEC-1 generated peak, 24-hour, and 72-hour maximum flows for each frequency had a good match with the new frequency curves. In response to concerns voiced in the text of the 1995 Study, "peak attenuation" and "volume change" between the Rumsey, Capay, and Yolo gages was studied in greater detail. Routing parameters and rainfall loss rates were changed to match those observed in historic events. After this was done, Indian Valley Dam regulation was put back into the model and synthetic regulated hydrographs for various frequencies (2%, 1%, 0.5%, and 0.2% chance events) were produced.

Finally, a regulated frequency curve was derived from the HEC-1 model output. Greatest confidence in the model is given to the Rumsey gage index point because of the available flow records. The confidence given to the hydrographs at index points below Rumsey, although less than that at Rumsey, is considered sufficient for a feasibility level study of alternatives and possible future levee design.

10. References

1. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Standard Project Floods," May 1974.

2. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Feasibility Report and Environmental Statement for Water Resources Development," February 1979.

3. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Hydrology Review Report," March 1985.

4. U.S. Army Corps of Engineers, Sacramento District, "Cache Creek Basin, California, Feasibility Report and Environmental Statement for Water Resource Development," February 1992.

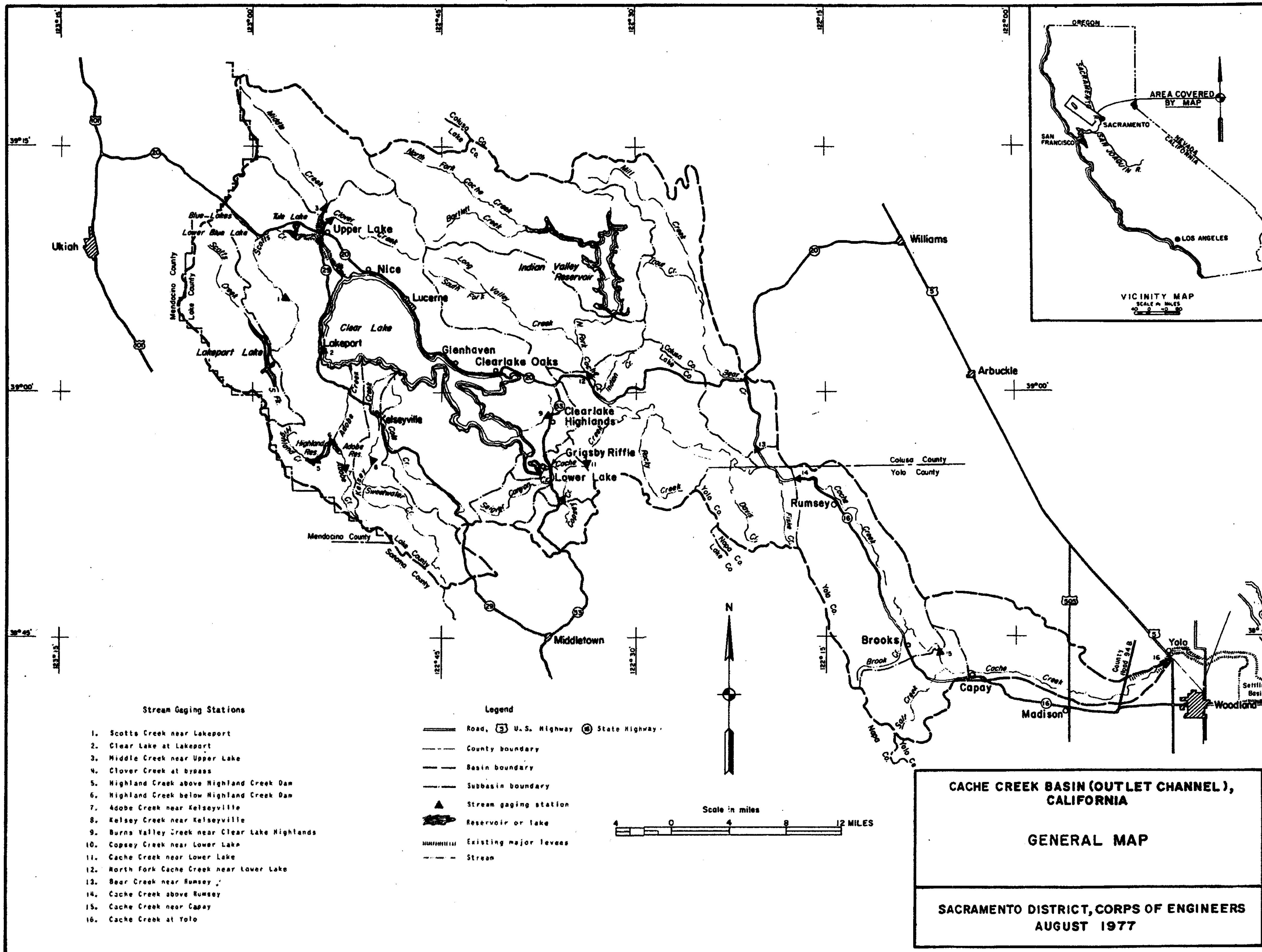
5. U.S. Army Corps of Engineers, Sacramento District, "Westside Tributaries to Yolo Bypass, California," Draft Reconnaissance Report, June 1994

6. Interagency Advisory Committee on Water Data, "Guidelines for Determining Flood Flow Frequency Analysis Bulletin 17B," revised 1981.

7. U.S. Army Corps of Engineers, Washington D.C., "Risk-Based Analysis for Flood Damage Reduction Studies," EM 1110-2-1619, 1 August 1996.

8. U.S. Army Corps of Engineers, Sacramento District, "Office Report, Hydrology for Cache Creek, Yolo County, California," August 1995.

9. A&M Consultants of California, San Diego, California, "Hydrology Report for Yolo County, California and City of Woodland, California," February 1997.

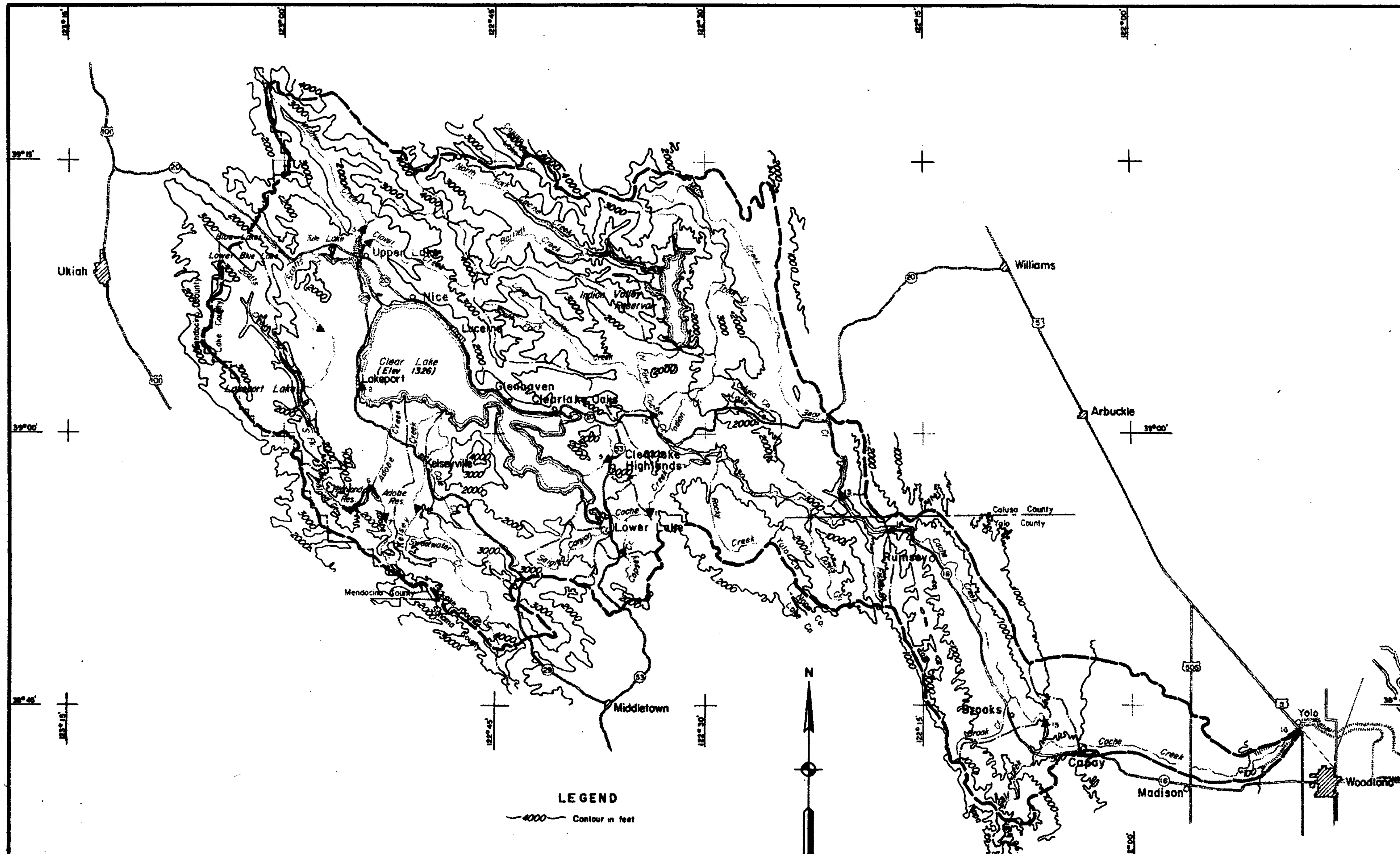


CACHE CREEK BASIN (OUTLET CHANNEL), CALIFORNIA

GENERAL MAP

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 1977

Chart 1.



CACHE CREEK BASIN
CALIFORNIA

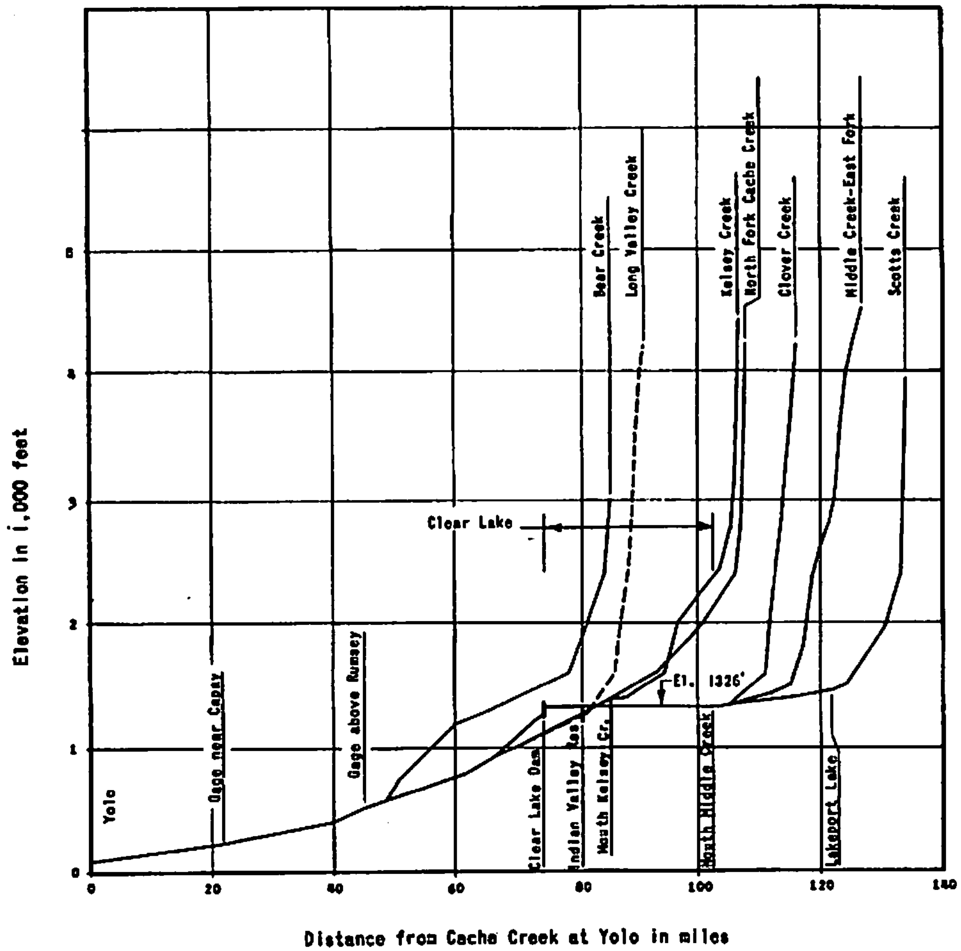
TOPOGRAPHY MAP

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: P. W.
Drawn: L. H. C.

Date: FEBRUARY 1974

Chart 2.



CACHE CREEK BASIN
CALIFORNIA

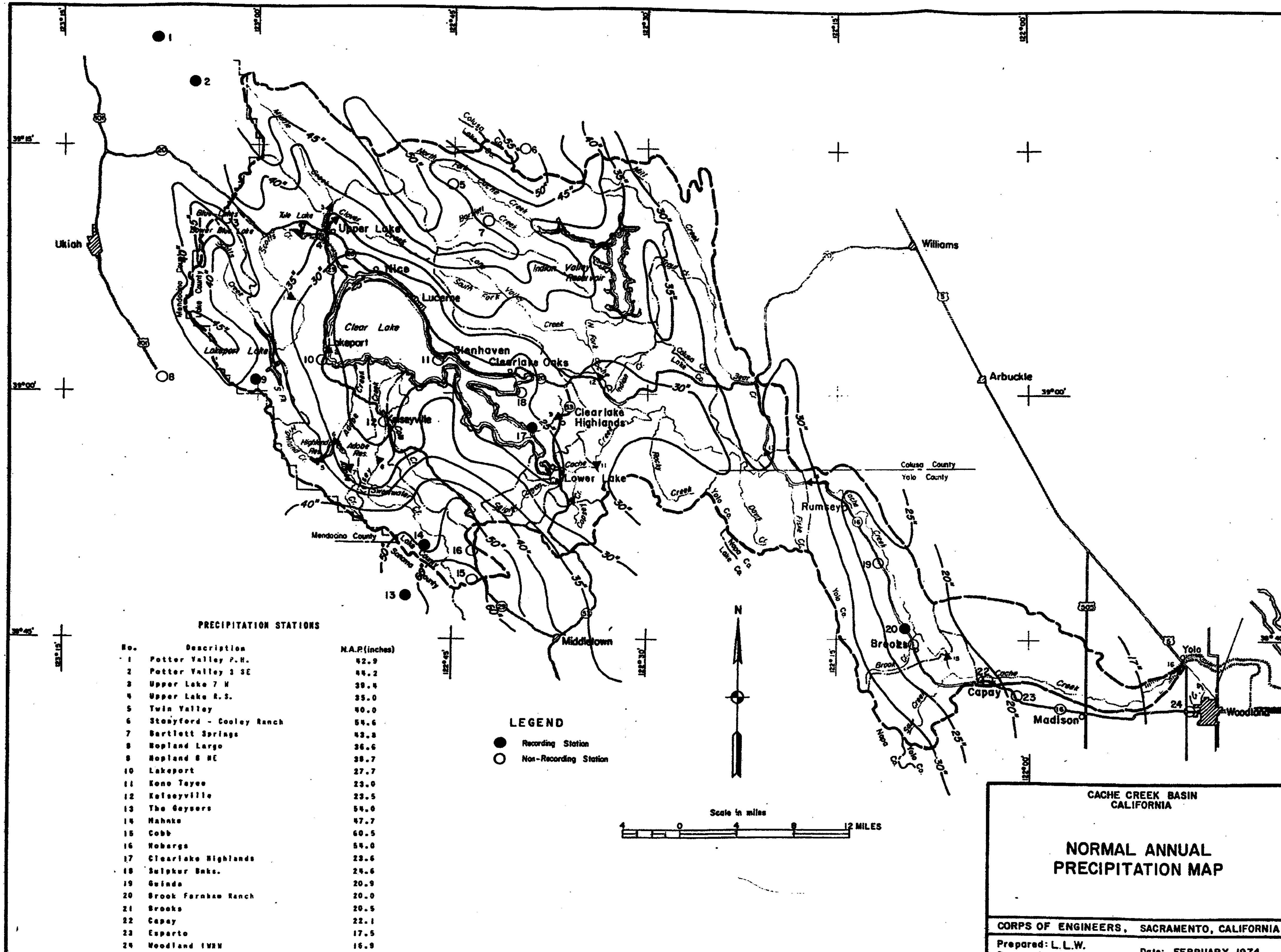
STREAM PROFILES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: P.V.
Drawn: L.N.C.

Date: FEBRUARY 1974

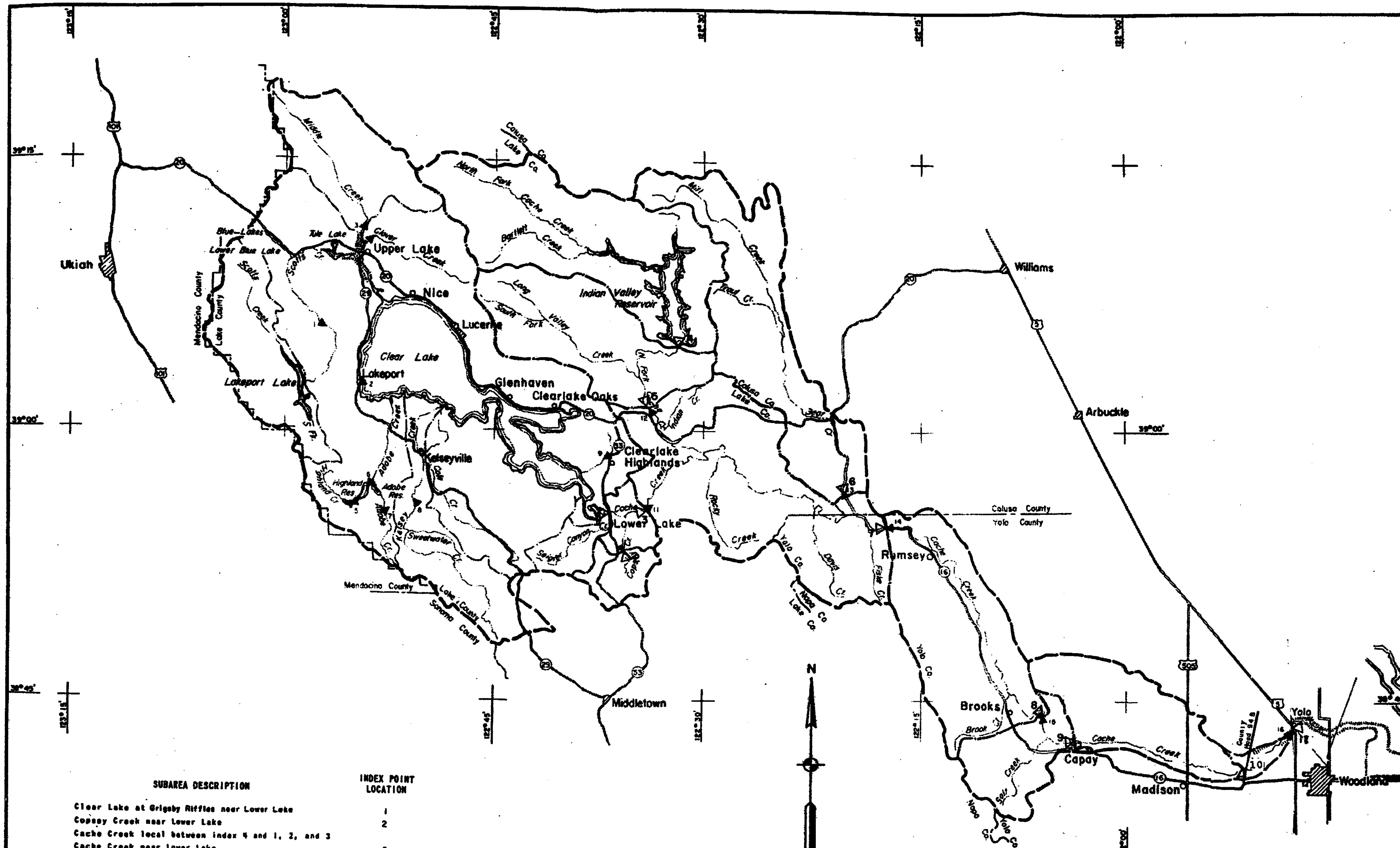
Chart 3.



PRECIPITATION STATIONS

No.	Description	N.A.P.(inches)
1	Potter Valley P.H.	42.9
2	Potter Valley 3 SE	44.2
3	Upper Lake 7 W	39.4
4	Upper Lake R.S.	35.0
5	Twin Valley	40.0
6	Stonyford - Cooley Ranch	54.6
7	Bartlett Springs	43.8
8	Hopland Largo	36.6
9	Hopland 6 NE	38.7
10	Lakeport	27.7
11	Kono Tayee	23.0
12	Kelseyville	23.5
13	The Geysers	54.0
14	Hahnke	47.7
15	Cobb	60.5
16	Hobergs	54.0
17	Clearlake Highlands	23.6
18	Sulphur Bnks.	24.6
19	Guinda	20.9
20	Brook Farnham Ranch	20.0
21	Brooks	20.5
22	Capay	22.1
23	Esparto	17.5
24	Woodland 1WNW	16.9

Chart 4.



SUBAREA DESCRIPTION	INDEX POINT LOCATION
Clear Lake at Grigsby Riffles near Lower Lake	1
Copsey Creek near Lower Lake	2
Cache Creek local between index 4 and 1, 2, and 3	
Cache Creek near Lower Lake	3
North Fork Cache Creek at Indian Valley Reservoir	4
North Fork Cache Creek local between 4 and 3	
North Fork Cache Creek near Lower Lake	5
Bear Creek near Rumsey	6
Cache Creek local between index 6 and 5, 4, and 3	
Cache Creek above Rumsey	7
Cache Creek local between index 7 and 6	
Cache Creek near Capay	8
Cache Creek local between index 8 and 7	9
Cache Creek local between index 9 and 8	
Cache Creek at Road 94B	10
Cache Creek at Yolo*	11

*(levees prevent local runoff from entering creek)

NOTE: For legend see CHART I

CACHE CREEK BASIN
CALIFORNIA

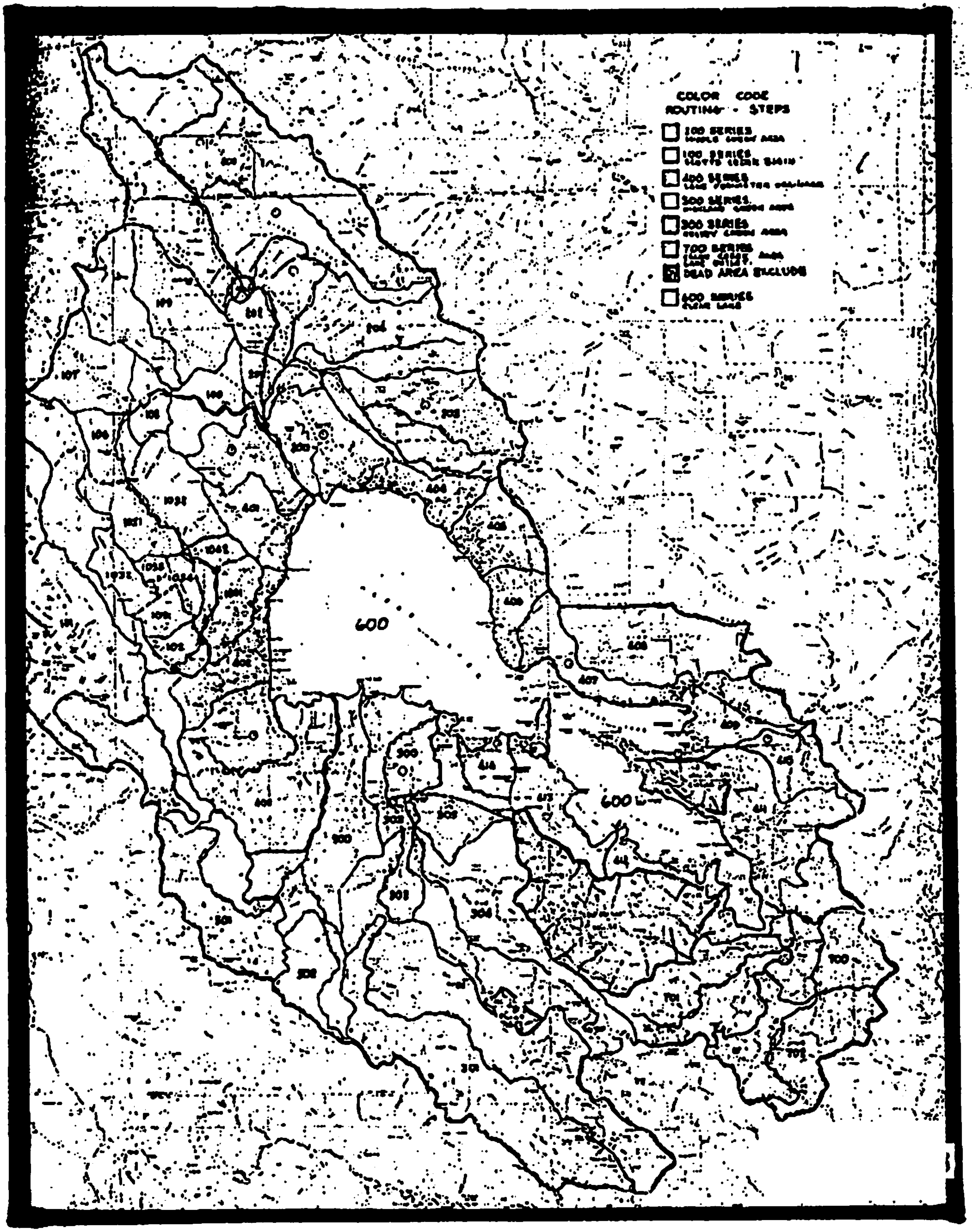
SUBAREA MAP

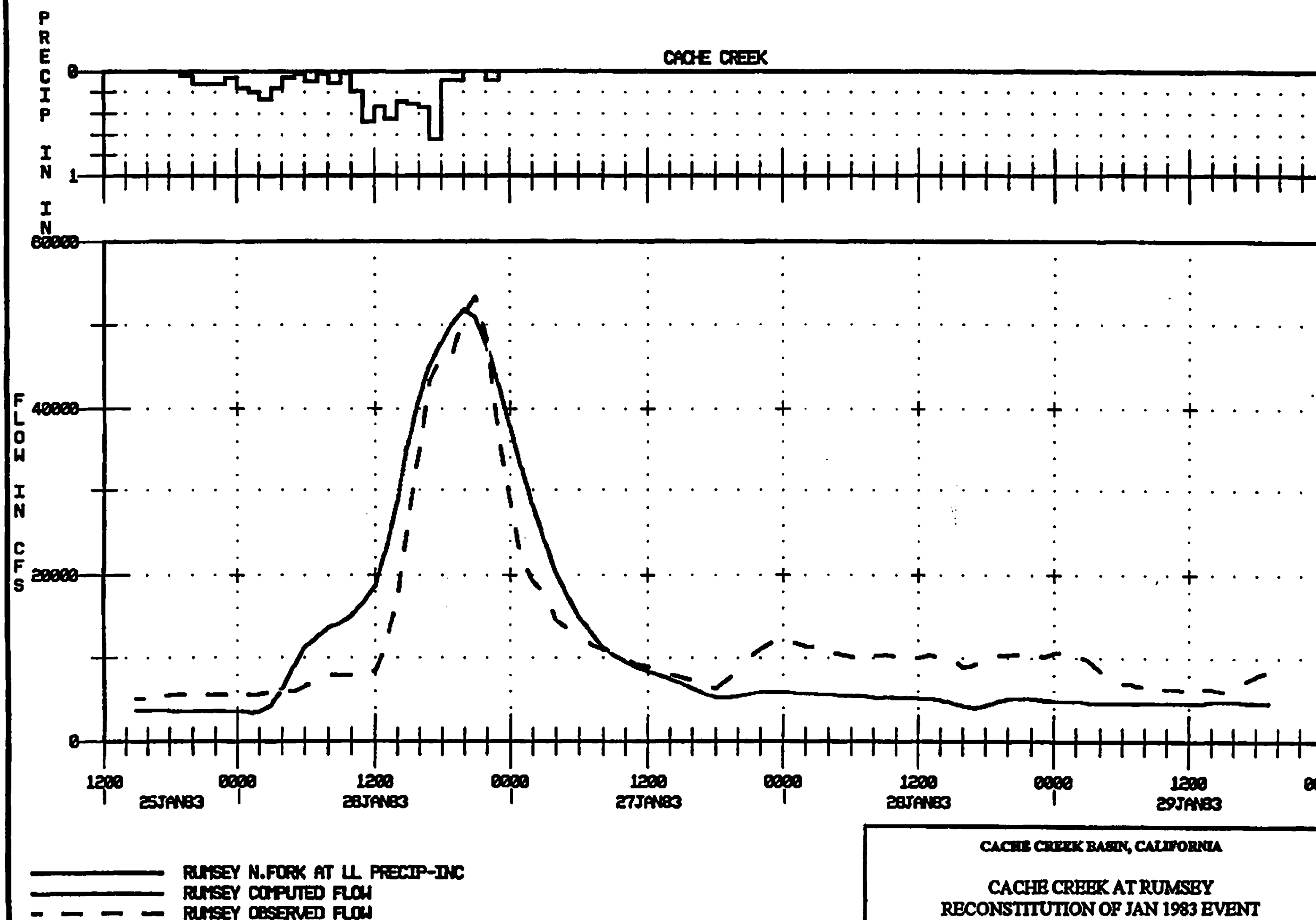
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: P. W.
Drawn: L. H. C.

Date: FEBRUARY 1974

CACHE CREEK HEC-1 SUB-BASINS MAP



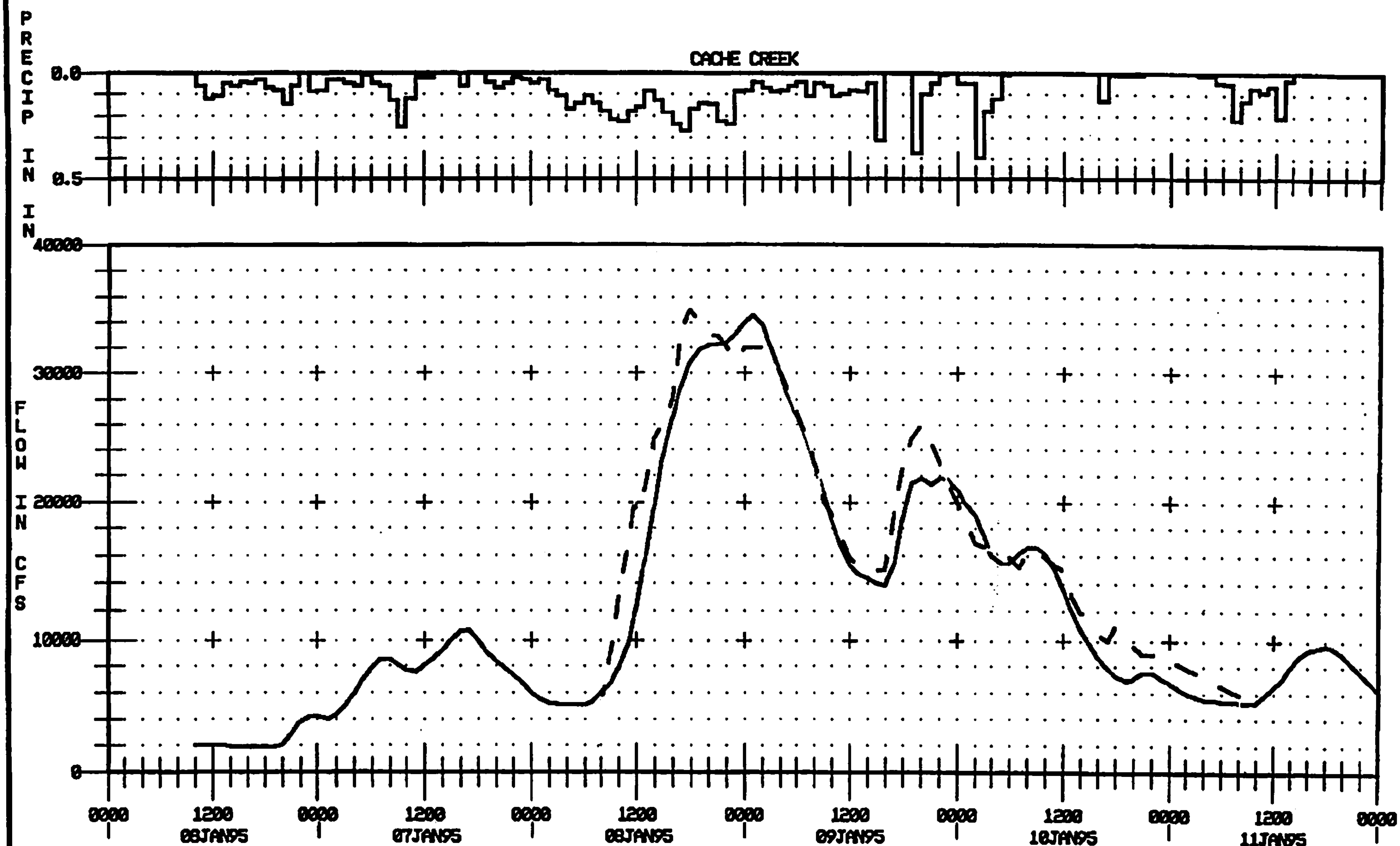


CACHE CREEK BASIN, CALIFORNIA

CACHE CREEK AT RUMSEY
RECONSTITUTION OF JAN 1983 EVENT

CORPS OF ENGINEERS, SACRAMENTO, CA

Chart 7.



RUMSEY INDIAN VALLEY PRECIP-INC
RUMSEY COMPUTED FLOW
RUMSEY OBSERVED FLOW

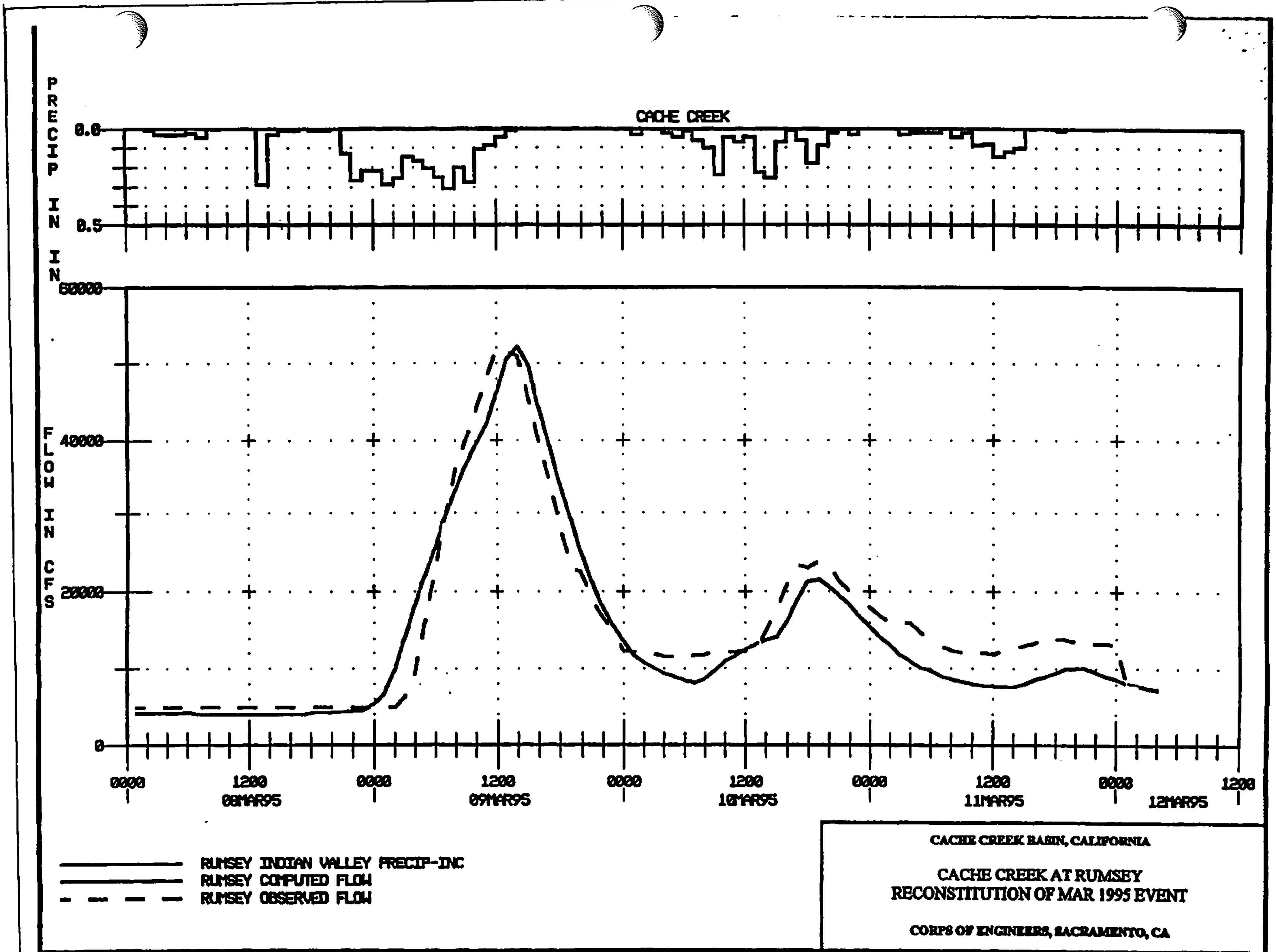
Note:
Observed event only plotted from
10:00 a.m. 8 Jan to 10:00 a.m. 11 Jan.

CACHE CREEK BASIN, CALIFORNIA

CACHE CREEK AT RUMSEY
RECONSTITUTION OF JAN 1995 EVENT

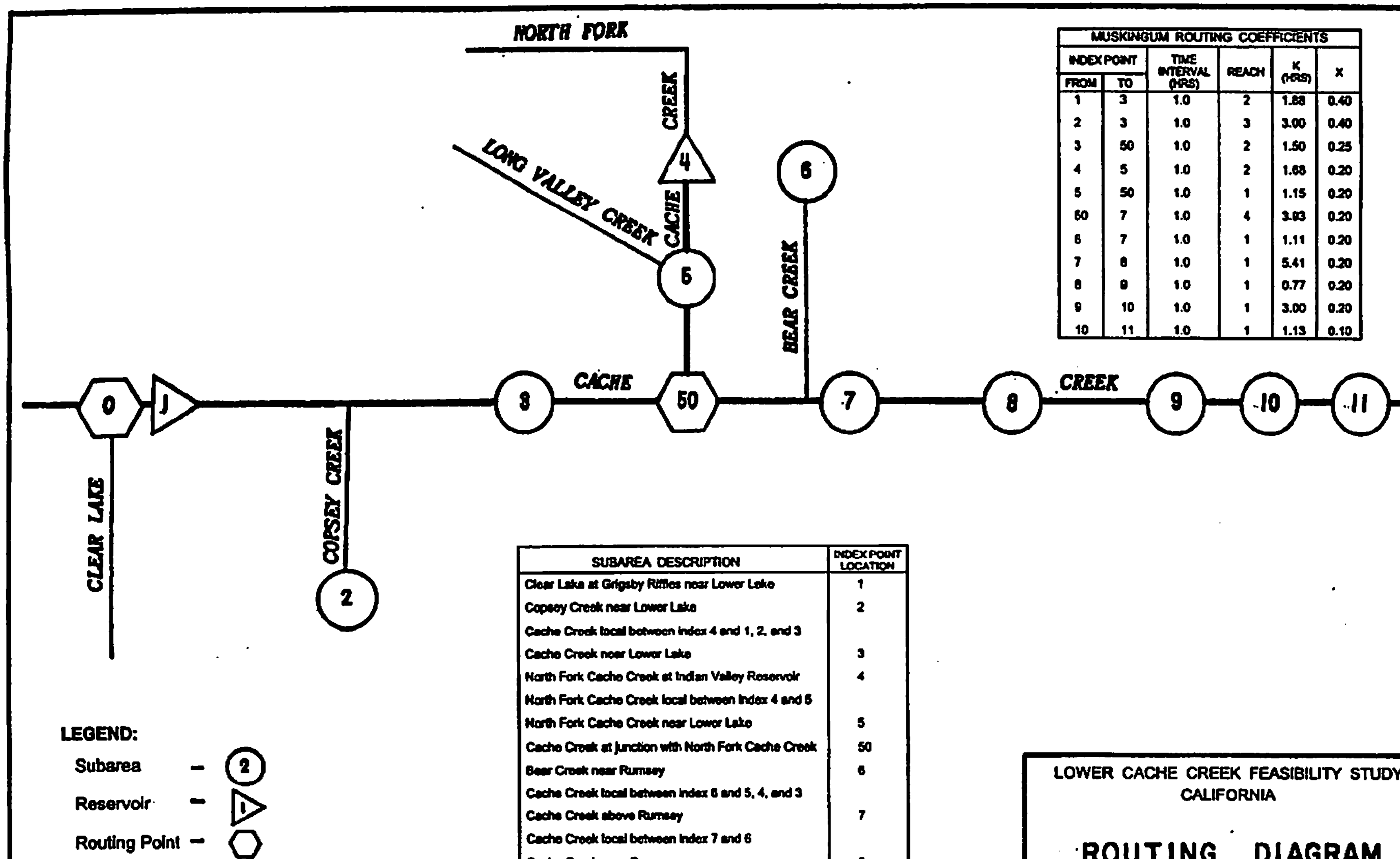
CORPS OF ENGINEERS, SACRAMENTO, CA

Chart 8.



CACHE CREEK
PRECIP IN IN
0.0
0.5
FLOW IN CFS
60000
40000
20000
0
0000
1200
08MAR95
0000
1200
09MAR95
0000
1200
10MAR95
0000
1200
11MAR95
0000
12MAR95
1200
RUMSEY INDIAN VALLEY PRECIP-INC
RUMSEY COMPUTED FLOW
RUMSEY OBSERVED FLOW
CACHE CREEK BASIN, CALIFORNIA
CACHE CREEK AT RUMSEY
RECONSTITUTION OF MAR 1995 EVENT
CORPS OF ENGINEERS, SACRAMENTO, CA

Chart 9.



MUSKINGUM ROUTING COEFFICIENTS					
INDEX POINT		TIME INTERVAL (HRS)	REACH	K (HRS)	X
FROM	TO				
1	3	1.0	2	1.88	0.40
2	3	1.0	3	3.00	0.40
3	50	1.0	2	1.50	0.25
4	5	1.0	2	1.68	0.20
5	50	1.0	1	1.15	0.20
50	7	1.0	4	3.83	0.20
6	7	1.0	1	1.11	0.20
7	8	1.0	1	5.41	0.20
8	9	1.0	1	0.77	0.20
9	10	1.0	1	3.00	0.20
10	11	1.0	1	1.13	0.10

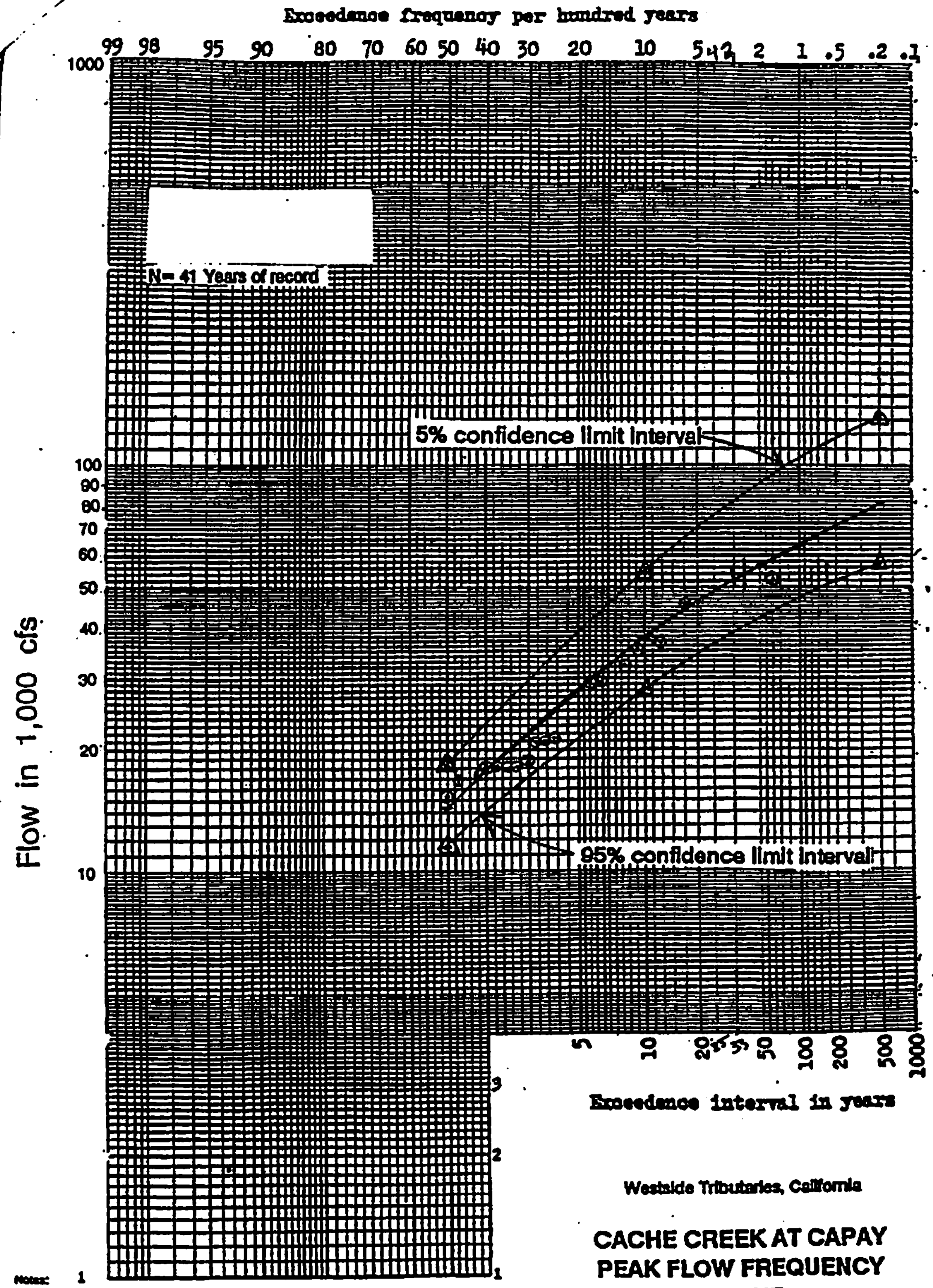
SUBAREA DESCRIPTION	INDEX POINT LOCATION
Clear Lake at Grigsby Riffles near Lower Lake	1
Copsey Creek near Lower Lake	2
Cache Creek local between index 4 and 1, 2, and 3	
Cache Creek near Lower Lake	3
North Fork Cache Creek at Indian Valley Reservoir	4
North Fork Cache Creek local between index 4 and 5	
North Fork Cache Creek near Lower Lake	5
Cache Creek at junction with North Fork Cache Creek	50
Bear Creek near Rumsey	6
Cache Creek local between index 6 and 5, 4, and 3	
Cache Creek above Rumsey	7
Cache Creek local between index 7 and 6	
Cache Creek near Capay	8
Cache Creek at Capay Diversion Dam	9
Cache Creek local between index 9 and 8	
Cache Creek at Road 94B	10
Cache Creek local between index 10 and 9	
Cache Creek at Yolo	11

LOWER CACHE CREEK FEASIBILITY STUDY
CALIFORNIA

ROUTING DIAGRAM

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: J. H.
Drawn: J. M.
Date: SEPT 2001



Notes:

1. Due to regulation of flow at Indian Valley Reservoir the curve is graphically drawn.
2. Period of record is 1943-1994.
3. Total contributary drainage area is 1019 square miles.
4. Sample statistics were computed for utilization in a risk and uncertainty analysis.

Westside Tributaries, California

CACHE CREEK AT CAPAY PEAK FLOW FREQUENCY CURVE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

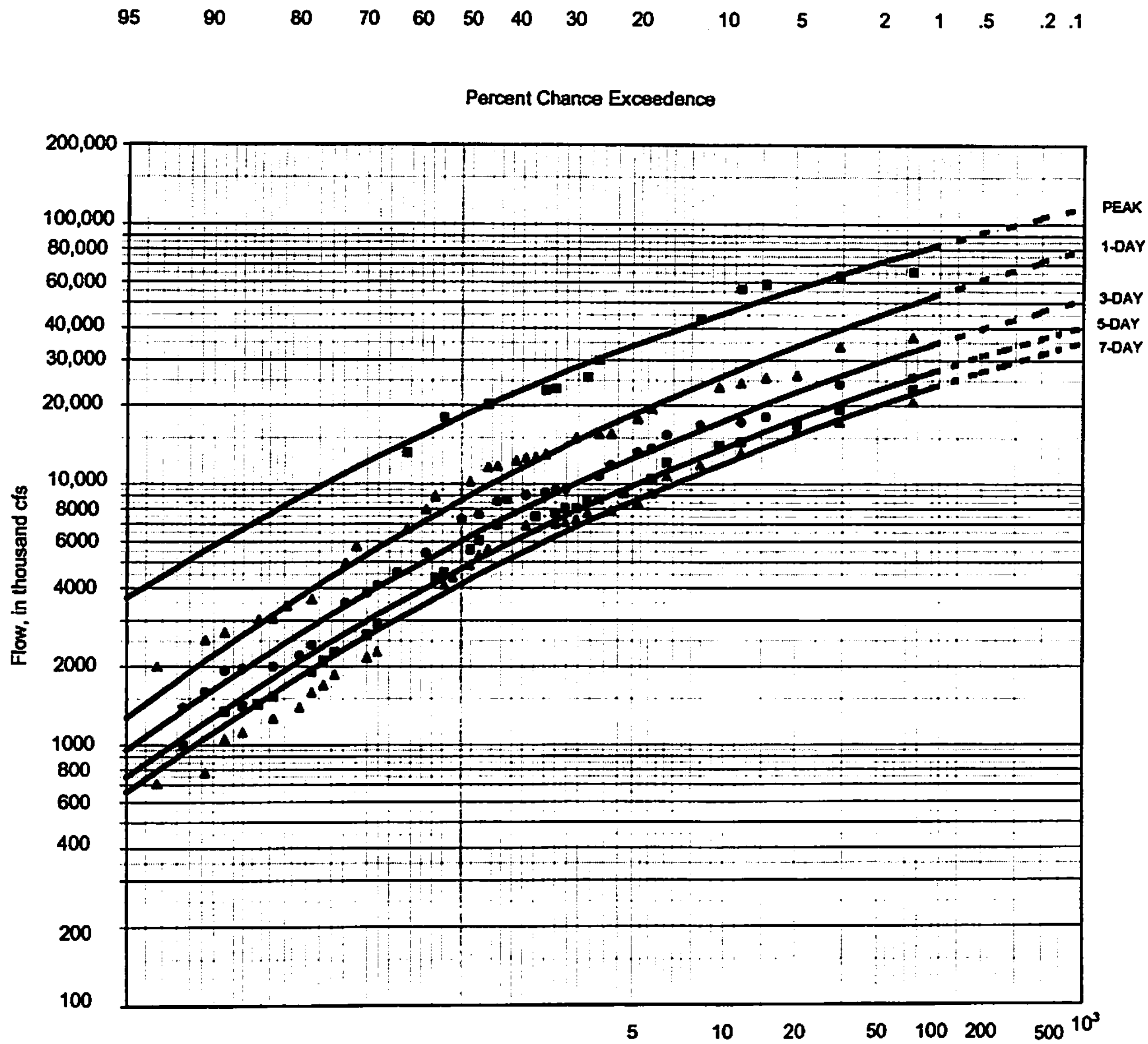
Prepared by: G.C.M. Date: AUG 1994

Drawn by: G.C.M. Rev. August 1994

CHART 5

FROM HYDROLOGY FOR WESTSIDE TRIBUTARIES, CALIFORNIA, JUNE 1994

Chart 11.



CURVE STATISTICS:

	Mean	Std Dev	Skew
Peak	4.223	0.355	-0.60
1-Day	3.895	0.426	-0.60
3-Day	3.741	0.410	-0.60
5-Day	3.636	0.410	-0.60
7-Day	3.576	0.410	-0.60

Notes: 1. Computed probability.
2. Cache Creek at Rumsey period of record is WY1961 - 1999, 33 years of record.
3. Curve statistics derived from correlation with Capay gage.
4. Indian Valley Dam regulation removed from gage records.

Prepared by JMH

CACHE CREEK, CA
2000 FEASIBILITY STUDY

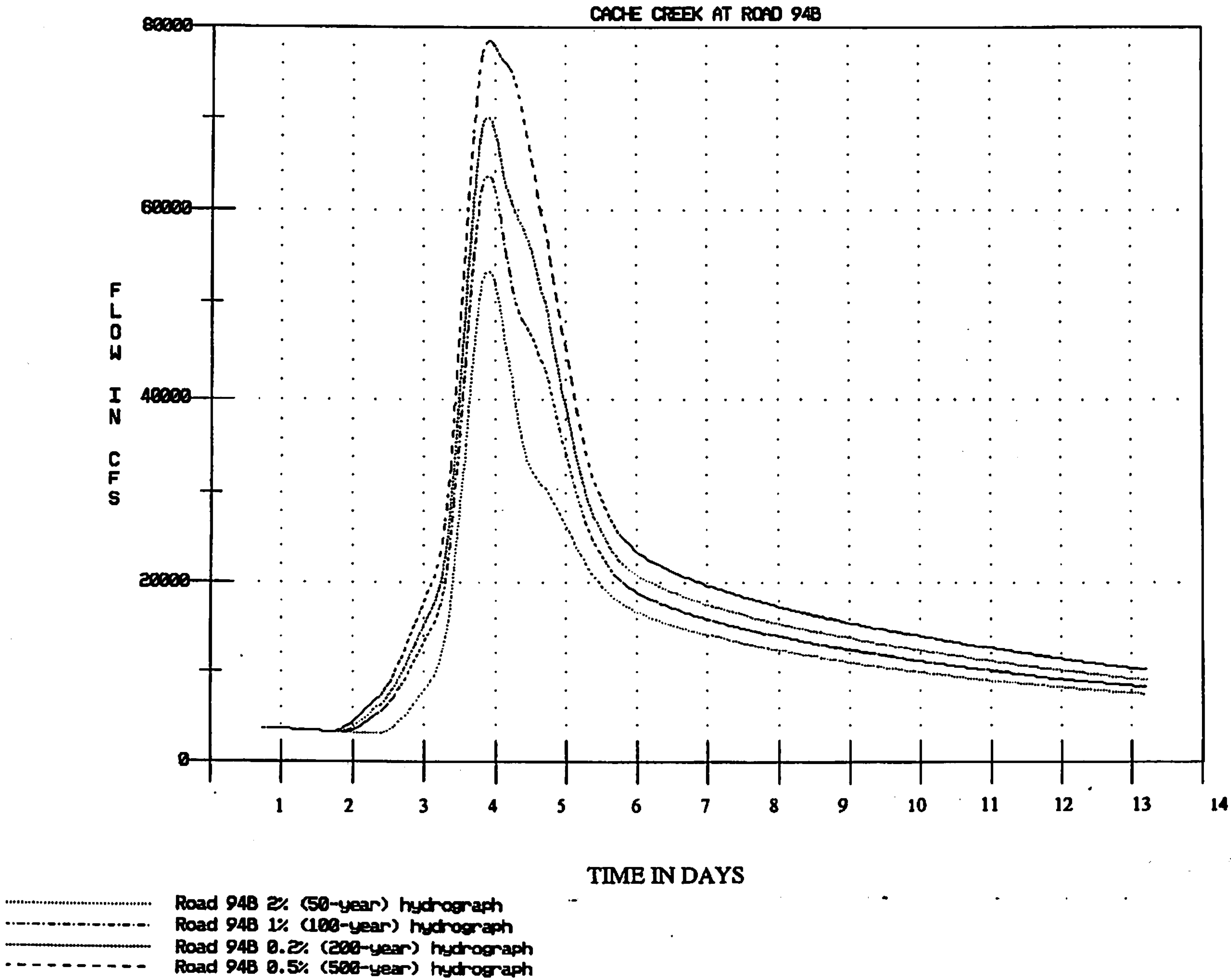
PEAK RAINFLOOD FREQUENCY CURVE

CACHE CREEK AT RUMSEY
WITH NO INDIAN VALLEY DAM

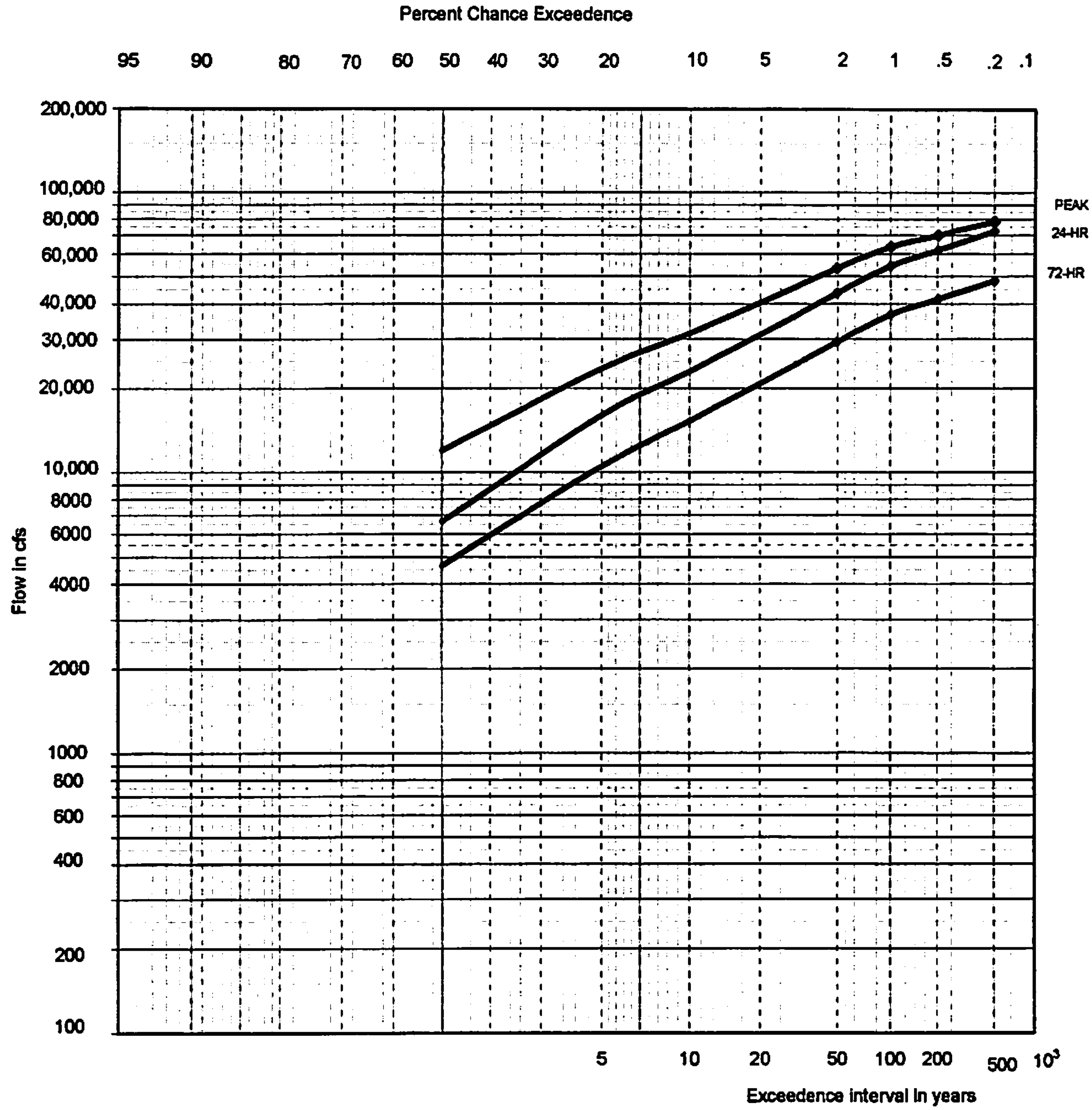
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

CHART 12

Chart 13.



CACHE CREEK AT ROAD 94B
FLOW IN CFS
80000
60000
40000
20000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TIME IN DAYS
Road 94B 2% (50-year) hydrograph
Road 94B 1% (100-year) hydrograph
Road 94B 0.2% (200-year) hydrograph
Road 94B 0.5% (500-year) hydrograph



Notes:

1) Computed Probability
2) 2%, 1%, 0.5% and 0.2% chance exceedance events generated by HEC-1 model output

Prepared by JMH

LOWER CACHE CREEK, CA

2000 FEASIBILITY STUDY

PEAK RAINFLOOD FREQUENCY CURVE

CACHE CREEK AT ROAD 94B

EXISTING CONDITIONS

U.S. ARMY CORPS OF ENGINEERS

SACRAMENTO DISTRICT

CHART 14

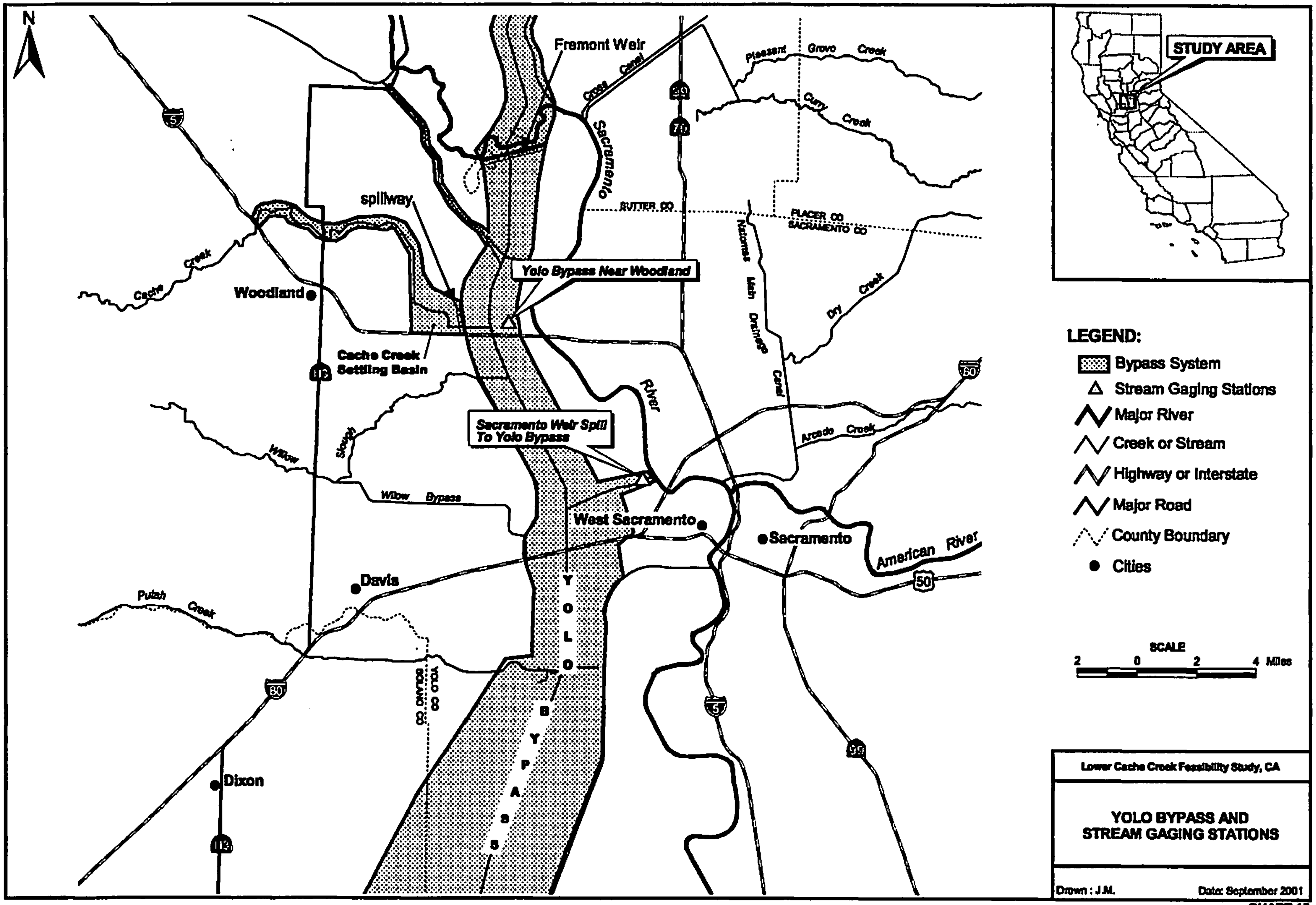

N
Fremont Weir
Cross Canal
Sacramento
River
spillway
SUTTER CO
PLACER CO
SACRAMENTO CO
Pleasant Grove Creek
Curry Creek
Natomas Main Drainage Canal
Dry Creek
Cache Creek
Woodland
Yolo Bypass Near Woodland
Cache Creek Settling Basin
Willow Slough
Willow Bypass
Sacramento Weir Spill To Yolo Bypass
Arcade Creek
West Sacramento
Sacramento
American River
Davis
Putah Creek
YOLO CO
SOLANO CO
YOLO BYPASS
Dixon
5
99
70
80
113
50
STUDY AREA
LEGEND:
Bypass System
Stream Gaging Stations
Major River
Creek or Stream
Highway or Interstate
Major Road
County Boundary
Cities
SCALE
2 0 2 4 Miles
Lower Cache Creek Feasibility Study, CA
YOLO BYPASS AND STREAM GAGING STATIONS
Drawn : J.M.
Date: September 2001

CHART 15

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix D

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX D

Hydraulic Analysis

US Army Corps
of Engineers
Sacramento District

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

CACHE CREEK
HYDRAULIC ANALYSIS
ROAD 94B TO CACHE CREEK SETTLING BASIN

MBK ENGINEERS

2450 Alhambra Blvd., 2nd Floor
Sacramento, CA 95817
916/456-4400

FEBRUARY 2002

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

SECTION 1 -- INTRODUCTION

1.01 Purpose and Scope

The purpose of this report is to present an evaluation of flood problems along Cache Creek from Road 94B to the Cache Creek Settling Basin. To evaluate the potential for flooding, it is necessary to define the existing system of flood protection and compare this to likely alternatives. The alternatives are then evaluated to select the most likely alternatives for further study on final selection.

This report was prepared as required by the Department of the Army, Sacramento District, US Army Corps of Engineers under contract with the City of Woodland.

SECTION 2 -- STUDY AREA DESCRIPTION

2.01 Cache Creek

As part of the Sacramento River Flood Control Project, authorized by the Flood Control Act of 1917, the Corps of Engineers completed construction for the Cache Creek Settling Basin in 1937. The settling basin, located in Yolo County about two miles east of Woodland, is bounded by levees on all sides and covers approximately 3,600 acres. The basin's fundamental purpose is to preserve the floodway capacity of the Yolo Bypass by entrapping the heavy sediment load carried by Cache Creek. Plate 1 is a location map for the study area.

The southern levee of the settling basin along the Sacramento Northern Railroad Track was constructed in 1940, and the "Cobble Weir" was constructed in 1944. A levee was not built on the western boundary of the basin because rights-of-way were acquired only to the 32-foot contour, USGS Datum. This was considered to be the westerly limit to which waters would spread.

In 1943, levees were constructed along Cache Creek from the mouth of the settling basin to Yolo, providing for a capacity of 20,000 cfs. In 1961, the north levees were extended approximately three miles upstream of the town of Yolo, and the entire settling basin levee system was strengthened to convey a design flow of 30,000 cfs. This work was authorized in "Design Memorandum No. 10 for the Sacramento River Flood Control Project, California, Cache Creek Yolo Bypass to High Ground Levee Construction," dated 1 November 1958. Plate 2 is a proposed levee construction plan from October 1958. Due to the proposed Wilson Valley Reservoir and subsequent anticipated flood protection, the south levee upstream of I-5 was not constructed, thus leaving lands south of Cache Creek vulnerable to overflow.

Interstate Highway 5, completed in 1973, forms a barrier to overland flow from Cache Creek, with the potential for diverting flood flows toward the City of Woodland. Although there have been many major floods from Cache Creek, the central City of Woodland has no recorded history of flooding.

During the flood of 1958, the sedimentation basin levees successfully contained flows of 41,400 cfs, but Cache Creek overflowed its banks upstream of the levees and flooded farmlands and roads. Flood damages for the 1958 flood along Cache Creek above the leveed reach and below Clear Lake Dam were estimated at $520,000 (1958 price level). In 1970, limited flooding in the lower basin adjacent to Cache Creek caused approximately $50,000 (1970 price level) in agricultural damages. In January 1983, flooding occurred adjacent to the settling basin due to a levee break on the southern project levee below Road 102. A partial estimate for flood damages in 1983 have totaled approximately $1,800,000 (1983 price level). In March 1995, flooding occurred to the north and south of Cache Creek upstream of I-5. Flooding downstream of I-5 was contained by flood fighting on top of the levee.

SECTION 3 -- HYDROLOGY

3.01 Cache Creek Hydrology

Limited historical runoff data are available for the Cache Creek basin. For this investigation, 60 years of runoff data were available for evaluating flow frequencies and magnitudes. Although this length or record is much better than the length of record for many rivers in California, it is still considered a relatively short period of time. It is important to understand that this study is based on past events that we assume will be equaled in the future; however, significantly greater flood flows may also occur.

The computer program HEC-1 was used for the Cache Creek basin model. Discharge hydrographs were developed for the without-project condition for Cache Creek for the 50-, 100-, 200-, and 500-year flood events. Historical flood stages and cross sections were used to verify the channel capacity of Cache Creek.

A detailed hydrology study was performed and is included as part of the feasibility report. For the hydraulic study, flows developed in the hydrology study were input at Road 94B. Tabulated below are the peak flows and associated frequency.

Table 1
Estimated Cache Creek Peak Flood Flow & Frequency

Return Period (years)	Peak Flow (cfs)
10	31,500
50	53,290
100	63,683
200	70,085
500	78,595

For comparison, historical flows at the Yolo gage are tabulated below in Table 1A. The Yolo Gage is downstream of RD 94B and does not represent flows fully contained by Cache Creek. Natural banks between RD 94B and Yolo begin to overtop between 36,000 and 38,000 cfs.

Table 1A
Cache Creek Historic Flows at Yolo

Location	Date	Flood Peak (cfs)	3-Day Flow Volume (ac-ft)
Cache Creek at Yolo	25 Feb 58	41,400	102,230
	23 Dec 64	26,200	79,360
	6 Jan 65	37,800	97,420
	24 Jan 70	34,600	125,720
	27 Jan 83	33,000	---
	9 Jan 95	32,000	---
	9 Mar 95	36,400	---

SECTION 4 -- SURVEYS and MAPPING

4.01 Surveys

Topographic mapping, field cross sections, and reconnaissance-level survey data were collected in the study area during the spring of 2000. Aerial photography was taken on March 24, 2000, and a GPS control survey was subsequently performed. In addition, DWR surveyed the bridges in mid-April 2000. The aerial topographic data was collected in Digital Terrain Model (DTM) format in a three-dimensional digital file. Planimetric detail was for a two-foot contour interval. Vertical control datum for the survey is NAVD '88.

SECTION 5 -- HYDRAULICS

5.01 Lower Cache Creek Channel Model Flood Plain Delineations

Hydraulic modeling and flood plain delineations were conducted on Cache Creek from Road 94B to the Cache Creek settling basin. Water-surface profiles and overbank flood depths were developed for the existing (pre-project) conditions for Cache Creek using the UNET and FLO-2D computer programs.

UNET is a computer program that models one-dimensional, unsteady flow for open channel hydraulics. The study reach extended from the Cache Creek settling basin to Road 94B. Cross sections for the model used the survey data to develop sections spaced about 500 feet apart. Overbank or levee failure flows were modeled as inflow to storage areas for later input in FLO-2D. Plate 3 shows the study reach and UNET cross section locations.

Manning's "n" values ranged from .04 to .052 for overbank and from .032 to .042 for channel. Contraction and expansion loss coefficients ranged from 0.1 to 0.3 for gradual transitions to 0.3 to 0.5 for some bridge crossing sections.

1. Calibration

The UNET model was calibrated to the January and March 1995 flood events. High water mark (HWM) data was collected from gage data and DWR flood freeboard surveys.

During calibration, thalweg elevations were adjusted from Highway 113 to the settling basin. These adjustments were necessary to account for water depths of up to 10 feet downstream of Road 102 that were not identified in the aerial survey. Manning's "n" values were subsequently adjusted to reasonably simulate historical HWM data. Plate 4 is a profile plot of the modeled March 1995 event with HWM data.

2. Flood Analysis

Once calibration was complete, hydrographs for the 50-year, 100-year, 200-year and 500-year flood events were modeled with the UNET model. The flood flows leaving the Cache Creek Channel were computed using UNET. The overbank flow, results from water escaping the channel upstream of the leveed portion on both the north and south banks, a levee failure on the south bank approximately 1,000 feet upstream of Interstate 5, and levee failures on both the north and south banks approximately 3500 feet downstream of Interstate 5. Embankment failures were defined at locations shown in the table below to simulate levee failures.

Table 2
Embankment Failure Locations

Left Stations	Right Stations
615+00 to 605+00	610+00 to 595+00
540+00 to 515+00	540+00 to 515+00
460+00 to 450+00	460+00 to 450+00
415+00 to 395+00	415+00 to 395+00
375+00 to 370+00	375+00 to 370+00

Embankment failures were defined as 300 feet long and failed to the landside toe elevation.

3. Estimated PFP, PNP and Non-Damaging Channel Capacity

The hydraulic analysis incorporated the estimated existing levee failure locations, including the Probable Non-Failure Point (PNP) and Probable Failure Point (PFP) for the existing Cache Creek levee system. The PNP is defined as the highest vertical elevation on the existing levee where it is determined to be highly unlikely that the levee would fail if the water-surface elevation is at or below this level. The PNP for reaches along Cache Creek is two feet below the top of the existing levees. The PFP is defined as the lowest vertical elevation on the levee where it is determined to be highly likely that the levee would fail. The PFP for reaches along Cache Creek is to the top of the existing levee. These elevations were based on a geotechnical risk-based analysis report (August 2000).

The non-damaging water surface elevations of the non-leveed reaches were assumed to be at the existing bank elevations. The flow calculated below the existing bank elevations and below the PNP is 30,000 cfs. This flow has an exceedance probability of 0.10 (10 year). For the hydraulic model, Cache Creek levees failed at the PFP.

Flows above 30,000 cfs are considered to have a potential result in flooding of developed areas. Historically, the levee system has performed well. The March 1995 flood was approximately a 20-year event (42,000 cfs at RD 94B). Water overtopped the right and left banks above I-5. Water levels also overtopped the levee downstream of I-5, but with the aid of DWR flood fighting did not fail the levee. On the contrary, in 1983, also about a 20-year event, the levee failed downstream of RD 102 and flooded areas in the eastern part of the City of Woodland.

Overbank and embankment failure flows calculated in the UNET model were compiled and the input into the FLO-2D model to determine flood plain routing and depths.

5.02 Lower Cache Creek FLO-2D Model

1. Model Description

The FLO-2D computer program, a two-dimensional flood routing model, was used to model the lower Cache Creek overbank flooding.

FLO-2D models the flood plain using a square grid format. The topography of the study area is defined by a single elevation point at the center of each grid element. Each grid element is also assigned a roughness (Manning's n) value and infiltration parameters. Storage and flow area in grid elements can be limited. Obstructions such as levees, roadways and embankments can also be modeled.

2. Study Area

The study area consists of Cache Creek downstream of Road 94B. The FLO-2D model grid network is shown in Plate 5. Due to the low variability of the topography of the lower Cache Creek overbank, the study area was modeled using a grid spacing of 1000 feet, resulting in a total of 1521 elements. Grid element elevations were generated from digital topography dated March 24, 2000. The areal extent of the modeling was limited by the available digital topography. The topography was sufficient to cover the inundation area of the south (right) bank, but was limited on the north (left) bank.

Obstruction of flow due to structures was modeled by reducing the flow area in the affected elements. Magnitudes of reduction were estimated from aerial photography.

A review of the topography indicated that the following were significant obstructions of overbank flow: Interstate 5 (I-5), Highway 113, Road 98, Road 102 and the Highline Canal. These were all modeled as embankments that could be overtopped if the flow exceeded their crest elevations.

3. Calibration

In March of 1995 flow escaped the Cache Creek channel upstream of I-5 and flooded a small area west of I-5 and north of Woodland. This event was used to calibrate the FLO-2D model. The Cache Creek UNET model was used to determine the flow that escaped from the channel during the 1995 flood event, and that flow (see Plate 6) was used as input to the FLO-2D model.

A Manning's "n" value of 0.08 was used for the overbank, and infiltration parameters, such as soil porosity (0.48) and hydraulic conductivity (0 to 0.1), were selected based on recommended values in the FLO-2D manual and soil types as delineated in the U.S. Soil Conservation Service General Soil Map for Yolo County. Initial saturation and final saturation were set at 0.8 and 1.0, respectively. FLO-2D also allows for surface detention in the grid elements which is defined as the depth of water below which no flood routing will be performed. This parameter is used to represent ponding of water due to local topographic features that are not directly modeled, such as roadways other than those previously mentioned as significant obstructions to flow and irrigation ditch embankments. A value of 0.5 feet was determined as appropriate through the calibration analysis.

The result of the calibration analysis are provided in Plate 7.

4. Flood Analysis

As noted previously, flood flows that escape the Cache Creek channel in the 50, 100, 200 and 500 year events were calculated using a UNET model. These flow, hydrographs are tabulated in Table 3 and plotted on Plates 8 through 11. These hydrographs were used as inputs to the FLO-2D model.

Flood depth contour maps (see Plates 12 through 15) were derived from the results of the FLO-2D studies. Overbank flood flow velocities did not exceed 3 feet per second in the 50 and 100 year flood events. With the exception of elements in which flow area was constricted due to structures, velocities did not exceed 4 feet per second in the 200 and 500 year flood events.

Table 3. Cache Creek Flood Flows Escaping Channel

	South (Right) Bank								North (Left) Bank							
	50-year		100-year		200-year		500-year		50-year		100-year		200-year		500-year	
	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5
Date/Time	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
3/9/95 12:00																
3/9/95 13:00																
3/9/95 14:00																
3/9/95 15:00							0								0	
3/9/95 16:00					0		2,803	0					0		1,029	
3/9/95 17:00					112		14,901	1,849					172		4,142	0
3/9/95 18:00			0		8,113	0	22,973	7,933			0		2,116	0	6,927	6,347
3/9/95 19:00			3,989	0	18,362	5,441	25,621	10,204			1,090		4,910	2,418	8,792	9,070
3/9/95 20:00	0		14,474	3,688	22,564	9,662	25,439	9,875			3,356		6,718	7,362	9,958	9,875
3/9/95 21:00	36		19,975	10,105	22,586	10,741	25,539	8,660	0		5,048		7,671	9,114	10,675	8,660
3/9/95 22:00	3,135	0	21,052	13,877	21,639	9,105	25,782	8,293	537		5,829		8,064	9,105	11,058	8,293
3/9/95 23:00	10,303	4,884	19,541	13,924	21,031	8,397	25,862	8,156	1,405		6,024		8,110	8,397	11,172	8,156
3/10/95 0:00	13,699	10,792	18,497	13,069	20,480	8,146	25,715	8,099	2,141		5,895		7,913	8,146	11,096	8,099
3/10/95 1:00	13,462	14,075	17,619	12,758	19,775	8,041	25,429	8,072	2,292		5,563		7,540	8,041	10,922	8,072
3/10/95 2:00	11,364	13,445	16,661	12,634	18,914	7,988	25,115	8,058	2,062		5,094		7,057	7,988	10,730	8,058
3/10/95 3:00	9,805	12,675	15,576	12,574	17,980	7,954	24,839	8,050	1,671		4,532		6,549	7,954	10,562	8,050
3/10/95 4:00	8,523	12,351	14,407	12,534	17,074	7,929	24,603	8,046	1,277		3,924		6,062	7,929	10,418	8,046
3/10/95 5:00	7,339	12,178	13,200	12,498	16,275	7,907	24,355	8,043	975		3,336		5,624	7,907	10,264	8,043
3/10/95 6:00	6,332	12,052	12,057	12,459	15,596	7,888	24,020	8,041	675		2,808		5,252	7,888	10,055	8,041
3/10/95 7:00	5,627	11,930	11,056	12,417	15,030	7,871	23,552	8,039	363		2,350		4,944	7,871	9,766	8,039
3/10/95 8:00	5,064	11,791	10,207	12,374	14,549	7,856	22,943	8,035	89		1,979		4,682	7,856	9,396	8,035
3/10/95 9:00	4,758	11,623	9,520	12,333	14,119	7,843	22,217	8,029	0		1,694		4,447	7,843	8,964	8,029
3/10/95 10:00	4,446	11,415	8,979	12,294	13,708	7,831	21,411	8,020			1,487		4,225	7,831	8,497	8,020
3/10/95 11:00	4,093	11,167	8,547	12,259	13,288	7,820	20,556	8,010			1,339		4,000	7,820	8,004	8,010
3/10/95 12:00	3,705	10,879	8,176	12,228	12,828	7,808	19,666	7,997			1,225		3,757	7,808	7,491	7,997
3/10/95 13:00	3,288	10,557	7,825	12,199	12,309	7,795	18,742	7,982			1,131		3,493	7,795	6,965	7,982
3/10/95 14:00	2,883	10,211	7,460	12,169	11,720	7,780	17,774	7,966			1,038		3,204	7,780	6,438	7,966
3/10/95 15:00	2,483	9,857	7,067	12,137	11,061	7,762	16,775	7,947			933		2,882	7,762	5,890	7,947

Table 3. Cache Creek Flood Flows Escaping Channel

	South (Right) Bank								North (Left) Bank							
	50-year		100-year		200-year		500-year		50-year		100-year		200-year		500-year	
	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5
Date/Time	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
3/10/95 16:00	2,125	9,505	6,650	12,100	10,345	7,742	15,747	7,925			811		2,533	7,742	5,319	7,925
3/10/95 17:00	1,776	9,161	6,235	12,054	9,569	7,717	14,695	7,900			668		2,164	7,717	4,736	7,900
3/10/95 18:00	1,450	8,811	5,861	11,997	8,734	7,689	13,622	7,872			502		1,788	7,689	4,148	7,872
3/10/95 19:00	1,151	8,471	5,474	11,925	7,860	7,656	12,519	7,842			321		1,432	7,656	3,570	7,842
3/10/95 20:00	900	8,147	5,103	11,835	6,956	7,619	11,402	7,808			142		1,150	7,619	3,026	7,808
3/10/95 21:00	682	7,845	4,857	11,723	6,067	7,576	10,305	7,772			7		912	7,576	2,496	7,772
3/10/95 22:00	486	7,556	4,648	11,583	5,304	7,525	9,218	7,733			0		661	7,525	1,990	7,733
3/10/95 23:00	306	7,268	4,397	11,409	4,733	7,465	8,136	7,690					397	7,465	1,529	7,690
3/11/95 0:00	149	6,975	4,101	11,196	4,228	7,394	7,074	7,644					150	7,394	1,176	7,644
3/11/95 1:00	33	6,677	3,758	10,944	3,945	7,307	6,062	7,592					0	7,307	906	7,592
3/11/95 2:00	0	6,369	3,363	10,646	3,698	7,200	5,237	7,534						7,200	628	7,534
3/11/95 3:00		6,032	2,940	10,302	3,406	7,068	4,634	7,466						7,068	345	7,466
3/11/95 4:00		5,675	2,487	9,923	3,070	6,912	4,148	7,385						6,912	96	7,385
3/11/95 5:00		5,304	2,042	9,514	2,688	6,728	3,886	7,289						6,728	0	7,289
3/11/95 6:00		4,930	1,569	9,070	2,268	6,512	3,620	7,171						6,512		7,171
3/11/95 7:00		4,555	1,123	8,597	1,834	6,273	3,311	7,030						6,273		7,030
3/11/95 8:00		4,181	746	8,126	1,412	6,013	2,960	6,863						6,013		6,863
3/11/95 9:00		3,812	423	7,668	979	5,731	2,564	6,669						5,731		6,669
3/11/95 10:00		3,450	161	7,208	590	5,428	2,152	6,447						5,428		6,447
3/11/95 11:00		3,100	3	6,750	289	5,129	1,725	6,205						5,129		6,205
3/11/95 12:00		2,766	0	6,271	69	4,837	1,321	5,949						4,837		5,949
3/11/95 13:00		2,456		5,772	0	4,541	914	5,672						4,541		5,672
3/11/95 14:00		2,166		5,271		4,239	558	5,384						4,239		5,384
3/11/95 15:00		1,894		4,784		3,927	287	5,105						3,927		5,105
3/11/95 16:00		1,640		4,314		3,614	86	4,837						3,614		4,837
3/11/95 17:00		1,405		3,867		3,308	0	4,571						3,308		4,571
3/11/95 18:00		1,186		3,448		3,012		4,303						3,012		4,303
3/11/95 19:00		990		3,062		2,732		4,035						2,732		4,035

Table 3. Cache Creek Flood Flows Escaping Channel

	South (Right) Bank								North (Left) Bank							
	50-year		100-year		200-year		500-year		50-year		100-year		200-year		500-year	
	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5
Date/Time	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
3/11/95 20:00		811		2,714		2,473		3,765						2,473		3,765
3/11/95 21:00		650		2,403		2,236		3,503						2,236		3,503
3/11/95 22:00		507		2,124		2,019		3,253						2,019		3,253
3/11/95 23:00		379		1,872		1,824		3,017						1,824		3,017
3/12/95 0:00		268		1,645		1,652		2,798						1,652		2,798
3/12/95 1:00		173		1,441		1,500		2,595						1,500		2,595
3/12/95 2:00		92		1,254		1,364		2,411						1,364		2,411
3/12/95 3:00		32		1,087		1,242		2,245						1,242		2,245
3/12/95 4:00		0		938		1,132		2,093						1,132		2,093
3/12/95 5:00				800		1,032		1,954						1,032		1,954
3/12/95 6:00				675		939		1,829						939		1,829
3/12/95 7:00				563		852		1,716						852		1,716
3/12/95 8:00				462		771		1,614						771		1,614
3/12/95 9:00				370		697		1,522						697		1,522
3/12/95 10:00				288		629		1,437						629		1,437
3/12/95 11:00				216		565		1,359						565		1,359
3/12/95 12:00				151		506		1,287						506		1,287
3/12/95 13:00				95		450		1,220						450		1,220
3/12/95 14:00				47		399		1,157						399		1,157
3/12/95 15:00				12		350		1,097						350		1,097
3/12/95 16:00				0		305		1,038						305		1,038
3/12/95 17:00						262		982						262		982
3/12/95 18:00						222		927						222		927
3/12/95 19:00						183		875						183		875
3/12/95 20:00						147		824						147		824
3/12/95 21:00						113		776						113		776
3/12/95 22:00						82		729						82		729
3/12/95 23:00						53		684						53		684

Table 3. Cache Creek Flood Flows Escaping Channel

	South (Right) Bank								North (Left) Bank							
	50-year		100-year		200-year		500-year		50-year		100-year		200-year		500-year	
	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5
Date/Time	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
3/13/95 0:00						28		641						28		641
3/13/95 1:00						9		599						9		599
3/13/95 2:00						0		558						0		558
3/13/95 3:00								518								518
3/13/95 4:00								479								479
3/13/95 5:00								441								441
3/13/95 6:00								405								405
3/13/95 7:00								369								369
3/13/95 8:00								334								334
3/13/95 9:00								300								300
3/13/95 10:00								267								267
3/13/95 11:00								236								236
3/13/95 12:00								206								206
3/13/95 13:00								177								177
3/13/95 14:00								149								149
3/13/95 15:00								122								122
3/13/95 16:00								96								96
3/13/95 17:00								72								72
3/13/95 18:00								49								49
3/13/95 19:00								29								29
3/13/95 20:00								12								12
3/13/95 21:00								1								1
3/13/95 22:00								0								0
3/13/95 23:00																
3/14/95 0:00																
Peak Flow	13,699	14,075	21,052	13,924	22,586	10,741	25,862	10,204	2,292	0	6,024	0	8,110	9,114	11,172	9,875

Table 3. Cache Creek Flood Flows Escaping Channel

	South (Right) Bank								North (Left) Bank							
	50-year		100-year		200-year		500-year		50-year		100-year		200-year		500-year	
	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5	Above I-5	Below I-5
Date/Time	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
Volume (AF)	10,694	27,861	27,423	41,409	36,955	29,958	55,605	35,196	1,115	0	5,630	0	10,792	29,383	19,767	34,818

February 2002

SECTION 6 – ALTERNATIVE PLANS

6.01 Alternative Planning Assumptions

Described below are the assumptions used to model Cache Creek alternatives. A base HEC-RAS model was developed to model and compare alternatives. HEC-RAS was used in evaluating alternatives because of its ease of model modification for a great number of alternatives, and the alternatives did not include levee failures. Alternatives for the existing flood conditions (attached) were chosen based on discussions with local interest and pervious studies. The HEC-RAS model was compiled from the calibrated existing condition UNET model. Five alternatives were selected for evaluation. These alternatives are:

- Raise existing levees.
- Clear vegetation and line channel.
- Expand existing channel area.
- Set back existing levees.
- Lower Cache Creek Overflow Barrier.

HEC-RAS was used to evaluate all of the alternatives except for the Lower Cache Creek Overflow Barrier. All the alternatives were modeled with the 200-year flow at Road 94B of 70,085 cfs. Routing effects along the creek were estimated with the previously developed UNET model.

1. Raise Existing Levees

The raise existing levees alternative was modeled using the levee option in HEC-RAS. This option allows the insertion of a vertical barrier at a location and elevation set by the user. Manning's n-values developed during calibration were not changed for this alternative. Bridges were not modified under this alternative. The results show that to pass the 200-year flood levee heights would need to be raised from 4 to 8 feet above existing levee heights, plus any required freeboard. Plate 16 is a profile plot of calculated water surface elevations and existing levee heights.

In all cases, the 200-year flow encroached into the bridge decks. Velocities on average increased by 1 to 2 fps in the channel with a maximum increase of about 7 fps (total of 15 fps) under Interstate Highway 5.

2. Clear Vegetation and Line Channel

This alternative considers the effect of cleaning vegetation and, in certain areas, lining the channel with rock riprap. To model channel cleaning, calibrated n-values were multiplied by 0.72 (28% reduction) throughout the study reach. A plot of the 200-year water surface elevation under existing and cleaned channel conditions is attached as Plate 17. For both conditions, the levee is assumed to be confined.

N-values in the cleaned channel range from 0.022 to .031 and from 0.028 to 0.036 in the overbank.

The results show that water surface elevations are reduced from 2 to 3 feet, compared to the existing condition. Existing levees would require raising by 2 to 5 feet and new levees would need to be constructed upstream of I-5.

Channel velocities ranged from 2 to 15 fps with a maximum increase of about 7 fps between the railroad bridge and Interstate Highway 5.

3. Expand Existing Channel Area

This alternative assumed that the width of the existing channel could be increased to contain the 200-year flow within an expanded cross-section. The expansion cut was set at an elevation near the two-year flow. Various widths were tried until the flow was contained at the existing levee heights. It was assumed that actual width expansion would be performed on one side of the creek, similar to the setback alternative.

The results indicate that a 700-foot wide terrace would be required downstream of Highway 113 and a 500-foot wide terrace would be required upstream of Highway 113. In addition, the Road 99 bridge, RR bridge and Highway 113 bridge should be replace due to excessive flow velocities. Attached as Plate 18 is a water surface comparison of the confined levee profile and expanded area profile. Channel velocities ranged from 2 to 25 fps with a maximum increase of 17 fps under the railroad bridge at I-5.

4. Set Back Levees

The set back levee alternative consists of setting back one or both of the existing levees to provide more cross sectional area. Three setback alignments were tested 1,000', 1,500', and 2,000' distance between the levees. Channel and overbank n-values were those developed during calibration runs and were left unchanged. Plate 19 is a drawing showing the alignment of each setback alternative.

The water surface calculations for 1,000' setback alternative shows that the 200-year water surface elevation is above the existing levee crown. This means that in addition to constructing a setback levee, the existing levee (on the opposite bank) would also require raising. The 2,000' setback alternative shows that the 200-year water surface elevation is below the existing levee. Some minor existing levee work would be required at isolated locations (bridges) on the existing levee opposite the new setback levee.

At the RR bridge, Highway 113, and I-5, velocities range from 15 fps to 17 fps. The RR bridge and Rd 99 bridge cross-sections have a smaller area than the existing I-5 cross sections and tend to accelerate velocities more so than I-5. Although these velocities are high, water surface elevations are not close to critical depth. Armoring should be possible for a stable section without removing the bridges.

For all the setback alternatives, water surface elevations for the 200-year flood are below the bridge soffits. Debris impacts were not considered. As the levee is setback further, the extent of work on the existing levee is minimized. Attached as Plate 20 is water surface profile for each alternative setback. Attached as Plate 21 is a velocity profile for each setback alternative.

5. <u>Lower Cache Creek Overflow Barrier</u>

The Lower Cache Creek Overflow Barrier (LCCOB) is essentially backup flood protection in the form of an embankment and/or wall located just north of the City of Woodland. The LCCOB alternative was hydraulically modeled using UNET and FLO-2D. The alignment modeled for preliminary alternative comparisons is shown in Plate 22.

For this alternative, it is assumed that the existing levee system will not be modified and will continue to be maintained. The LCCOB will provide protection from flows coming out of the bank above the existing levees, as well as flows resulting from failures in the existing levees.

A 4,000-foot section of the Settling Basin levee was removed to original ground at the east end of the LCCOB to allow for drainage of overbank flows. The analysis assumed the corresponding section of training levee is also removed.

The analysis assumed the weir connecting the Settling Basin to the Yolo Bypass is at the ultimate crest elevation of 41.0 feet (NAVD 1988).

The resulting inundated area for the 200-year flood event is shown in Plate 22.

No bridge modifications are required for the plan. Cache Creek channel velocities will remain the same as existing conditions.

SECTION 7 – FINAL ALTERNATIVE PLANS

7.01 Alternative Selection

Selection of preliminary alternatives to carry further along in the feasibility process was based upon four general planning criteria: (1) completeness; (2) effectiveness; (3) efficiency; and (4) acceptability. The relative ranking of the preliminary alternatives resulted in the selection of setback levee alternative and Lower Cache Creek Overflow Barrier for further detailed hydraulic analysis.

7.02 Setback Levee Alternative

1. Plan Description

Based on the preliminary alternative plan analysis, a viable setback levee alternative was identified. Setback alignments were further refined and adjusted from the preliminary 1,000 feet (levee to levee) setback levee alternative. Aerial photography and public comments were utilized to minimize impacts to land and facilities. The setback alignment chosen is shown on Plate 23.

2. Flood Analysis

Further flood analysis consisted of running the selected alternative with three flows. The flows were chosen to cover a range of relatively frequent events to rare events. The flows input into the hydraulic model at Road 94B are 50,000 cfs, 70,000 cfs and 91,000 cfs. High flows were evaluated to determine if they would reach Road 94B. Both the 1994 Corps Reconnaissance Study and 1999 FEMA hydraulic models were reviewed. These hydraulic models extend up to Capay Dam. Both models studied up to the 500-year event and show that the Cache Creek will overtop its banks in some locations. However, this overbank flow is localized and because of high adjacent ground elevations, does not leave the creek corridor. Impacts on channel velocities and encroachments were evaluated to determine the need for bank protection, bridge replacement and levee heights. The HEC-RAS model was modified to reflect the expanded sections. Mannings n-values were adjusted for proposed riprap and concrete revetment at bridges (n=0.015). Bridge replacement criteria for existing bridges was coordinated with the various agencies and agreed to be replaced if water surface elevation encroached onto the bridge soffit (pressure flow). Where channel velocities for the alternative were greater than existing conditions (7 to 8 fps), bank protection was included in the model.

A summary table for bridge replacement is shown below.

Table 4
Bridge Replacement
Setback Levee Alternative

Flow	I-5 S	I-5 N	Cty Rd 99	RR Bridge	Hwy 113	RD 102
50,000 cfs	OK	OK	OK	OK	OK	OK
70,000 cfs	OK	OK	OK	OK	OK	OK
91,000 cfs	Lengthen	Lengthen	Lengthen	Replace	Replace	Replace

3. Hydraulic Impacts

Hydraulic impacts evaluated for the alternative include water surface elevations in the project reach and within the settling basin. Summarized in Tables 5, 6, and 7 are hydraulic impacts for each flow profile compared to existing conditions.

Table 5
HEC-RAS Plan: 50K Setback
River: Cache Creek Reach: Cache Creek Profile 50-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
154	53290	95.58	8.62	84499	95.17	0.41
153	53290	95.74	4.2	83996	95.26	0.48
152	53290	95.7	2.76	83496	95.23	0.47
151	53290	95.59	2.81	82997	95.12	0.47
150	53290	95.5	2.73	82497	95.05	0.45
149	53290	95.46	2.06	81999	95.01	0.45
148	53290	95.39	2.25	81499	94.93	0.46
147	53290	95.32	2.32	80999	94.86	0.46
146	53290	95.26	2.2	80498	94.8	0.46
145	53290	95.14	2.73	79999	94.68	0.46
144	53290	94.89	3.88	79499	94.44	0.45
143	53290	94.69	4	78999	94.24	0.45
142	53290	94.59	3.28	78499	94.15	0.44
141	53290	94.45	3.22	77999	94.02	0.43
140	53290	94.29	3.25	77499	93.85	0.44
139	53290	94.24	2.17	76999	93.82	0.42
138	53290	94.18	2.05	76499	93.83	0.35
137	53290	94.11	2.36	75999	93.8	0.31
136	53290	94.06	2.06	75499	93.77	0.29
135	53290	93.94	2.91	74999	93.63	0.31

Table 5

HEC-RAS Plan: 50K Setback

River: Cache Creek   Reach: Cache Creek   Profile 50-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
134	53290	93.83	3.06	74499	93.51	0.32
133	53290	93.71	2.99	73999	93.39	0.32
132	53290	93.65	2.43	73499	93.35	0.3
131	53290	93.64	1.68	72999	93.36	0.28
130	53290	93.59	1.97	72499	93.32	0.27
129	53290	93.49	2.95	71999	93.25	0.24
128	53290	93.52	1.12	71499	93.25	0.27
127	53290	93.49	1.52	70999	93.22	0.27
126	53290	93.43	2.1	70499	93.17	0.26
125	53290	93.36	2.37	69999	93.14	0.22
124	53290	93.35	1.7	69499	93.11	0.24
123	53290	93.28	2.05	68999	93.06	0.22
122	53290	93.19	2.57	68499	92.98	0.21
121	53290	93.03	3.26	67999	92.86	0.17
120	53290	92.82	3.81	67499	92.7	0.12
119	53290	92.36	5.4	66996	92.36	0
118	53290	92.01	5.25	66499	91.05	0.96
117	53290	91.85	4.11	65999	90.09	1.76
116	53290	91.62	4.44	65501	89.88	1.74
115	53290	90.85	7.2	65001	89.15	1.7
114	53290	89.56	10.02	64498	87.89	1.67
113	53290	89.17	8.33	63994	87.79	1.38
112	53290	88.6	8.43	63497	87.37	1.23
111	53290	88.41	6.95	63000	87.17	1.24
110	53290	87.4	9.27	62499	85.94	1.46
109	53290	86.94	8.45	61999	85.74	1.2
108	53290	86.25	8.74	61499	84.86	1.39
107	53290	86.25	5.43	60999	85.33	0.92
106	53290	86.21	3.96	60501	85.41	0.8
105	53290	86	4.7	59997	85.24	0.76
104	53290	85.26	7.46	59500	84.57	0.69
103	53290	84.68	7.63	58999	84.3	0.38
102	51500	82.25	11.41	58530	83.58	-1.33
101	51500	82.01	11.52	58490	83.53	-1.52
100	51500	82.06	11.25	58430	83.48	-1.42
99	51500	81.9	11.32	58390	83.42	-1.52
98	51500	81.3	12.73	58300	83.21	-1.91

Table 5

HEC-RAS Plan: 50K Setback

River: Cache Creek Reach: Cache Creek Profile 50-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
97	51500	81.1	12.83	58276	83.2	-2.1
96	51500	81.15	12.6	58220	83.19	-2.04
95	51500	81.14	12.6	58195	83.18	-2.04
94	51500	80.93	11.64	57999	83.13	-2.2
93	51500	80.18	9.97	57499	82.86	-2.68
92	51500	79.71	8.59	57001	82.78	-3.07
91	51500	79.27	7.88	56499	82.64	-3.37
90	51500	78.7	8.24	56002	82.02	-3.32
89	51500	78.02	8.52	55499	81.61	-3.59
88	51500	77.83	6.37	54996	81.26	-3.43
87	51500	77.46	6.52	54498	80.93	-3.47
86	51500	77.06	6.71	53998	80.46	-3.4
85	51500	76.75	6.21	53499	79.24	-2.49
84	51500	76.32	6.53	53002	76.66	-0.34
83	51500	75.8	7.26	52503	74.89	0.91
82	51500	75.35	6.72	52000	73.85	1.5
81	51500	74.81	7.18	51499	73.03	1.78
80	51500	74.52	6.06	50995	72.25	2.27
79	51500	74.45	4.37	50498	72.33	2.12
78	51500	74.33	4.36	49998	71.62	2.71
77	51500	73.96	5.53	49500	70.72	3.24
76	51500	73.55	6.11	48998	70.34	3.21
75	51500	73.14	6.54	48499	69.75	3.39
74	51500	72.58	6.88	48000	69.27	3.31
73	51500	72.23	6.41	47497	68.95	3.28
72	51500	71.93	6.34	46999	68.53	3.4
71	51500	71.72	5.26	46505	68.17	3.55
70	51500	71.5	5.01	46002	67.79	3.71
69	51500	71.28	4.9	45499	67.25	4.03
68	51500	71.02	5.25	44999	66.72	4.3
67	51500	70.83	4.72	44499	66.1	4.73
66	51500	70.6	4.86	44000	65.84	4.76
65	51500	70.31	5.26	43498	65.16	5.15
64	51500	70.01	5.26	42999	64.51	5.5
63	51500	69.66	5.7	42499	63.92	5.74
62	51500	69.17	6.51	41999	63.17	6
61	51500	67.87	8.96	41499	62.62	5.25

Table 5

HEC-RAS Plan: 50K Setback

River: Cache Creek   Reach: Cache Creek   Profile 50-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
60	51000	66.22	11.83	41346	62.46	3.76
59	51000	66.01	11.95	41300	62.39	3.62
58	51000	65.74	10.11	41000	61.98	3.76
57	51000	65.66	7.35	40500	61.89	3.77
56	51000	65.32	7.04	40008	61.63	3.69
55	51000	64.14	9.38	39498	61.05	3.09
54	51000	62.74	10.58	39001	60.6	2.14
53	51000	62.24	8.29	38498	60.29	1.95
52	51000	61.51	8.31	37999	59.52	1.99
51	51000	61.28	5.93	37499	59.29	1.99
50	51000	61.06	5.54	36997	58.97	2.09
49	51000	60.66	6.14	36498	58.2	2.46
48	51000	60.23	6.31	35997	57.72	2.51
47	51000	59.76	6.58	35499	57.17	2.59
46	51000	59.48	5.07	35001	56.95	2.53
45	51000	59.11	5.33	34502	56.27	2.84
44	51000	58.73	5.22	33999	55.68	3.05
43	51000	58.35	5.32	33501	55.21	3.14
42	51000	57.92	5.56	33000	54.72	3.2
41	51000	57.51	5.19	32490	54.37	3.14
40	51000	57.25	4.33	31996	53.96	3.29
39	51000	56.95	4.62	31499	53.46	3.49
38	51000	56.76	3.97	30999	53.17	3.59
37	51000	56.49	4.4	30499	52.86	3.63
36	51000	56.11	5.13	29999	52.51	3.6
35	50000	55.56	5.75	29499	52.2	3.36
34	50000	54.86	7.72	29332	52.02	2.84
33	50000	54.79	7.75	29300	51.99	2.8
32	50000	53.62	9.94	28999	51.62	2
31	50000	52.48	9.63	28499	50.47	2.01
30	50000	51.73	7.74	28001	49.52	2.21
29	50000	51.45	5.34	27496	49.14	2.31
28	50000	51.31	3.65	27014	48.53	2.78
27	50000	51.16	3.58	26489	47.84	3.32
26	50000	51.02	3.51	25991	47.02	4
25	50000	50.87	3.42	25506	46.56	4.31
24	50000	50.76	3.33	25002	46.15	4.61

Table 5

HEC-RAS Plan: 50K Setback

River: Cache Creek Reach: Cache Creek Profile 50-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
23	50000	50.65	3.64	24502	45.72	4.93
22	50000	50.31	5	23990	45.48	4.83
21	50000	50.2	4.57	23503	45.39	4.81
20	50000	49.9	5.33	22997	45.21	4.69
19	50000	49.65	5.51	22499	45	4.65
18	50000	49.4	5.67	21999	44.77	4.63
17	50000	49.15	5.7	21499	44.54	4.61
16	50000	48.85	5.94	20999	44.24	4.61
15	50000	48.57	5.92	20499	43.97	4.6
14	50000	48.37	5.59	20000	43.79	4.58
13	50000	48.18	5.4	19502	43.8	4.38
12	50000	48.04	5.08	18999	43.8	4.24
11	50000	47.64	6.07	18496	43.79	3.85
10	50000	47.35	6	17998	43.79	3.56
9	50000	46.92	6.45	17504	43.78	3.14
8	50000	46.48	6.7	16994	43.78	2.7
7	50000	46.43	5.17	16499	43.77	2.66
6	50000	46.22	5.31	15998	43.76	2.46
5	50000	45.98	5.53	15503	43.76	2.22
4	50000	45.79	5.43	14999	43.75	2.04
3	50000	45.62	5.31	14502	43.75	1.87
2	50000	45.46	5.09	14001	43.75	1.71
1	50000	45.3	4.65	13496	43.74	1.56

Table 6

HEC-RAS Plan: 70K Setback

River: Cache Creek Reach: Cache Creek Profile 200-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
154	70000	98.12	9.44	84499	96.63	1.49
153	70000	98.42	4.59	83996	96.88	1.54
152	70000	98.41	3.03	83496	96.87	1.54
151	70000	98.31	3.08	82997	96.73	1.58
150	70000	98.21	3.01	82497	96.74	1.47
149	70000	98.19	2.27	81999	96.65	1.54
148	70000	98.11	2.44	81499	96.55	1.56

Table 6

HEC-RAS Plan: 70K Setback

River: Cache Creek   Reach: Cache Creek   Profile 200-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
147	70000	98.04	2.54	80999	96.44	1.6
146	70000	97.99	2.44	80498	96.37	1.62
145	70000	97.86	3.02	79999	96.2	1.66
144	70000	97.57	4.34	79499	95.84	1.73
143	70000	97.36	4.44	78999	95.55	1.81
142	70000	97.26	3.65	78499	95.44	1.82
141	70000	97.13	3.51	77999	95.27	1.86
140	70000	96.99	3.46	77499	95.03	1.96
139	70000	96.95	2.44	76999	95.01	1.94
138	70000	96.9	2.32	76499	95.01	1.89
137	70000	96.81	2.69	75999	94.97	1.84
136	70000	96.76	2.41	75499	94.91	1.85
135	70000	96.64	3.26	74999	94.69	1.95
134	70000	96.51	3.38	74499	94.5	2.01
133	70000	96.39	3.25	73999	94.33	2.06
132	70000	96.33	2.71	73499	94.25	2.08
131	70000	96.32	1.93	72999	94.29	2.03
130	70000	96.26	2.3	72499	94.22	2.04
129	70000	96.14	3.33	71999	94.13	2.01
128	70000	96.18	1.36	71499	94.13	2.05
127	70000	96.15	1.73	70999	94.09	2.06
126	70000	96.09	2.32	70499	94.02	2.07
125	70000	96.02	2.6	69999	93.98	2.04
124	70000	96	1.89	69499	93.95	2.05
123	70000	95.93	2.3	68999	93.9	2.03
122	70000	95.82	2.92	68499	93.8	2.02
121	70000	95.64	3.64	67999	93.66	1.98
120	70000	95.4	4.3	67499	93.5	1.9
119	70000	94.89	5.93	66996	93.15	1.74
118	70000	94.52	5.65	66499	91.62	2.9
117	70000	94.35	4.68	65999	90.46	3.89
116	70000	94.09	5.06	65501	90.24	3.85
115	70000	93.38	7.32	65001	89.47	3.91
114	70000	92.66	8.9	64498	88.11	4.55
113	70000	92.46	7.3	63994	88.01	4.45
112	70000	92.04	7.54	63497	87.56	4.48
111	70000	91.75	6.98	63000	87.36	4.39

Table 6

HEC-RAS Plan: 70K Setback

River: Cache Creek   Reach: Cache Creek   Profile 200-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
110	70000	91.05	8.7	62499	86.06	4.99
109	70000	90.66	8.22	61999	85.86	4.8
108	70000	90.23	8.01	61499	84.95	5.28
107	70000	90.24	5.26	60999	85.45	4.79
106	70000	90.21	4.01	60501	85.54	4.67
105	70000	90.06	4.57	59997	85.38	4.68
104	70000	89.5	7.06	59500	84.69	4.81
103	70000	89.02	7.38	58999	84.42	4.6
102	70000	85.25	13.85	58530	83.68	1.57
101	70000	84.86	14.04	58490	83.62	1.24
100	70000	85	13.7	58430	83.57	1.43
99	70000	84.69	13.85	58390	83.52	1.17
98	70000	83.62	15.83	58300	83.3	0.32
97	70000	83.21	16.07	58276	83.28	-0.07
96	70000	83.24	15.95	58220	83.28	-0.04
95	70000	83.23	15.96	58195	83.26	-0.03
94	70000	83.2	14.07	57999	83.22	-0.02
93	70000	82.33	11.41	57499	82.94	-0.61
92	70000	81.85	9.68	57001	82.86	-1.01
91	70000	81.38	8.79	56499	82.72	-1.34
90	70000	80.86	8.6	56002	82.09	-1.23
89	70000	80.32	8.61	55499	81.68	-1.36
88	70000	80.14	6.42	54996	81.32	-1.18
87	70000	79.82	6.55	54498	80.99	-1.17
86	70000	79.43	6.88	53998	80.51	-1.08
85	70000	79.13	6.31	53499	79.25	-0.12
84	70000	78.77	6.42	53002	76.63	2.14
83	70000	78.4	6.86	52503	74.83	3.57
82	70000	78.03	6.42	52000	73.78	4.25
81	70000	77.58	6.94	51499	72.95	4.63
80	70000	77.37	5.71	50995	72.15	5.22
79	70000	77.3	4.32	50498	72.24	5.06
78	70000	77.21	4.07	49998	71.51	5.7
77	70000	76.91	5.3	49500	70.55	6.36
76	70000	76.56	5.85	48998	70.13	6.43
75	70000	76.21	6.39	48499	69.5	6.71
74	70000	75.72	6.79	48000	68.98	6.74

Table 6

HEC-RAS Plan: 70K Setback

River: Cache Creek Reach: Cache Creek Profile 200-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
73	70000	75.43	6.43	47497	68.65	6.78
72	70000	75.15	6.36	46999	68.24	6.91
71	70000	74.98	5.29	46505	67.89	7.09
70	70000	74.79	5.07	46002	67.51	7.28
69	70000	74.59	5.04	45499	66.99	7.6
68	70000	74.37	5.38	44999	66.46	7.91
67	70000	74.22	4.75	44499	65.85	8.37
66	70000	74.02	4.88	44000	65.59	8.43
65	70000	73.78	5.29	43498	64.92	8.86
64	70000	73.53	5.36	42999	64.26	9.27
63	70000	73.23	5.89	42499	63.67	9.56
62	70000	72.84	6.7	41999	62.93	9.91
61	70000	71.55	9.47	41499	62.39	9.16
60	70000	68.73	14.35	41346	62.24	6.49
59	70000	68.29	14.66	41300	62.17	6.12
58	70000	68.16	11.47	41000	61.76	6.4
57	70000	68.2	8.17	40500	61.67	6.53
56	70000	67.86	7.76	40008	61.41	6.45
55	70000	66.54	10.41	39498	60.84	5.7
54	70000	64.87	11.94	39001	60.41	4.46
53	70000	64.45	8.78	38498	60.1	4.35
52	70000	63.86	8.3	37999	59.34	4.52
51	70000	63.68	5.86	37499	59.11	4.57
50	70000	63.52	5.5	36997	58.8	4.72
49	70000	63.16	6.04	36498	58.03	5.13
48	70000	62.74	6.36	35997	57.56	5.18
47	70000	62.28	6.77	35499	57.02	5.26
46	70000	62.01	5.36	35001	56.79	5.22
45	70000	61.65	5.58	34502	56.11	5.54
44	70000	61.3	5.52	33999	55.54	5.76
43	70000	60.95	5.6	33501	55.08	5.87
42	70000	60.58	5.74	33000	54.59	5.99
41	70000	60.2	5.44	32490	54.24	5.96
40	70000	59.98	4.58	31996	53.83	6.15
39	70000	59.7	4.86	31499	53.33	6.37
38	70000	59.52	4.32	30999	53.03	6.49
37	70000	59.23	4.82	30499	52.72	6.51

Table 6

HEC-RAS Plan: 70K Setback

River: Cache Creek   Reach: Cache Creek   Profile 200-Year

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
36	70000	58.84	5.61	29999	52.38	6.46
35	70000	58.22	6.51	29499	52.06	6.16
34	70000	56.91	9.75	29332	51.89	5.02
33	70000	56.76	9.81	29300	51.86	4.9
32	70000	54.86	12.75	28999	51.5	3.36
31	70000	53.09	12.59	28499	50.35	2.74
30	70000	51.27	11.53	28001	49.42	1.85
29	70000	50.35	8.53	27496	49.04	1.31
28	70000	49.9	5.88	27014	48.44	1.46
27	70000	49.43	5.9	26489	47.75	1.68
26	70000	48.95	5.99	25991	46.95	2
25	70000	48.37	6.04	25506	46.5	1.87
24	70000	47.9	6.05	25002	46.09	1.81
23	70000	47.53	6.22	24502	45.67	1.86
22	70000	47.45	4.39	23990	45.43	2.02
21	70000	47.38	3.36	23503	45.34	2.04
20	70000	47.31	3.05	22997	45.16	2.15
19	70000	47.24	2.95	22499	44.96	2.28
18	70000	47.17	2.85	21999	44.73	2.44
17	70000	47.1	2.79	21499	44.5	2.6
16	70000	47.03	2.8	20999	44.21	2.82
15	70000	46.95	2.86	20499	43.95	3
14	70000	46.9	2.7	20000	43.77	3.13
13	70000	46.84	2.7	19502	43.78	3.06
12	70000	46.78	2.73	18999	43.78	3
11	70000	46.72	2.6	18496	43.77	2.95
10	70000	46.67	2.67	17998	43.77	2.9
9	70000	46.61	2.6	17504	43.76	2.85
8	70000	46.55	2.6	16994	43.75	2.8
7	70000	46.5	2.77	16499	43.75	2.75
6	70000	46.45	2.83	15998	43.74	2.71
5	70000	46.4	2.85	15503	43.74	2.66
4	70000	46.35	2.75	14999	43.73	2.62
3	70000	46.3	2.77	14502	43.73	2.57
2	70000	46.25	2.69	14001	43.72	2.53
1	70000	46.2	2.46	13496	43.72	2.48

Table 7

HEC-RAS Plan: 91K Setback

River: Cache Creek   Reach: Cache Creek   Profile 91K

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
154	91000	100.24	10.63	84499	97.93	2.31
153	91000	100.71	5.14	83996	98.42	2.29
152	91000	100.72	3.42	83496	98.44	2.28
151	91000	100.61	3.47	82997	98.26	2.35
150	91000	100.51	3.4	82497	98.3	2.21
149	91000	100.49	2.58	81999	98.17	2.32
148	91000	100.41	2.73	81499	98.05	2.36
147	91000	100.33	2.86	80999	97.92	2.41
146	91000	100.26	2.77	80498	97.82	2.44
145	91000	100.11	3.43	79999	97.6	2.51
144	91000	99.74	4.96	79499	97.09	2.65
143	91000	99.51	5.05	78999	96.69	2.82
142	91000	99.41	4.16	78499	96.54	2.87
141	91000	99.27	3.96	77999	96.41	2.86
140	91000	99.12	3.88	77499	96.04	3.08
139	91000	99.09	2.82	76999	96.03	3.06
138	91000	99.03	2.69	76499	96.04	2.99
137	91000	98.92	3.1	75999	95.96	2.96
136	91000	98.86	2.85	75499	95.87	2.99
135	91000	98.71	3.75	74999	95.57	3.14
134	91000	98.57	3.84	74499	95.28	3.29
133	91000	98.44	3.67	73999	95.02	3.42
132	91000	98.37	3.12	73499	94.92	3.45
131	91000	98.37	2.27	72999	94.98	3.39
130	91000	98.29	2.72	72499	94.88	3.41
129	91000	98.13	3.87	71999	94.75	3.38
128	91000	98.18	1.65	71499	94.76	3.42
127	91000	98.15	2.02	70999	94.7	3.45
126	91000	98.07	2.66	70499	94.62	3.45
125	91000	97.99	2.97	69999	94.57	3.42
124	91000	97.98	2.18	69499	94.54	3.44
123	91000	97.89	2.68	68999	94.48	3.41
122	91000	97.74	3.41	68499	94.37	3.37
121	91000	97.52	4.22	67999	94.21	3.31
120	91000	97.22	5.01	67499	94.05	3.17
119	91000	96.62	6.75	66996	93.7	2.92

Table 7

HEC-RAS Plan: 91K Setback

River: Cache Creek   Reach: Cache Creek   Profile 91K

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
118	91000	96.2	6.46	66499	92.03	4.17
117	91000	95.98	5.52	65999	90.66	5.32
116	91000	95.64	6	65501	90.42	5.22
115	91000	94.9	8.11	65001	89.6	5.3
114	91000	94.24	9.57	64498	88.21	6.03
113	91000	94.04	7.9	63994	88.11	5.93
112	91000	93.56	8.32	63497	87.64	5.92
111	91000	93.12	8.12	63000	87.43	5.69
110	91000	92.2	10.21	62499	86.09	6.11
109	91000	91.63	9.86	61999	85.9	5.73
108	91000	91.01	9.71	61499	84.96	6.05
107	91000	91.05	6.42	60999	85.48	5.57
106	91000	91	4.92	60501	85.58	5.42
105	91000	90.84	5.32	59997	85.42	5.42
104	91000	90.27	7.69	59500	84.73	5.54
103	91000	89.81	7.76	58999	84.45	5.36
102	91000	86.6	13.86	58530	83.71	2.89
101	91000	86.36	13.6	58490	83.66	2.7
100	91000	86.36	13.58	58430	83.6	2.76
99	91000	86.1	13.84	58390	83.55	2.55
98	91000	85.39	15.37	58300	83.33	2.06
97	91000	85.2	14.98	58276	83.31	1.89
96	91000	85.59	12.85	58220	83.31	2.28
95	91000	85.54	12.9	58195	83.29	2.25
94	91000	85.07	12.65	57999	83.25	1.82
93	91000	84.58	10.16	57499	82.97	1.61
92	91000	83.83	9.96	57001	82.89	0.94
91	91000	83.19	9.64	56499	82.74	0.45
90	91000	82.7	9.05	56002	82.11	0.59
89	91000	82.2	8.91	55499	81.7	0.5
88	91000	82.02	6.66	54996	81.34	0.68
87	91000	81.7	6.79	54498	81.01	0.69
86	91000	81.25	7.29	53998	80.53	0.72
85	91000	80.94	6.63	53499	79.28	1.66
84	91000	80.58	6.74	53002	76.66	3.92
83	91000	80.21	7.21	52503	74.86	5.35

Table 7

HEC-RAS Plan: 91K Setback

River: Cache Creek   Reach: Cache Creek   Profile 91K

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
82	91000	79.85	6.87	52000	73.81	6.04
81	91000	79.38	7.51	51499	72.98	6.4
80	91000	79.17	6.02	50995	72.19	6.98
79	91000	79.1	4.73	50498	72.27	6.83
78	91000	79.02	4.41	49998	71.55	7.47
77	91000	78.69	5.78	49500	70.59	8.1
76	91000	78.3	6.46	48998	70.17	8.13
75	91000	77.9	7.1	48499	69.54	8.36
74	91000	77.33	7.64	48000	69.02	8.31
73	91000	76.99	7.31	47497	68.7	8.29
72	91000	76.66	7.28	46999	68.29	8.37
71	91000	76.46	6.09	46505	67.93	8.53
70	91000	76.23	5.89	46002	67.56	8.67
69	91000	75.99	5.89	45499	67.03	8.96
68	91000	75.7	6.3	44999	66.51	9.19
67	91000	75.52	5.58	44499	65.9	9.62
66	91000	75.27	5.76	44000	65.64	9.63
65	91000	74.95	6.26	43498	64.97	9.98
64	91000	74.61	6.39	42999	64.31	10.3
63	91000	74.18	7.12	42499	63.73	10.45
62	91000	73.48	8.26	41999	62.98	10.5
61	91000	72.16	10.65	41499	62.45	9.71
60	91000	70.85	12.37	41346	62.29	8.56
59	91000	70.7	12.47	41300	62.23	8.47
58	91000	70.46	11.58	41000	61.81	8.65
57	91000	70.3	9.04	40500	61.72	8.58
56	91000	69.96	8.55	40008	61.47	8.49
55	91000	68.47	11.52	39498	60.89	7.58
54	91000	66.71	12.87	39001	60.46	6.25
53	91000	66.22	9.41	38498	60.15	6.07
52	91000	65.66	8.67	37999	59.39	6.27
51	91000	65.49	6.14	37499	59.16	6.33
50	91000	65.34	5.83	36997	58.84	6.5
49	91000	64.97	6.48	36498	58.08	6.89
48	91000	64.53	6.92	35997	57.61	6.92
47	91000	64.02	7.43	35499	57.06	6.96

Table 7

HEC-RAS Plan: 91K Setback

River: Cache Creek Reach: Cache Creek Profile 91K

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
46	91000	63.74	5.96	35001	56.83	6.91
45	91000	63.35	6.18	34502	56.16	7.19
44	91000	62.96	6.17	33999	55.58	7.38
43	91000	62.58	6.27	33501	55.12	7.46
42	91000	62.15	6.42	33000	54.63	7.52
41	91000	61.72	6.17	32490	54.28	7.44
40	91000	61.47	5.22	31996	53.87	7.6
39	91000	61.14	5.57	31499	53.37	7.77
38	91000	60.92	5.02	30999	53.07	7.85
37	91000	60.56	5.66	30499	52.76	7.8
36	91000	60.05	6.62	29999	52.42	7.63
35	91000	59.3	7.43	29499	52.11	7.19
34	91000	58.12	10.23	29332	51.93	6.19
33	91000	57.99	10.36	29300	51.9	6.09
32	91000	57.13	10.92	28999	51.54	5.59
31	91000	54.53	13.91	28499	50.39	4.14
30	91000	52.73	12.33	28001	49.45	3.28
29	91000	51.84	9.19	27496	49.08	2.76
28	91000	51.4	6.51	27014	48.47	2.93
27	91000	50.9	6.6	26489	47.78	3.12
26	91000	50.35	6.71	25991	46.98	3.37
25	91000	49.71	6.82	25506	46.52	3.19
24	91000	49.16	6.88	25002	46.11	3.05
23	91000	48.77	7.01	24502	45.69	3.08
22	91000	48.71	4.83	23990	45.45	3.26
21	91000	48.63	3.75	23503	45.36	3.27
20	91000	48.55	3.46	22997	45.18	3.37
19	91000	48.46	3.36	22499	44.98	3.48
18	91000	48.38	3.26	21999	44.75	3.63
17	91000	48.3	3.2	21499	44.52	3.78
16	91000	48.21	3.22	20999	44.23	3.98
15	91000	48.13	3.28	20499	43.96	4.17
14	91000	48.06	3.12	20000	43.78	4.28
13	91000	47.99	3.13	19502	43.79	4.2
12	91000	47.92	3.17	18999	43.79	4.13
11	91000	47.85	3.03	18496	43.78	4.07

Table 7
HEC-RAS Plan: 91K Setback
River: Cache Creek   Reach: Cache Creek   Profile 91K

River Sta. Sec. No.	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	River Sta. (ft)	Exist W.S. (ft)	Diff. W.S. (ft)
10	91000	47.77	3.11	17998	43.78	3.99
9	91000	47.7	3.03	17504	43.77	3.93
8	91000	47.63	3.03	16994	43.77	3.86
7	91000	47.57	3.23	16499	43.76	3.81
6	91000	47.51	3.3	15998	43.75	3.76
5	91000	47.45	3.32	15503	43.75	3.7
4	91000	47.39	3.21	14999	43.74	3.65
3	91000	47.32	3.23	14502	43.74	3.58
2	91000	47.26	3.12	14001	43.74	3.52
1	91000	47.2	2.87	13496	43.73	3.47

The hydraulic model shows that water surface impacts in the settling basin range from 1.50 feet to 3.40 feet for flows between 53,000 cfs and 91,000 cfs. Table 8 below summarizes the impacts at the settling basin. This stage impact is due to confining flows within the setback levee. At RD 94B, the models show water surface impacts of 0.40 feet to 2.31 feet for the 53,000 cfs (50-year event) to 91,000 cfs (1,000-year event), respectively.

Table 8
Setback Levee
Settling Basin Hydraulic Impacts

	Settling Basin Data [2/]	
Flow (cfs) [1/]	Existing Condition Flow / Stage	Setback Levee Flow / Stage
50,000	25,300 / 43.8	46,900 / 45.3
70,000	25,000 / 43.8	67,200 / 46.2
91,000	25,100 / 43.8	87,300 / 47.2

[1/] Flow at Road 94 B
[2/] Assumes ultimate weir height of 41.0 (NAVD88).

Peak stages for the 91,000 cfs flow (1,000-year) do not fail the settling basin levee, but do encroach into the freeboard. Settling basin rehabilitation maybe required once the R & U flow is analyzed.

There are several gravel mining operations from Station 740+00 to 830+00, between I-5 and Road 94B. The operations are protected by levees built and maintained by the respective operator. Table 8A shows the increase in water surface elevations within the mining reach.

Table 8A
Water Surface Increases
Station 740+00 to 840+00

Frequency	Flow	Stage Increase
50-year	53,290 cfs	0.32 to 0.41
200-year	70,000 cfs	2.06 to 1.49
1,000-year	91,000 cfs	3.42 to 2.31

These flow increases reduce the existing freeboard for the local levees.

Hydraulic impacts for existing bridges were evaluated using the UNET model existing condition compared to each alternative. These impacts, both stage and velocity are presented below in Table 8B.

Table 8B

Pre & Post Project

Calculated Hydraulic Bridge Data 1/

50,000 cfs 2/

	Existing	Condition	Flood Barrier		Narrow Max. W.S. Elev.	Setback Levee
Bridge Location	Max. W.S. Elev. 3/	Max. Velocity	Max.W.S. Elev.	Max. Velocity	Max. W.S. Elev.	Max. Velocity 4/
RD 94B	95.27	4.78	75.27	4.78	94.85	4.73
I-5 South Upstream	83.60	9.56	83.60	9.56	81.85	12.07
I-5 North Downstream	83.50	9.44	83.50	9.44	81.65	11.90
RD 99 Upstream	83.24	10.05	83.24	10.05	80.82	13.12
SP Railroad Upstream	83.22	9.75	83.20	9.75	80.84	12.69
SP Railroad Downstream	83.20	9.75	83.22	9.75	80.80	12.67
Hwy 113 Upstream	62.46	7.31	62.46	7.31	66.42	11.25
Hwy 113 Downstream	62.40	7.34	62.40	7.34	66.24	11.35
RD 102 Upstream	52.02	4.71	52.02	4.71	54.63	8.15
RD 102 Downstream	52.00	4.72	52.00	4.72	54.08	7.73

Calculated Hydraulic Bridge Data 1/

70,000 cfs 2/

	Existing	Condition	Flood Barrier		Narrow	Setback Levee
Bridge Location	Max. W.S. Elev. 3/	Max. Velocity	Max.W.S. Elev.	Max. Velocity	Max. W.S. Elev.	Max. Velocity 4/
RD 94B Downstream	96.88	5.10	96.88	5.10	97.44	5.05
I-5 South Upstream	83.68	10.31	83.68	10.31	83.96	14.75
I-5 North Upstream	83.57	10.21	83.57	10.21	83.68	14.62
RD 99 Upstream	83.30	10.91	83.30	10.91	82.17	16.72
SP Railroad Upstream	83.28	10.65	83.28	10.65	82.20	16.11
SP Railroad Downstream	83.26	10.66	83.26	7.25	81.97	16.15
Hwy 113 Upstream	62.24	7.25	62.24	7.28	68.48	14.00
Hwy 113 Downstream	62.17	7.28	62.17	4.66	68.15	14.10
RD 102 Upstream	51.90	4.66	51.90	4.66	56.89	9.84
RD 102 Downstream	51.86	4.67	51.86	4.67	56.70	9.86

1/ UNET Results

2/ Flow @ RD94B

3/ NAVD '88
4/ No Bridge Modifications

7.03 Lower Cache Creek Overflow Barrier

1. Plan Description

Based on the preliminary alternative plan analysis, the Lower Cache Creek Overflow Barrier was identified for further analysis. Levee alignments were further refined and adjusted from the preliminary levee alignment alternative. Aerial photography and public comments were utilized to minimize impacts to land and facilities. The levee alignment chosen is shown on Plate 24 & 25.

2. Flood Analysis

Further flood analysis consisted of running the selected alternative with three flows. The flows were chosen to cover a range of relatively frequent events to rare events. The flows input into the hydraulic model at Road 94B are 50,000 cfs, 70,000 cfs and 91,000 cfs. Impacts on channel velocities and encroachments were evaluated to determine the need for bank protection, bridge replacement and levee heights. The FLO-2D model was modified to reflect the proposed flood barrier along the northern city limit. Overland flow obstructions such as I-5 and Hwy 113 were field reviewed and included in the model. A 4,000-foot section of the west levee of the settling basin was removed to allow overland flow into the settling basin.

The Lower Cache Creek Overflow Barrier (LCCOB) consists of a flood barrier (combination of levee and floodwalls) north of the City of Woodland that ties into the west levee of the settling basin. A portion of the settling basin west levee is removed to allow flood waters to pass into the settling basin. Initial studies assumed a 4,000-foot wide opening, with levee removed to ground. Review and analysis indicated that with this configuration, the area north of the LCCOB on the west side of the settling basin west levee, including Road 102, would be inundated by flows in Cache Creek as low as the two-year event. In an effort to prevent Road 102 from flooding in events smaller than the 10-year event (largest event during which flow in Cache Creek would remain confined within the creek and, therefore, discharge into the settling basin), two alternatives were developed. Details of the study alternative configurations are summarized below.

Plan A:	Construct Weir in West Levee Opening
Weir crest elevation:	45.0 feet (NAVD88)
Opening width:	2,000 feet (50 kcfs and 100-year studies) 3,000 feet (70 kcfs and 91 kcfs studies)
Plan B:	Raise Road 102
Elevation:	48 feet (NAVD88)
Opening width:	4,000 feet in west levee

Plates 26 and 27 compare the innundation boundaries north of the LCCOB for the 50 and 100-year floods with and without the LCCOB. Innundation boundaries for the LCCOB are shown for the initial configuration (existing Road 102 and not west levee weir) and Plans A and B. Table 9 summarizes peak stage for the alternatives.

Table 9
Peak W.S. Elevations
between
Road 102 and West Levee

Flow (cfs) [1/]	Existing Condition (ft)	Plan A Weir @ West Levee	Plan B Raise Road 102
50,000	42.65	48.68	45.84
70,000	43.42	49.41	46.62
91,000	44.33	50.64	47.60

[1/] Flow at Road 94 B

The Cache Creek channel was assumed to remain in existing condition for this alternative. Overbank flow and potential levee failures, downstream of I-5, criteria remained the same. No bridge replacement is required for this alternative. Velocities along the LCCOB are low and do not require riprap. However, geotechnical analysis indicates that riprap is required east of RD 102 for wind and wave hydraulic forces.

3. <u>Hydraulic Impacts</u>

Hydraulic impacts evaluated for this alternative show that water surface increases in the flood plain south of Cache Creek and north of the flood barrier, range from 0 to 6 feet. Plates 28 and 29 show the flood depth differences between the proposed flood barrier alternative and the existing conditions.

Hydraulic impacts at the settling basin for this alternative are less than the impacts under the setback levee plan. The water surface elevations increase for the flood barrier alternative range from 0.8 to 2.1 feet in the settling basin. Rating curves for the settling basin impacts are shown on Plate 31.

Table 10 below summarizes the impacts at the settling basin.

Table 10
Lower Cache Creek Overflow Barrier
Settling Basin Hydraulic Impacts

	Settling Basin Data	
Flow (cfs) [1/]	Existing Condition Flow (cfs) / Stage	LLCOB Flow (cfs) / Stage [2/]
50,000	25,300 / 43.8	37,000 / 44.6
70,000	25,000 / 43.8	45,600 / 45.2
91,000	25,100 / 43.8	57,900 / 45.9

[1/] Flows at Road 94B.
[2/] Data for worst case scenario (Plan A or Plan B). All stages are in NAVD '88.

To evaluate the flood barrier alternatives, stage impacts within the effected lands, depth duration curves were prepared to compare existing conditions to project conditions. Six locations were chosen that represent typical impacts within specific areas. Plate 30 shows the chosen FLO-2D grid locations and Plates 32 to 37 are plots of the overbank flood depth duration. In general, the comparisons show significant impacts near the west levee of the Settling Basin. The hydraulic impacts decrease, moving westerly away from the west levee location.

The preferred flood barrier plan (Plan A) chose an inlet weir elevation of 45, based on no backflow from the settling basin prior to potential flooding. As discussed under non-damaging flows section, the 10-year event was used in the initial evaluation of inlet weir heights. The 10-year event is the non-damaging flow and the goal for choosing an inlet weir elevation is to not increase flood frequency west of the proposed inlet weir. Subsequent evaluation shows (50-year, 100-year, 200-year and 1,000-year hydrograph analysis) that the settling basin does not flow over the proposed inlet weir prior to flooding of the area between Road 102 and the inlet weir. Plates 38, 39, 40 and 41 are stage hydrographs for the studied flows, showing the sequence of flooding.

MF/mv
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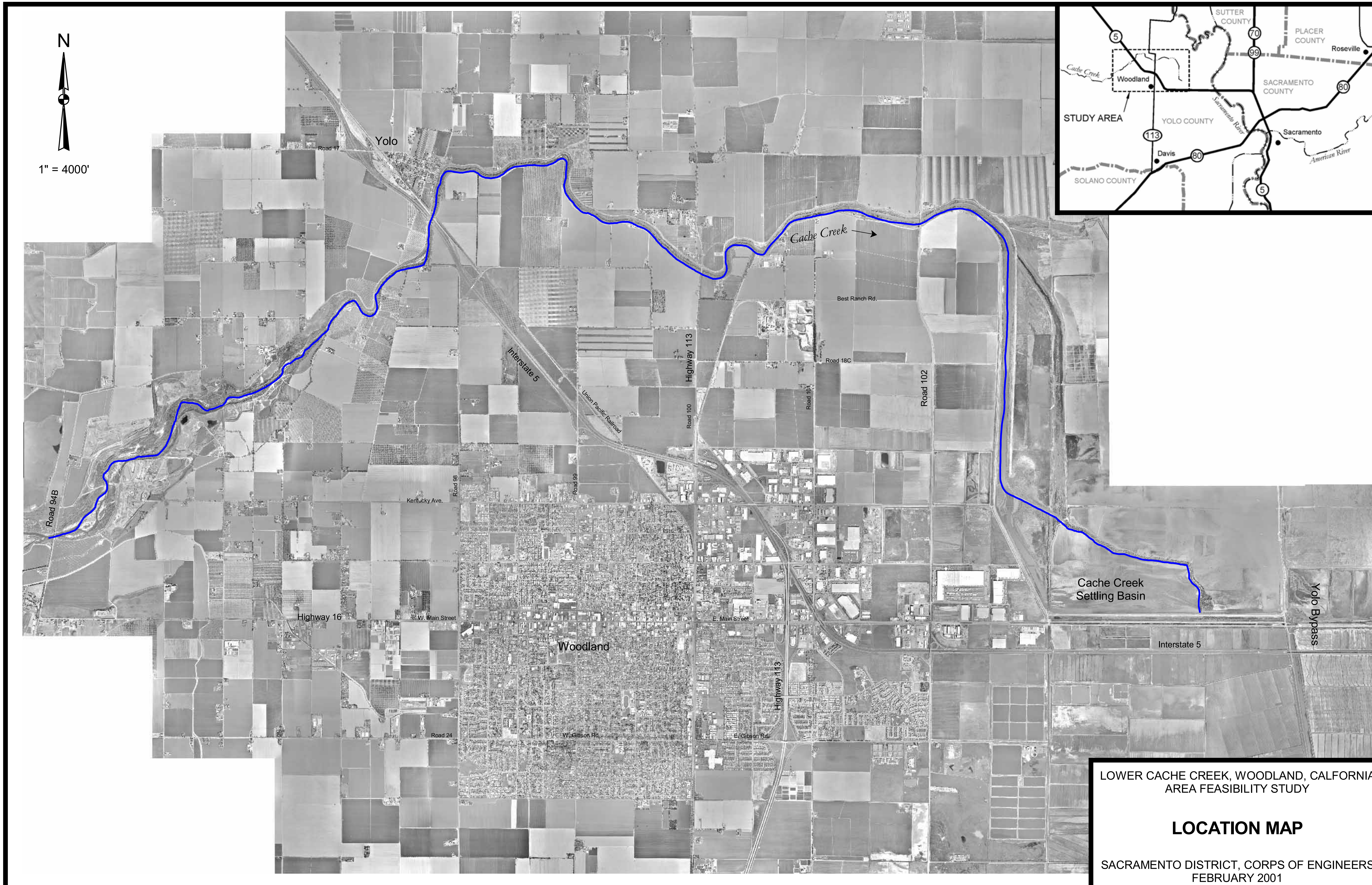
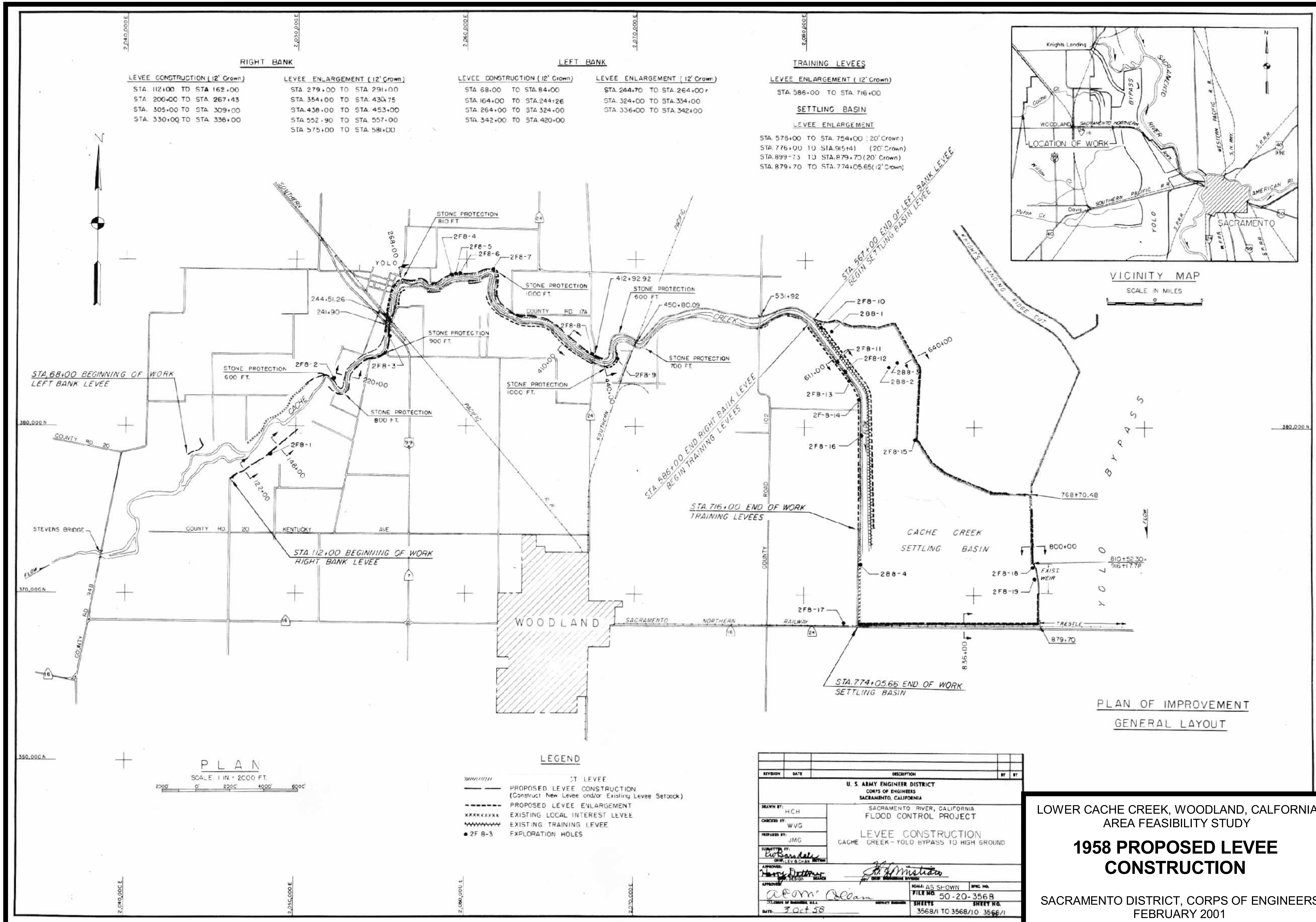


LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

LOCATION MAP

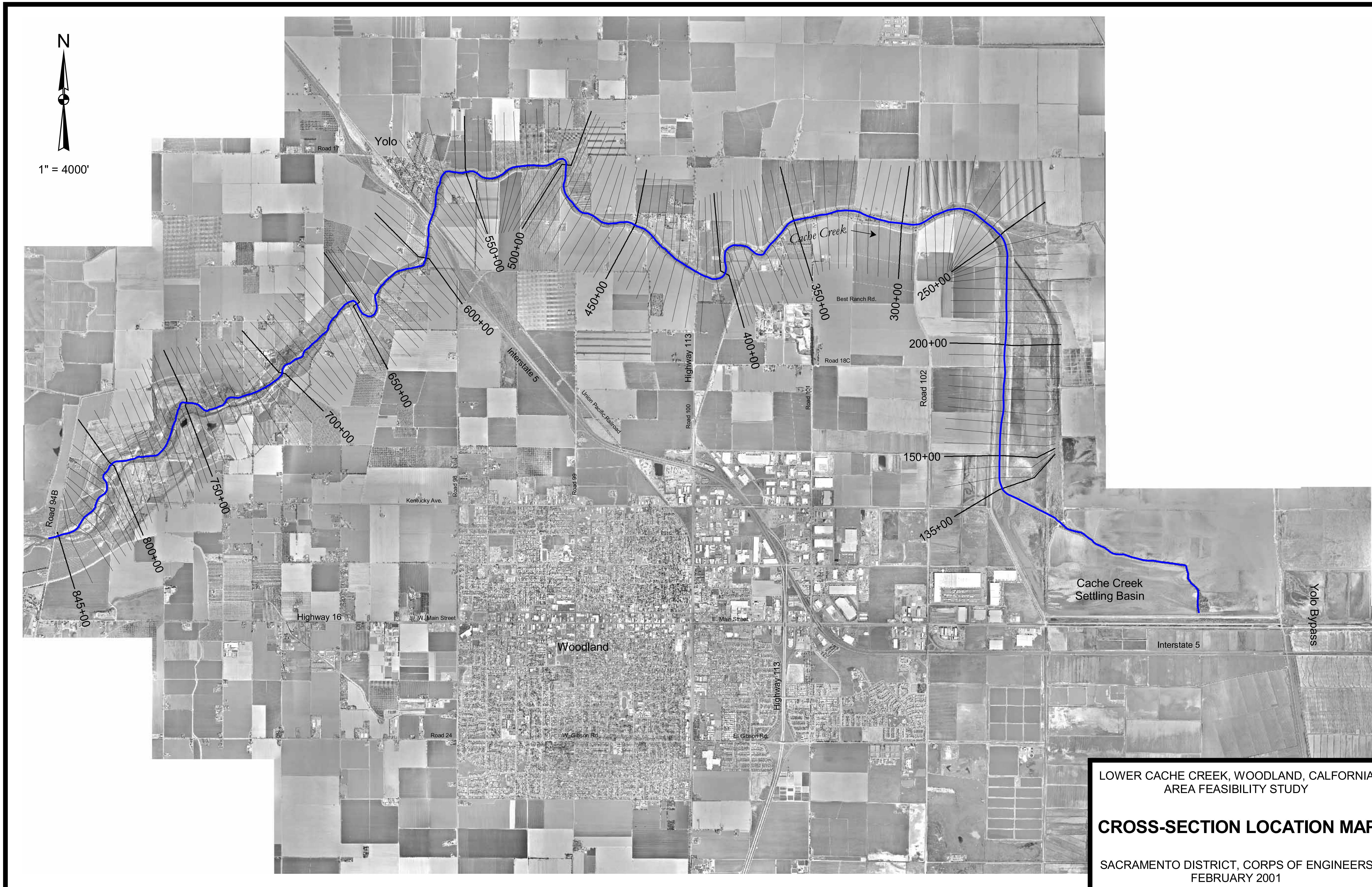
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

1958 PROPOSED LEVEE CONSTRUCTION

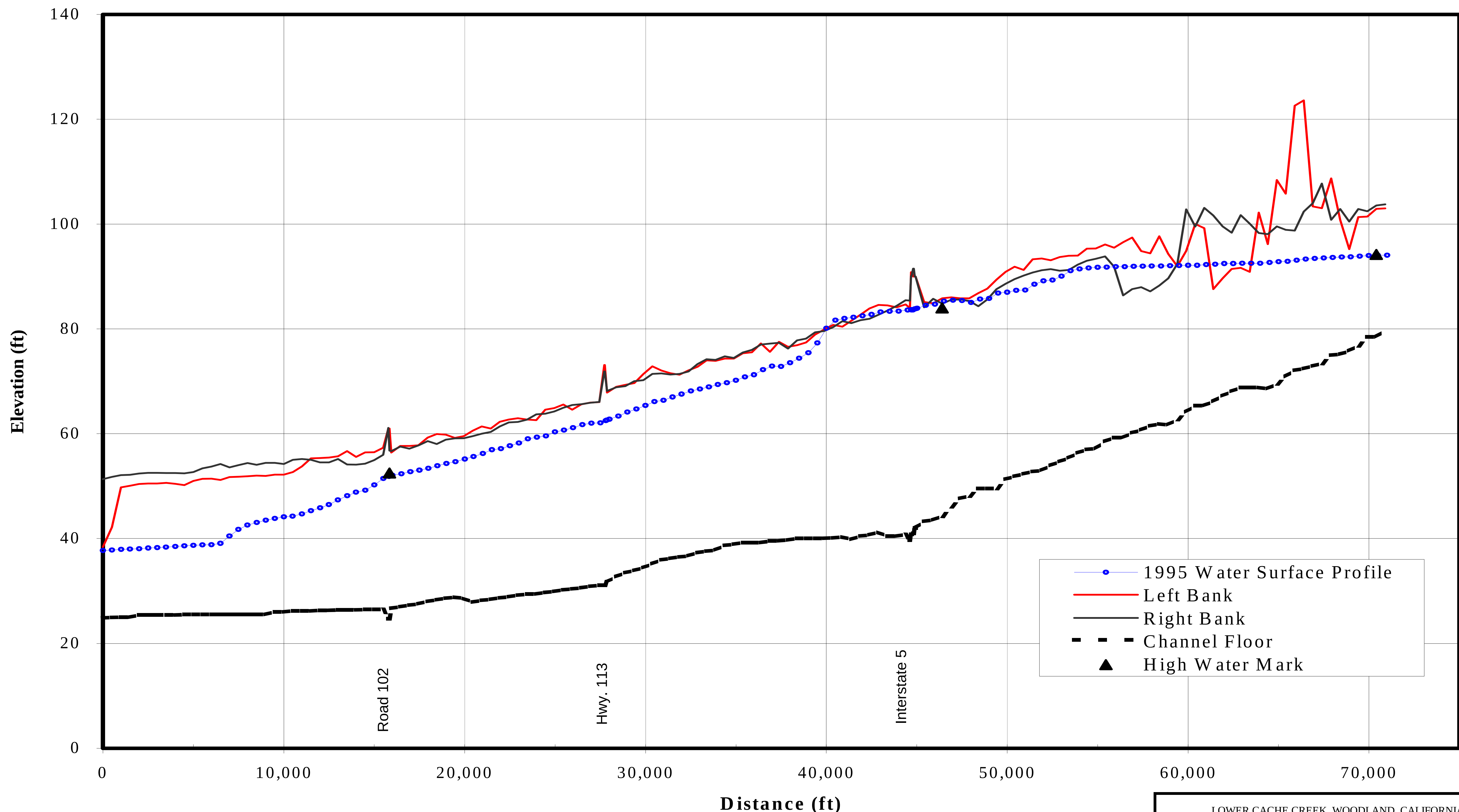
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

CROSS-SECTION LOCATION MAP

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

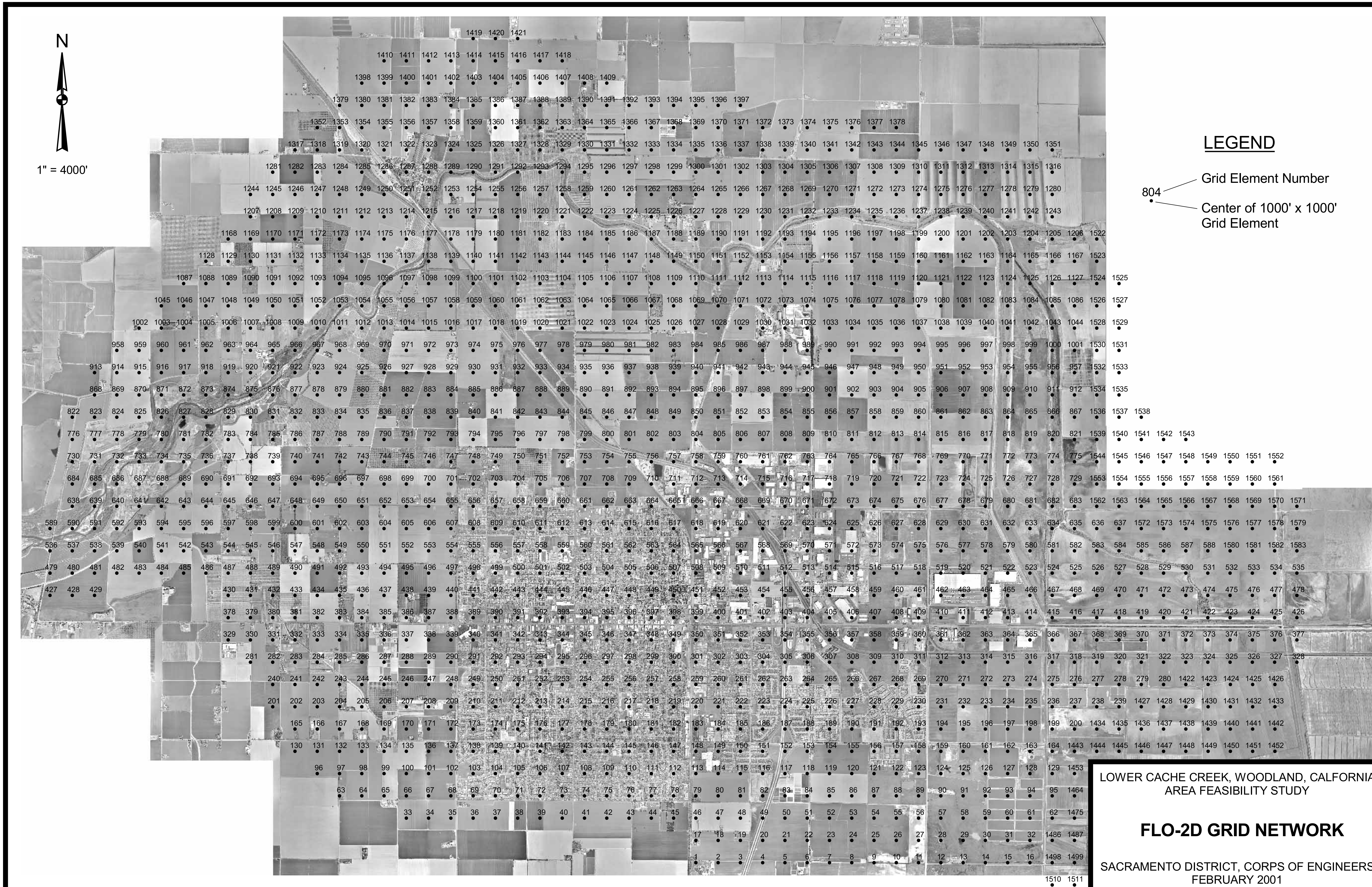


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASSIBILITY STUDY

WATER SURFACE PROFILE
MARCH 1995

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

Plate 4

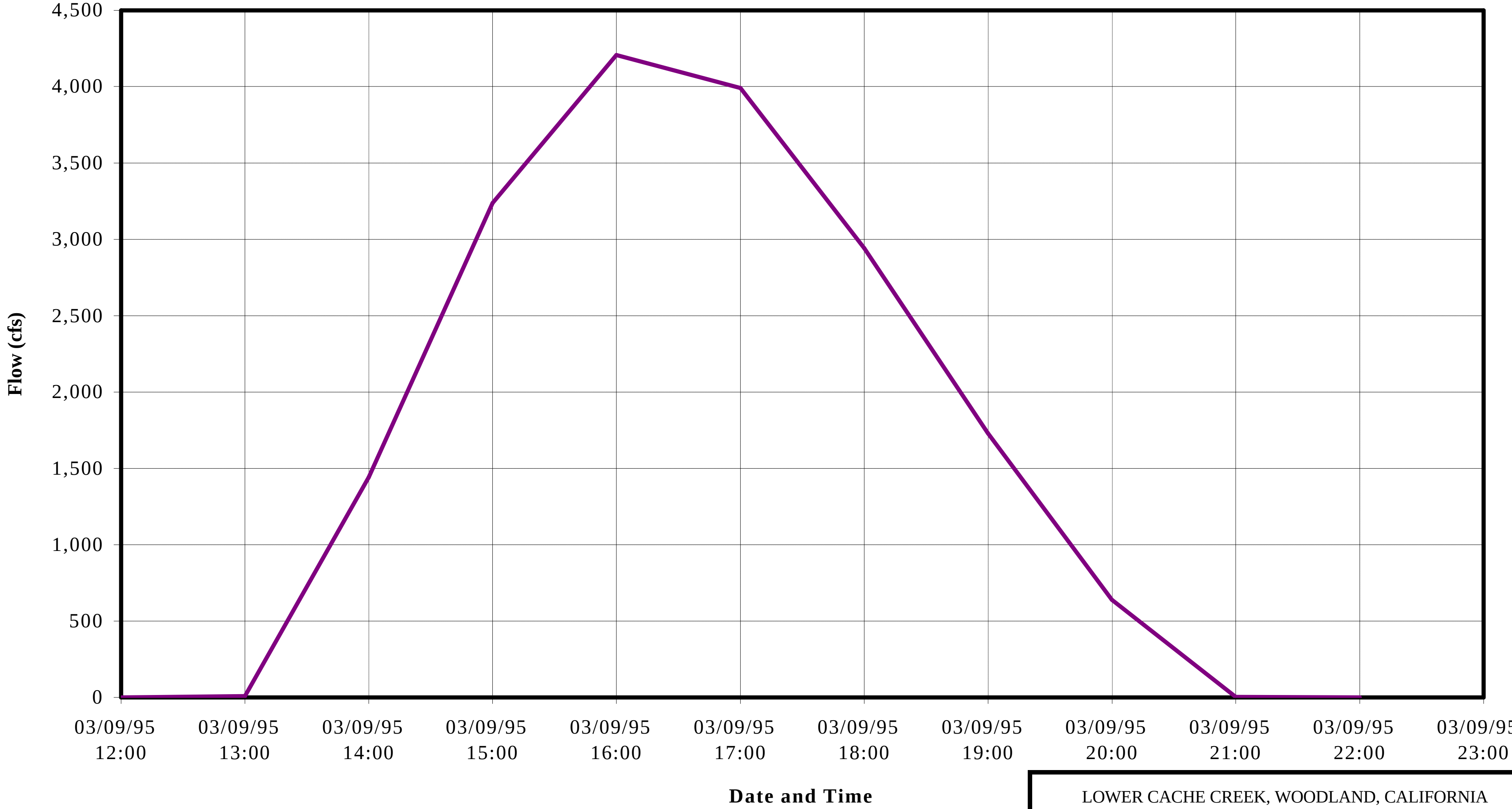


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

FLO-2D GRID NETWORK

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

Cache Creek 1995 Flood
Spill to Right Overbank
(from UNET study GOCHE95B)



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASABILITY STUDY

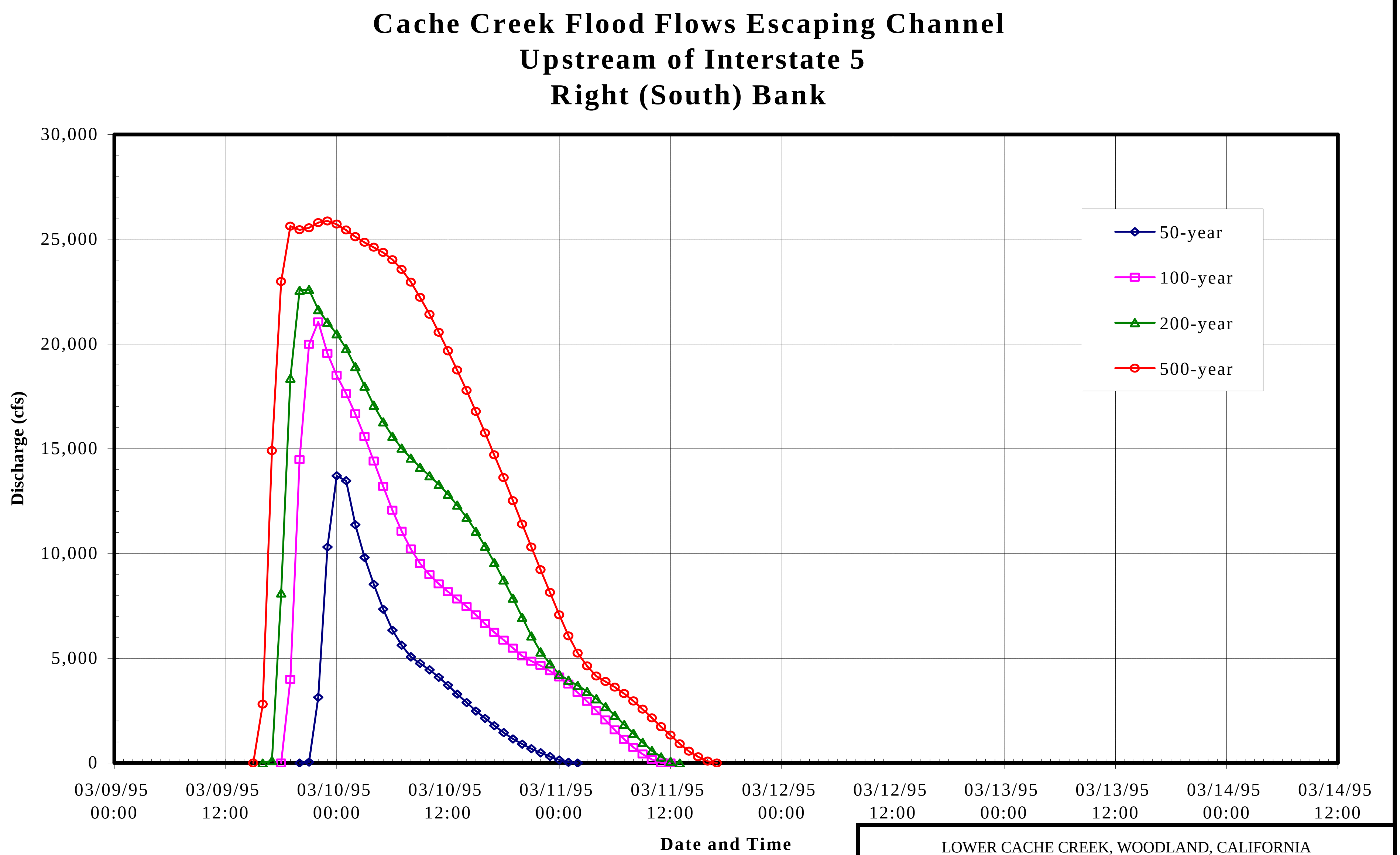
CACHE CREEK 1995 FLOOD
SPILL TO OVERBANK
(FROM UNET STUDY GOCHE95B)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

FLOOD CONTOUR MAP
MARCH 1995

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



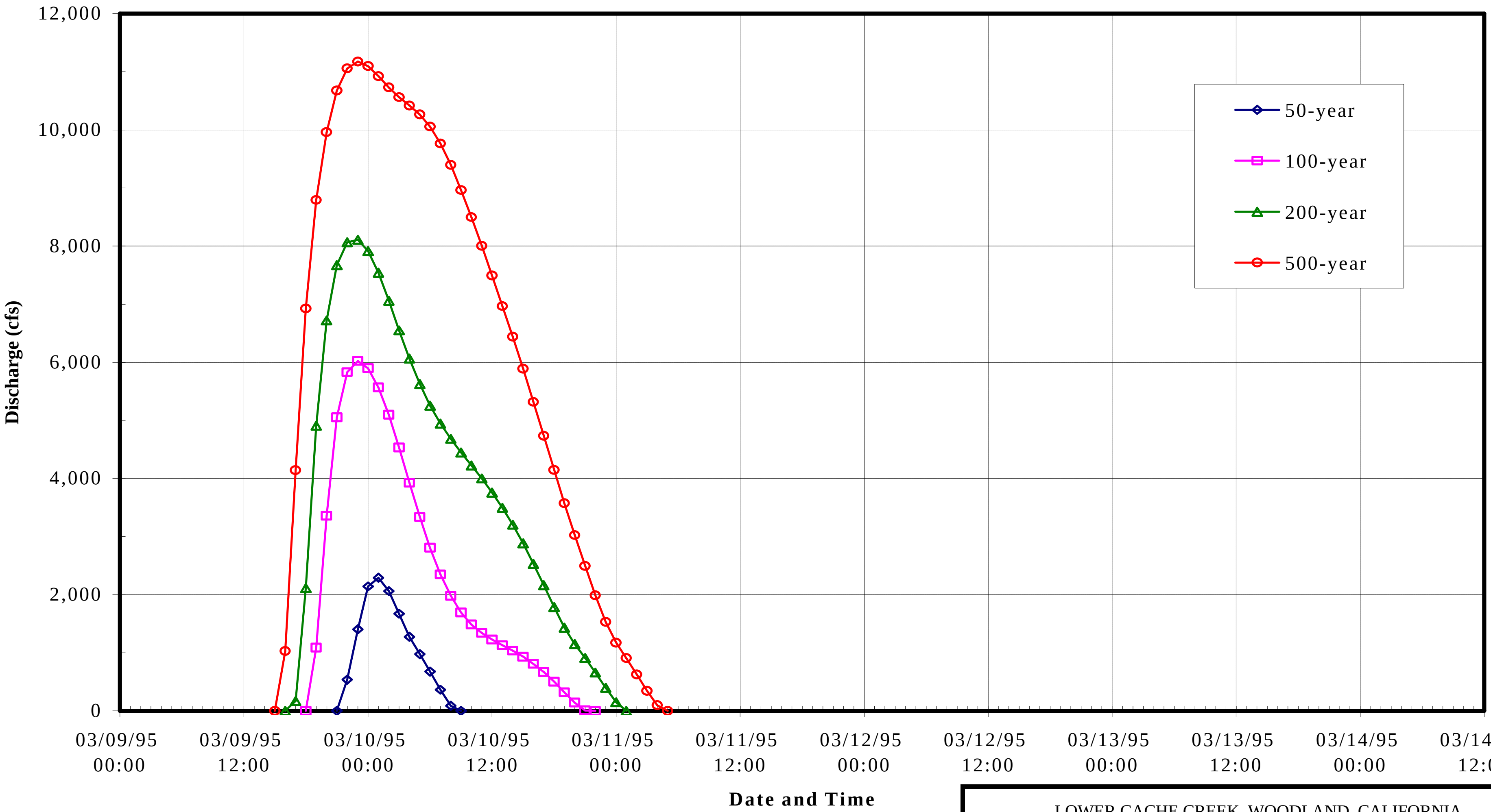
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASABILITY STUDY

CACHE CREEK FLOOD FLOWS ESCAPING CHANNEL
UPSTREAM OF INTERSTATE 5
RIGHT (SOUTH) BANK

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

Plate 08

Cache Creek Flood Flows Escaping Channel
Upstream of Interstate 5
Left (North) Bank



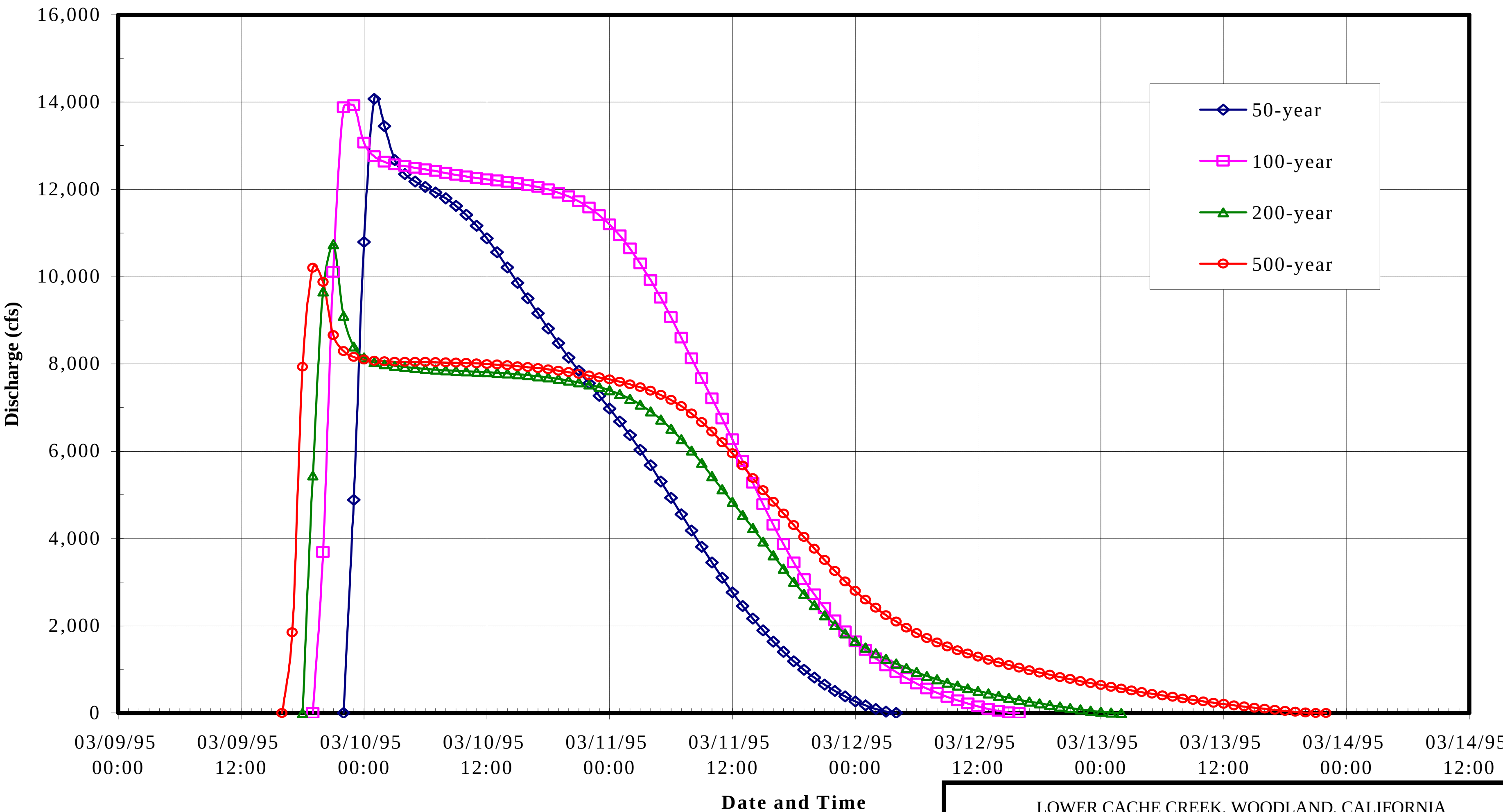
LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASABILITY STUDY

CACHE CREEK FLOOD FLOWS ESCAPING CHANNEL
UPSTREAM OF INTERSTATE 5
LEFT (NORTH) BANK

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

Plate 09

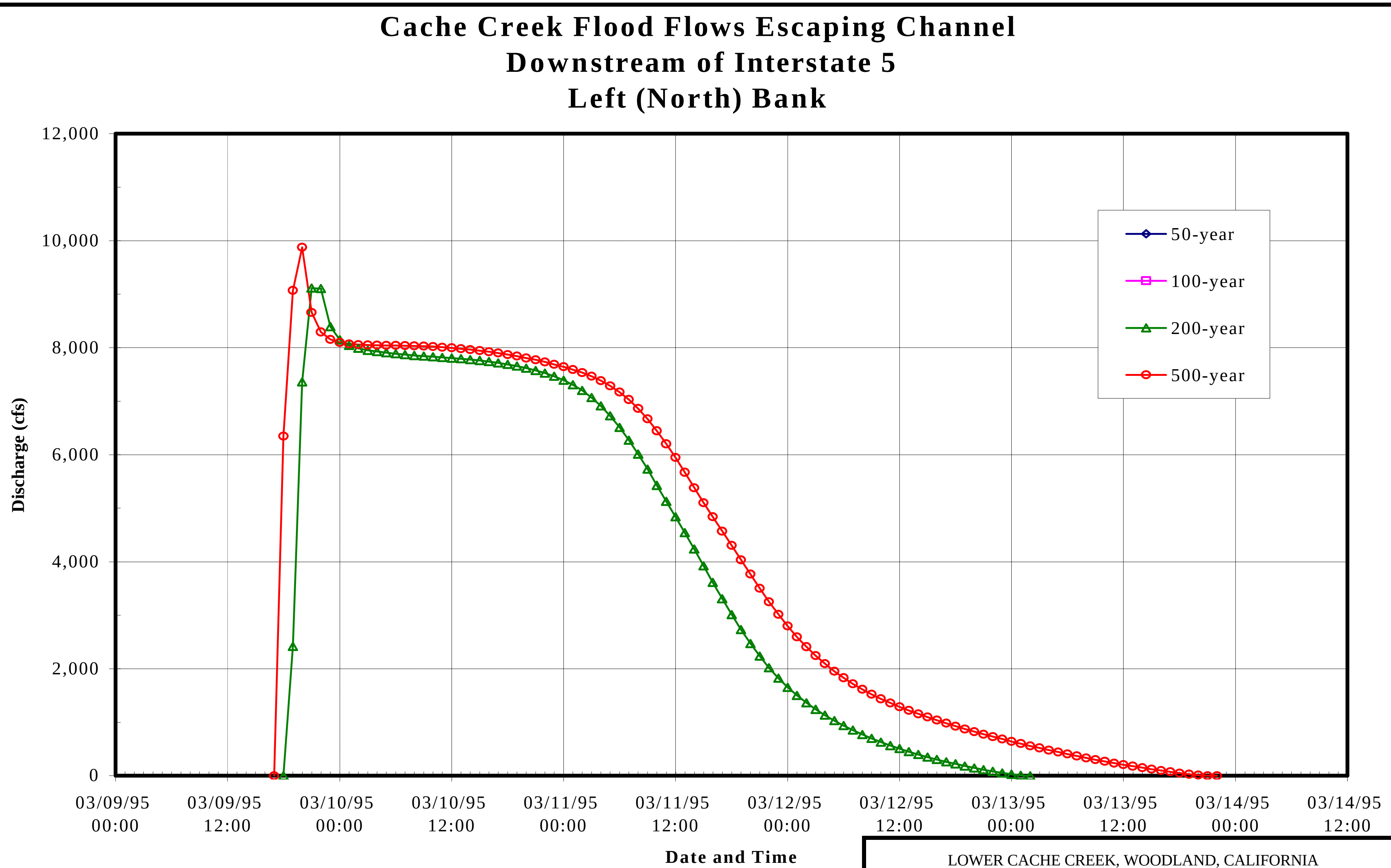
Cache Creek Flood Flows Escaping Channel
Downstream of Interstate 5
Right (South) Bank



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASABILITY STUDY

CACHE CREEK FLOOD FLOWS ESCAPING CHANNEL
DOWNSTREAM OF INTERSTATE 5
RIGHT (SOUTH) BANK

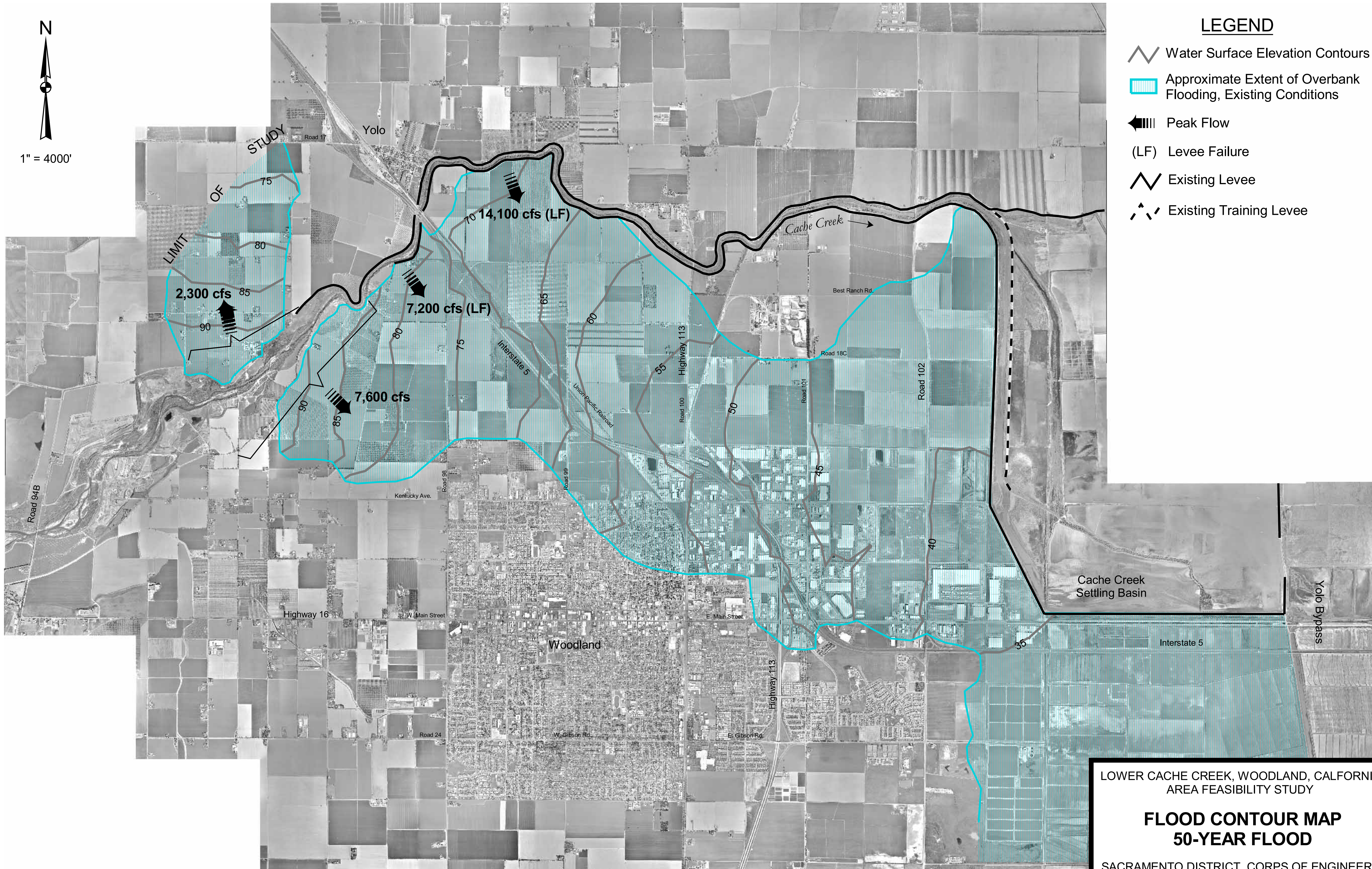
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASABILITY STUDY

CACHE CREEK FLOOD FLOWS ESCAPING CHANNEL
DOWNSTREAM OF INTERSTATE 5
LEFT (NORTH) BANK

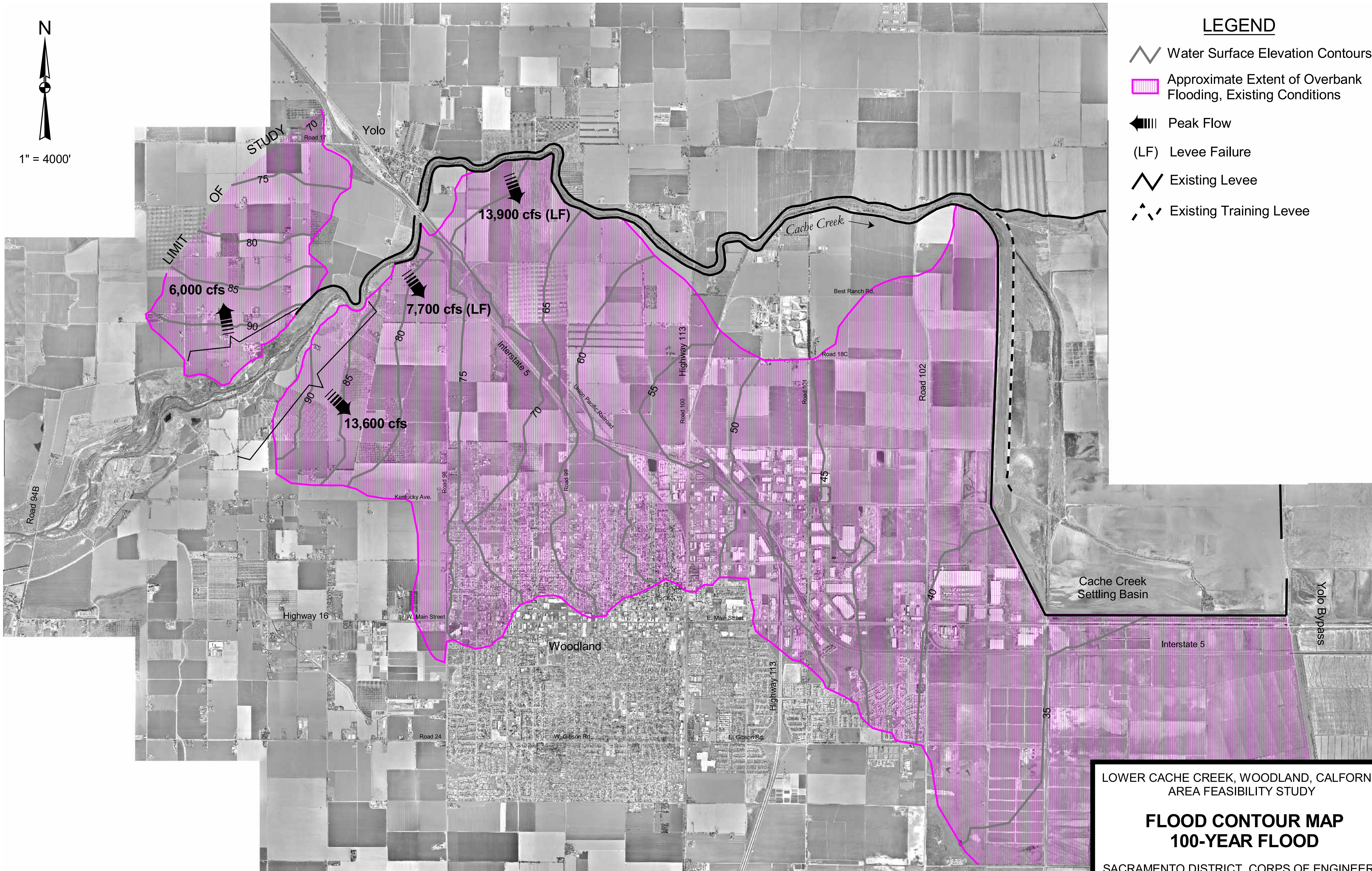
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

FLOOD CONTOUR MAP
50-YEAR FLOOD

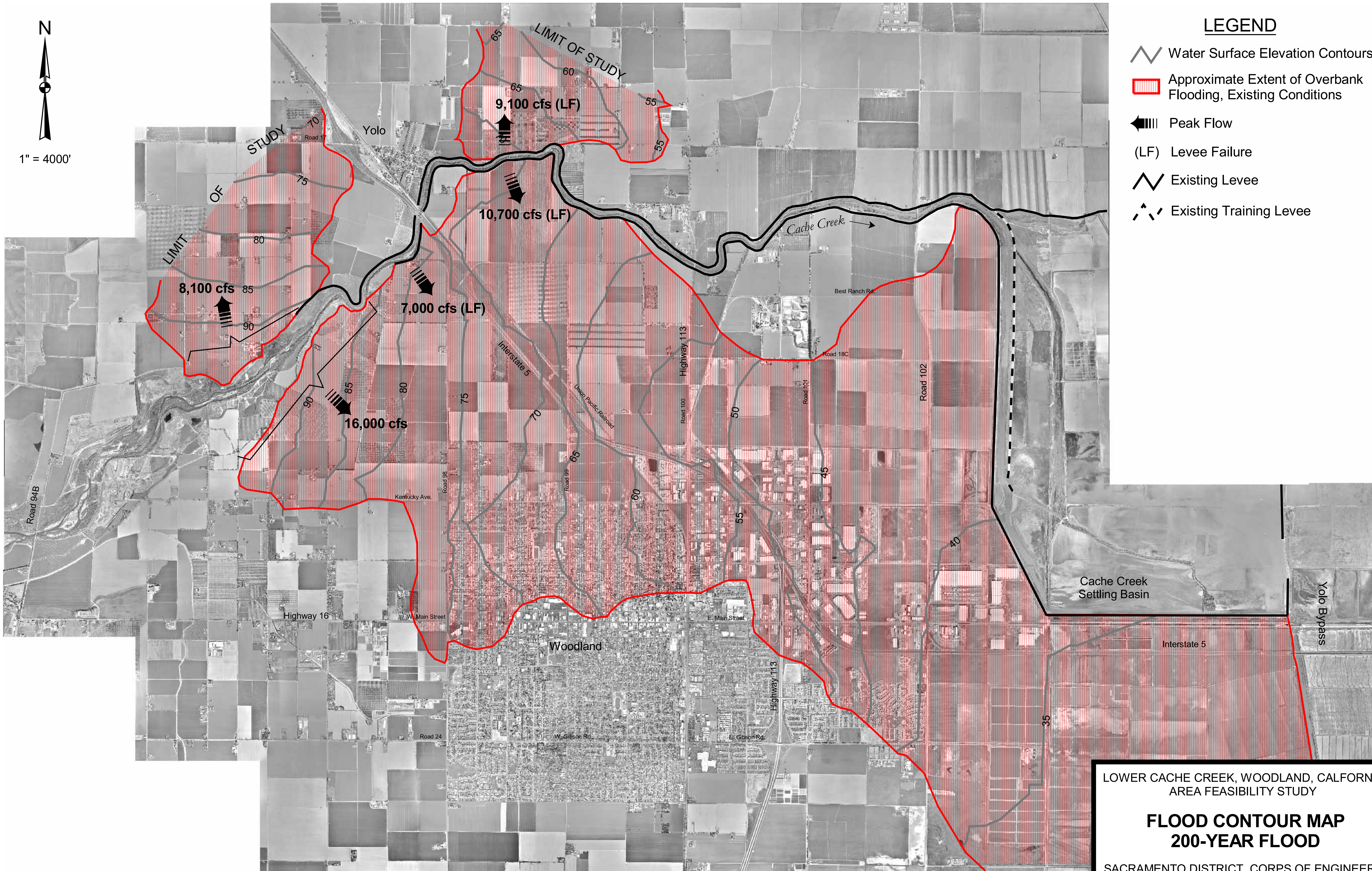
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

FLOOD CONTOUR MAP
100-YEAR FLOOD

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

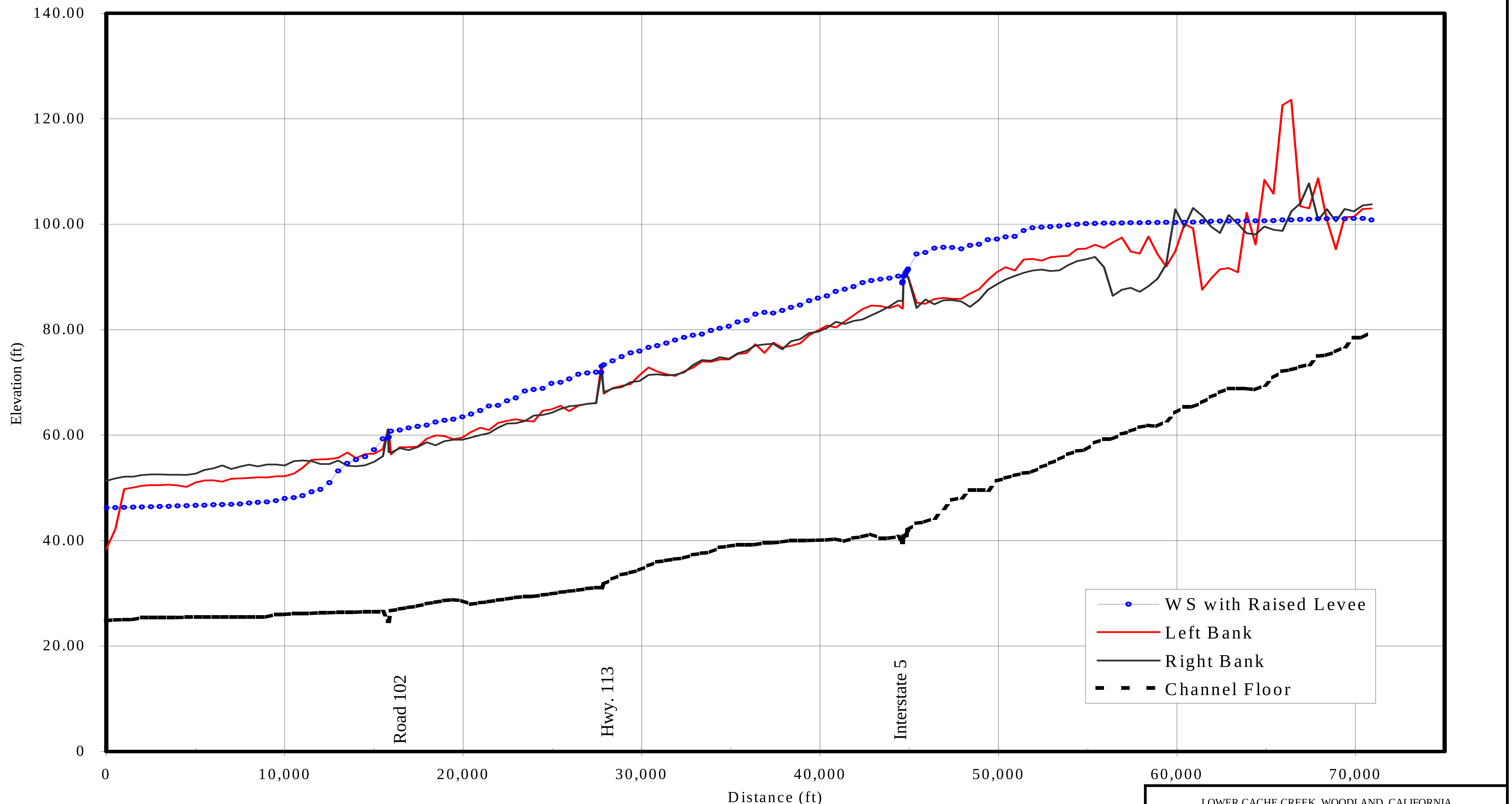
FLOOD CONTOUR MAP
200-YEAR FLOOD

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

FLOOD CONTOUR MAP
500-YEAR FLOOD

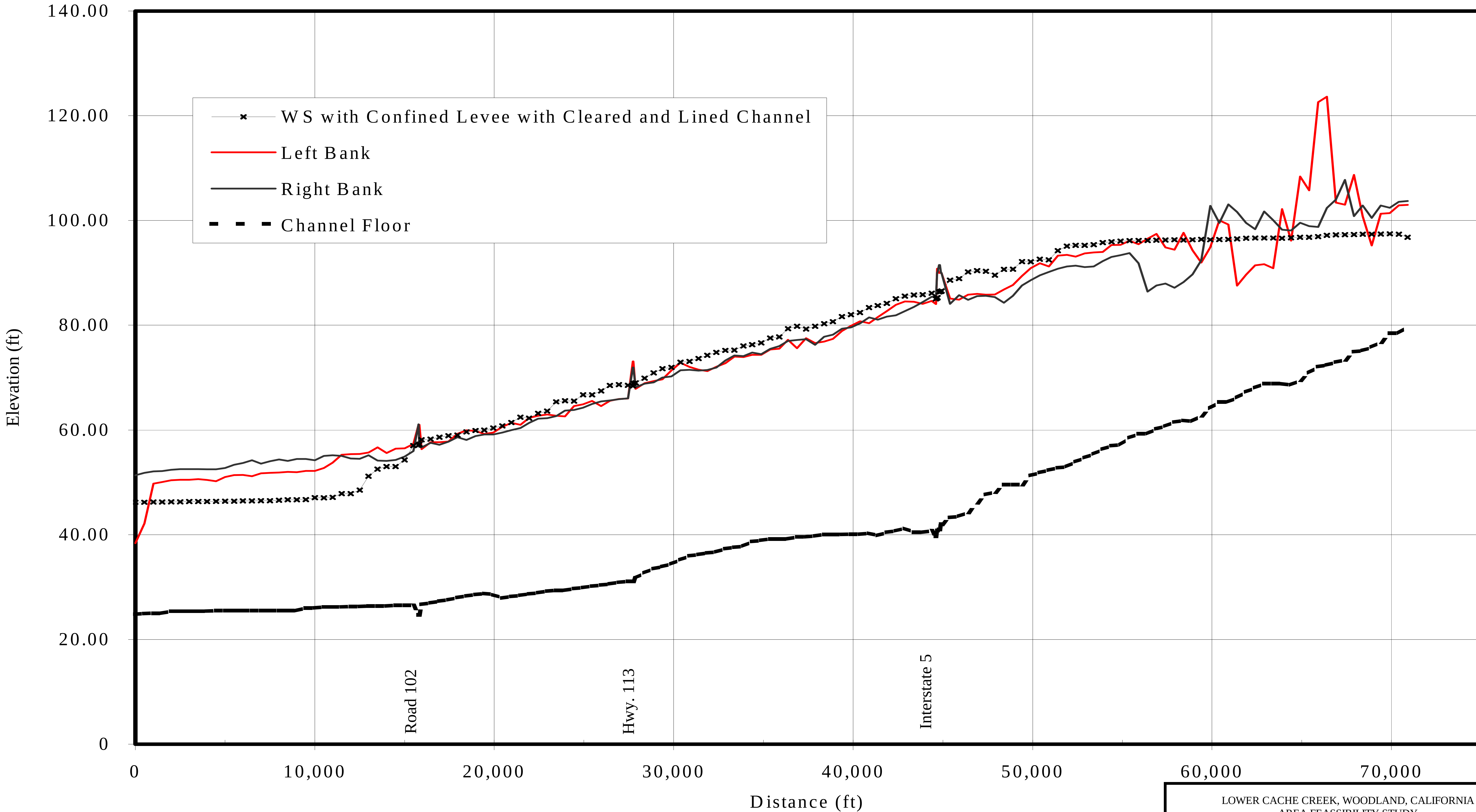
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASSIBILITY STUDY

WATER SURFACE PROFILE
RAISE LEVEES

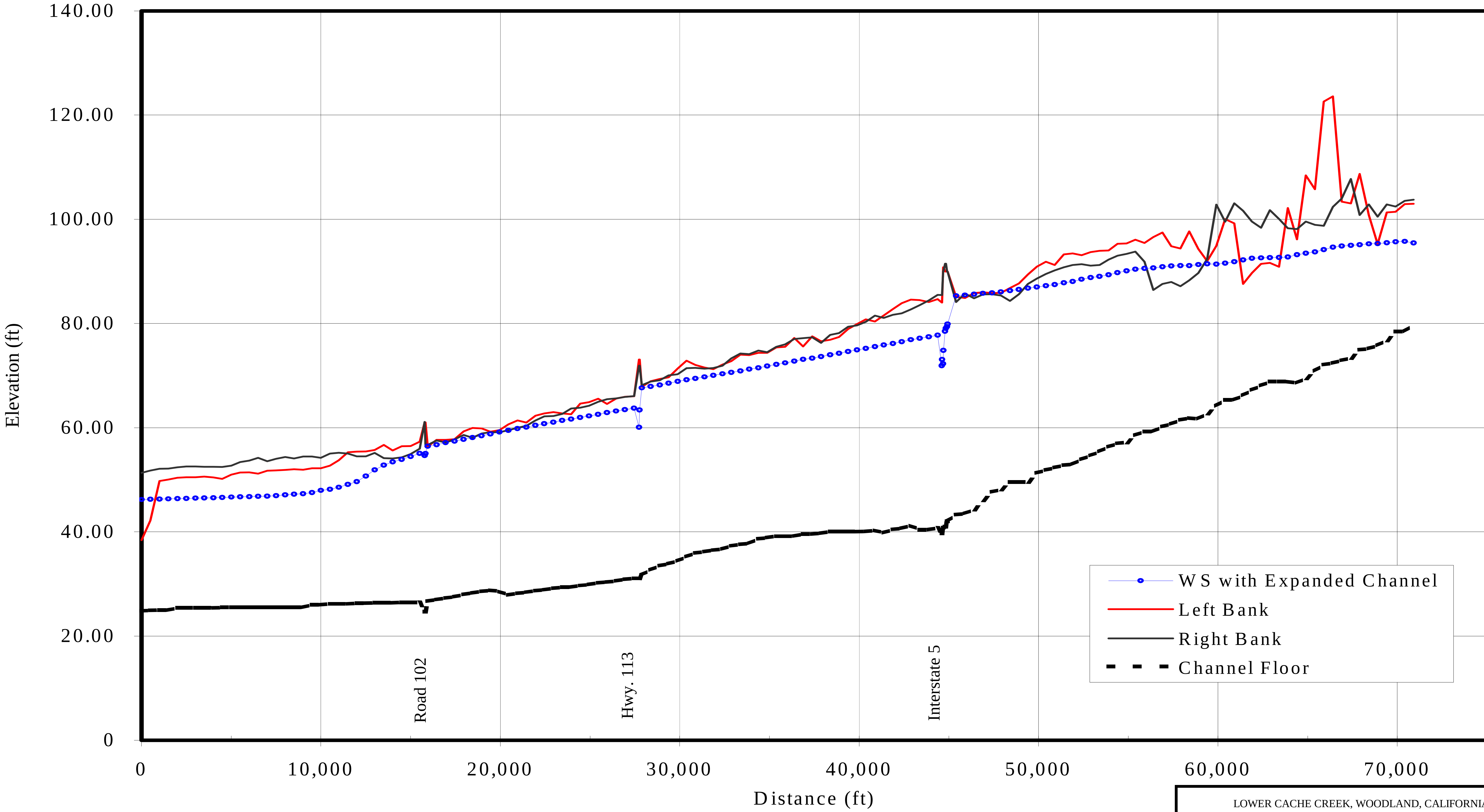
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASSIBILITY STUDY

WATER SURFACE PROFILE
CLEARED AND LINED CHANNEL ALTERNATIVE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

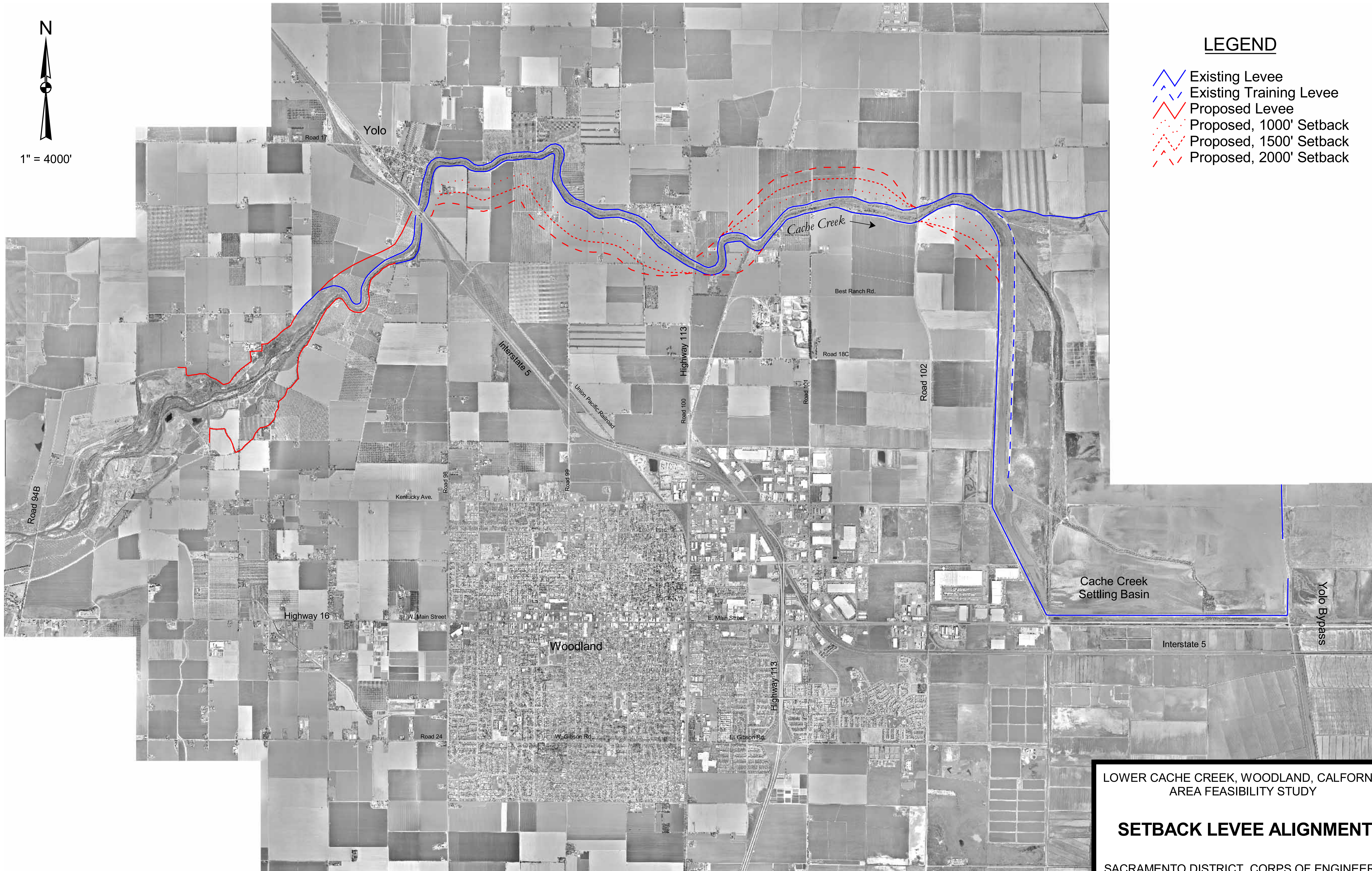


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASSIBILITY STUDY

WATER SURFACE PROFILE
EXPANDED CHANNEL

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

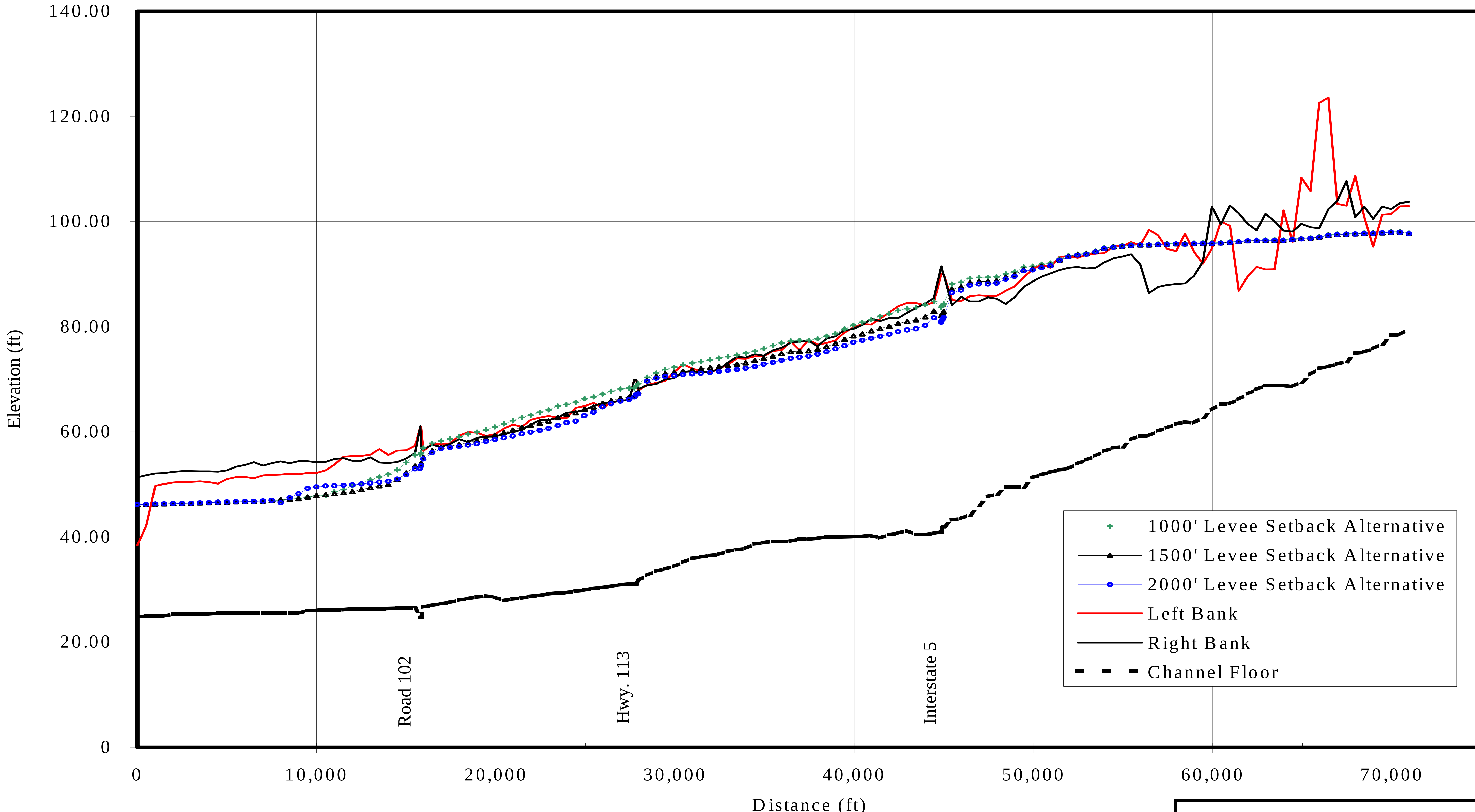
Plate 18



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

SETBACK LEVEE ALIGNMENT

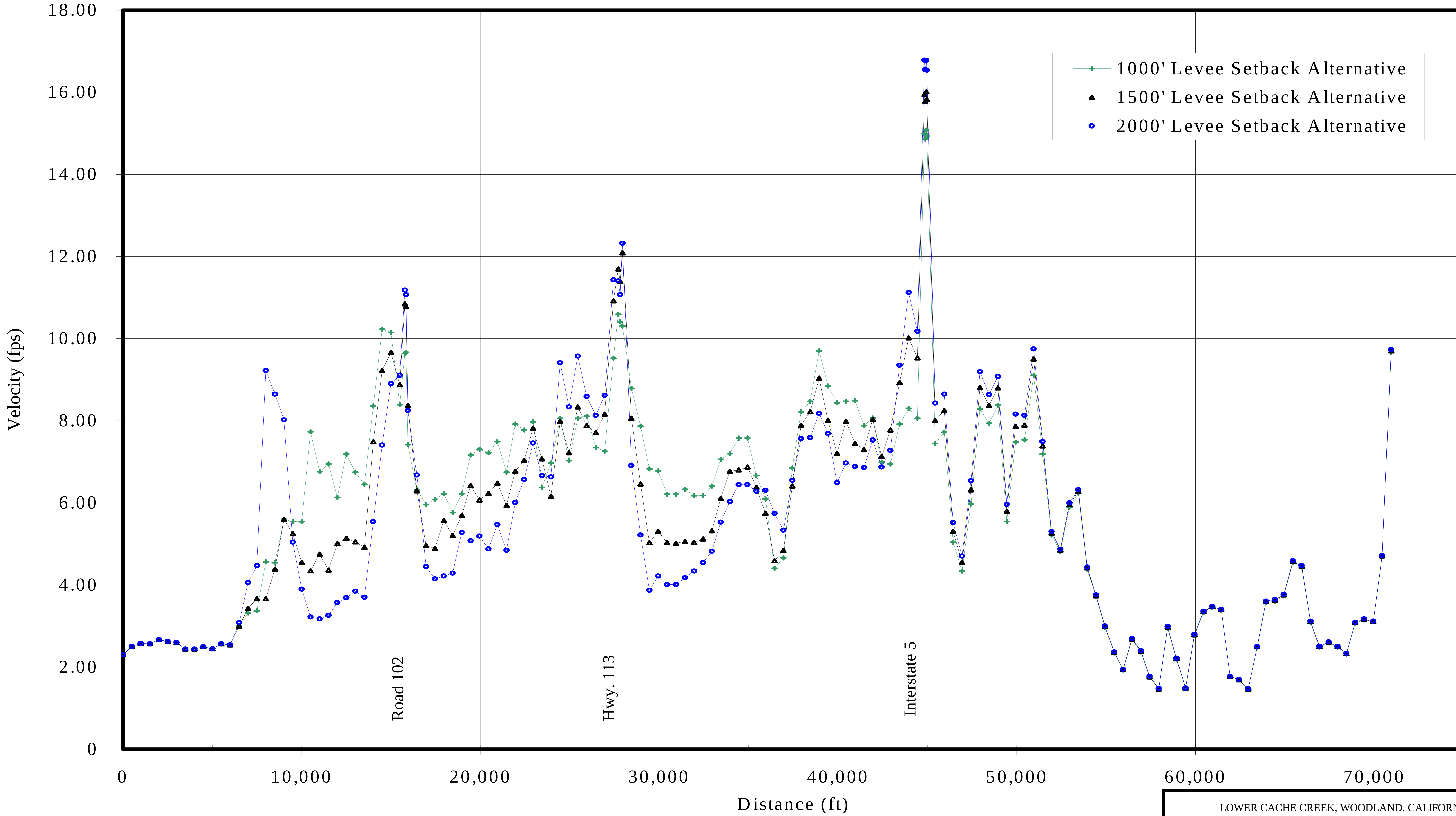
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASSIBILITY STUDY

WATER SURFACE PROFILE
SETBACK LEVEE ALTERNATIVE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

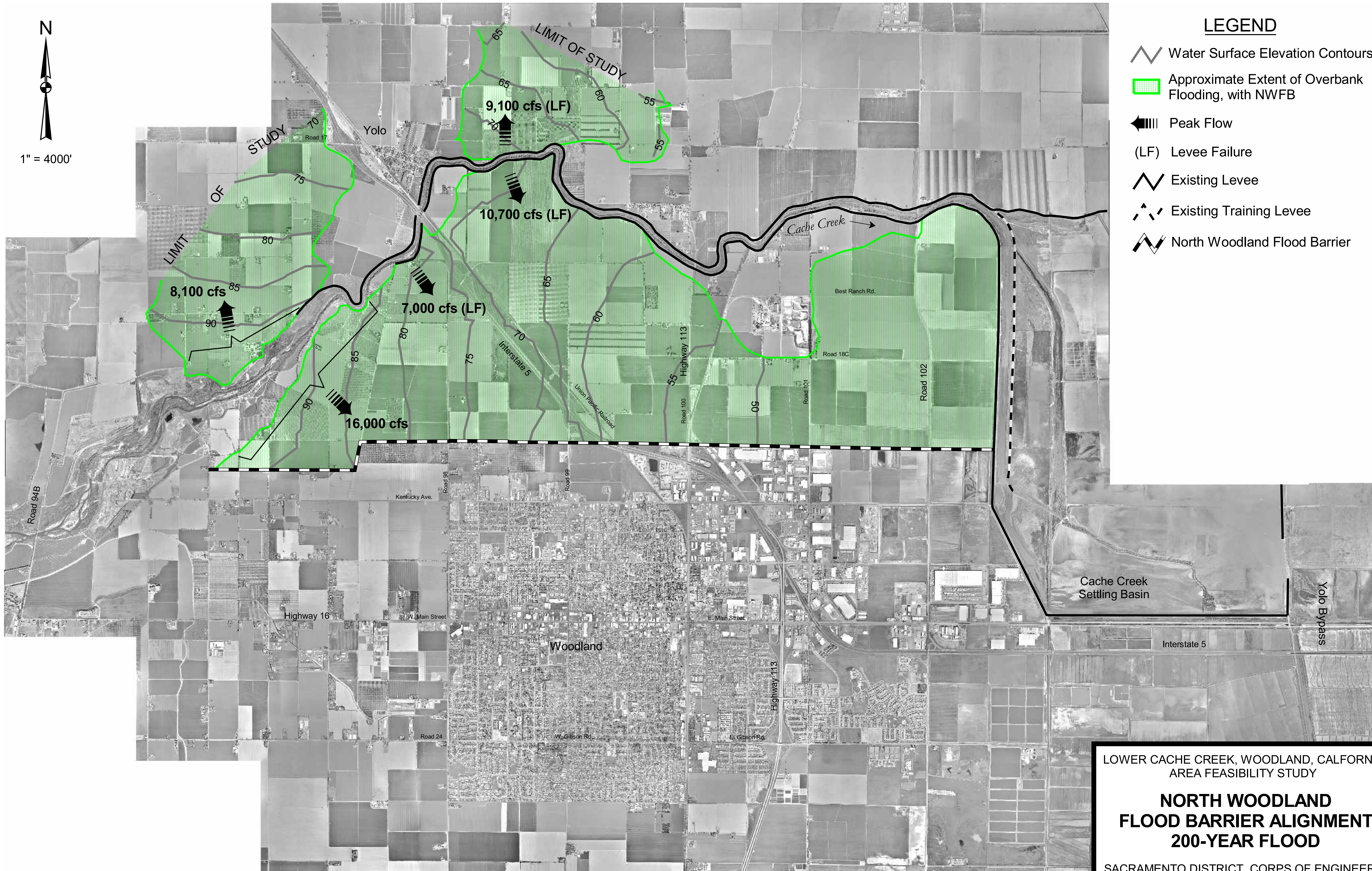


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASSIBILITY STUDY

WATER VELOCITY COMPARISON
SETBACK LEVEE ALTERNATIVE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

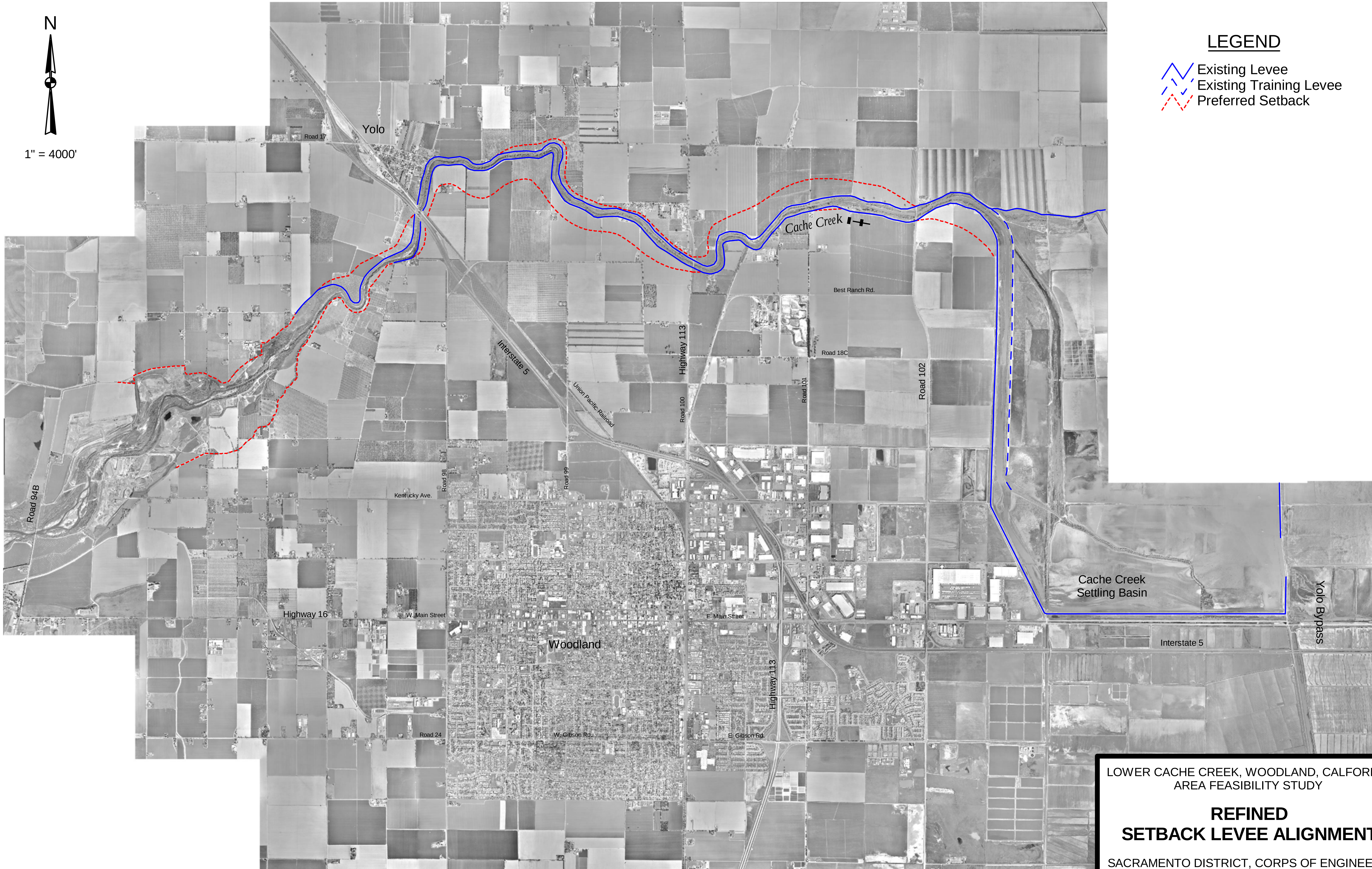
Plate 21



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

NORTH WOODLAND FLOOD BARRIER ALIGNMENT 200-YEAR FLOOD

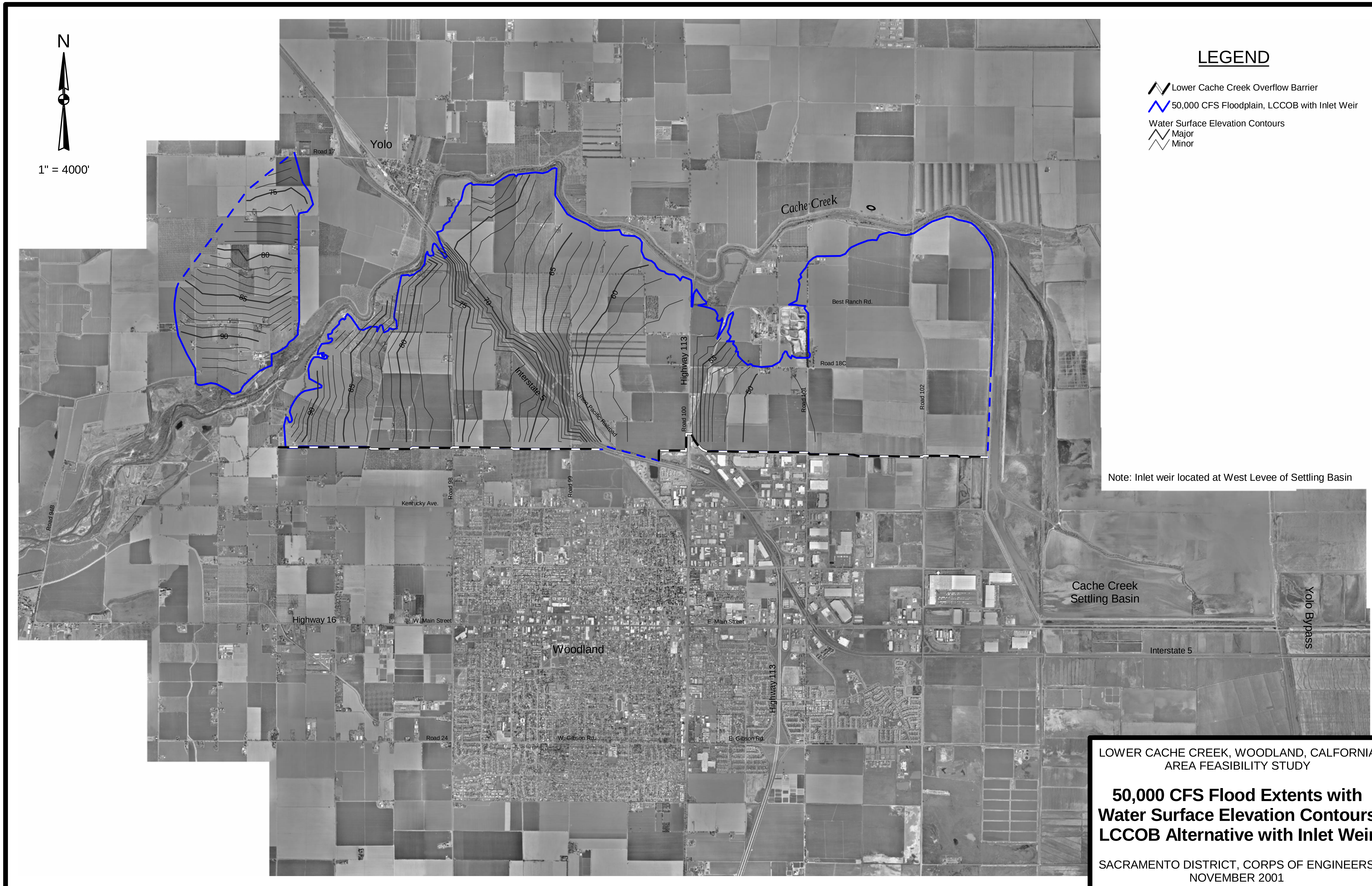
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

REFINED
SETBACK LEVEE ALIGNMENT

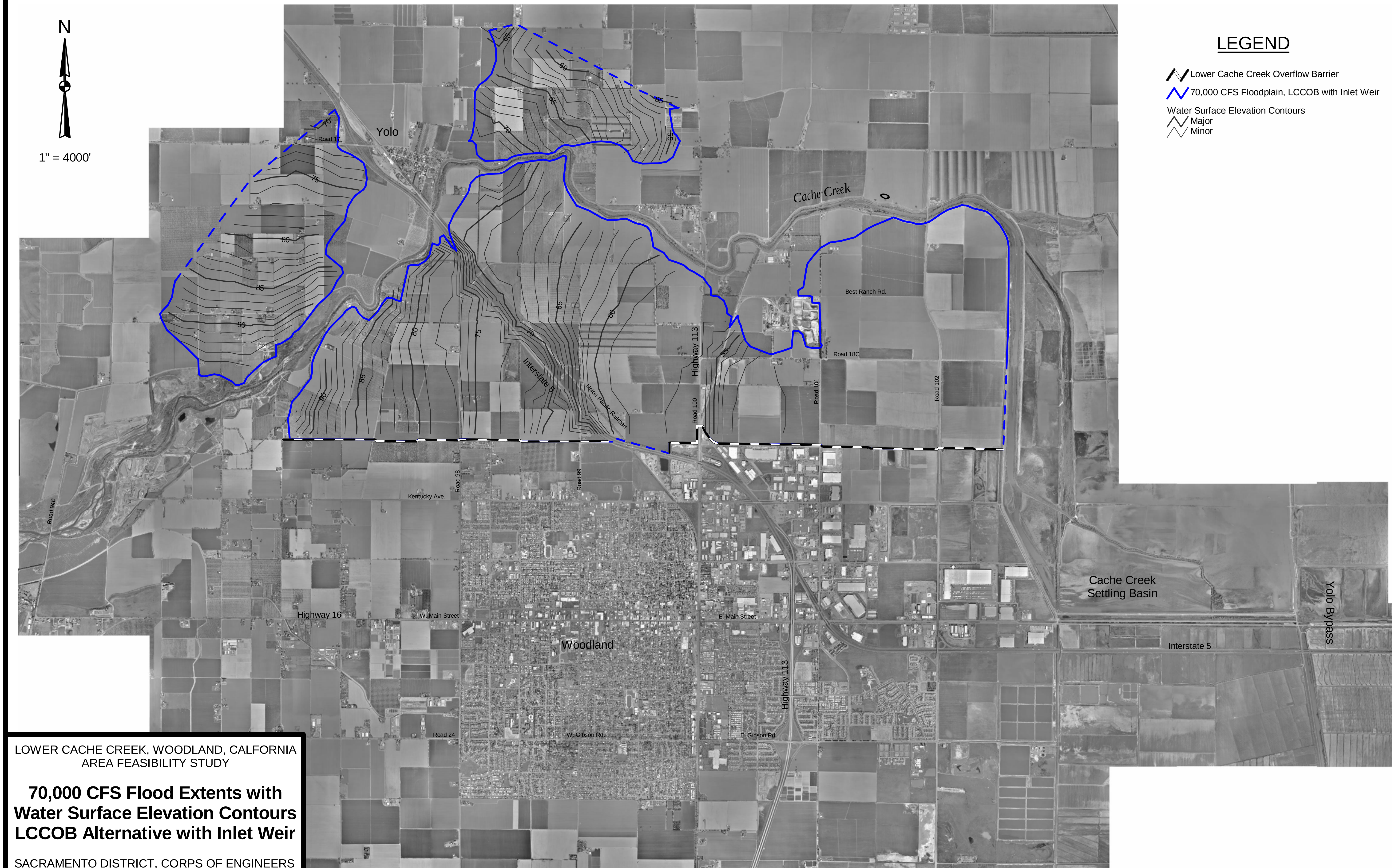
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

50,000 CFS Flood Extents with Water Surface Elevation Contours LCCOB Alternative with Inlet Weir

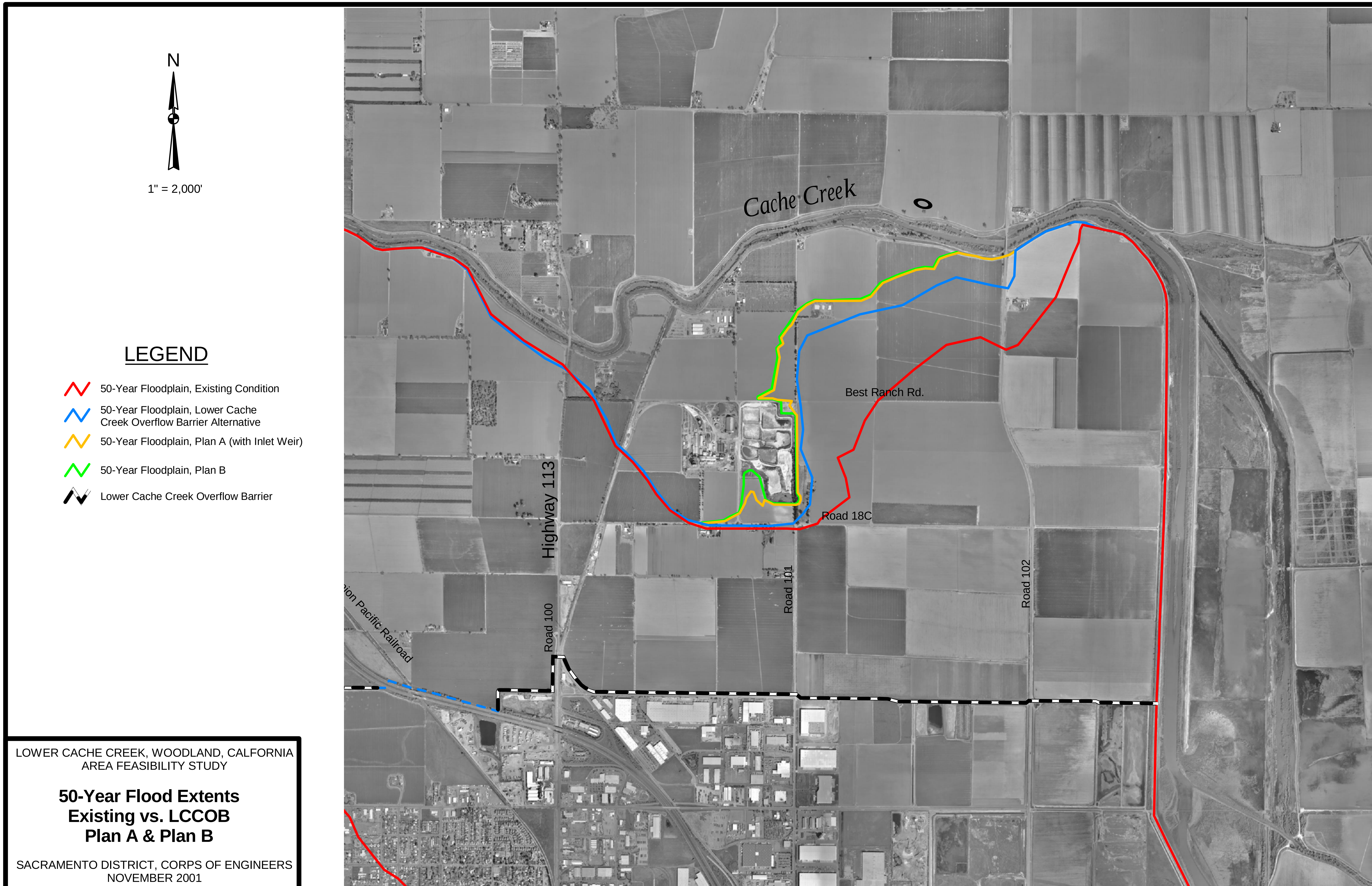
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
NOVEMBER 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

70,000 CFS Flood Extents with Water Surface Elevation Contours LCCOB Alternative with Inlet Weir

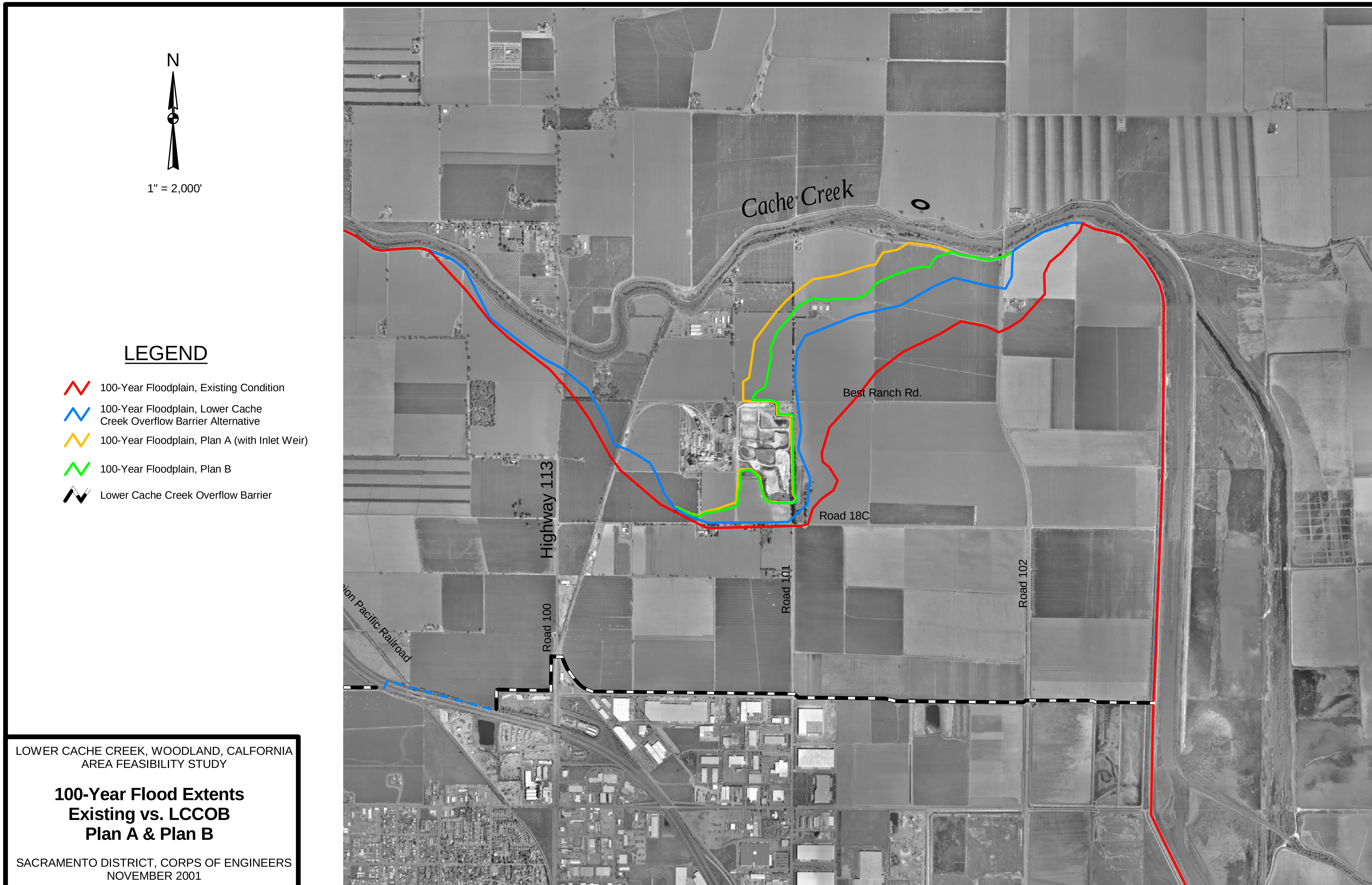
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
NOVEMBER 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

50-Year Flood Extents
Existing vs. LCCOB
Plan A & Plan B

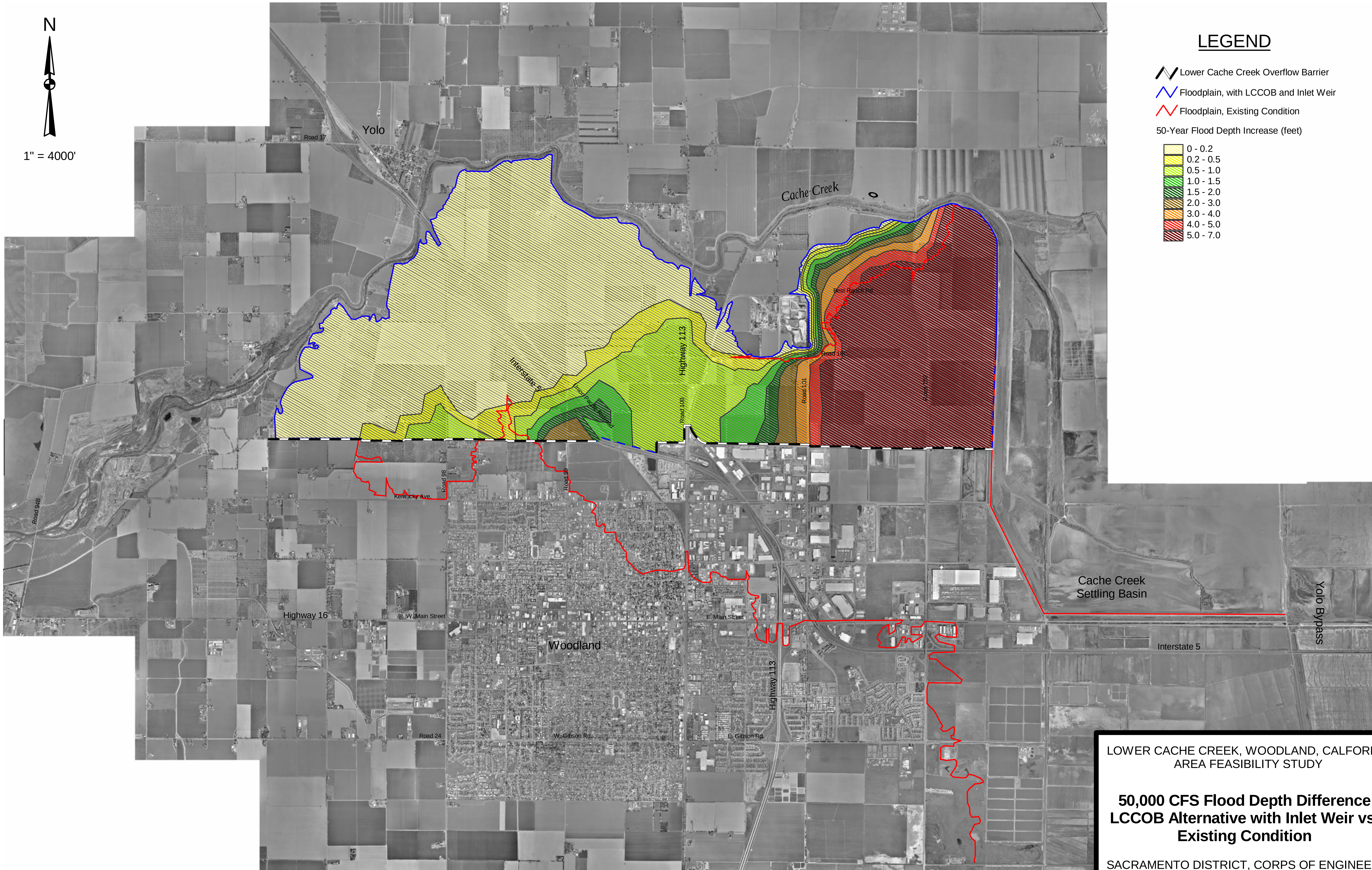
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
NOVEMBER 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

100-Year Flood Extents
Existing vs. LCCOB
Plan A & Plan B

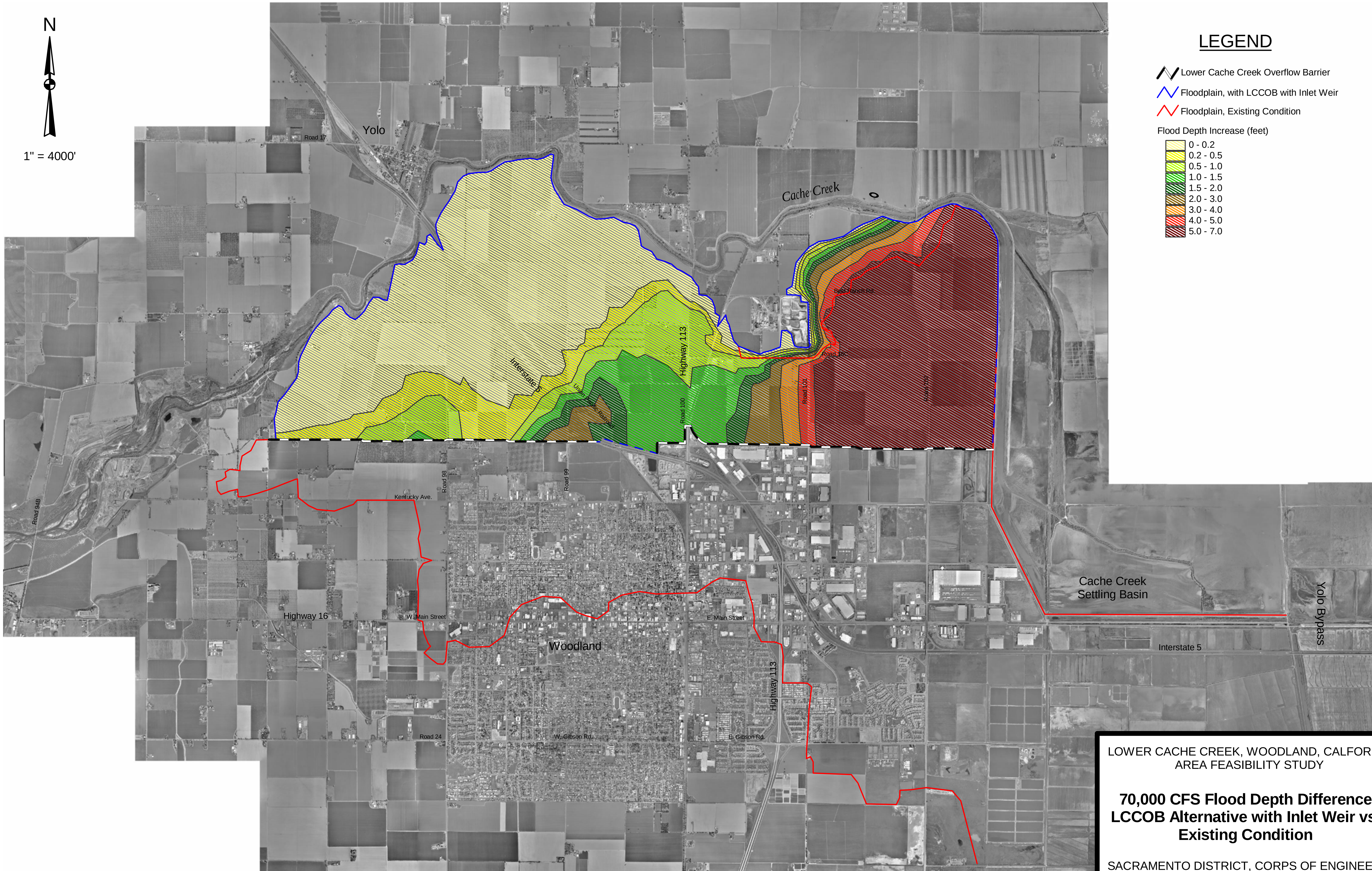
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
NOVEMBER 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

50,000 CFS Flood Depth Difference LCCOB Alternative with Inlet Weir vs. Existing Condition

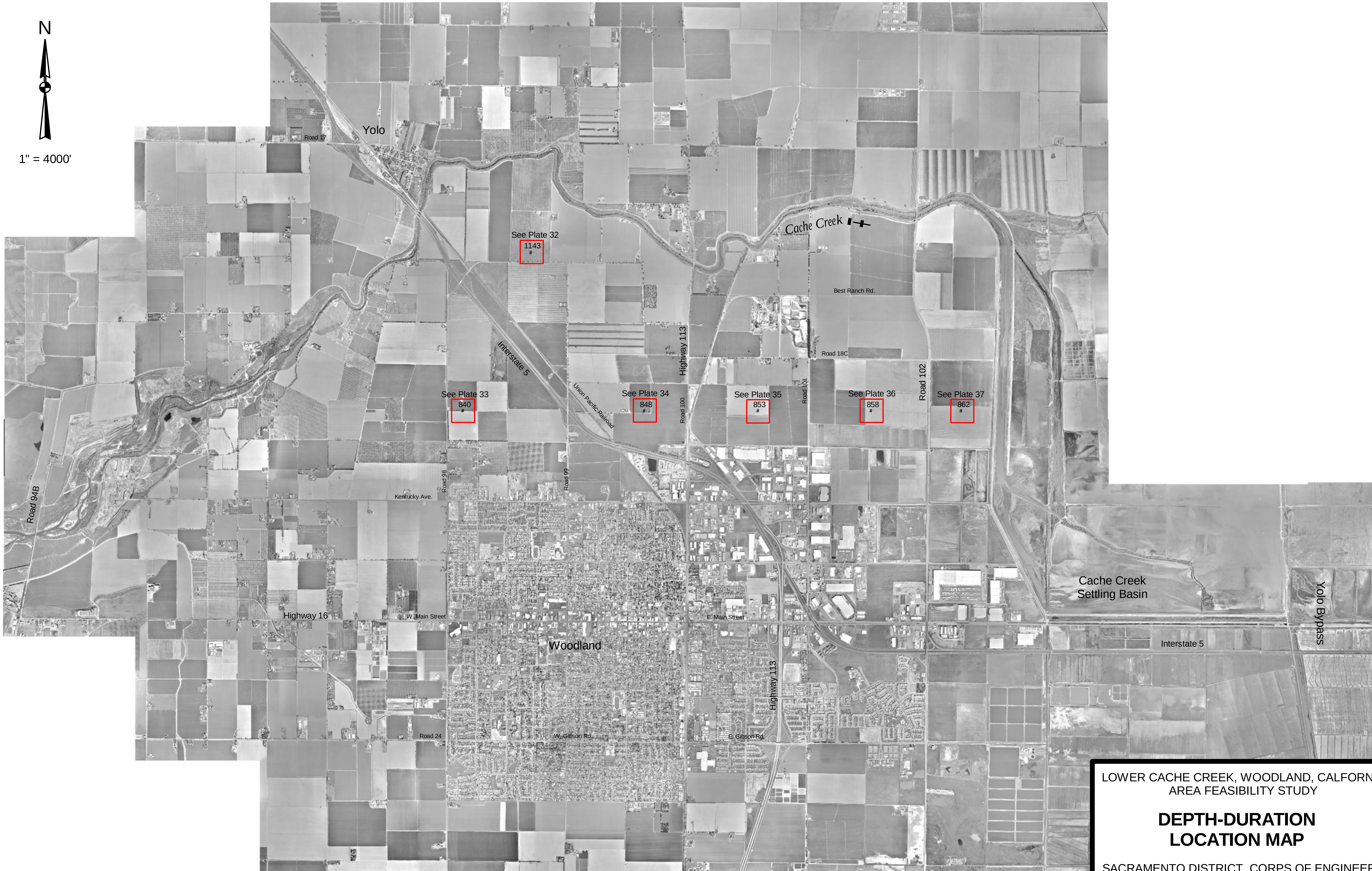
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
NOVEMBER 2001



LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

70,000 CFS Flood Depth Difference LCCOB Alternative with Inlet Weir vs. Existing Condition

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
NOVEMBER 2001

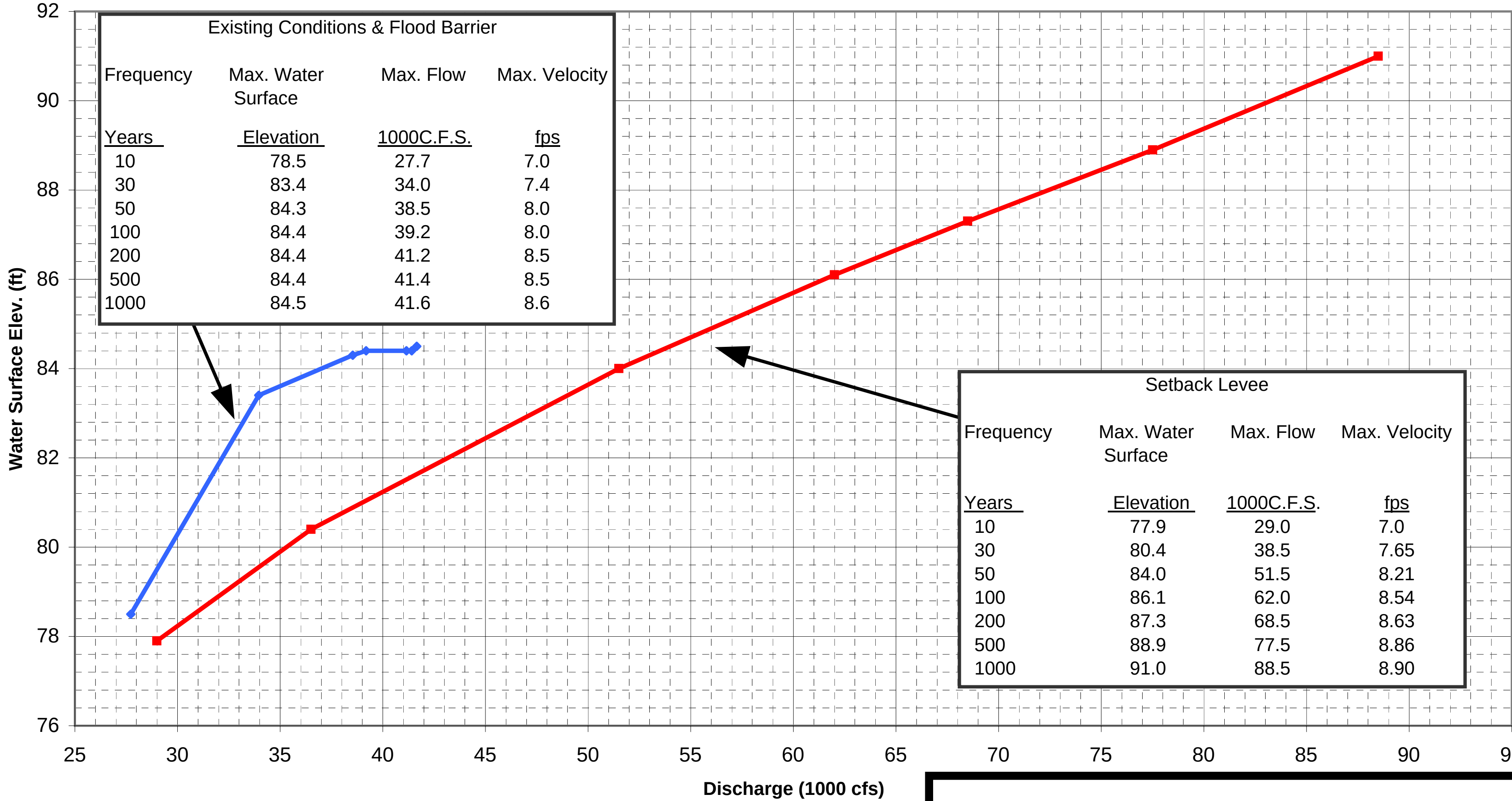


LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

DEPTH-DURATION LOCATION MAP

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001

Rating Curve from UNET Results
Index Point Above I-5
(XS 59000)



Existing Conditions & Flood Barrier

Frequency Years	Max. Water Surface Elevation	Max. Flow 1000C.F.S.	Max. Velocity fps
10	78.5	27.7	7.0
30	83.4	34.0	7.4
50	84.3	38.5	8.0
100	84.4	39.2	8.0
200	84.4	41.2	8.5
500	84.4	41.4	8.5
1000	84.5	41.6	8.6

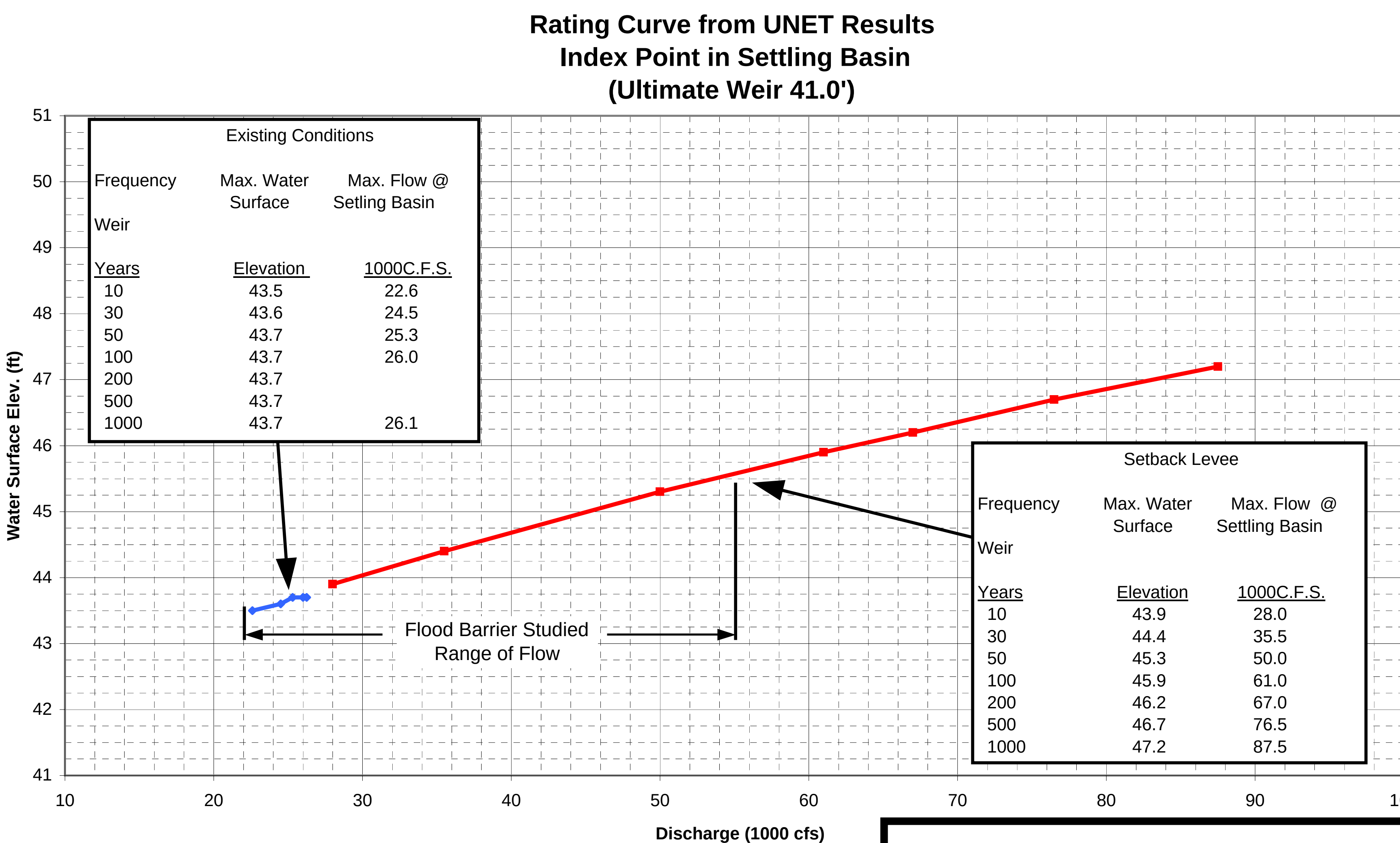
Setback Levee

Frequency Years	Max. Water Surface Elevation	Max. Flow 1000C.F.S.	Max. Velocity fps
10	77.9	29.0	7.0
30	80.4	38.5	7.65
50	84.0	51.5	8.21
100	86.1	62.0	8.54
200	87.3	68.5	8.63
500	88.9	77.5	8.86
1000	91.0	88.5	8.90

LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

RATING CURVE FROM UNET RESULTS
INDEX POINT ABOVE I-5
(XS 59000)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2002

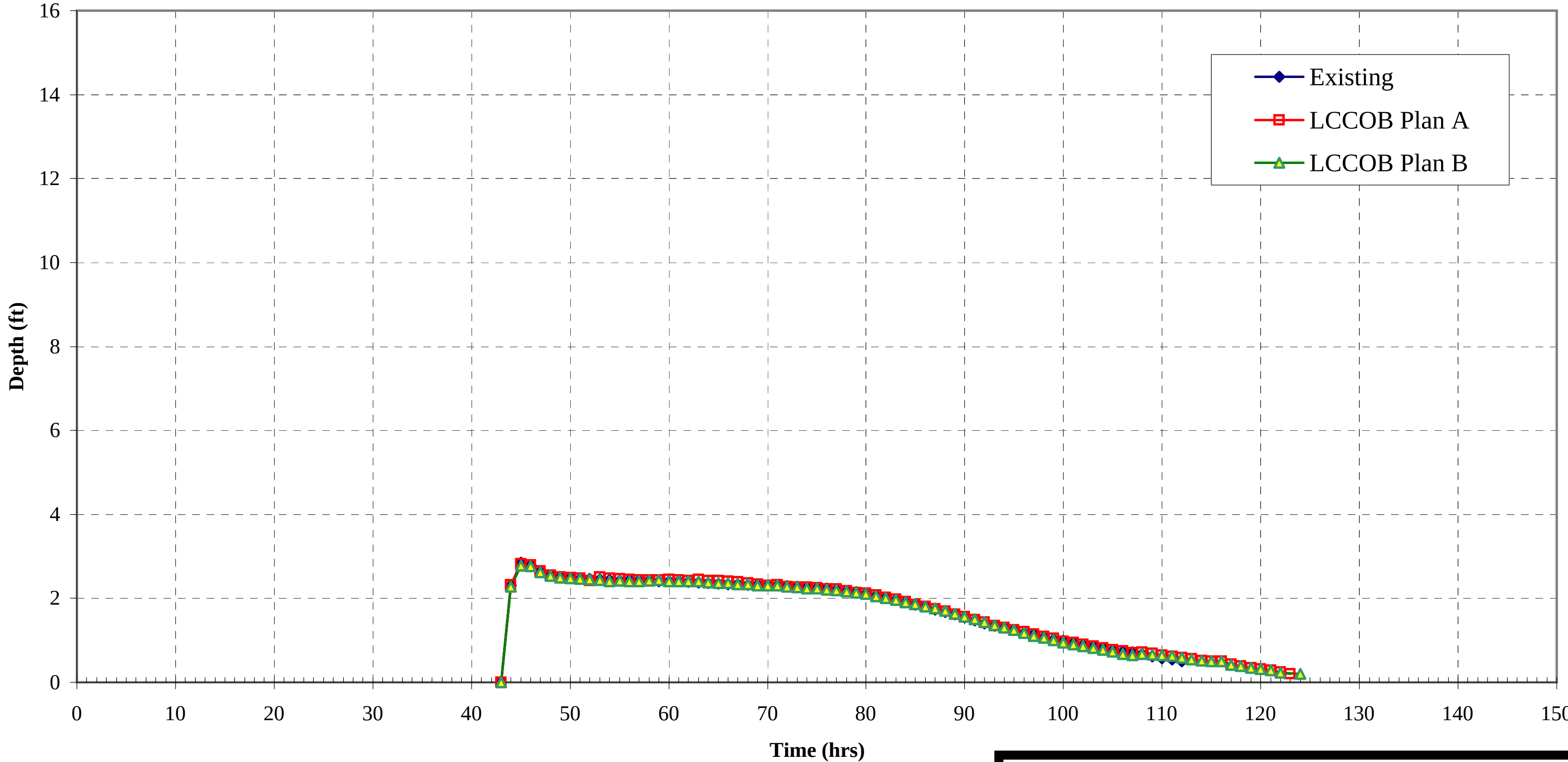


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

RATING CURVE FROM UNET RESULTS
INDEX POINT IN SETTLING BASIN
(ULTIMATE WEIR 41.0')

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2002

Lower Cache Creek
Overbank Flood Depth-Duration - 70 kcfs (200 year)
Flo-2d Node 1143

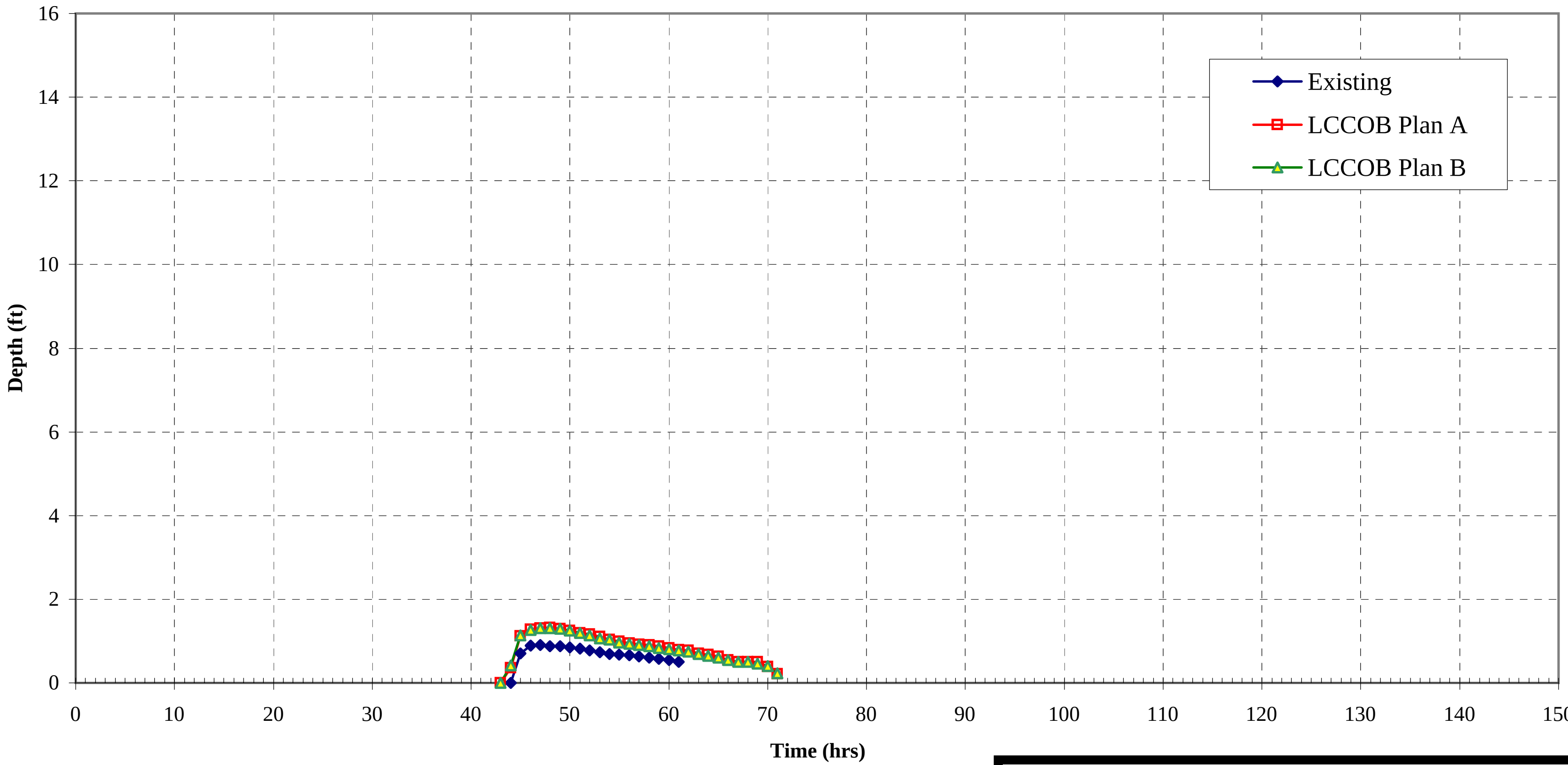


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK
OVERBANK FLOOD DEPTH-DURATION - 70 KCFS (200-YEAR)
FLO-2D NODE 1143

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001

Lower Cache Creek
Overbank Flood Depth-Duration - 70 kcfs (200 year)
Flo-2d Node 840

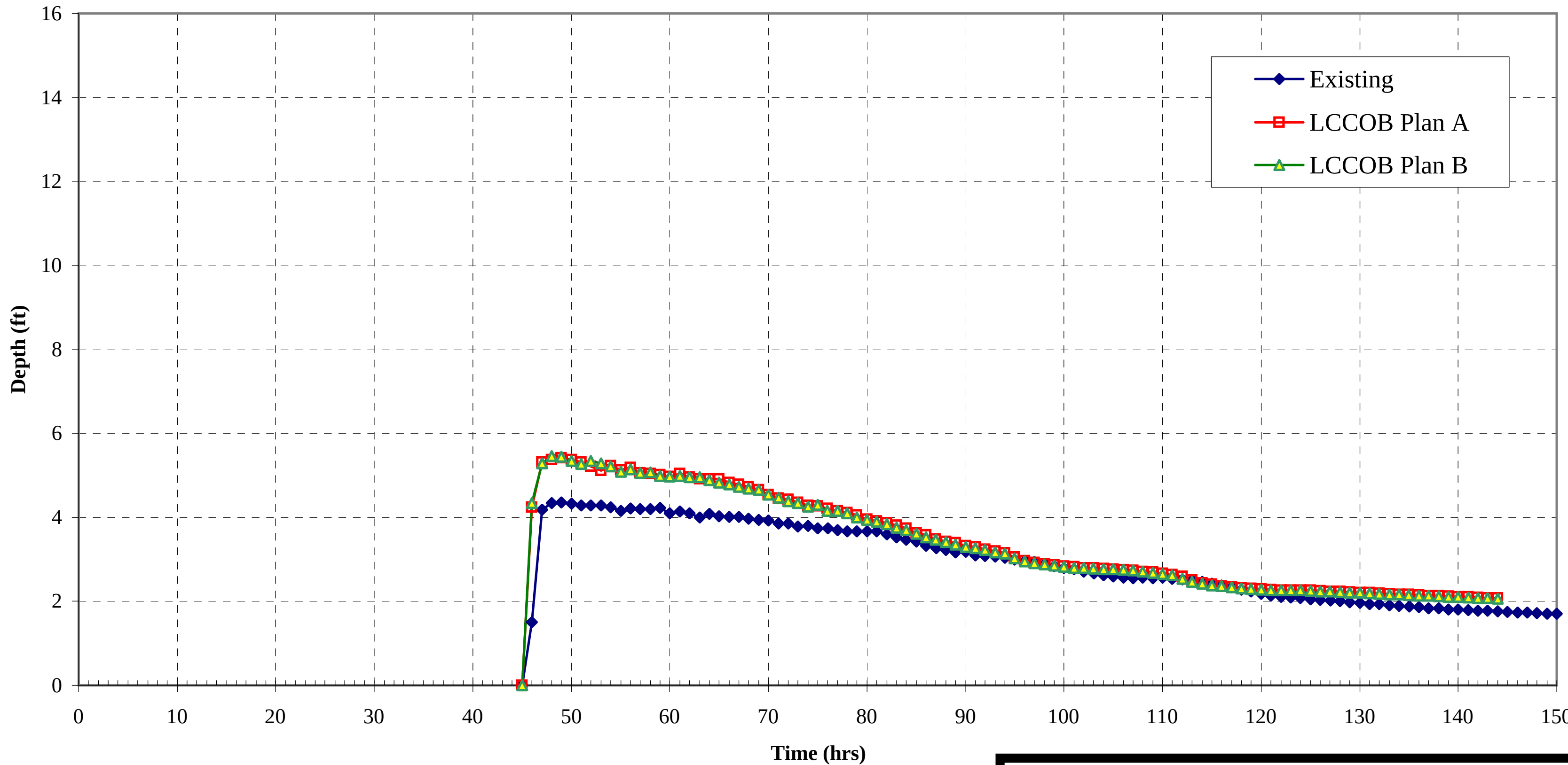


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK
OVERBANK FLOOD DEPTH-DURATION - 70 KCFS (200-YEAR)
FLO-2D NODE 840

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001

Lower Cache Creek
Overbank Flood Depth-Duration - 70kcfs (200 year)
Flo-2d Node 848

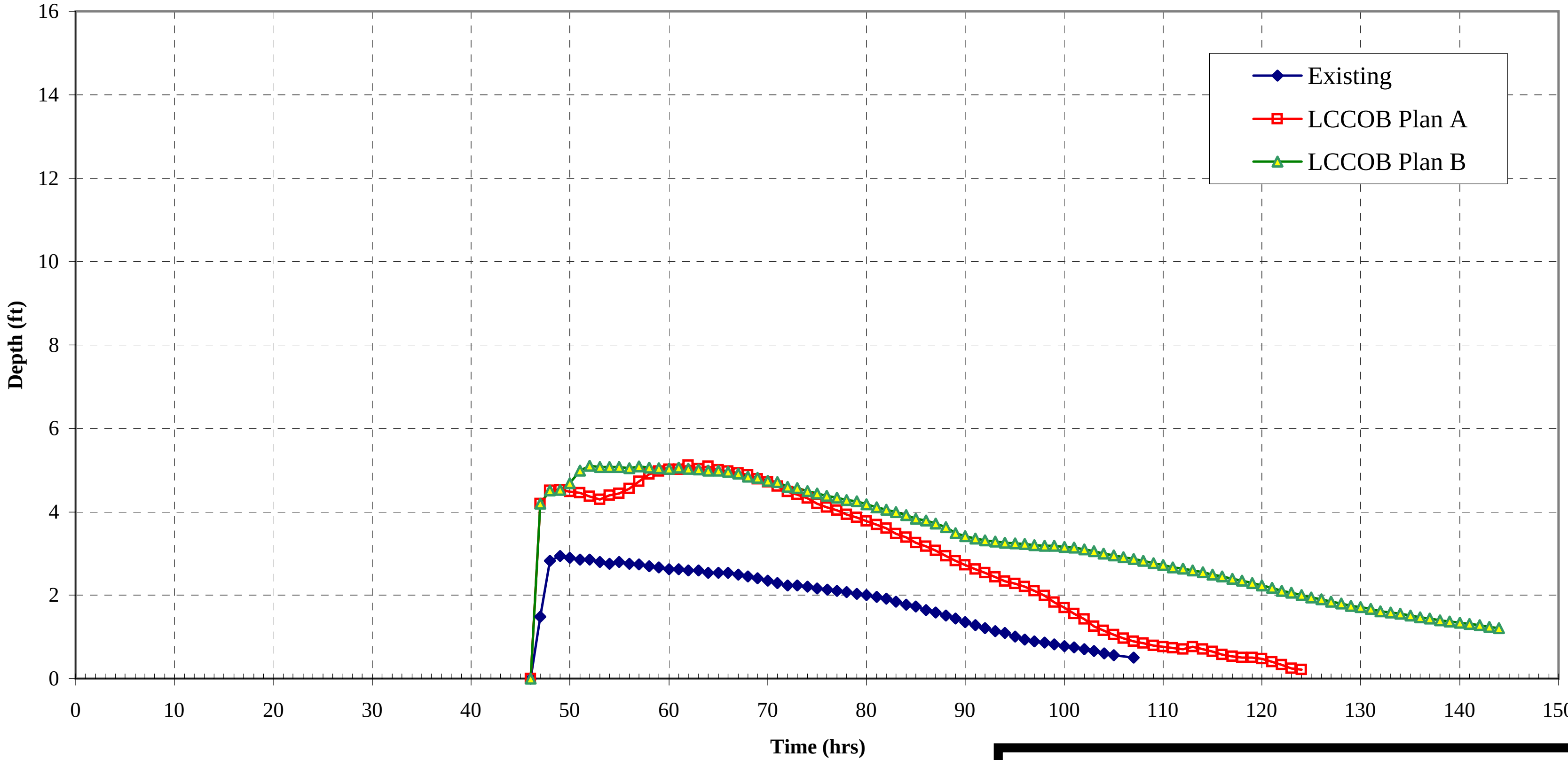


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK
OVERBANK FLOOD DEPTH-DURATION - 70 KCFS (200-YEAR)
FLO-2D NODE 848

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001

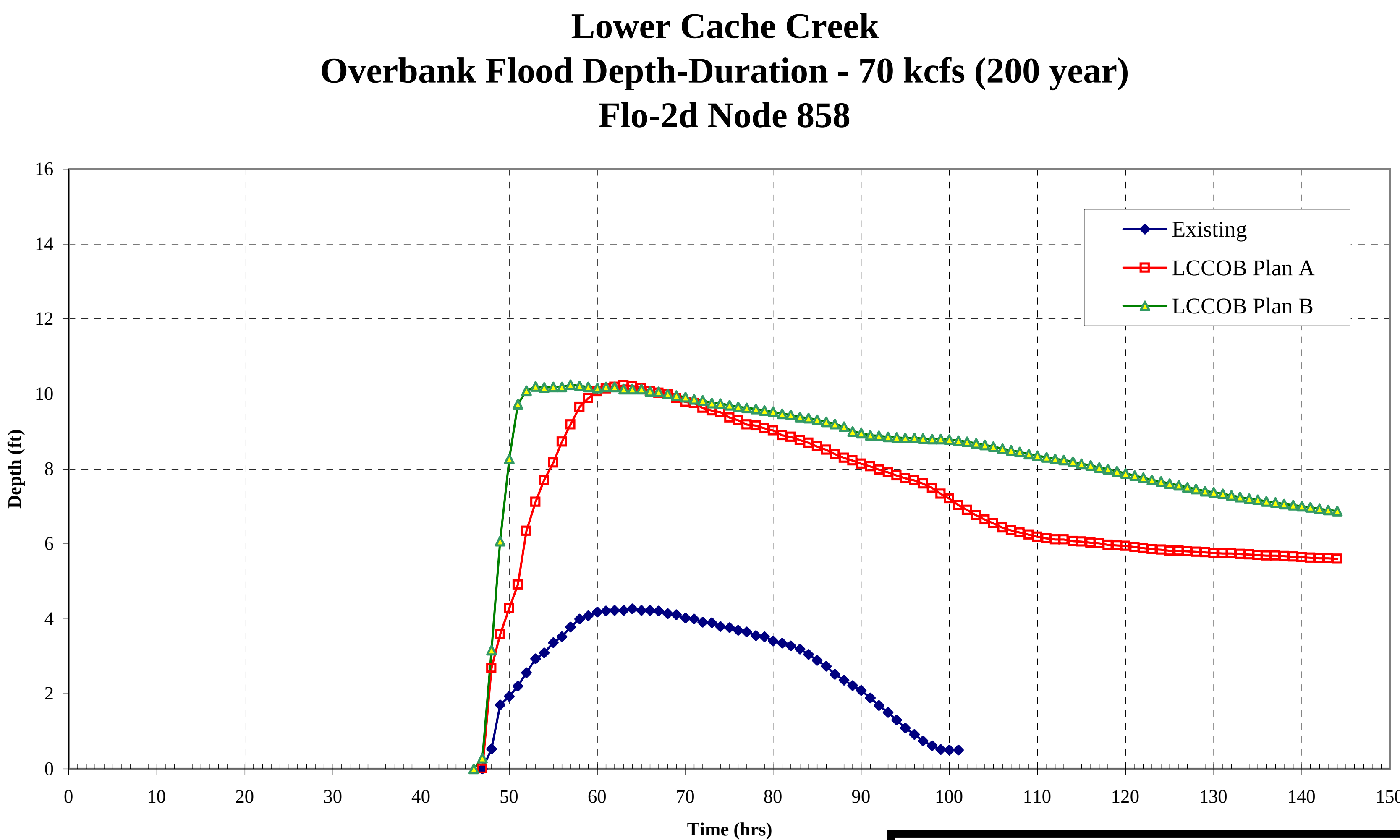
Lower Cache Creek
Overbank Flood Depth-Duration - 70 kcfs (200 year)
Flo-2d Node 853



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK
OVERBANK FLOOD DEPTH-DURATION - 70 KCFS (200-YEAR)
FLO-2D NODE 853

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001

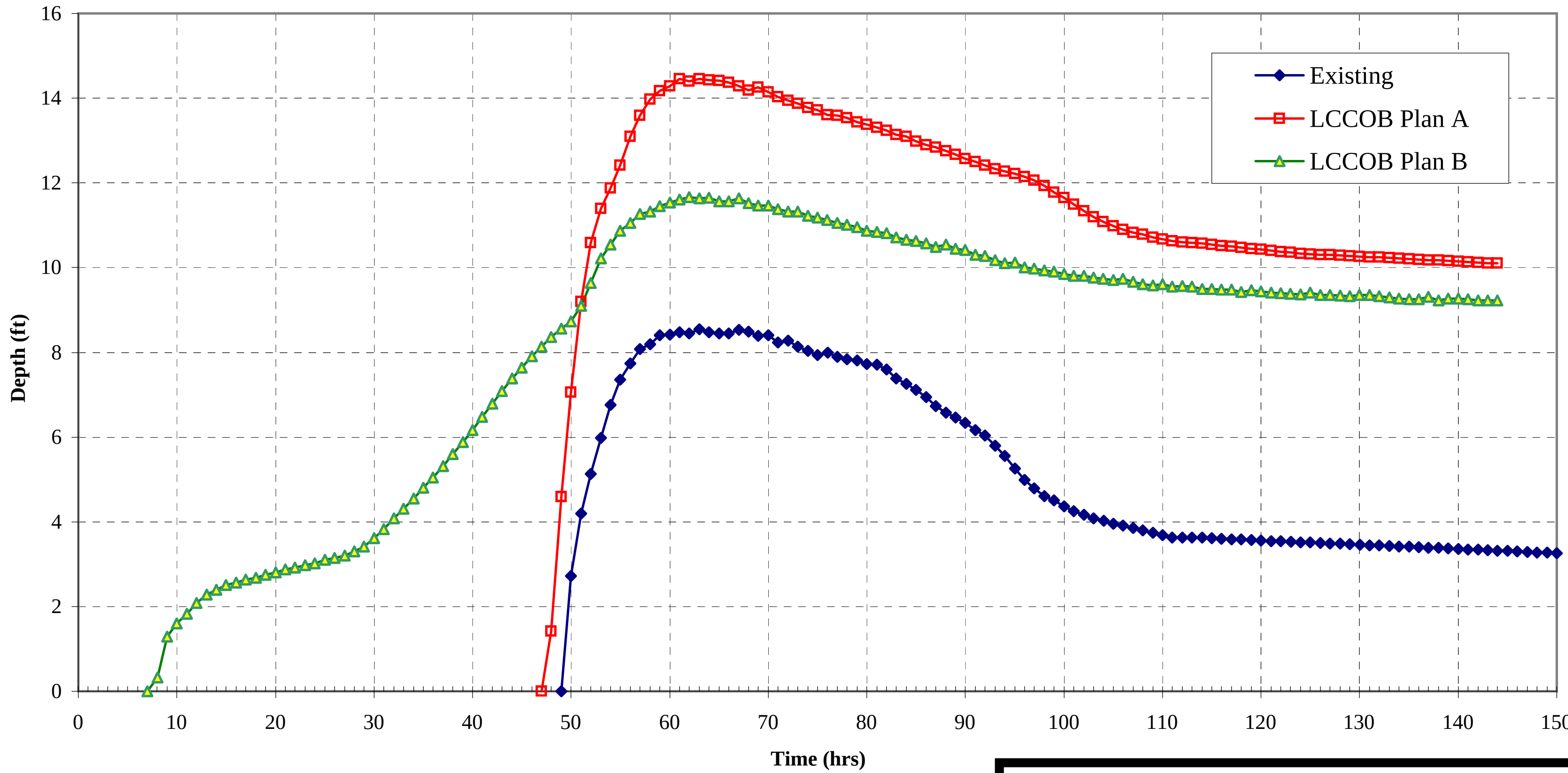


LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK
OVERBANK FLOOD DEPTH-DURATION - 70 KCFS (200-YEAR)
FLO-2D NODE 858

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001

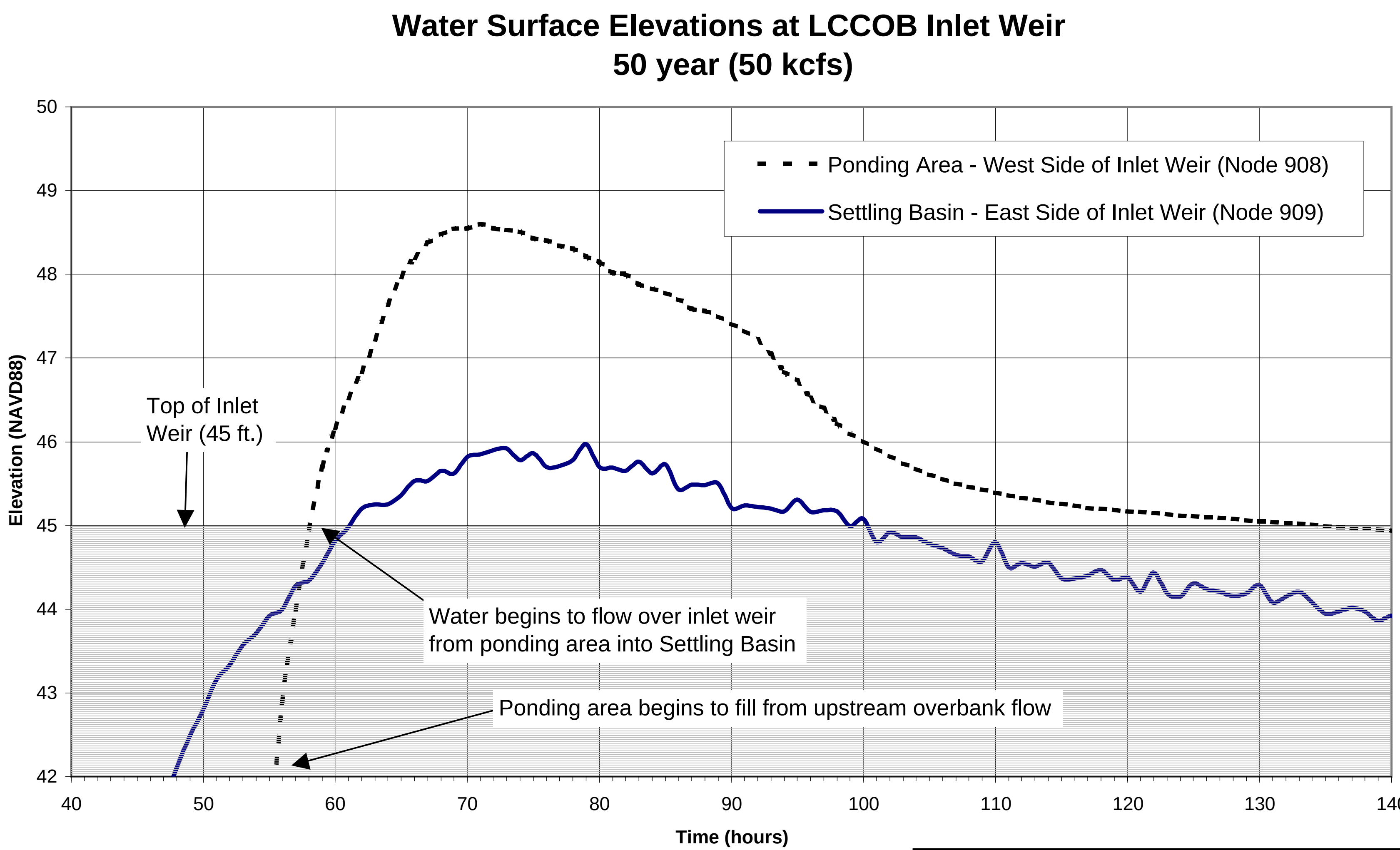
Lower Cache Creek
Overbank Flood Depth-Duration - 70 kcfs (200 year)
Flo-2d Node 862



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

LOWER CACHE CREEK
OVERBANK FLOOD DEPTH-DURATION - 70 KCFS (200-YEAR)
FLO-2D NODE 862

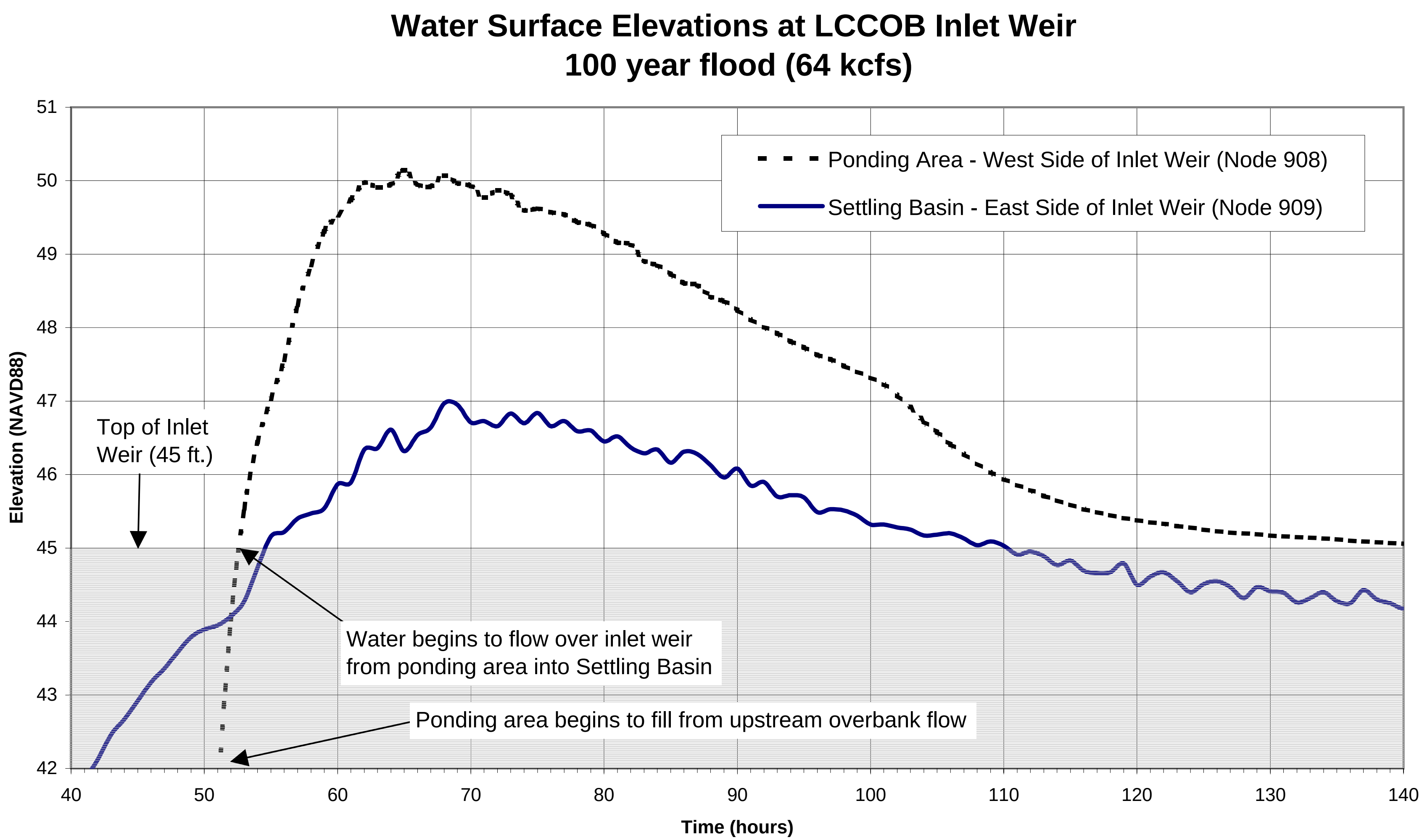
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
AUGUST 2001



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

WATER SURFACE ELEVATIONS AT LCCOB INLET WEIR
50 YEAR FLOOD (50 KCFS)

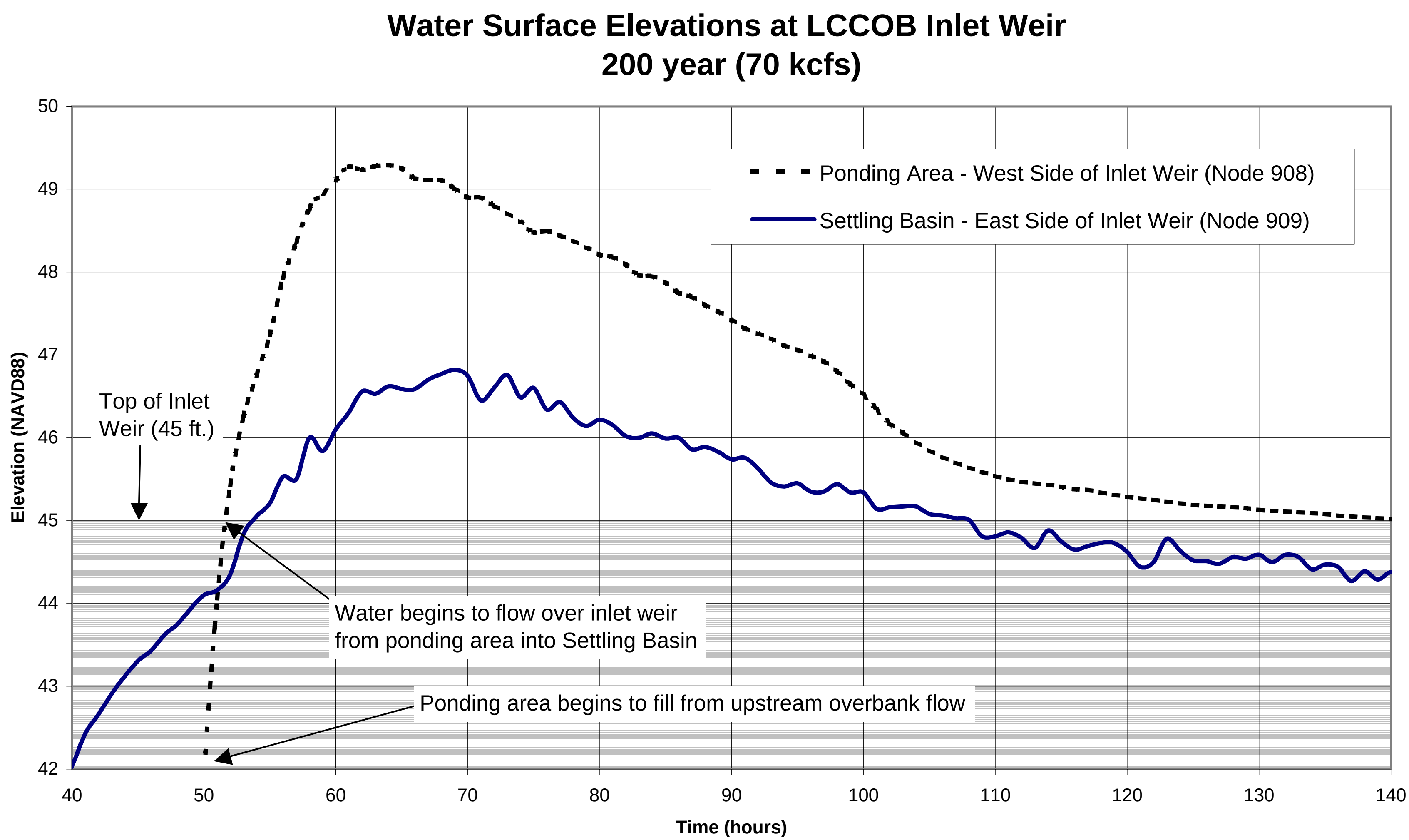
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

WATER SURFACE ELEVATIONS AT LCCOB INLET WEIR
100 YEAR FLOOD (64 KCFS)

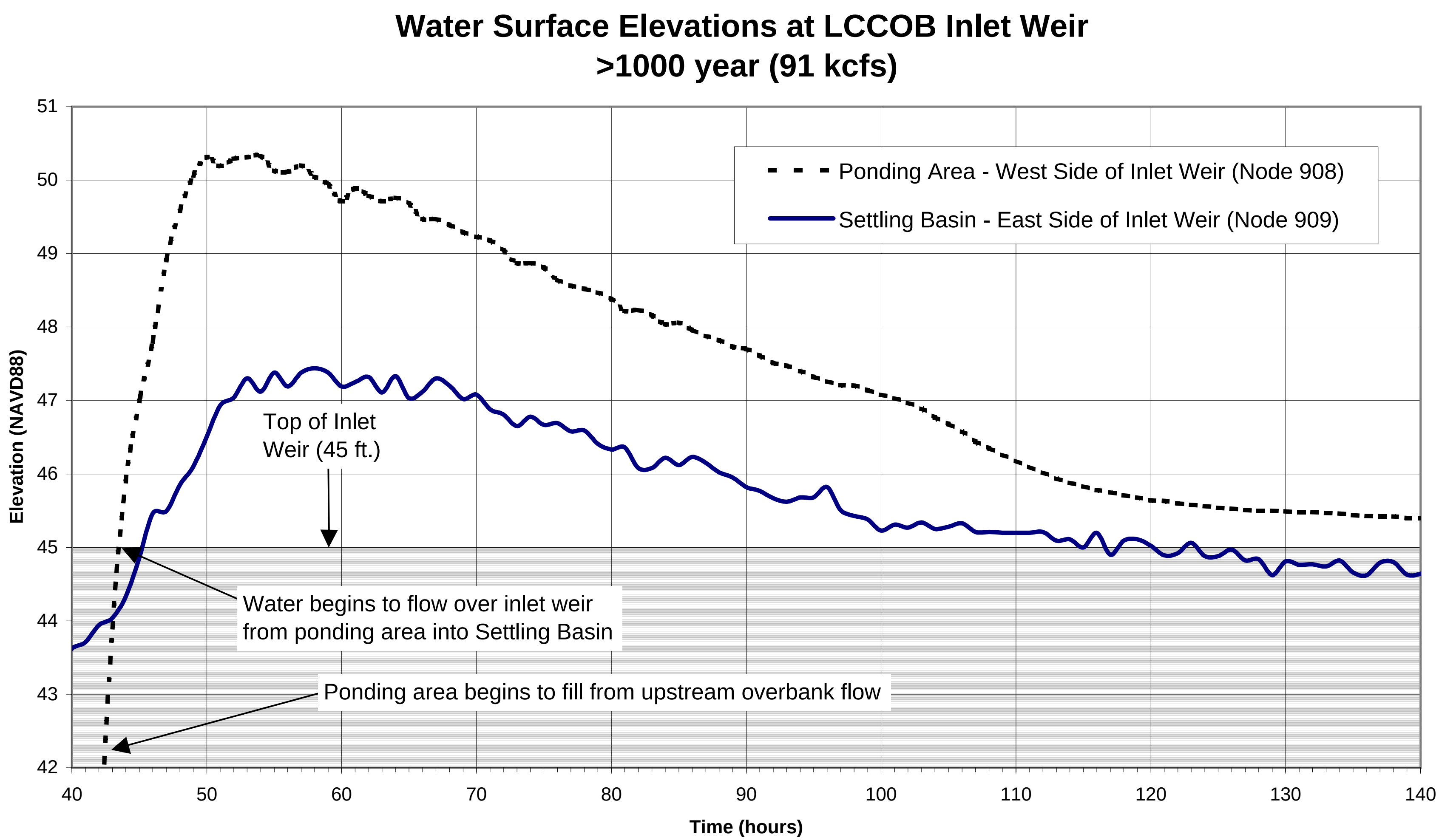
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

WATER SURFACE ELEVATIONS AT LCCOB INLET WEIR
200 YEAR FLOOD (70 KCFS)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2002



LOWER CACHE CREEK, WOODLAND, CALIFORNIA
AREA FEASIBILITY STUDY

WATER SURFACE ELEVATIONS AT LCCOB INLET WEIR
>1000 YEAR FLOOD (91 KCFS)

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2002

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix E

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX E

Environmental Site Assessment

ENVIRONMENTAL SITE ASSESSMENT
LOWER CACHE CREEK
YOLO COUNTY, WOODLAND AREA

Prepared By:

U.S. Army Corps
of Engineers
Environmental Design Section

May 2000

ENVIRONMENTAL SITE ASSESSMENT
LOWER CACHE CREEK
YOLO COUNTY, WOODLAND AREA

1.0 SUMMARY

This Environmental Site Assessment (ESA) did not confirm any known contamination due to Hazardous, Toxic, or Radioactive Waste (HTRW) on the site during records research, phone interviews, and field survey. Data research of government records showed several sources of potential contamination within a one mile radius of the project site by regulatory agencies, but it is not anticapated that any of these sources will affect this project. All of the potential sources have been or are currently under investigation by other agencies.

However, there is one item of potential concern, not in the data base, that should be addressed prior to proceeding with construction. The item of concern involves chemical mixing along the alignment of the levee (Item No. 1). No field or records evidence was found to indicate that this potential source has caused any contamination, but the physical presence of this source indicates further investigation is warranted. Confirmation sampling can be performed at the option of the Project Manager. Also, this does not rule out the possible presence of contamination from pesticides and herbicides used during normal agricultural operations over the years.

Item No. 1: Chemical mixing area

2.0 INTRODUCTION

2.1 Scope of Report

The purpose of this ESA is to identify recognized environmental conditions, including the presence or likely presence of any hazardous substances or petroleum products under conditions that indicate an existing release, a past release, or the material threat of a release into structures, the ground, ground water or surface waters of the property. This report addresses HTRW within the study area which may affect this project. This report was prepared in accordance with ASTM E-1527-94, Standard Practice for Environmental Site Assessment: Phase I Environmental Site Assessment Process; ER 1165-2-132; Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects; and EC 1105-2-206, Project Modifications for Improvement of the Environment. A literature search, interviews, and an on-site investigation were conducted in order to compile information for this ESA. This assessment did not include sampling or analysis of soil or groundwater.

3.0 SITE DESCRIPTION

3.1 Location

For the purpose of this ESA, Cache Creek, the levees, and the settling basin plus a 100-foot construction zone on the land side of the project, will be referred to as "the site". A one mile corridor on the land side of the site, in accordance to ASTM-E 1527-94, shall be referred to as "the study area". This project encompasses approximately 12 river miles with levees on both sides of the creek. The section of Cache Creek investigated for this ESA starts above the town of Yolo at County Road 94B and ends at the Cache Creek settling basin near the Yolo Bypass.

3.2 Site and Vicinity Characteristics

The study area, located in Yolo County, is primarily rural and sparsely populated, except for the town of Yolo. Generally, the study area consist of flat agriculture, pasture, and undeveloped land. The creek serves as a source of water for domestic use, farming, cattle grazing, gravel mining, and other industrial uses, and recreation. Approximately 3 miles of this study area, from County Road 94B to the town of Yolo, has been the site of gravel mining since the late 1800's. Approximately 90% of the top of the levees are accessible by vehicle but are limited to public access by locked gates.

3.3 Descriptions of Improvements on the Site

No improvements have been made to the site in recent years.

3.4 Current and Former Uses of Property

The site has been and is currently being used mostly for flood control purposes.

3.5 Current and Former Uses of Adjoining Property

The adjacent properties surrounding the site are either used for agricultural, commercial and residential purposes. There are numerous structures in the study area including single family residences and businesses in the town of Yolo, and farm buildings throughout the rest of the site.

4.0 RECORDS REVIEW

The following sources were used in researching the occurrence of HTRW within the study area. The following information was acquired during a records search and phone interviews.

Data Base Review

On March 17, 2000 Environmental Data Resources, Inc. (EDR) conducted a search consisting of 38 publicly available databases. Seven different sites showed up on the search within the study area. All seven sites are located on the map in Appendix A. Three of the sites were listed as having accidental releases or spills (1,2, & 6), that have since been cleaned up. Two of the sites were listed because they are on the mines list (4 & 5). The last two sites (7 & 3) have active underground storage tanks (UST's), and leaking UST's that have already been removed and the soil cleaned up. None of the sites possess environmental hazards which would interfere with any construction. All seven sites were investigated and are considered closed cases. See Appendix A for site map with database results and explanation of data results.

California Department of Toxic Substances Control (DTSC) (916-323-3399)

Ben McIntosh was contacted and asked if he had any information on releases or potential releases of hazardous substances in the study area. Mr. McIntosh stated that his CalSites database, which primarily deals with residential and commercial areas, is not malleable enough to extract much information from a sparsely populated area.

State Water Resources Control Board (SWRCB) (916-227-4416)

Steve Mizera of the Division of Clean Water Programs, Tanks Unit, faxed a current

SWRCB list of leaking underground storage tanks (LUSTs) in the study area. The UST information within the SWRCB list was a duplicate of the LUST sites that were reported in the EDR database search, which shows no UST's in the site.

Yolo County Agriculture Department (916-666-8140)

Mr. Ray Perkins maintains records and keeps tract of pesticide use for the County. Mr. Perkins stated he had no concerns in the study area of anything other than registered pesticide use. He said that to his knowledge there are no operations where mixing and loading take place within the study area.

Yolo County Department of Environmental Health Services (916-666-8646)

Bruce Sarazin is a supervising hazardous materials specialist who is responsible for maintaining a data base of hazardous waste, emergency response, and leaking underground storage tanks for the county. Mr. Sarazin's records show no incidents that have occurred within the study area.

5.0 SITE RECONNAISSANCE AND INTERVIEWS

On 27 & 28 March 2000, Bruce Van Etten from the Environmental Design Section (EDS) of the United States Army Corps of Engineers-Sacramento District (USACE) visited the study area. The objective of the site visit is to identify recognizable environmental concerns in connection with the property. Common environmental concerns that were looked for include the following: asbestos; construction and demolition debris; drums; landfill or solid waste disposal sites; pits, ponds or lagoons; wastewater; fill dirt, depressions, mounds, or any artificial structures; PCB containing transformers; and the presence or likely presence of any hazardous substance or petroleum products on the property under conditions that indicate an existing release, a past release, or a material threat of a release on the property or into the ground, groundwater, or surface water of the property.

5.1 Hazardous Substances Associated with Property Use

No hazardous substances were seen during the site visit.

5.2 Hazardous Substances Associated with Storage Containers

No storage containers were encountered during the site visit.

5.3 Storage Tanks

No Underground Storage Tanks (UST's) or Aboveground Storage Tanks (AST) were located within the site. Several UST's and AST's were located within the study area but outside of the site. They appear to be in good condition, no signs of leakage, and no threat to project operations.

5.4 Indications of PCBs

Transformers observed during the site visit appear to have been recently replaced. No field or records evidence was found to indicate that any contamination due to transformers was present.

5.5 Indications of Solid Waste

No solid waste sites showed up from the data base or the site visit within the site.

6.0 FINDINGS AND CONCLUSIONS

Based on information gathered during the site visit, data base search, and interviews conducted, there is no apparent HTRW contamination that will impact activities within the project site.

However the following factors should be considered before proceeding with the Project.

- Possible pesticide residuals in the soil due to normal pesticide application.
- The pesticide mixing trailers, located at LM 0.75.

Appendix A

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR).

TARGET PROPERTY ADDRESS

LOWER CACHE CREEK
WOODLAND, CA 95776

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

SURROUNDING SITES: DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records within the requested search area for the following Databases:

FEDERAL ASTM STANDARD

NPL:........................ National Priority List
Delisted NPL:............... NPL Deletions
CERCLIS:.................... Comprehensive Environmental Response, Compensation, and Liability Information System
CERC-NFRAP:................. Comprehensive Environmental Response, Compensation, and Liability Information System
CORRACTS:................... Corrective Action Report
RCRIS-TSD:.................. Resource Conservation and Recovery Information System
RCRIS-LQG:.................. Resource Conservation and Recovery Information System
ERNS:....................... Emergency Response Notification System

STATE ASTM STANDARD

AWP:........................ AWP
Notify 65:.................. Notify 65
Toxic Pits:................. Toxic Pits
SWF/LF:..................... State Landfill
WMUDS:...................... WMUDS/SWAT
Ca. BEP:.................... CA Bond Exp. Plan
Ca. FID:.................... CA FID

FEDERAL ASTM SUPPLEMENTAL

CONSENT:.................... Superfund (CERCLA) Consent Decrees
ROD:........................ ROD
HMIRS:...................... Hazardous Materials Information Reporting System
MLTS:....................... Material Licensing Tracking System
NPL Lien:................... NPL Liens
PADS:....................... PCB Activity Database System
RAATS:...................... RCRA Administrative Action Tracking System
TRIS:....................... Toxic Chemical Release Inventory System
TSCA:....................... Toxic Substances Control Act

STATE OR LOCAL ASTM SUPPLEMENTAL

AST:........................ Aboveground Petroleum Storage Tank Facilities

Ca. WDS: CA WDS
CA SLIC: CA SLIC regions.
SMS R_2: South Bay Site Management System

EDR PROPRIETARY DATABASES

Coal Gas: Former Manufactured gas (Coal Gas) Sites.

SURROUNDING SITES: DATABASES WITH MAPPED SITES

Unmapped (orphan) sites are not considered in the foregoing analysis.

Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

FEDERAL ASTM STANDARD

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-SQG list, as provided by EDR, and dated 09/01/1999 has revealed that there is 1 RCRIS-SQG site within the searched area.

Site	Address	Map ID	Page
R C COLLET	***2290 E MAIN ST***	*7*	*6*

STATE ASTM STANDARD

CAL-SITES: Formerly known as ASPIS, this database contains both known and potential hazardous substance sites. The source is the California Department of Toxic Substance Control.

A review of the Cal-Sites list, as provided by EDR, has revealed that there is 1 Cal-Sites site within the searched area.

Site	Address	Map ID	Page
AGRIFORM FARM SUPPLY, INC	40189 COUNTY ROAD 18C	3	3

CHMIRS: The California Hazardous Material Incident Report System contains information on reported hazardous material incidents, i.e., accidental releases or spills. The source is the California Office of Emergency Services.

A review of the CHMIRS list, as provided by EDR, and dated 12/31/1994 has revealed that there are 4 CHMIRS sites within the searched area.

Site	Address	Map ID	Page
Not reported	CR 17 / CR 103	1	3

EXECUTIVE SUMMARY

Site	Address	Map ID	Page
Not reported	.5 MILE S/O CR 17, .25	1	3
Not reported	COUNTY RD 102 / 18B	2	3
Not reported	YOLO FLYERS CLUB	6	6

CORTESE: This database identifies public drinking water wells with detectable levels of contamination, hazardous substance sites selected for remedial action, sites with known toxic material identified through the abandoned site assessment program, sites with USTs having a reportable release and all solid waste disposal facilities from which there is known migration. The source is the California Environmental Protection Agency/Office of Emergency Information.

A review of the Cortese list, as provided by EDR, has revealed that there is 1 Cortese site within the searched area.

Site	Address	Map ID	Page
R C COLLET	*2290 E MAIN ST*	*7*	*6*

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the State Water Resources Control Board Leaking Underground Storage Tank Information System.

A review of the LUST list, as provided by EDR, and dated 01/03/2000 has revealed that there is 1 LUST site within the searched area.

Site	Address	Map ID	Page
R C COLLET	*2290 E MAIN ST*	*7*	*6*

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the State Water Resources Control Board's Hazardous Substance Storage Container Database.

A review of the UST list, as provided by EDR, and dated 10/15/1990 has revealed that there is 1 UST site within the searched area.

Site	Address	Map ID	Page
R C COLLET	*2290 E MAIN ST*	*7*	*6*

FEDERAL ASTM SUPPLEMENTAL

FINDS: The Facility Index System contains both facility information and "pointers" to other sources of information that contain more detail. These include: RCRIS; Permit Compliance System (PCS); Aerometric Information Retrieval System (AIRS); FATES (FIFRA [Federal Insecticide Fungicide Rodenticide Act] and TSCA Enforcement System, FTTS [FIFRA/TSCA Tracking System]; CERCLIS; DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes); Federal Underground Injection Control (FURS); Federal Reporting Data System (FRDS); Surface Impoundments (SIA); TSCA Chemicals in Commerce Information System (CICS); PADS; RCRA-J (medical waste transporters/disposers); TRIS; and TSCA. The source of this database is the U.S. EPA/NTIS.

A review of the FINDS list, as provided by EDR, and dated 10/13/1999 has revealed that there is 1

FINDS site within the searched area.

Site	Address	Map ID	Page
R C COLLET	***2290 E MAIN ST***	*7*	*6*

Mines: Mines Master Index File. The source of this database is the Dept. of Labor, Mine Safety and Health Administration.

A review of the MINES list, as provided by EDR, and dated 08/01/1998 has revealed that there are 2 MINES sites within the searched area.

Site	Address	Map ID	Page
SCHWARZGRUBER & SONS, INC		4	5
TEICHERT AGGREGATES		5	5

STATE OR LOCAL ASTM SUPPLEMENTAL

HAZNET: The data is extracted from the copies of hazardous waste manifests received each year by the DTSC. The annual volume of manifests is typically 700,000-1,000,000 annually, representing approximately 350,000-500,000 shipments. Data from non-California manifests & continuation sheets are not included at the present time. Data are from the manifests submitted without correction, and therefore many contain some invalid values for data elements such as generator ID, TSD ID, waste category, & disposal method. The source is the Department of Toxic Substance Control is the agency

A review of the HAZNET list, as provided by EDR, has revealed that there is 1 HAZNET site within the searched area.

Site	Address	Map ID	Page
R C COLLET	***2290 E MAIN ST***	*7*	*6*

EXECUTIVE SUMMARY

Please refer to the end of the findings report for unmapped orphan sites due to poor or inadequate address information.

MAP FINDINGS SUMMARY

	Database	Total Plotted
FEDERAL ASTM STANDARD		
	NPL	0
	Delisted NPL	0
	CERCLIS	0
	CERC-NFRAP	0
	CORRACTS	0
	RCRIS-TSD	0
	RCRIS Lg. Quan. Gen.	0
	RCRIS Sm. Quan. Gen.	1
	ERNS	0
STATE ASTM STANDARD		
	AWP	0
	Cal-Sites	1
	CHMIRS	4
	Cortese	1
	Notify 65	0
	Toxic Pits	0
	State Landfill	0
	WMUDS/SWAT	0
	LUST	1
	UST	1
	CA Bond Exp. Plan	0
	CA FID	0
FEDERAL ASTM SUPPLEMENTAL		
	CONSENT	0
	ROD	0
	FINDS	1
	HMIRS	0
	MLTS	0
	MINES	2
	NPL Liens	0
	PADS	0
	RAATS	0
	TRIS	0
	TSCA	0
STATE OR LOCAL ASTM SUPPLEMENTAL		
	AST	0
	CA WDS	0
	CA SLIC	0
	HAZNET	1
	SMS R_2	0

Database	Total Plotted
EDR PROPRIETARY DATABASES	
Coal Gas	0
AQUIFLOW - see EDR GeoCheck Summary	

* Sites may be listed in more than one database

Map ID Direction Distance Distance (ft.)	Site	Database(s)	EDR ID Number EPA ID Number

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

---

1 | **CR 17 / CR 103**
WOODLAND, CA 95695 | **CHMIRS** | **S100278317**
N/A

CHMIRS:

OES Control Number:	9119740	DOT ID:	1268
DOT Hazard Class:	Not Reported		
Chemical Name:	PETROLEUM WASTE		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	0
Environmental Contamination:	Other	Property Use:	Agricultural
Incident Date:	15-OCT-91	Date Completed:	22-OCT-91

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1 | **.5 MILE S/O CR 17, .25 MILE OF CR 103**
WOODLAND, CA | **CHMIRS** | **S100279124**
N/A

CHMIRS:

OES Control Number:	8803960	DOT ID:	1993
DOT Hazard Class:	Flammable liquid		
Chemical Name:	DIESEL FUEL		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	14637
Environmental Contamination:	Ground	Property Use:	Agricultural
Incident Date:	05-NOV-88	Date Completed:	05-NOV-88

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2 | **COUNTY RD 102 / 18B**
WOODLAND, CA 95695 | **CHMIRS** | **S100219323**
N/A

CHMIRS:

OES Control Number:	9000646	DOT ID:	Not reported
DOT Hazard Class:	Not Reported		
Chemical Name:	SEEPAGE FROM A CHEMICAL TOILET		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	150
Environmental Contamination:	Ground	Property Use:	County/City Road
Incident Date:	14-MAR-90	Date Completed:	14-MAR-90

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3 | **AGRIFORM FARM SUPPLY, INC**
40189 COUNTY ROAD 18C
WOODLAND, CA 95695 | **Cal-Sites** | **S100714883**
N/A

AGRIFORM FARM SUPPLY, INC (Continued) **S100714883**

CAL-SITES:

Facility ID	57280008
Status:	REFRW - DOES NOT REQUIRE DTSC ACTION. REFERRED TO REGIONAL WATER QUALITY CONTROLBOARD (RWQCB) LEAD
Status Date:	12/28/1995
Lead:	Not reported
Region:	1 - SACRAMENTO
Branch:	CC - CENTRAL CALIFORNIA
File Name:	Not reported
Status Name:	PROPERTY/SITE REFERRED TO RWQCB
Lead Agancy:	N/A
NPL:	Not reported
SIC:	28 MANU - CHEMICALS & ALLIED PRODUCTS
Facility Type:	N/A
Facility Type Name:	Not reported
Staff Member Responsible for Site:	Not reported
Supervisor Responsible for Site:	Not reported
Region Water Control Board:	Not reported
Access:	Not reported
Cortese:	Not reported
Hazardous Ranking Score:	Not reported
Date Site Hazard Ranked:	Not reported
Groundwater Contamination:	Not reported
No. of Contamintion Sources:	0.00000
Lat/Long:	0.00000° 0.00000′ 0.00000″ / 0.00000° 0.00000′ 0.00000″
Lat/long Method:	Not reported
State Assembly District Code:	Not reported
State Senate District:	Not reported

Activity:

Activity:	SS
Activity Name:	Not reported
AWP Code:	Not reported
Proposed Budget:	0.00000
AWP Completion Date:	Not reported
Revised Due Date:	Not reported
Comments Date:	12/28/1995
Est Person-Years to complete:	0.00000
Estimated Size:	Not reported
Request to Delete Activity:	Not reported
Activity Status:	REFRW
Definition of Status:	PROPERTY/SITE REFERRED TO RWQCB
Solids Removed (Cubic Yards):	0.00000
Solids Treated (Cubic Yards):	0.00000
Liquids Removed (Gals):	0.00000
Liquids Treated (Gals):	0.00000
Action Included Capping:	Not reported
Well Decommissioned:	Not reported
Action Included Fencing:	Not reported
Removal Action Certification:	Not reported
Qnty Removed/Treated Comments:	Not reported
Acres Available Upon Completion Of Activity	
For Commercial Reuse:	0.00000
For Industrial Reuse:	0.00000
For Residential Reuse:	0.00000
Unknown Type:	0.00000

All Site Names Associated with Site: AGRIFORM FARM SUPPLY, INC

AGRIFORM FARM SUPPLY, INC (Continued) S100714883

CHEVRON/AGRIFORM FARM SUPPLY/ACID SPILL

All Street Addresses: 40189 COUNTY ROAD 18C
WOODLAND, CA 95695

Background: Not reported
Id Name: Not reported
Id Value: Not reported

Special Programs:
Program Name: Not reported
Program Code: Not reported
Comments:
Date: 02/15/1980
Comment: QUESTIONNAIRE SENT: WADE'S

Date: 03/25/1980
Comment: QUESTIONNAIRE RECEIVED: WADE'S
WASTES DISPOSED AT RD. 18-C (OFF-SITE)

Date: 10/20/1980
Comment: INSPECTION(LOCAL) INSPECTION & SAMPLING BY CO. AG. DEPT.

Date: 03/26/1982
Comment: FACILITY DRIVE-BY DRIVE BY

Date: 12/28/1995
Comment: Site Screening completed. Test results from samples taken from rinsewater pond revealed Di-Syston at up to 2491.8 ppm, O,P'-DDE at up to 35 ppm, P,P'-DDE at up to 46.5 ppm, and Toxaphene at up to 2281.5 ppm of contamination in the dried pond bed. A cleanup agreement was made between the Regional Water Quality Control Board (RWQCB) and Agriform. On 11/5/95 the RWQCB certified that the rinsewater pond contamination levels were below standards set by the RWQCB. Refer site to RWQCB for ongoing oversight.

---

4 **SCHWARZGRUBER & SONS, INC** **MINES** **M000009379**
N/A

YOLO (County), CA

U.S. MINES:

Mine ID:	0401941	SIC Codes:	14410 00000 00000 00000 00000 00000
Entity Name:	SCHWARZGRUBER PIT &	Company:	SCHWARZGRUBER & SONS, INC
State FIPS code:	06	County FIPS code:	113
Status Date:	10/17/1991	Status:	Full-time permanent
Operation Class:	Non-coal mining	Number of Shops:	0
Number of Pits:	000	Number of Plants:	0
Latitude:	38 42 06	Longitude:	121 50 26

---

5 **TEICHERT AGGREGATES** **MINES** **M000009411**
N/A

YOLO (County), CA

Map ID Direction Distance Distance (ft.)Site	Database(s)	EDR ID Number EPA ID Number

TEICHERT AGGREGATES (Continued) M000009411

U.S. MINES:

Mine ID:	0401973	SIC Codes:	14410 00000 00000 00000 00000 00000
Entity Name:	WOODLAND PLANT	Company:	TEICHERT AGGREGATES
State FIPS code:	06	County FIPS code:	113
Status Date:	03/17/1988	Status:	Full-time permanent
Operation Class:	Non-coal mining	Number of Shops:	5
Number of Pits:	000	Number of Plants:	0
Latitude:	38 41 42	Longitude:	121 51 05

6 **YOLO FLYERS CLUB**
WOODLAND, CA 95695
CHMIRS S100276182 N/A

CHMIRS:

OES Control Number:	9014173	DOT ID:	1155
DOT Hazard Class:	Flammable liquid		
Chemical Name:	ETHER		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	.25
Environmental Contamination:	Ground	Property Use:	Public Assembly
Incident Date:	29-NOV-90	Date Completed:	29-NOV-90

7 **R C COLLET**
2290 E MAIN ST
WOODLAND, CA 95695
RCRIS-SQG 1000108252
FINDS CAD981669484
HAZNET
LUST
Cortese
UST

RCRIS:

Owner: RC COLLET INC
(415) 555-1212

Contact: ENVIRONMENTAL MANAGER
(916) 446-3157

Record Date: 11/20/1986

Classification: Small Quantity Generator

Used Oil Recyc: No

Violation Status: No violations found

State LUST:

Cross Street:	CO RD 102		
Reg Board:	Central Valley Region	Qty Leaked:	Not reported
Chemical:	Gasoline		
Lead Agency:	Local Agency		
Case Type:	Soil only		
Status:	Not reported		
Abate Method:	Other Means		
Review Date:	Not reported	Confirm Leak:	8/9/1994
Workplan:	Not reported	Prelim Assess:	Not reported
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	Not reported	Release Date:	10/19/1994

R C COLLET (Continued) **1000108252**

LUST Region 5:

Respble Party:	R.C. COLLET, INC.	Substance:	GASOLINE
Case Type:	Soil only		
Program:	Local Implementing Activity - County Run Activity		
Staff Initials:	DFS	Case Number:	570243
Status:	Leak being confirmed		
MTBE:	0		

HAZNET:

Gepaid:	CAD981669484	Tepaid:	CAD009452657
Contact:	R C COLLET INC	Telephone:	(000) 000-0000
Gen County:	Yolo	Tsd County:	San Mateo
Tons:	0.1876		
Category:	Unspecified organic liquid mixture		
Disposal Method:	Recycler		
Mailing Address:	PO BOX 1965 WOODLAND, CA 95776 - 9503		
County	Yolo		

CORTESE:

Reg By:	LTNKA
Reg Id:	570243
Region:	CORTESE

State UST:

Facility ID:	12938		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Constrctn:	1/4 inches
Leak Detection:	Visual		
Contact Name:	DON SIMS	Telephone:	(916) 446-3157
Total Tanks:	8	Region:	Not reported
Facility Type:	2	Other Type:	CONSTRUCTION

Facility ID:	12938		
Tank Num:	2	Container Num:	4
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Constrctn:	1/4 inches
Leak Detection:	Visual		
Contact Name:	DON SIMS	Telephone:	(916) 446-3157
Total Tanks:	8	Region:	Not reported
Facility Type:	2	Other Type:	CONSTRUCTION

Facility ID:	12938		
Tank Num:	3	Container Num:	5
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Constrctn:	1/4 inches
Leak Detection:	Visual		
Contact Name:	DON SIMS	Telephone:	(916) 446-3157
Total Tanks:	8	Region:	Not reported
Facility Type:	2	Other Type:	CONSTRUCTION

R C COLLET (Continued) 1000108252

Facility ID: 12938
Tank Num: 4
Tank Capacity: 1000
Tank Used for: WASTE
Type of Fuel: WASTE OIL
Leak Detection: Visual
Contact Name: DON SIMS
Total Tanks: 8
Facility Type: 2

Container Num: 6
Year Installed: 1974

Tank Constrctn: 1/4 inches

Telephone: (916) 446-3157
Region: Not reported
Other Type: CONSTRUCTION

Facility ID: 12938
Tank Num: 5
Tank Capacity: 5000
Tank Used for: PRODUCT
Type of Fuel: UNLEADED
Leak Detection: Visual
Contact Name: DON SIMS
Total Tanks: 8
Facility Type: 2

Container Num: 7
Year Installed: 1974

Tank Constrctn: 1/4 inches

Telephone: (916) 446-3157
Region: Not reported
Other Type: CONSTRUCTION

Facility ID: 12938
Tank Num: 6
Tank Capacity: 6000
Tank Used for: PRODUCT
Type of Fuel: UNLEADED
Leak Detection: Visual
Contact Name: DON SIMS
Total Tanks: 8
Facility Type: 2

Container Num: 8
Year Installed: 1974

Tank Constrctn: 1/4 inches

Telephone: (916) 446-3157
Region: Not reported
Other Type: CONSTRUCTION

Facility ID: 12938
Tank Num: 7
Tank Capacity: 8000
Tank Used for: PRODUCT
Type of Fuel: REGULAR
Leak Detection: Visual
Contact Name: DON SIMS
Total Tanks: 8
Facility Type: 2

Container Num: 9
Year Installed: 1974

Tank Constrctn: 1/4 inches

Telephone: (916) 446-3157
Region: Not reported
Other Type: CONSTRUCTION

Facility ID: 12938
Tank Num: 8
Tank Capacity: 10000
Tank Used for: PRODUCT
Type of Fuel: REGULAR
Leak Detection: Visual
Contact Name: DON SIMS
Total Tanks: 8
Facility Type: 2

Container Num: 10
Year Installed: 1974

Tank Constrctn: 1/4 inches

Telephone: (916) 446-3157
Region: Not reported
Other Type: CONSTRUCTION

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix F

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX F

Real Estate Plan

REAL ESTATE PLAN

Lower Cache Creek, Yolo County, Woodland Area

1. Introduction. This Real Estate Plan is prepared in accordance with ER 405-1-12, 12-16, Real Estate Plan, and presents the Real Estate requirements for the Lower Cache Creek, Yolo County, Woodland Area Draft Feasibility Report.

The general authority for this investigation is provided by the Flood Control Act of 1962 (Public Law 87-874). In the Energy and Water Development Appropriations Act of 1993 (Public Law 102-377), Congress directed the Corps of Engineers to conduct a "reconnaissance study of flooding problems in the westside tributaries, Putah and Cache Creeks, of Yolo Bypass". The reconnaissance study was initiated in April 1993 at the request of the Yolo County Board of Supervisors. Federal interest in proceeding with a feasibility level investigation of flood reduction along Lower Cache Creek was found to exist.

New draft Flood Insurance Rate Maps issued by FEMA in September 1998 show a significant increase in the areas of Yolo County and the City of Woodland that are subject to 100-year floods.

A feasibility cost share agreement between the Corps and the State of California Reclamation Board, and a local feasibility cost share agreement between the Reclamation Board and the City of Woodland were signed in January 2000.

The study is for the purpose of evaluating alternatives for the reduction of flood damage in the City of Woodland in Yolo County, California, and vicinity. The study began with an analysis and comparison of five alternatives of which three were eliminated and two selected for further study. In actuality four alternatives were analyzed, three of which were different variations of a setback levee. The alternatives studied were: a flood barrier north of the City of Woodland and south of Lower Cache Creek in a primarily agricultural area; a narrow setback levee plan along the Creek; a wider setback levee plan, and a modified wide setback levee plan.

Setback Levee Alternatives Eliminated . Three preliminary setback levee alternative plans were evaluated during the development of the modified wide setback levee plan. The narrow setback levee alternative was an attempt to minimize the effect of the levee on agricultural lands and residences by having most levee construction performed near or immediately adjacent to the creek. This alternative required significant alteration of the stream channel, including the placement of rock within the channel to provide bank protection from high stream-flow velocities. Environmental impacts would require replacement of habitat lost due to work in the channel. Insufficient areas of land are available within or near the project area to meet the extensive environmental mitigation requirements, making this alternative extremely difficult to implement.

The wide setback levee alternative would involve moving the flood protection levees away from the creek to a distance that would reduce stream channel impacts, but it would also involve taking of more agricultural lands and buildings than the narrow setback alternative. The impact of armoring the creek near the bridges, coupled with the number of structures and land that would be affected by the wide setback levees, lead to further refinements and development of the modified wide setback levee alternative.

The narrow and wide setback levee alternatives are included in this real estate plan to demonstrate the effort and analysis involved in the development of an optimal and feasible setback levee alternative.

2. General Description of the Real Estate Requirements.

The entire project is in Yolo County, California. The study area lies east of the Teichert Gravel mining operation in the vicinity of Cache Creek as it flows northeast to I-5 and on to the Cache Creek Settling Basin. The project would impact lands that are in agricultural or rural residential land uses in an unincorporated area of Yolo County located immediately north of the City of Woodland. The majority of the lands located within the study area are zoned A-1, an agricultural zone. A minimum of 20 acres is required for a home site. Many of the parcels have land conservation contracts with the county (Williamson Act) that preserve an agricultural use for a minimum period of ten years.

Estates required for each alternative and ownerships affected are as follows:

Flood barrier.

Flood Protection Levee Easement
Permanent Easement for Occasional Flowage
2 year Temporary Work Area Easement and Permanent Easement for Occasional Flowage (overlapping estates)
2 year Temporary Work Area Easement

ownerships - 28

Narrow setback levee.

Channel Improvement Easement
Flood Protection Levee Easement
Flood Protection Levee Easement and Road Easement (overlapping estates)
Permanent Flowage Easement
Road Easement
2 year Temporary Work Area Easement and Permanent Flowage Easement (overlapping estates)
2 year Temporary Work Area Easement

ownerships - 86

Wide setback levee.

Channel Improvement Easement
Flood Protection Levee Easement
Permanent Flowage Easement
Drainage Easement and Permanent Flowage Easement (overlapping estates)
Borrow Easement and Permanent Flowage Easement (overlapping estates)
Borrow Easement
2 year Temporary Work Area Easement and Permanent Flowage Easement (overlapping estates)

ownerships - 106

Modified wide setback levee.

Channel Improvement Easement
Flood Protection Levee Easement
Permanent Flowage Easement
Borrow Easement
Borrow Easement and Permanent Flowage Easement (overlapping estates)
Drainages Easement and Permanent Flowage Easement (overlapping estates)
2 year Temporary Work Area Easement and Permanent Flowage Easement (overlapping estates)
2 year Temporary Work Area Easement and Flood Protection Levee Easement (overlapping estates)
2 year Temporary Work Area Easement
Fee for mitigation

ownerships - 95

NOTE: Mitigation area(s) would be required for all alternatives. Mitigation for the flood barrier alternative is proposed to be acquired in the form of mitigation land bank credits from Wildlands, Inc. in the Pope Ranch Conservation Bank area in Yolo County. The mitigation lands required for the modified wide setback levee are within the project footprint.

3. Federal Lands.

No federal lands are located within the project boundary. There are no lands subject to the application of navigational servitude.

4. Sponsored Owned Lands.

Overflow barrier: The non-Federal sponsor has existing rights in levees associated with the Cache Creek Settling Basin project which provide sufficient rights for the Lower Cache Creek project. The lands are suitable and available for use for this project. Borrow material from Settling Basin levees immediately east of the overflow barrier would be used for construction of the overflow barrier. These lands, from which borrow material would be taken, have been previously provided as an item of local cooperation in a Federal project.

Setback levees: The non-Federal sponsor holds a real estate interest in approximately 472 acres of land required for all of the setback levee alternatives. The lands are suitable and available for this project. These lands have been previously provided as an item of local cooperation in a Federal project.

5. Attorney's Preliminary Takings Analysis.

The land in the study area between Cache Creek and the City of Woodland is presently in a floodplain and subject to pre-project flooding during the estimated 50-year and 100-year flood events. The land is zoned as agriculture with some scattered residences and out buildings. The agricultural uses are dry land and wet land farming of row crops and in some areas orchards.

The placement of the proposed flood barrier and weir will cause little change to what is the pre-project depth and duration of flooding of the land, except in the far eastern portion of the study area. For the 50 and 100-year flood events, the post-project changes in the flooding on the large majority of the land will be from 2/10s of a foot to 3 feet in additional peak flow, and from 1 to 10 hours increase in duration of flooding. For the majority of the land, the effects generated by the proposed flood barrier are minor and do not amount to any substantial, material, or continual additional interference with the present beneficial use of the land as agricultural, residential, or commercial.

A portion of the lands in the eastern area receives an additional inundation time of up to 4 weeks due to ponding behind the weir. The depth of peak flows on the eastern acres will also increase from 5 to 7 feet. Both of these post-project changes on those acres could materially affect the use of the land by changing the amount or type of crops grown. Subject to verification by additional detailed studies and appraisal analysis, it is likely the post-project affects will create the need for just compensation in the form of the purchase of an occasional flowage easement on the eastern acres that are materially affected by the changes in depth or duration of flooding.

In the event that some actual, unforeseen, or previously unexamined locations receive an increase in flooding that causes a diminution of value or use that is attributable solely to the proposed project, the increase may result in the requirement to pay just compensation for a "taking".

6. Public Law 91-646-Relocations. Public Law 91-646 relocations associated with each alternative are as follows:

Flood barrier
1 residence

Narrow setback levee
10 residences

Wide setback levee
56 residences
2 businesses

Modified wide setback levee
31 residences
1 business

7. Facility/Utility Relocations and Removals.

Information on relocations of facilities and utilities is attached as Exhibit A. An attorney's Opinion of Compensability will be completed for the selected alternative.

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REPORT THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES.

8. Sponsors Ability to Acquire. The non-Federal sponsor is the State of California Reclamation Board with the City of Woodland participating as the local sponsor. The Reclamation Board, through the Department of Water Resources (DWR), has the ability to acquire the necessary rights in real estate for this flood control project. DWR has the power of eminent domain pursuant to Water Code Section 8590, et seq., and Code of Civil Procedures Section 1230.010, et seq. The sponsor has been advised of P.L. 91-646 requirements and the requirements for documenting expenses for credit purposes.

9. Maps. See Exhibit B for real estate maps. All real estate maps depict the approximate areas of estates required for each alternative.

10. Minerals. No analyses of mineral interests associated with the alternatives under study have been conducted.

11. Hazardous, Toxic and Radiological Waste (HTRW).

An Environmental Site Assessment performed by the Corps in May 2000, did not confirm any known contamination due to HTRW. However, there is one area of potential concern along the alignment of the Lower Cache Creek levee at LM 0.75 where a chemical mixing area was observed. No field or records evidence was found to indicate that this potential source has caused any contamination, but the physical presence of this source indicates further investigation is warranted. Also, the possible presence of contamination from pesticides and herbicides used during normal agricultural operations over the years cannot be ruled out. HTRW issues are addressed in Appendix E.

12. Attitude of Landowners and Community.

Flood barrier. Many agricultural landowners north of the proposed flood barrier have a negative view of the alternative. The agricultural land north of the flood barrier would be permanently separated from the City and remain in the flood plain. These owners fear that the barrier would slow the transition of agricultural land to urban development land, thus reducing the value of the properties. Some landowners north of the flood barrier have joined together to threaten litigation should the flood barrier alternative be selected.

The narrow setback levee, in many cases, could cause agricultural lands along the Creek to be severed from the larger portions of owners' parcels. Some landowners along the Creek are not happy with this potential situation. The potential for litigation exists.

Under **the wide setback levee plan**, many rural residences and outbuildings would need to be relocated and agricultural uses would be affected. The potential for litigation exists.

The modified wide setback levee plan has similar characteristics to those of the other two levee plans.

On the March 5, 2002 election, three measures were included on the ballot relating to the financing of the City share of the Lower Cache Creek Flood Damage Reduction Project. One was a local sales tax extension and the remaining two were advisory measures related to the sunsetting of the sales tax measure if the setback levee were the selected plan, or if the flood barrier were the selected plan. The funding measure was put on the ballot in advance of release of the Feasibility Study in order to facilitate seeking federal funding support in 2000.

All three were voted down, indicating a lack of community support for the project.

Release and public review of the Feasibility Study and EIS/EIR are expected to clarify misconceptions raised during the March 2002 election process. Community support can be more accurately evaluated after the study is released, the public has a chance to formally review the study, comments are received and responded to, and environmental review process is completed.

13. Baseline Cost Estimate. The following tables show the components of the baseline cost estimate. The difference between State and Federal appraisal rules have been considered and are not expected to have any appreciable impact on the estimated real estate cost. All lands needed for the project have been appraised at fair market value utilizing mass appraisal techniques.

Lands in which the non-Federal sponsor has a real estate interest as the result of the previous local cooperation Federal project for the existing levee system are not included in the cost estimate that follows. Contingencies that have been added to the fair market value take into account unknown property splits, undetected improvements, minor project design changes and any additional costs involved in the application of PL 91-646.

While the real estate requirements 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. Increases in the crown width from 12 to 20 feet can be accommodated by a corresponding reduction in the size of the Temporary Work Area Easement that parallels the base of the levee, without a change in the width of the project footprint. The value of the lands required for the Flood Protection Levee Easement will be applied to the additional lands that will be required for the widening of the levee crown. The value of the Flood Protection Levee Easement is greater than the value of the Temporary Work Area Easement, thus increasing the real estate cost of all alternatives. Crown widths will be refined for the selected alternative, and related real estate requirements will be described in the final Feasibility Report. Potential real estate costs associated with the wider crown width are not reflected in the tables that follow in this report, but are provided immediately below:

Modified Wide Setback Levee Alternative:

Potential real estate cost increase due to increase in levee crown = $\underline{\$163,000}$

Overflow Barrier Alternative:

Potential real estate cost increase due to increase in levee crown = $76,000
Additional borrow material will be required to construct the wider levee under this alternative. Real estate cost for a 14 acre borrow easement = $92,000
Total = $\underline{\$168,000}$

A gross level appraisal was completed for all alternatives in March 2002. For the feasibility study, no detailed and site specific appraisal or parcel-by-parcel valuation is performed. The gross appraisal provides a broad estimate of the value of real estate to be included in the alternatives under study.

FLOOD BARRIER

ESTATES and Other TAKES	ACRES or UNITS	LERRDS COST
Flood Protection Levee Easement	103.68	$807,337
Permanent Easement for Occasional Flowage	1,774.36	$2,240,563
Temp. Work Area Easement	49.06	$54,646
Permanent Easement for Occasional Flowage and Temp. Work Area Easement	41.6	$24,075
Roads	12	$12,000
Structures	1	$50,000
Severance	10% of above	$318,862
Relocations	1	$22,500

Total Ownerships - 28

Total LERRDS $ - $3,529,983

NOTES:

A drainage ditch along the northern toe of the flood barrier is included in the flood protection levee easement estate above.

An encroachment permit from CALTRANS to the non-Federal sponsor would provide for placement of drainage pipes under I-5. No drainage ditch easement would be required.

NARROW SETBACK LEVEE

ESTATES	ACRES	LERRDS COST
Flood Protection Levee Easement	145.66	$1,208,985
Channel Improvement Easement	21.34	$190,854
Permanent Flowage Easement	856.67	$8,373,571
Temp. Work Area Easement	69.57	$112,814
Road Easement	1.23	$10,595
Borrow Easement	135.43	$677,134
Flood Protection Levee Easement and Road Easement	1.54	$10,110
Temporary Work Area Easement and Permanent Flowage Easement	55.99	$570,434
Roads	9	$9,000
Structures	10	$741,956
Severance	10% of above	$1,190,545
Relocations	10	$225,000

Total Ownerships - 86

Total LERRDS $ - $13,320,998

WIDE SETBACK LEVEE

ESTATES	ACRES	LERRDS COST
Flood Protection Levee Easement	221.29	$1,631,560
Channel Improvement Easement	10.88	$62,146
Permanent Flowage Easement	1919.33	$20,737,647
Temp. Work Area Easement and Permanent Flowage Easement	87.69	$711,953
Drainage Easement and Permanent Flowage Easement	9.59	$55,737
Borrow Easement	135.34	$676,687
Permanent Flowage Easement and Borrow Easement	84.22	$600,652
Roads	13	$13,000
Structures	58	$8,343,628
Severance	10% of above	$3,283,211
Relocations	58	$1,300,000

Total Ownerships - 106

Total LERRDS $ - $37,415,321

MODIFIED WIDE SETBACK LEVEE

ESTATES	ACRES	LERRDS COST
Flood Protection Levee Easement	209	$1,788,825
Channel Improvement Easement	.06	$559
Permanent Flowage Easement and Fee	1587	$18,139,323
Drainage Easement and Permanent Flowage Easement	7.82	$45,163
Borrow Easement and Permanent Flowage Easement	96.12	$567,262
Temporary Work Area Easement and Permanent Flowage Easement	91.58	$695,088
Temp. Work Area Easement	70	$534,262
Temporary Work Area Easement and Flood Protection Levee Easement	3.13	$19,374
Borrow Easement	135.51	$677,216
Roads	9	$9,000
Structures	32	$5,444,658
Severance	10% of above	$2,792,073
Relocations	32	$717,500

Total Ownerships - 95

Total LERRDS $ - $ 31,430,303

COST SUMMARY BY ALTERNATIVE

Fair Market Value of the project real estate requirements, potential relocations, severance, and contingencies are included in Acquisition Costs that follow. Non-Federal and Federal Administrative Costs to acquire real estate requirements and perform relocations are also shown below.

Flood Barrier

ACQUISITION COSTS	NON-FEDERAL ADM. COSTS	FEDERAL ADM. REVIEW COSTS	TOTAL
$5,284,000	$2,764,920	$528,500	$8,577,420

Narrow Setback Levee

ACQUISITION COSTS	NON-FEDERAL ADM. COSTS	FEDERAL ADM. REVIEW COSTS	TOTAL
$16,595,000	$7,513,150	$1,376,900	$25,485,050

Wide Setback Levee

ACQUISITION COSTS	NON-FEDERAL ADM. COSTS	FEDERAL ADM. REVIEW COSTS	TOTAL
$46,444,000	$9,502,550	$1,666,300	$57,612,850

Modified Wide Setback Levee

ACQUISITION COSTS	NON-FEDERAL ADM. COSTS	FEDERAL ADM. REVIEW COSTS	TOTAL
$38,410,000	$8,713,400	$1,523,900	$48,647,300

14. Acquisition Schedule. A detailed acquisition task list is shown on the following table. No schedule for this project has been developed to date. The non-Federal sponsor will be directed to begin real property acquisitions for the project only after the PCA is fully executed. The non-Federal sponsor is aware of the risks of initiating the acquisition process in advance of the PCA being signed.

TASK	COE START	COE FINISH	NFS START	NFS FINISH
Receipt of final drawings from Engineering	Sep2003	May2005		
Execution of PCA	Jan2004	Jan2005	Jan2004	Jan2005
Formal transmittal of final ROW drawings and instruction to acquire LERRDS	Jun2005			
Conduct landowner meetings	TBD		TBD	
Prepare/review mapping and legal descriptions	TBD		TBD	
Obtain/review title evidence	TBD		TBD	
Obtain/review tract appraisals	TBD		TBD	
Conduct negotiations	TBD		TBD	
Perform closing	TBD		TBD	
Prepare/review condemnations	TBD		TBD	
Obtain possession	TBD		TBD	
Complete/review PL 91-646 benefit assistance	TBD		TBD	
Conduct/review facility and utility relocations	TBD		TBD	
Certify all necessary LERRDS are available for construction	TBD		TBD	
Prepare and submit credit requests	TBD		TBD	
Review/approve or deny credit requests	TBD		TBD	
Establish value for creditable LERRDS in F&A cost accounting system	TBD		TBD	

NFS: Non-Federal Sponsor COE: Corps of Engineers

* TBD=To be determined when an alternative is selected for cost sharing.

15. Assessment of Non-Federal Sponsor's Real Estate Capacity

Non-Federal Sponsor: The non-Federal sponsor is the State of California Reclamation Board with the City of Woodland participating as the local sponsor.

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **YES**

b. Does the sponsor have the power of eminent domain for this project? **YES**

c. Does the sponsor have "quick-take" authority for this project? **YES**

d. Are any of the lands/interests inland required for the project located outside the sponsor's political boundary? **No**

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **No**

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects, including P.L. 91-646, as amended? **No**

b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training?

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes**

d. Is the sponsor's in-house staffing level sufficient considering its other workload, if any, and the project schedule? **N/A**

e. Can the sponsor obtain contractor support, if required, in timely fashion? **Yes**

f. Will the sponsor likely request USACE assistance in acquiring real estate? **No**

III. Other Project Variables:

a. Will the sponsor's staff office be located within reasonable proximity to the project site? **YES**

b. Has the sponsor approved the project real estate schedule/milestones? **N/A**

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? **YES**

b. With regard to this project, the sponsor is anticipated to be: California State Department of Water Resources

V. Coordination:

a. Has this assessment been coordinated with the sponsor? **YES**

b. Does the Sponsor concur with this assessment? **YES**

16. **<u>National Economic Plan and Locally Preferred Plan</u>**

<u>The Flood Barrier Plan</u> is the National Economic Plan.

As of the date of this submission the non-Federal sponsors have not selected a Locally Preferred Plan.

EXHIBIT A

Lower Cache Creek Feasibility Study

ROAD & BRIDGE RELOCATIONS

		ROAD & BRIDGE RELOCATIONS	Length	ROW 1/	Modification
Flood Barrier Plan					
0	County Road 19B		300'	Probably	Raise roadway
1	County Road 97A		1200'	Yes	Raise roadway
2	State Hwg 16		2880'	No	Raise roadway
3	County Road 99		3450	No	Raise roadway
4	Dubach Field Road		1200'	No	Raise roadway
5	County Road 101		5400'	No	Raise roadway
6	County Road 102		5700'	No	Raise roadway
					Subalternative
Narrow Setback Levee Plan					
	Bridges 4/				
7		CR 102	400'	No	Design floods > 200-yr
8		State Hwg 113	300'	No	Design floods > 200-yr
9		I-5 & CR 99W	300'	No	Design floods > 500-yr
10		Railroad	300'	No	Design floods > 400-yr
	Roads				
11		CR 17B	800'	Yes	
12		CR 97B	1150'	Yes	
13		CR 97A	700'	Yes	
Wide Setback Levee Plan					
	Roads				
11		CR 17B	TBD	Yes	
12		CR 97B	3600'	Yes	
13		CR 97A	4100'	Yes	
	Bridges 5/		TBD	No	
Modified Wide Setback Levee Plan					
	Roads				
11		CR 17	TBD	Yes	
12		CR 18 & 18A	3600'	Yes	
13		CR 97A	4100'	Yes	
9		I-5 Ramps AC & AB	TBD	No	
	Bridges				
7		CR 102	400'	No	
8		Highway 13	300'	No	
9		CR 99W	300'	No	
9		I-5 NB & SB	300'	No	
10		Railroad	300'	No	

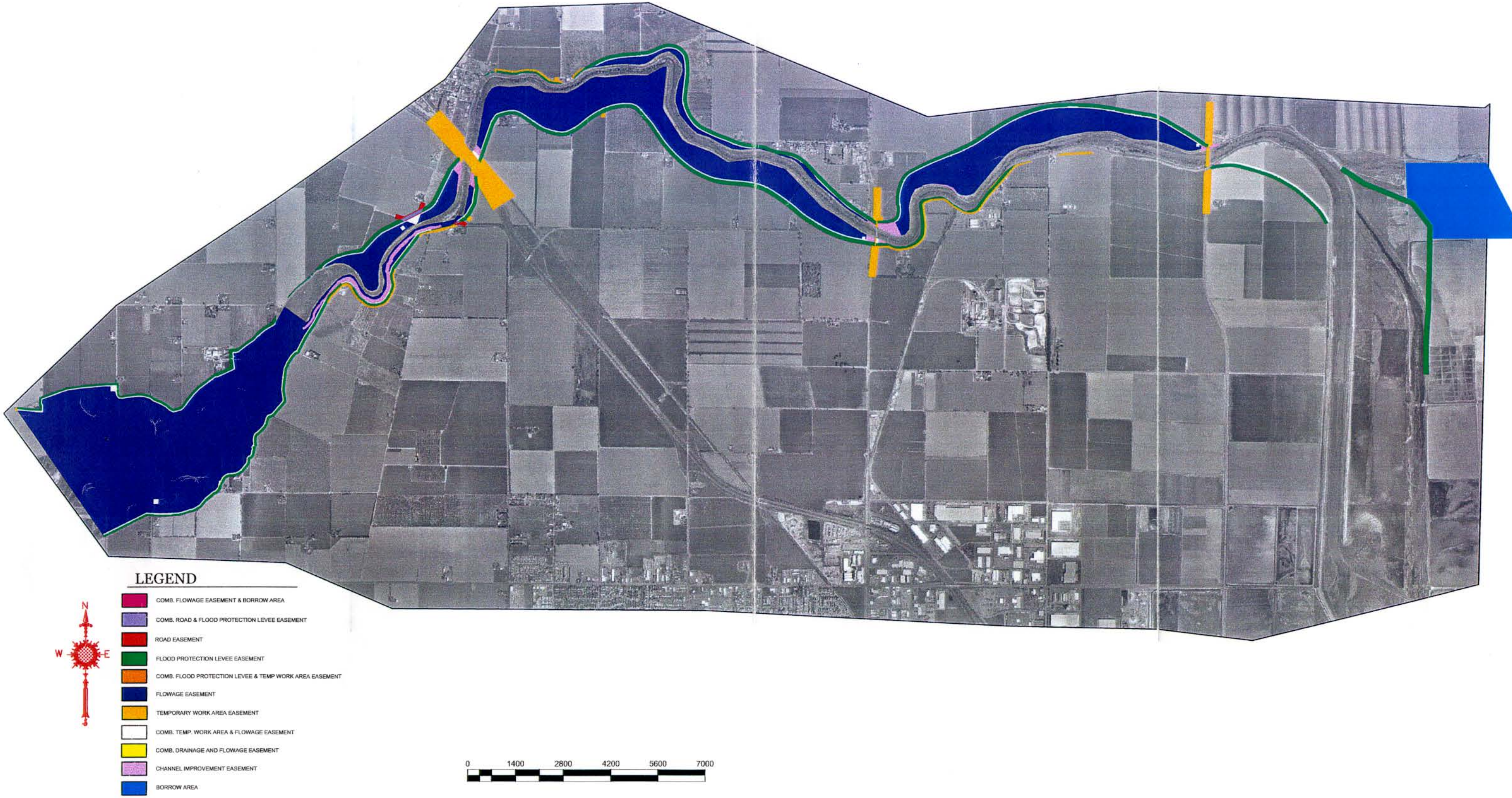
1/ Additional ROW needed for relocated facility
2/ Bridge lengths do not include approaches, only approx length of the structure
3/ Facilities located within road ROW
4/ Relocations are not anticipated for design floods < 500-year
5/ No bridges have been identified as needing relocation for this alternative (work in progress)

Lower Cache Creek Feasibility Study						
Road & Utility Relocations						
				Underground 1/		
UTILITY RELOCATIONS			Overhead	Public	Private	Other
	Barrier Levee Alt					
0		CR 19B at FBL	OHE, P			2/
1		CR 97A at FBL	OHE, P, C			
2		State Hwg 16 at FBL	OHE			
3		CR 99 at FBL	OHE, P, C	W	G	
4		Dubach Field Rd / RR	OHE, P, C			3/
5		CR 101at FBL	OHE, P, C, T/L	W	G	
6		CR 102 at FBL	OHE, P, C		FO	
	Setback Levee Alternative (Min RE, Lot of rock)					
7		CR 102 at CC	OHE, P, C			
8		Hwg 113 at CC	OHE,P, C	W	G	
9		I-5 at CC	None			
9		Hwg 16 at CC	OHE			
10		Railroad	OHE, P			
11		CR 17B at SB levee	OHE			
12		CR 97B at SB levee	OHE, P			
13		CR 97A at SB levee	OHE		G	?
	Setback Levee Alternative (Minimum rock)					
7		CR 102 at CC	OHE,P, C			
8		Hwg 113 at CC	OHE,P, C	W	G	
9		I-5 at CC	None			
9		Hwg 16 at CC	OHE			
10		Railroad	OHE, P, C			
11		CR 17B at SB levee	OHE			
12		CR 97B at SB levee	OHE, P, C			
13		CR 97A at SB levee	OHE		G	
Legend						
OHE	Overhead Electric					
P	Phone					
C	Cable					
W	Water					
SS	Sewer					
FO	Fiber Optic					
FBL	Flood Barrier Levee					
SB	Setback Levee					
T/L	Transmission Line					
Notes						
1/	Underground facilities identified by drive by inspection of site (not a records search)					
2/	Unkown vault					
3/	Cased UG utility					

EXHIBIT B

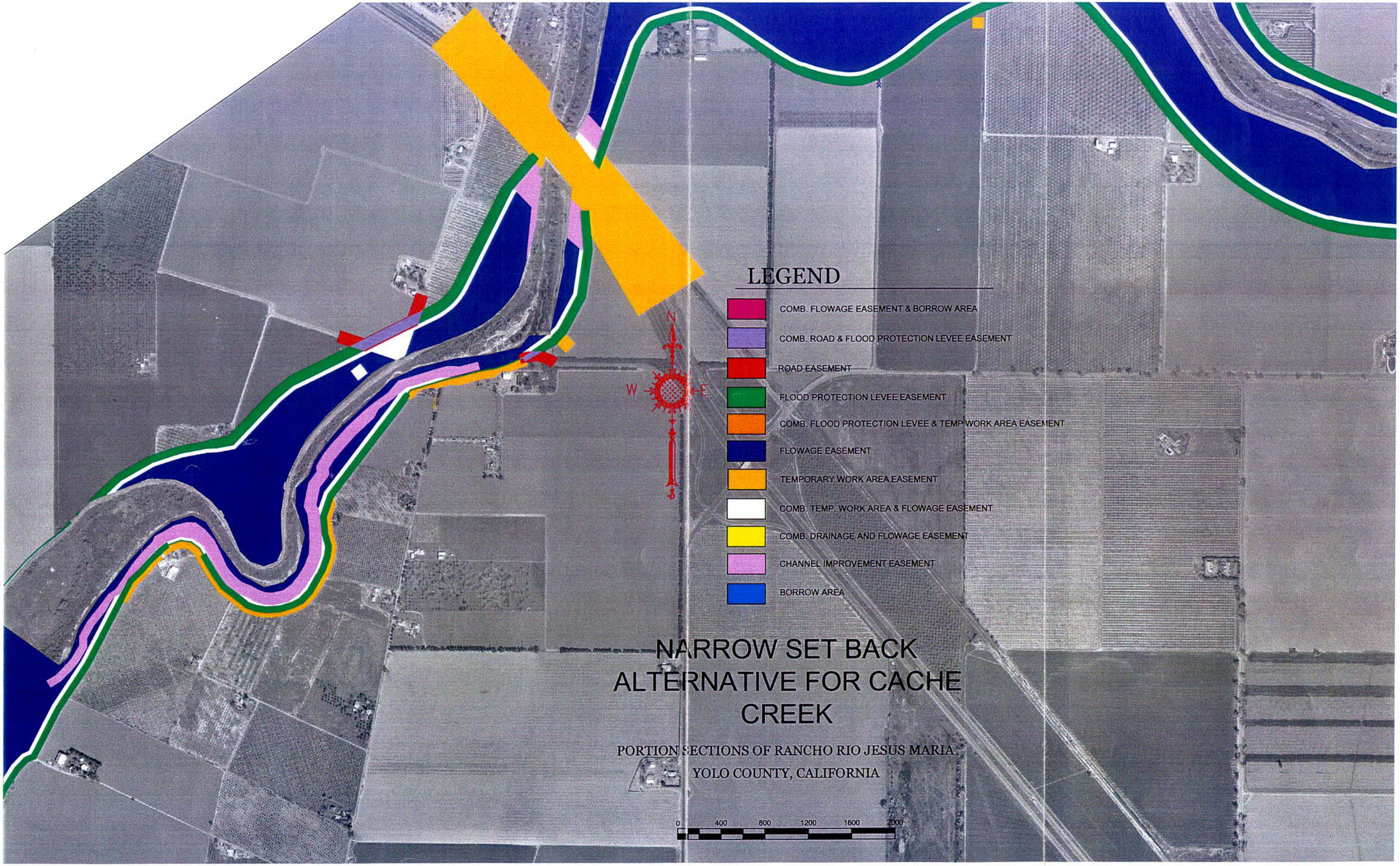
FLOOD BARRIER ALTERNATIVE FOR CACHE CREEK

PORTION SECTIONS OF RANCHO RIO JESUS MARIA
YOLO COUNTY, CALIFORNIA



NARROW SET BACK ALTERNATIVE FOR CACHE CREEK

PORTION SECTIONS OF RANCHO RIO JESUS MARIA
YOLO COUNTY, CALIFORNIA


LEGEND
COMB. FLOWAGE EASEMENT & BORROW AREA
COMB. ROAD & FLOOD PROTECTION LEVEE EASEMENT
ROAD EASEMENT
FLOOD PROTECTION LEVEE EASEMENT
COMB. FLOOD PROTECTION LEVEE & TEMP WORK AREA EASEMENT
FLOWAGE EASEMENT
TEMPORARY WORK AREA EASEMENT
COMB. TEMP. WORK AREA & FLOWAGE EASEMENT
COMB. DRAINAGE AND FLOWAGE EASEMENT
CHANNEL IMPROVEMENT EASEMENT
BORROW AREA
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ALTERNATIVE FOR CACHE
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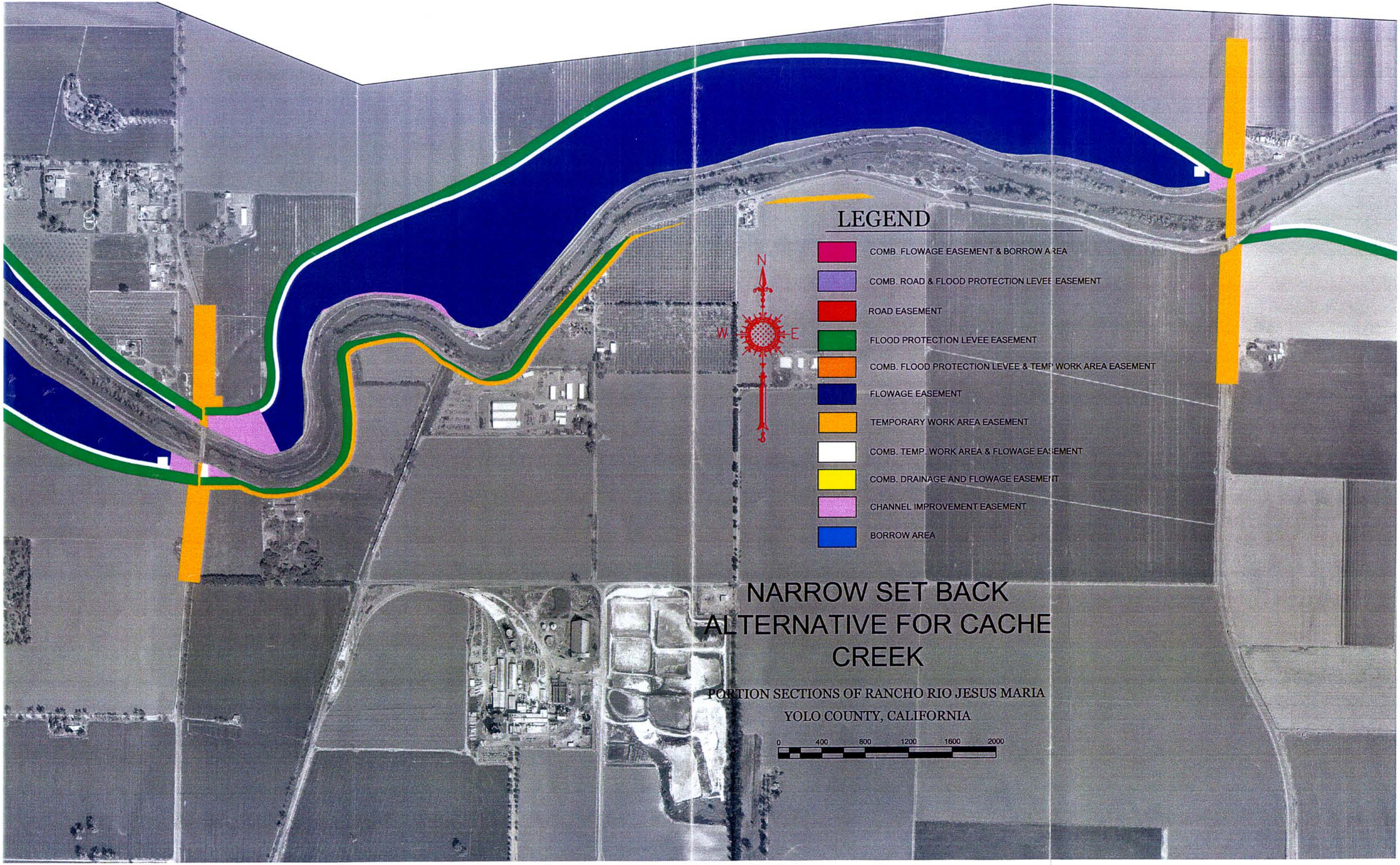
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COMB. FLOWAGE EASEMENT & BORROW AREA
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ROAD EASEMENT
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COMB. FLOOD PROTECTION LEVEE & TEMP WORK AREA EASEMENT
FLOWAGE EASEMENT
TEMPORARY WORK AREA EASEMENT
COMB. TEMP. WORK AREA & FLOWAGE EASEMENT
COMB. DRAINAGE AND FLOWAGE EASEMENT
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NARROW SET BACK ALTERNATIVE FOR CACHE CREEK
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YOLO COUNTY, CALIFORNIA
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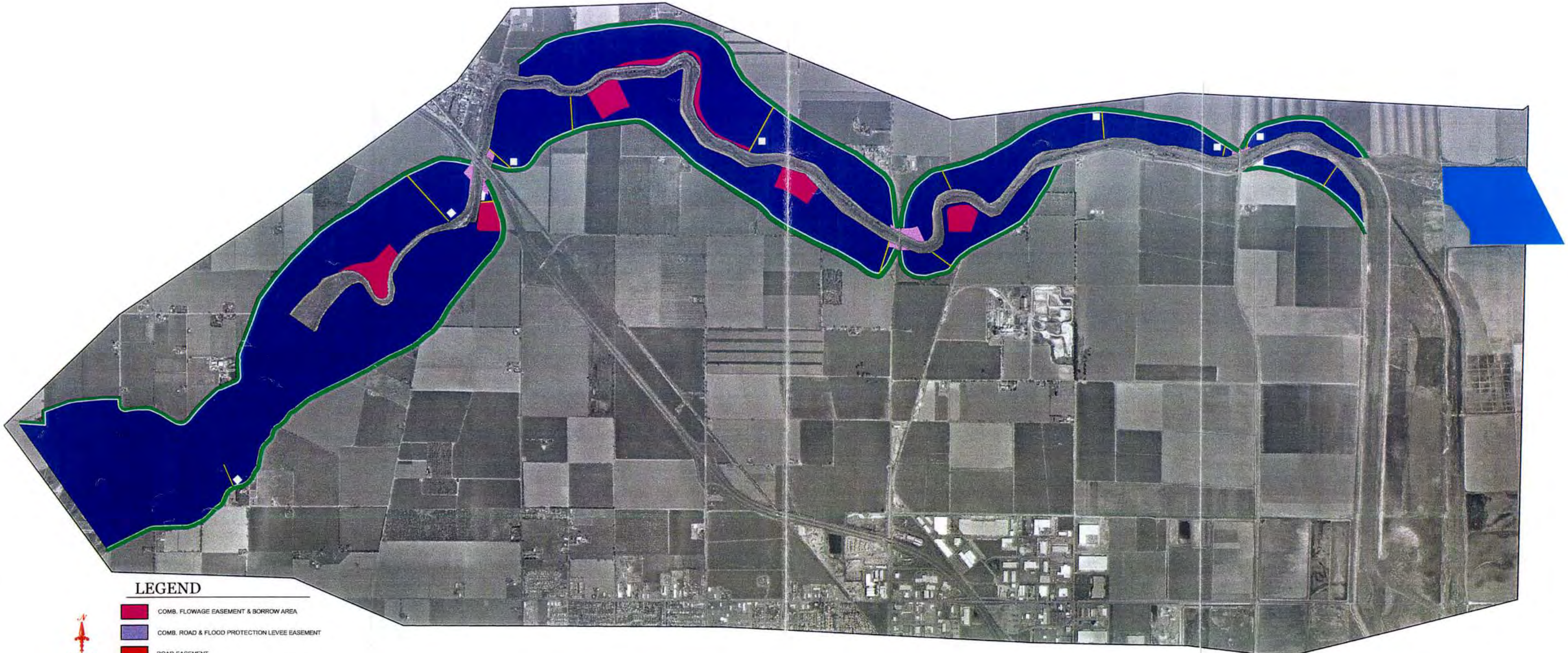


LEGEND

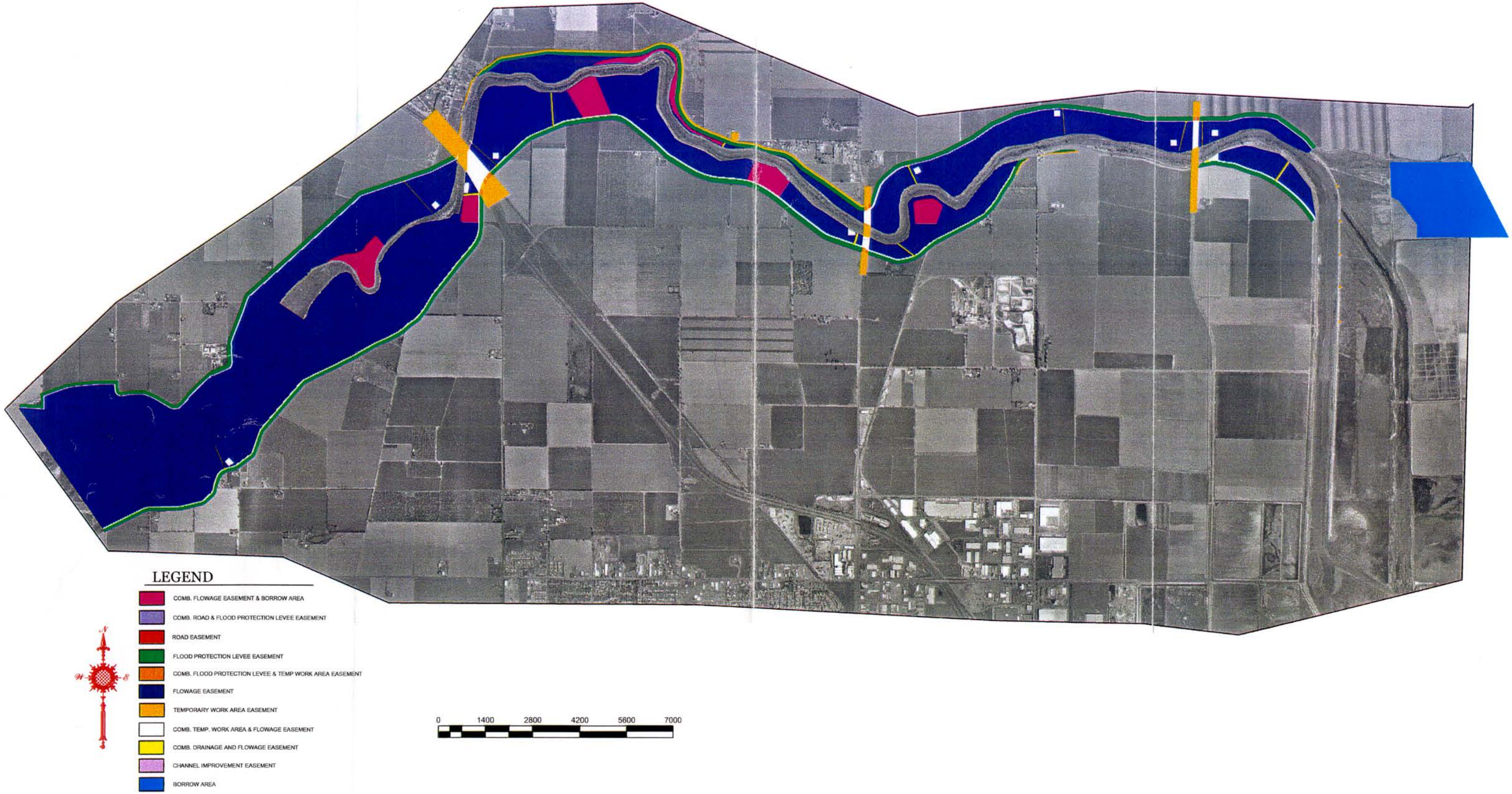
- COMB. FLOWAGE EASEMENT & BORROW AREA
- COMB. ROAD & FLOOD PROTECTION LEVEE EASEMENT
- ROAD EASEMENT
- FLOOD PROTECTION LEVEE EASEMENT
- COMB. FLOOD PROTECTION LEVEE & TEMP WORK AREA EASEMENT
- FLOWAGE EASEMENT
- TEMPORARY WORK AREA EASEMENT
- COMB. TEMP. WORK AREA & FLOWAGE EASEMENT
- COMB. DRAINAGE AND FLOWAGE EASEMENT
- CHANNEL IMPROVEMENT EASEMENT
- BORROW AREA

N W E

0 1400 2800 4200 5600 7000

WIDE SET BACK ALTERNATIVE FOR CACHE CREEK

PORTION SECTIONS OF RANCHO RIO JESUS MARIA
YOLO COUNTY, CALIFORNIA



MODIFIED WIDE SET BACK ALTERNATIVE FOR CACHE CREEK

PORTION SECTIONS OF RANCHO RIO JESUS MARIA
YOLO COUNTY, CALIFORNIA

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix G

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX G

Economics

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX G

Economics

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

ECONOMIC APPENDIX
Draft Feasibility

Economics Branch
Planning Division
SOctober 2002Sacramento 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.

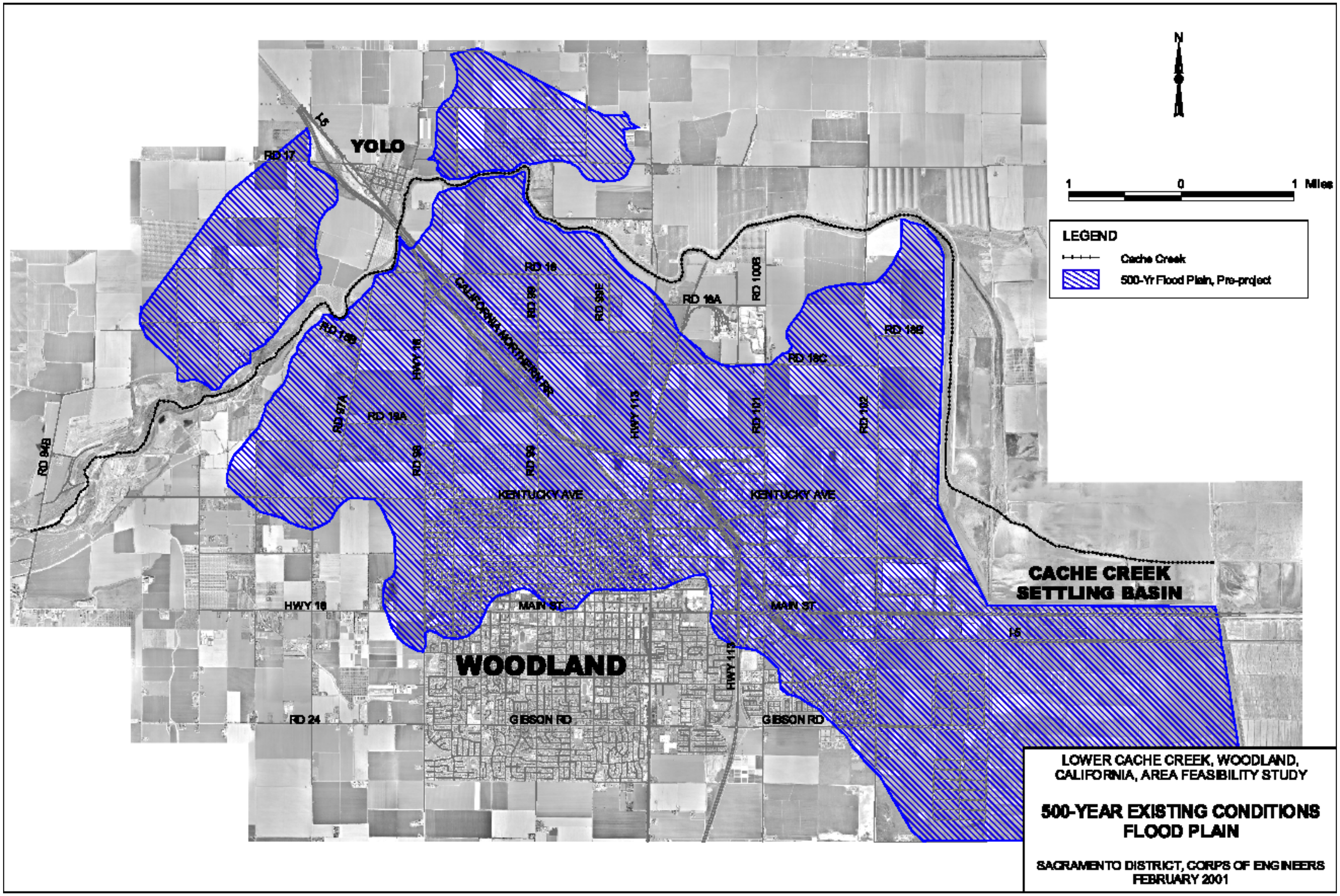
Study Area Development

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

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

Reach Name Economic	Reach Name 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 6-8 (COMPARE TO FEAS REPT)

Table 12—Costs

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

Table 13

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

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

ALTERNATIVE	Exp. Ann. Benes.	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).

<u>Lower Cache Creek/City of Woodland Alternatives</u>

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%

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix H

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX H

(Not Used)

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix I

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX I

Qualitative Geomorphologic and Channel Stability Assessment of Lower Cache Creek

Final Report

Qualitative Geomorphic and Channel Stability Assessment of Lower Cache Creek

Date: September 12, 2001

Prepared for:
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West Sacramento, CA 95691

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1.0 INTRODUCTION

The objective of this reconnaissance level study is to assist Camp Dresser & McKee (CDM) and the Sacramento District Corps of Engineers (Corps) in identifying key geomorphic processes affecting channel morphology and river dynamics of Lower Cache Creek from Road 94-B to the Yolo Settling Basin. A qualitative review of past reporting and obvious channel stability and sediment transport conditions found in the Lower Cache Creek study reach was conducted during a three week period using readily available data and information gathered during a site inspection of the project reach. Hydraulic model results from the CDM/MBK HEC-RAS model were used to bracket hydraulic characteristics for a range of flows and to perform a qualitative review of channel dynamics. Model results from the Cache Creek Settling Basin FLO-2D model were used to qualitatively estimate changes in the settling basin performance and trap efficiency for baseline conditions and the Flood Barrier Alternative. Settling Basin modeling results for the Setback Levee Alternative were not available at the time of reporting. Findings from the review of available information were used to:

- Estimate existing channel stability;
- Estimate existing O&M requirements;
- Assess the stability and maintenance requirements of the Setback Levee Alternative;
- Assess impacts of the Flood Barrier and Setback Levee Alternatives to flow and sediment transport to the Settling Basin and its sediment trap efficiency;
- Assess the need for a training levee or modifications to the proposed training levee in the Settling Basin;
- Determine the need for additional information or future studies in order to complete the project design.

1.1 Data Collection

Information for this investigation was obtained from CDM, the U.S. Army Corps of Engineers the Corps, MBK Engineers, the California State Division of Mines & Geology, and NHC archives. A list of historical aerial photographs used for this project is shown in Table 1, and a list of historical topographic maps is shown in Table 2. Key documents, plans, and other materials collected for this study are listed in the References section. An on-site field inspection of the project area was conducted in August, 2001 by nhc.

2.0 GEOMORPHOLOGY

2.1 Background

Located north of the City of Woodland, the project area consists of the downstream 12.1 miles of Cache Creek, referred to as Lower Cache Creek (Figure 1). The project area begins at station 780+00, about 2 miles downstream of County Road 94B, and extends downstream (easterly) to station 140+00 in the Cache Creek Settling Basin. Originally constructed in 1937, the settling basin has been modified several times to increase flood capacity and to provide sediment storage. The primary function of the settling basin is to preserve the flow conveyance capacity of the

Yolo Bypass by trapping Cache Creek sediments in the settling basin rather than allowing them to enter the bypass (Corps, 2001).

Six bridges cross the creek in the project area, the I-5 bridge complex at station 582+00, SR 113 at station 415+00, and CR 102 at station 292+00. The I-5 bridge complex consists of 4 bridges, northbound and southbound lanes of I-5, CR 99W, and a railroad bridge. Earthen levees border Cache Creek from the settling basin to I-5. Upstream of I-5, a levee extends along the north bank whereas the south bank is higher in elevation and unleveed. Levees have existed along this reach of Cache Creek for many decades. In 1943, existing levees along Lower Cache Creek were improved from Yolo to the creek mouth to accommodate a maximum design flow of 20,000 cfs. The north side levees along Lower Cache Creek were upgraded in 1961 to convey 30,000 cfs (Corps, 2001).

Prior to 1996, Cache Creek was a major source of construction grade aggregate within the State of California (EIP, 1995). In 1996, instream aggregate mining was banned on Cache Creek as part of a stream restoration plan to protect stream habitat, groundwater, and infrastructure. During the gravel mining era, average annual gravel extraction volumes greatly exceeded estimates of inflowing gravel. Current estimates indicate that it would take several hundred years for Cache Creek to replace the volume of gravel removed as a result of aggregate mining (EIP, 1995).

2.2 Geology

Lower Cache Creek flows on alluvial fan and floodplain deposits ranging from clay and silt to coarse sand and gravel (Wahler Associates, 1982). Borehole data show clay deposits to be common at depths in excess of 20 ft to 25 ft from the ground surface, whereas more recently deposited silt and sand characterize sediments above the 20 ft to 25 ft depth (Corps, 1958; Wahler Associates, 1982).

Several faults are located in the vicinity of the project area. The Dunnigan Hills Fault is less than 5 miles northwest of the project area and is considered active due to recent activity during the Holocene epoch (the last 10,000 years) (Toppozada et al., 2000). Other faults in the region include the Zamora Fault and the Capay Fault, both of which are considered to be inactive (Jennings et al., 1994).

Lower Cache Creek has experienced a small amount of land subsidence due to ground water withdrawal. A maximum of 2.25 ft of cumulative land subsidence is estimated in the City of Woodland from 1942 to 1987.

2.3 Existing Conditions within the Lower Cache Creek Project Area

Lower Cache Creek exhibits several geomorphically distinct reaches along its length. The most significant reach change occurs near station 670+00, located 1.7 miles upstream of I-5. Upstream of station 670+00 Cache Creek was historically mined for aggregate whereas areas downstream were not. As a result, channel morphology is vastly different between these two sections of the project area. These and other geomorphic changes can be used to subdivide the creek into 6 distinct reaches (Figure 1). Key hydraulic characteristics of each reach for the 2-year flow and 100-year flow are shown in Table 3. Key geomorphic characteristics of each reach are discussed below.

Reach 1 (station 260+00 to station 140+00) is 12,000 ft in length, Cache Creek flows south in an artificially constructed channel that directs Cache Creek flows into the settling basin. The artificial channel exhibits a regular, trapezoidal cross-section with little or no change in flow capacity along its length. Dense vegetation cover throughout this reach greatly restricted the observation of in-channel features during the field inspection. As a result, in-channel features were assessed primarily from year 2000 aerial photographs which showed no apparent bank erosion sites in Reach 1.

Reach 2 (station 415+00 to station 260+00) is 15,500 ft in length and located between SR 113 and Reach 1. Reach 2 downstream of SR 113 was not visited during the site inspection due to a locked gate. From air photographs, bank vegetation in Reach 2 varied from forest cover with dense understory to open areas of tall grass extending to the water's edge. Channel banks in Reach 2 appeared stable and no areas of significant bank erosion were observed. However, some small, isolated areas of stream bank erosion were identified in the reach, such as near station 377+00. In addition, vertical scarps of exposed bank sediments approximately 3 ft high were also observed near the top of bank in the upstream part of the reach. These breaks in bank slope indicate possible slump failures along the bank, although no indications of active or excessive erosion along the toe of these banks were evident at any of these locations.

Three meander bends are located in the upstream part of Reach 2. Rock bank protection was observed at the edge of water in some parts of these meander bends, such as at station 378+00, indicating that these areas had once been eroding and were later stabilized.

Examination of Table 3 shows that Reach 2 is wider than Reaches 3 and 4 for both the 2-year and 100-year flows. Sections of Reach 2 upstream of County Road 102 exhibit broad, open areas of floodplain between the levees whereas Reaches 3 and 4 exhibit little or no floodplain surfaces and tend to become increasingly more narrow and confined with distance upstream.

Reach 3 (station 480+00 to station 415+00) is 6,500 ft in length and forms a transitional reach between the wider Reach 2 downstream and the narrower Reach 4 upstream. The downstream 1,500 feet of Reach 3 exhibits a fairly consistent line of trees along the south bank, probably planted there several decades ago. These trees occupy the lower part of the stream bank near the water's edge, indicating that little or no bank erosion has occurred here over the last several decades. Other areas of Reach 3, particularly along the north bank, are largely devoid of tree cover and instead exhibit grass and shrub covered bank slopes.

Reach 3 is significantly narrower and more entrenched than Reach 2, resulting in higher, steeper channel banks that are more prone to bank erosion and instability. In contrast to Reach 2, significant areas of bank erosion and instability are evident in several locations in Reach 3. These areas are typically characterized by eroded, vertical stream banks, slump failures, and single or multiple vertical scarps (2 ft to 3 ft high) at varying levels on the bank slope, indicating slumping of the downslope segment of bank.

Reach 4 (station 580+00 to station 480+00) is 10,000 ft in length. Trees line much of the south bank of Reach 4 whereas the north bank is virtually devoid of tree cover. Dense shrubs and grasses typically line both banks in this reach.

The frequency of bank erosion and bank instability is greater in Reach 4 than in Reach 3. Reach 4 exhibits the narrowest channel cross-section in the project area and is deeper and more entrenched than Reach 3 (Table 3). Both factors contribute to the higher incidence of bank erosion in this reach. Similar to Reach 3, 2 ft to 3 ft high vertical scarps occur at varying elevations in several parts of the stream bank (both low and high), indicating probable areas of bank slumping. A large bank erosion site is located at station 542+00 on the north bank. The erosion site is very near the levee road and will be repaired by the California State Department of Water Resources. A tight meander bend at station 502+00 also exhibits a large bank failure on the inner bank. A grade control structure constructed of sac-crete is located in the channel at station 557+00.

The frequency and magnitude of instream bar features also increases in this reach relative to Reach 3. Well-developed instream gravel bars cause the low flow channel to migrate from one side of the creek bed to the other.

Reach 5 (station 670+00 to station 580+00) is 9,000 ft in length and characterized by large meander bends that exhibit severe bank erosion along high (30+ ft) vertical banks over hundreds of lineal feet. This morphology results in the most severe and extensive bank erosion in the project area. In general, the low flow channel in this reach is much narrower than in downstream reaches, due to lower water depths and confinement of the low flow channel by large gravel bars that occupy much of the channel bed. A borrow area is located at station 602+00, separated from the creek by a high, narrow ridge of material left in place between the creek and borrow area.

A widening trend in channel morphology begins in this reach and continues with distance upstream toward Reach 6 where historical gravel mining has greatly increased channel width and depth from pre-mining levels.

Reach 6 (station 670+00 to station 780+00) is 11,000 ft long and located in a historically gravel-mined section of the project reach. This reach is very broad in comparison with the rest of the project area and is characterized by large gravel bars, areas with little vegetation that were mined as recently as the mid-1990's, and undisturbed areas of dense vegetation. Vegetation is gradually returning to denuded portions of the creek following the cessation of instream gravel mining operations in 1996.

2.4 General Comments

The following general comments regarding the geomorphic characteristics of the project area can be made from the reach descriptions listed above:

- In general, the frequency and severity of bank erosion and bank instability in the project area increases with distance upstream from Reach 1 to Reach 5.

- Channel width generally decreases with distance upstream from Reach 1 to the I-5 bridge (Reach 5). Conversely, channel depth increases with distance upstream from Reach 1 to the I-5 bridge. In other words, Cache Creek exhibits a narrower, more entrenched channel cross-section with distance upstream from the settling basin to I-5 bridge. This results in channel banks that are generally higher, steeper, and more prone to bank erosion and instability with distance upstream.
- Cache Creek exhibits a widening trend with distance upstream from I-5 bridge, due to active meander bend migration in Reach 5 and channel widening caused by gravel mining in Reach 6.
- Bank instability in the project area is characterized primarily by areas of active bank erosion and by bank slumping. Areas of active bank erosion typically exhibit nearly vertical banks of exposed sediment, indicative of recent erosion. Blank slumping is evidenced by single or multiple vertical scarps (2ft to 3 ft high) at varying levels on the bank slope, indicating slumping and subsequent erosion of the downslope segment of the bank.
- Historically, numerous bank protection works have been constructed in the project area, primarily in river bends. Thus, bank stability in these areas is due to artificial bank protection rather than inherent stream stability. Future maintenance of existing and construction of new bank protection works will be necessary in the project area, even for without-project conditions.

3.0 CHANNEL STABILITY

3.1 Longitudinal Profiles

Longitudinal profiles of Lower Cache Creek from 1955 and 2000 are compared in Figure 2 (Corps, 1958; Ayres, 2000). Examination of Figure 2 shows a clear lowering of the channel invert elevation over time, due to multiple factors including the excavation of gravel from Cache Creek, channel confinement by bridges and levees, and other factors. The amount of channel bed lowering in Figure 2 decreases with distance downstream. At the I-5 bridge, the channel invert shows a lowering of about 16 ft from 1955 to 2000 whereas only 4 ft of channel invert lowering is observed at station 270+00. Data from 1905 to 1994 at I-5 bridge show that as much as 26 ft of invert lowering has occurred here (EIP Associates, 1995). Given that channel banks at I-5 are approximately 30 ft to 35 ft in height, the historical channel was probably about 10 feet deep and much wider than it is today. Thus, channel confinement, the effects of increased flows and more than 50 years of aggregate extraction in the project reach has resulted in severe channel lowering over the last 100 years.

In addition to significant channel degradation from 1955 to 2000, Figure 2 also shows much greater channel bed variability in the 1955 invert versus the 2000 invert. This is likely due to differences in survey methods. The 1955 invert is based on ground surveys whereas the 2000 invert is extrapolated from aerially derived, GPS-based topography of the water surface. Thus, the 2000 invert profile represents estimated rather than actual measured values of the invert and lacks the bedform variability shown in 1955 survey data.

The 2000 survey also shows an unusual convex shape in the long profile from station 580+00 to station 420+00 in Figure 2. The reason for this is unclear although a grade control structure at

557+00 probably contributes to the unusually gradual stream gradient (0.00015) from station 580+00 to station 557+00 in Figure 2.

In contrast, stream gradient is about 10 times this amount in the reach immediately upstream of I-5 (station 582+00 to station 840+00), the steepest section of the project area. Stream gradient generally decreases with distance downstream of station 480+00 from about 0.0011 from station 480+00 to station 41+200 to 0.00011 from station 287+00 to station 140+00.

3.2 Historical Planform Shift

Prior to significant gravel mining, Cache Creek is described as being a wide, relatively steep braided channel upstream of Yolo and a narrow, incised channel flowing in fine-grained overbank deposits and Tule marsh downstream of Yolo (EIP Associates, 1995). In general, average channel width in gravel mined reaches of Cache Creek has decreased from this historic condition due to bridge and levee construction and aggregate extraction. Conversely, average channel depths have increased as a result of channel degradation and confinement by levees and bridges.

Readily available historical mapping and aerial photographs (Tables 1 and 2) were collected and examined to identify key changes in channel planform in the project area over time. Examination of historical aerial photographs from 1937-38, 1952, 1964, and 2000 show significant planform changes in the project area over this period. The most significant planform change from 1937-38 to 2000 is the diversion of the downstream end of Cache Creek into an artificial channel flowing south into the settling basin. In 1937-38 aerial photographs, the downstream end of Cache Creek flows east and spreads out in a series of distributary channels. By 1952, the creek is confined into a single artificial channel that flows south and terminates near the south end of the settling basin. By 2000, this artificial channel has been relocated slightly westward but retains its southerly alignment into the settling basin.

Upstream of the settling basin, historical aerial photographs from 1937-38 show Lower Cache Creek to have been in much the same alignment that it is today. Other than in the settling basin, no major changes in channel alignment are observed in the project area. There are, however, some key differences in channel appearance between 1937-38 and 2000. First, the active channel appears wider in 1937-38 aerial photographs when compared to 2000. In particular, from station 330+00 to station 260+00 the 1937-38 aerial photographs show the low flow channel meandering between large alternating gravel bars. In contrast, 2000 aerial photographs show a much narrower active channel bed with very few bar surfaces.

Visual examination of aerial photographs also showed an apparent decline in the amount of tree cover along channel banks in the project area from 1937-38 to 2000. This is likely due to a combination of factors, including lowering of the ground water table as the river bed lowered over time and as ground water pumping for irrigation became common practice in the late 1930's and early 1940's.

A visual comparison of historical aerial photographs was conducted to assess changes bank erosion and instability from 1937-38 to 2000. The amount of bank erosion in the project area in

1937-38 did not appear to be significantly different from today; however, this type of visual comparison is limited by several factors. Among them, bank erosion is typically not easily seen in aerial photographs where overhanging vegetation often obscures the river bank or in cases where the degree of erosion is not severe. Historical activities to mitigate bank erosion problems were, however, easily observed in historical aerial photographs. In particular, 1964 aerial photographs showed relatively recent bank protection works constructed along channel bends and in the vicinity of bridges throughout the project area.

3.3 Overview of Existing Channel Stability

Based on the review of the longitudinal profiles and historical planforms the following key points are listed below:

- Channel bed lowering of 4 to 26 feet has occurred since 1955 along the project reach resulting in a narrower and entrenched channel cross section as compared to historical channel morphology. Generally, channel bed lowering within the project reach increases with distance upstream of the settling basin.
- The active channel width appears to have decreased since 1937.
- The planform alignment has remained relatively constant since 1937.
- Reaches 4 and 5 exhibit the greatest degree of channel instability manifested primarily as bank erosion and bank sloughing.
- Stream gradient on Lower Cache Creek varies from about 0.0015 upstream of I-5 to about 0.00011 near the settling basin. An unusual convex-up ‘hump’ is present in the stream profile from station 580+00 to station 412+00. A grade control structure at station 557+00 is a likely contributor to the unusual profile.

4.0 FUTURE CHANNEL STABILITY

4.1 General Considerations

Cache Creek has experienced severe historical channel bed lowering (channel entrenchment) as a result of instream gravel mining, bridge and levee construction, and other factors. Due to the cessation of instream gravel mining in 1996, some future channel aggradation is expected to occur in historically mined areas along Cache Creek. Ultimately, this channel aggradation will affect the entire creek invert profile but the channel invert is not expected to return to its former historical profile within the life of this project. The rate of channel aggradation in Lower Cache Creek is expected to be low given the vast area available for gravel storage in historically mined reaches upstream of the project area. Current estimates indicate that it will take several hundred years for Cache Creek to replace the gravel removed as a result of aggregate mining (EIP, 1995).

Future channel aggradation on Lower Cache Creek will also occur as a result of sediment accumulation in the settling basin. Sediment accumulation results in a rise in base level of the downstream end of Cache Creek. As the base level rises, overall slope in the downstream part of the project area will decline, promoting sediment deposition and channel bed aggradation. As the settling basin fills, this process will migrate in an upstream direction. It is recommended that the rate of increase in base level be determined from historical topographic data of the settling basin and adjusted where possible for the effects of subsidence. If the rate of increase is substantial, channel aggradation could significantly reduce flow capacity in the downstream part of the project area during the life of the project. Mitigation of this effect can be accomplished by raising levees, excavation of accumulating sediments, channel widening, developing floodplain storage, or a combination of these activities.

Bank erosion in rivers most commonly occurs in areas where flow is concentrated along the toe of channel bank, such as on the outside of a river bend, in a reach where the channel narrows significantly, or where flows are diverted toward the bank by an in-channel island or bar. Future bank erosion sites in the project area are likely to result from one or more of these characteristics and processes. Future bank erosion in the project area will be most common in Reaches 4 and 5 due to the more narrow, sinuous, and entrenched morphology of these reaches. Based on historical records and existing morphology, the likelihood of future bank erosion should decrease with distance downstream of Reaches 4 and 5.

4.2 Future Channel Stability for Reaches 1 through 6 (Without-Project)

Future channel stability in the project area for without-project (existing) conditions is discussed in this section on a reach by reach basis. This discussion is based on information gathered from the site inspection, review of historical information, and examination of output from the HEC-RAS model of the project area for without-project conditions (Corps, 2001b).

Plots of shear stress and channel velocity were produced from a HEC-RAS model to assist in projecting the potential occurrence of future bank erosion and instability in the project area. Shear stress and velocity for the 2-year and 25-year flood flows are shown in Figures 3 and 4. The 25-year flow (41,000 cfs) represents the maximum flow capacity of Lower Cache Creek in the project area. Flows in excess of 41,000 cfs overtop the creek channel and flow overland in the floodplain. The 2-year flow is shown to illustrate typical shear stresses and velocities for lower, more frequent flows.

Examination of Figures 3 and 4 shows that shear stress and velocity are highest in Reaches 2, 3, 4, and 5 whereas Reaches 1 and 6 exhibit significantly lower values. Thus, based on simplified hydraulic estimates, Reaches 2, 3, 4, and 5 tend to be more efficient at passing sediment loads downstream and are therefore, more likely to experience significant bank erosion than Reaches 1 and 6. More detailed examination of these plots and the potential for future bank erosion and instability in each reach is provided below.

Reach 1 (station 260+00 to station 140+00)
Located in an artificial channel with a flat channel slope, flowing south into the settling basin, Reach 1 is not expected to experience significant bank erosion or bank instability in the future. Examination of year 2000 aerial photographs shows no indication of bank erosion in Reach 1. HEC-RAS model results show Reach 1 to lie in a backwater area, even at the 2-year flow discharge. Thus, flow velocities, sediment transport capacity, and shear stresses are low. Future channel bed aggradation due to ongoing sedimentation in the settling basin is expected to occur in Reach 1. This reach is likely to require aggressive sediment and vegetation maintenance.

Reach 2 (station 415+00 to station 260+00)
The potential for future bank erosion in Reach 2 is generally low with two exceptions. First, from station 415+00 to station 360+00 the potential for future bank erosion is moderate due to the presence of 3 river meanders. Future maintenance of the existing rock protection in these river meanders will likely be necessary to ensure continued channel stability. Second, Figures 3 and 4 show two large increases in local shear stress and velocity for the 25-year flow downstream of CR 102 (station 293+00). These increases are due to narrow sections in the channel that cause flows to accelerate through the constriction. There is a moderate potential for future localized bank erosion at these 2 sites.

Some channel aggradation due to sedimentation in the settling basin is expected to occur in Reach 2, though significantly less than that in Reach 1. However, Reach 2 could be affected by long-term sediment accumulation in the Settling Basin and Reach 1 if regular maintenance is not performed.

Reach 3 (station 480+00 to station 415+00) and Reach 4 (station 580+00 to station 480+00)
The potential for future bank erosion in Reaches 3 and 4 is generally moderate due to a narrow channel width, entrenchment, and steep banks. Flow velocities and shear stresses are generally higher along the channel banks of deep, narrow river reaches versus those that are more wide and shallow. River meanders in Reach 4 also present areas for future bank erosion if existing rock bank protection is not maintained. Furthermore, a relic slough channel at the outside of a bend at station 502+00 in Reach 4 should be investigated from a geotechnical perspective to ensure levee stability is not compromised. Examination of Figures 3 and 4 shows no large spikes in flow velocity or shear stress in Reaches 3 or 4 for the 2-year and 25-year flows. Instead, average values are generally higher throughout Reaches 3 and 4 when compared to the rest of the project area.

The potential for channel aggradation in Reaches 3 and 4 is low due to their elevation above the settling basin, channel dimensions, and slope. Reaches 2, 3, and 4 have higher sediment transport potential for the 25-year flood event than Reaches 1, 5, and 6 (Figure 5).

Reach 5 (station 670+00 to station 580+00)
The potential for future bank erosion in Reach 5 is high due to river meanders, entrenchment, and nearly vertical, high unstable banks in several areas. The potential for channel aggradation in this reach is low due to its elevation above the settling basin, its relatively high velocity and sediment transport capacity, and relatively low rates of future channel aggradation which are expected to occur in the historically mined reaches upstream.

Reach 6 (station 670+00 to station 780+00)
Bank erosion and instability in Reach 6 are not a significant issue for this project due to the very wide levee setbacks proposed for this reach. Over the very long term (100 to 200 years), a moderate to high amount of channel aggradation is expected to occur in this reach due to the cessation of gravel mining.

Existing channel stability was estimated by reviewing numerical results from the Corps' existing conditions HEC-RAS model (Corps, 2001). Mean channel shear stresses (tractive forces) and mean channel velocities along the project reach were reviewed for the 2, 10, and 25 year peak discharges for steady state conditions. The 25 year peak discharge, 41,000 cfs, exceeds the existing channel capacity and likely provides an upper limit on the maximum channel discharge capacity and sediment transport potential. Shear stresses range from approximately 0 to 1.3 lbs/ft^2 for the 2-year peak discharge of 12,000 cfs and from 0 to 1.8 lbs/ft^2 at a peak discharge of 41,000 cfs, the 25-year flood event. Velocities in the project reach range from 0.6 to 8 fps and 1 to 9 fps for the 2 and 25-year peak discharges, respectively. Assuming a homogeneous bed material and a critical mobility number of 0.046, Shields criteria estimates particles as large as 162 mm and 224 mm could be moved for a boundary shear of 1.3 and 1.8 lbs/ft^2, respectively. Velocities and shear stresses within the channel cross section will deviate from the average channel velocities calculated by HEC-RAS. Notably, velocities and shear stresses along the outside of bends and near obstructions such as bridge piers will likely exceed the mean channel velocity.

Allowable shear stresses calculated from flume studies for cohesive materials are below 1 lb/ft^2 (Corps, 1994). In vegetated channels with heterogeneous bank material tractive forces may exceed this value without producing appreciable bank instability (Chow 1959). The highest values of shear stress occurs near the bridges and at the transition from the wider mined channel in Reach 6 to the narrow confined channel in Reach 5. High shear stresses calculated by the model in Reach 5 correlate well with extensive bank erosion in this reach. To maintain the channel in it’s current planform the channel will likely require periodic channel stabilization.

Based on the assessment of the site, historical information, examination of the Corp’s HEC-RAS model and the discussion above, the following key points are listed below:

- The 25-year peak discharge represents the maximum discharge capacity in the project area.
- The potential for erosion and bank instability is greatest at constrictions (e.g. bridges) and along the outer bank at tight river bends.
- Model results indicated that Reaches 1 and 6 have the lowest sediment transport potentials and Reaches 2, 3, and 4 significantly higher sediment transport potentials during the 25-year peak flow. Therefore, sediment materials are more likely to accumulate in Reaches 1 and 6 and pass through Reaches 2, 3, and 4.
- Sediment transport potential is relatively constant through the project reach for the 2-year peak discharge.
- Channel banks in Reaches 4 and 5 are high, steep, and relatively unstable and will likely require treatment to minimize further erosion.

4.3 Future Channel Stability for Reaches 1 through 6 (With Flood Barrier Alternative)

The Flood Barrier Alternative proposes the construction of approximately 6.8 miles of levee between Cache Creek and the City of Woodland. This alternative allows the channel to function as it currently does with flows overtopping the levee and leaving the channel and flowing out onto the broad floodplain. Channel topping flows are routed over the floodplain south of the Creek to the Settling Basin. Future channel stability issues remain identical to those discussed in Section 4.2. Areas identified as potentially and currently instable are proposed to be lined with rock. In total approximately 24,100 lineal feet of rock bank protection and two rock grade control structures downstream of I-5 and SH-113 are proposed to reduce potential bank erosion in the existing channel. These stability measures in conjunction with routine inspection and maintenance appear to be sufficient to maintain channel stability over the 50-year life of the project.

4.4 Future Channel Stability for Reaches 1 through 6 (With Setback Levee Alternative)

Future channel stability in the project area for the Setback Levee Alternative is discussed in this section on a reach by reach basis. This discussion is based on information gathered from the site inspection, a review of historical information, and examination of output from the HEC-RAS model of the project area for existing (Corps, 2001)and Setback Levee Alternative (Corps, 2001b).

Plots of shear stress and flow velocity were produced from a HEC-RAS model to assist in assessing the future occurrence of bank erosion in the project area for Setback Levee Alternative. Shear stress and velocity for the with-project 25-year and 100-year flood flows are shown in Figures 6 and 7. Note that, for comparison, values for the 25-year flood under existing conditions are also shown.

Examination of Figures 6 and 7 shows several key differences between the existing design flood (25-year event) and the with-project design flood (100-year event). First, all reaches except Reach 3 exhibit an increase in average shear stress and velocity for the Setback Levee Alternative during the 100-year peak flood discharge. Second, most of the spikes in velocity and shear stress that are present under existing conditions become much more pronounced for the Setback Levee Alternative 100-year flood. These locations include the I-5 bridge complex (station 583+00), the SR 113 bridge (station 414+00), and narrow sections of the channel at stations 390+00 and 289+00. All of these locations exhibit a reduction in channel cross-section area and corresponding increase in flow velocity and shear stress as flows accelerate through these sections of the project area. Third, Reach 3 shows a very significant and abrupt decline in velocity and shear stress for the Setback Levee Alternative when compared to the existing condition. Similar but less dramatic declines are also observed in Reaches 2 and 4 where many locations show a decrease in velocity and shear stress for the Setback Levee Alternative 100-year flood. These declines are the result of backwater effects caused by bridge obstruction at SR 113 and CR 102 in the project area. Fourth, Reach 1 exhibits a significant increase in flow velocity for both the 25-year and 100-year flood flows under Setback Levee Alternative conditions. Channel shear stress and velocity more than double in the downstream half of Reach 1. This results from the modification of the training levee along Reach 1 under the Setback Levee Alternative. Generally, abrupt changes in velocity from cross section to cross section lead to localized scour and deposition, which could result in additional operations and maintenance needs or require additional channel stability measures.

Difference plots showing the change in flow velocity and shear stress from existing to the Setback Levee Alternative for the 2-, 10-, 25-, and 100-year floods are shown in Figures 8 and 9, respectively. A detailed examination of these plots and the potential for future bank erosion and instability in each reach is provided below.

Reach 1 (station 260+00 to station 140+00)
When compared to existing conditions, the Setback Levee Alternative flow velocity and shear stress exhibit a decline in Reach 1 from station 260+00 to station 239+00 (Figures 8 and 9). This decline is due to the levee offset proposed in the Setback Levee Alternative design. In contrast, Setback Levee Alternative flow velocity and shear stress increase over existing levels from station 239+00 to station 140+00 in Reach 1. This is the result of modifications that will be made to the training levee. These significant increases in flow velocity and shear stress from station 239+00 to station 140+00 indicate that future bank erosion in this section of Reach 1 will likely increase somewhat over historic levels.

Reach 2 (station 415+00 to station 260+00)
When compared to existing conditions, flow velocity and shear stress for the Setback Levee Alternative are higher at the SR 113 and CR 102 bridge crossings and at station 390+00 where the channel narrows through a tight bend (Figures 8 and 9). Bank erosion and instability in these areas for with-project conditions is expected to be higher than historic levels. In contrast, flow velocity and shear stresses are somewhat lower in other parts of the project reach for the Setback Levee Alternative, particularly downstream of CR 102. This is due primarily to the Setback Levee Alternative offset levee configuration proposed for this section of the reach. These areas are expected to show future levels of bank erosion for the Setback Levee Alternative that are similar to historic levels.

Reach 3 (station 480+00 to station 415+00)
The Setback Levee Alternative flow velocity and shear stress are lower than for existing conditions in all of Reach 3 (Figures 8 and 9). This results from the replacement of existing levees with offset levees that will be constructed throughout the project reach. Thus, bank erosion and instability in this reach for the Setback Levee Alternative is expected to be lower than historic levels.

Reach 4 (station 580+00 to station 480+00)
The Setback Levee Alternative flow velocity and shear stress are generally lower than for existing conditions from station 552+00 to station 480+00. Lower sediment transport potential during less frequent flows in this reach may lead to a new trend of sediment deposition in this reach not seen in the existing conditions. This potential trend should be addressed in the design or operations and maintenance costs. Similar to Reach 3, this results from the replacement of existing levees with offset levees that will be constructed throughout the project reach. Thus, for the Setback Levee Alternative, bank erosion and instability in this part of the reach is expected to be lower than historic levels.

From station 580+00 to station 552+00, the Setback Levee Alternative flow velocity and shear stress are higher than for existing conditions. This results from flow confinement by the I-5 bridge complex and narrower offset levees through this section of Reach 4. As a result, this section of Reach 4 is expected to experience rates of bank erosion and instability that are higher than historic levels.

Reach 5 (station 670+00 to station 580+00)
Reach 5 exhibits somewhat higher flow velocities and shear stresses for the Setback Levee Alternative than for existing conditions. This is due to increased flow confinement by the levee constructed on the north bank. Thus, rates of bank erosion and instability that are somewhat higher than historic levels can be expected in Reach 5. Concrete lining is proposed to protect against scour resulting from increases in velocity due at the I-5, 99W, and railroad bridge constriction.

Reach 6 (station 670+00 to station 780+00)
Reach 6 exhibits the lowest average values of flow velocity and shear stress for both existing and the Setback Levee Alternative. This is due to the very wide channel cross-section in this reach, resulting from historic gravel mining prior to 1996. Except for the 2-year flow, shear stress and velocity for the Setback Levee Alternative are similar to those for existing conditions. The cause of the abrupt declines in the Setback Levee Alternative velocity and shear stress for the 2-year flow in Figures 8 and 9 is due to differences in modeling of flow in the left overbank. These abrupt declines disappear in the with-project 25- and 100-year flood flows, both of which exhibit flow velocities and shear stresses similar to those for existing conditions. As a result, bank erosion and instability in Reach 6 is not expected to increase significantly for with-project conditions.

The Setback Levee Alternative increases the capacity of the existing channel by as much as 2.3 times, from 30,000 cfs to 70,000 cfs, by installing setback levees while maintaining the existing channel configuration. These modifications effectively increase conveyance capacity during flood events with return periods greater than the 25-year flood event. Along with increases in flood stage, the alternative also increases in-channel velocity and shear stresses in some locations, most notably in areas of channel constrictions (e.g. bridges). Calculated shear stresses and velocities at the bridges are estimated to be as high as 2.9 lbs/ft^2 and 14.5 fps, respectively. Figures 6 and 7 show shear stress and velocity profiles along the project reach. Lower channel velocities and shear stresses upstream of bridges occur as a result of increased floodplain conveyance and backwater conditions at bridge constrictions. Calculated shear stresses and velocities are reduced by as much as 0.7 lbs/ft and 2.3 fps upstream of bridge structures as a result of these modifications. To prevent bank erosion rock bank protection is proposed by CDM in areas where model results calculate high channel velocities (greater than 6 to 8 fps). Figure 9 shows the relative differences in shear stress between the Setback Levee Alternative and existing conditions for the 2, 10, 25, and 100-year peak discharges.

The proposed setback levee design was reviewed with respect to potential impacts to main channel stability. The present channel configuration has a design capacity of 30,000 cfs (Corps 2001). The setback levee alternative proposes to increase the overall channel capacity to 70,000 cfs, corresponding to the 200-year peak flood discharge by removing or raising sections of the existing levee and constructing new levees setback from the existing channel. In-stream stability measures developed by CDM (Corps, 2001b) to stabilize the creek include constructing approximately 5.7 miles of rock bank protection and lining the bridge inverts with concrete. Based on initial review of calculated shear stresses and channel velocities from the HEC-RAS project conditions model, these stability measures with routine inspection and maintenance appear to be sufficient to maintain channel stability for the 50 year life of the project. However, a significant increase in maintenance could result with this alternative because it promotes several abrupt changes in flow characteristics within the project reach during less frequent flood events. River morphology tends to adjust in plan and profile to reduce abrupt changes in hydraulic and sediment transport characteristics.

Alternative methods of bank protection such as rock groins, barbs, channel widening, and reducing bank slopes could reduce the amount and cost of the rock bank protection for the Setback Levee Alternative. The use of rock structures, such as streambarbs, to reduce velocities on the outside of bends and the construction of benched surfaces could potentially reduce the rock bank protection needs, conceivably by as much as 25 percent. However, these structures typically have higher design costs, unit construction costs and require more area for bench construction than rock blankets. A further increase in the distance between the setback levees and the channel reduces the potential for the channel to migrate into the levee prism. Construction of setback levees and removal of the existing levees helps to reduce in-channel velocities and depths at discharges greater than bankfull between constrictions. In the Setback Levee Alternative, flows contained within the setback levees return to the channel at constriction points, i.e. bridges, substantially increasing channel velocities and shear stresses at these locations than under existing conditions. These areas will require engineered re-entry points to prevent bank erosion and gully formation in the floodplain. The construction of this alternative dramatically changes the in channel hydrologic regime during less frequent, channel topping flood flows and should therefore be designed to minimize abrupt changes in hydraulic characteristics.

5.0 OPERATIONS AND MAINTENANCE

DWR reports the annual operations and maintenance costs of $10,000/mi in the Lower Cache Creek channel (McQuirk 2001). Current O&M consists primarily of channel clearing, weed abatement, and rodent impact management (Romero 2001). Maintenance to stabilize the channel and banks has not been conducted for the last 15 to 20 years. However, the recent high flows in 1995 and 1997 have caused bank erosion in three sites in the project reach. DWR is investigating these bank erosion sites. Cost estimates for these activities were not available at the time of this reporting.

The 1958 Yolo Bypass to High Ground Levee Construction General Design Memorandum states that 6410 lineal feet of stone protection was to be placed in the channel. At the time of this writing the construction of the stone protection could not be confirmed by the USACE or DWR (Boedtker 2001, McQuirk 2001). DWR does not currently maintain any rock bank protection within the main channel of Cache Creek in the project reach (Romero 2001).

Construction of the Setback Levee Alternative increases the range of flood events conveyed within the channel. To mitigate against higher anticipated boundary shear stresses approximately 5.7 miles of rock bank protection is proposed. Increases in boundary shear and the routine maintenance of the proposed rock bank protection will increase O&M costs above existing O&M costs. Within those regions in Reaches 1, 2, 3, and 4 where average velocities and shear stress are reduced, sediment accumulation may occur, potentially requiring future maintenance to remove deposits. This increase will include routine maintenance on the existing rock and maintenance of channel banks during large flood events. An approximate annual O&M cost for the Setback Levee Alternative is 0.014 x total project rock cost + weed abatement and rodent control.

Based on the information provided by DWR, examination of the Corp's HEC-RAS model and the discussion above, the following key points are listed below:

- Current maintenance practices are focused on annual channel clearing, weed abatement, and rodent impact management. Channel stabilization activities are conducted infrequently as they are deemed necessary.
- To ensure satisfactory performance of rock bank protection, rock work should be annually inspected and periodically maintained.
- Current Corps and DWR maintenance records of Cache Creek and similar channels should be reviewed to more accurately identify maintenance costs for proposed alternatives.
- Design of selected the project alternative should consider changes in flow hydraulics to estimate potential maintenance requirements.

6.0 SETTLING BASIN

The project impacts on the Settling Basin were assessed using existing analyses and information published in the Investigations of Alternative Plans for Control of Sediment from Cache Creek (DWR, 1968), the Cache Creek Settling Basin Final General Design Memorandum (Corps, 1987), and numerical results calculated from the MBK FLO-2D model of the Settling Basin for the existing conditions and the Flood Barrier Alternative. Both the 1968 DWR and 1987 USACE reports assess sediment deposition and trap efficiency in the Settling Basin.

Measured sediment data has been collected on Cache Creek at Yolo since 1943 to present. The Corps (1987) reports that 93 percent of the total sediment load passing the Yolo gage is suspended sediment with the remaining 7 percent transported as bed load. Approximately 86 percent of the suspended load at Yolo is less than 0.064 mm, silts and clays.

The annual suspended sediment inflow into the Settling Basin between 1904 and 1963 is estimated to be 675 acre-ft (DWR 1968). An annual deposition rate of 340 acre-feet was calculated between 1934 and 1968 (DWR 1968). The 1987 USACE estimate of trap efficiency through time is shown in Figure 10. This estimate for trap efficiencies is based on the current channel design capacity of 30,000 cfs and training levee configuration. Raising the Settling Basin outlet weir 25 years from initiation of the project produced an average trap efficiency of 55 percent over a 50 year period. Assuming that time zero corresponds with the date of construction, 1991, then the analysis estimates a trap efficiency of approximately 45 percent at the time of this writing, 2001. Sediment loadings from single flood events were not identified in the DWR and Corps reports.

The proposed Setback Levee alternative and the Flood Barrier Alternatives affect the Settling Basin performance in several ways. These alternatives route more water and sediment into the Settling Basin than would have otherwise left the channel onto the floodplain and not entered the channel under the current conditions. In doing so, these alternatives increase the magnitude of maximum inflow and outflow discharges and volume of runoff entering the basin during flood events. Generally, both flood control alternatives will reduce the sediment storage capacity at a more rapid rate, thereby more rapidly reducing the trap efficiencies through time than under current channel conditions. Quantification of the changes in rates is beyond the scope of this study, but should be assessed for project design. Presumably, with the Flood Barrier Alternative much of the sediment will deposit in overbank areas, south of the Cache Creek, before returning to the settling basin creating a much smaller increase in peak discharge and sediment inflow than would the Setback Levee Alternative which routes flood flows with a relatively high sediment transport potential directly to the Settling Basin. The Flood Barrier Alternative should have a significantly lower impact to the overall long-term performance of the basin than the Setback Levee Alternative.

Velocities in the basin during the peak inflowing discharges for the 50 and 200-year flood events were reviewed to assess the potential impact on deposition of fine sediments and scour during high flow. Figures 11, 12, and 13 show maximum velocity contour maps of the entire simulation period. These contour data were generated from FLO-2D data provided by MBK. The existing conditions plan simulates the existing channel and Settling Basin conditions. Plan A simulates the Flood Barrier Alternative with a 4,000 feet section of the west settling basin weir removed. Flood hydrographs for the 50-year and 200-year flood events were routed from Road 94B. The peak discharge entering the Settling Basin in the existing conditions is 25,300 cfs. The peak discharge entering the Settling Basin for the Flood Barrier Alternative is 37,000 and 45,600 cfs for the 50-year and 200-year flood events, respectively. Maximum velocities through the settling basin for the existing conditions 50-year flood event, 53,000 cfs range from 8 fps at the training levee outlet to a low near 0 fps in the lee of the training levee. The Flood Barrier Alternative, Plan A, calculates a velocities range similar to the existing conditions. Comparison between the maximum velocities shows that generally maximum velocities are 1 and 3 fps for the majority of the basin in each of the three plots. Plan A would increase velocities by less than 1 fps through most of the basin over existing conditions. Comparison of the velocities between the existing conditions and Plan A at a discharge of 70,000 cfs indicates basin maximum velocities will increase approximately 0 to 1.5 fps throughout most of the basin with larger increases occurring near the inlet of the basin. Maximum velocities for Plan A for a discharge of 70,000 cfs range from 1 to 5 fps throughout most of the basin with higher velocities at the inlet to the basin. . Permissible velocities range from 1 to 6.5 fps for loosely to very compacted cohesive soils. These relatively small increases of 1 to 1.5 fps in maximum velocity are unlikely to induce significant scour of the bottom sediments. Increases in maximum velocities indicate the impact of the Flood Barrier Alternative on resuspension of deposited material in the Settling Basin is likely low.

Future analysis could assess how time dependant changes in velocity influence trap efficiency and particle resuspension in the Settling Basin.

7.0 CONCLUSIONS & RECOMMENDATIONS

The qualitative geomorphic, and channel stability assessment conducted by nhc in the development of this memorandum is based on the review of readily available information. Furthermore, detailed study of the issues discussed herein is recommended prior to final design of the selected flood control alternative.

Under existing conditions the channel has remained generally stable in its planform with significant degradation of the invert since 1938. Flood events in excess of bankfull generally produce erosive velocities that may lead to bank erosion. Extended periods of high flows may induce sloughing of saturated banks as flows recede. Reaches 4 and 5 (Figure 1) exhibit signs of moderate to high channel instability. These reaches may suffer extreme bank erosion during storm flows. Stabilization measures are recommended in these reaches to maintain channel stability.

The Flood Barrier Alternative maintains the current channel capacities while stabilizing the areas identified as unstable. Additionally, this alternative has a significantly lower impact on routing flows to the Settling Basin. Flows overtopping the north levee are distributary to the Settling basin. Flows overtopping the south are conveyed across the floodplain at low velocities and shallow depths allowing time for infiltration, attenuation, and sediment deposition on floodplain. The Flood Barrier Alternative will have a significantly lower affect on Settling Basin sediment accumulation rates and trap efficiency than the Setback Levee Alternative. Quantification of sediment accumulation rates and changes in trap efficiencies are beyond the scope of this report but should be investigated prior to design.

The Setback Levee Alternative increases the current design capacity of the channel by approximately 2.3 times to 70,000 cfs. The significant increase in the magnitude and volume of flow that will be contained by the Setback Levee Alternative is likely to increase channel velocities and shear stresses during high flow events. Mitigation for the increase in velocity and shear stress will require substantial placement of bed and bank stabilization features (e.g. rock slope protection). Complete containment of flow with the Setback Levee Alternative will increase the total volume and magnitude of flow and sediment to the Settling Basin for events greater than channel topping flows. Rock slope protection is proposed along approximately 5.7 miles of bank to prevent erosion resulting from increase velocities for this alternative.

Qualitative assessment of the Settling Basin performance is based on previous studies (Corps, 1968; Corps, 1987). These studies calculated an annual trap efficiency of approximately 340 acre-feet. Over time as deposition occurs within the basin the trap efficiency of the basin is estimated to decrease. Figure 10 plots computed trap efficiency with time for the current conditions. Due to the more efficient routing characteristics of the Setback Levee Alternative the Settling Basin trap efficiency is presumed to decrease more rapidly with the construction of the Setback Levee Alternative than under both the current conditions and the Flood Barrier Alternative. Further analyses are required to recomputed expected changes in basin trap efficiencies for various project changes.

7.1 Key Unresolved Issues and Data Needs for Further Study and Project Design

- Future channel bed aggradation in Reaches 1 and 2 resulting from Settling Basin aggradation needs to be quantified and incorporated in design to ensure flow capacity;
- Channel stability due to abrupt local changes in transport potential, observed primarily for the Setback Levee Alternative should be assessed;

- Under the Setback Levee Alternative, further analyses and/or design are required to ensure bank erosion and gully formation in the floodplain does not occur as a result of flows reentering the channel from the floodplain.
- Changes in sediment supply (sediment loading) to the project reach as a result of the cessation of in-channel gravel mining should be quantified to determine the impact on the project alternatives and Settling Basin performance;
- The potential for levee instability at Station 502+00, the location of a relic slough channel, due to subsurface flow should be investigated.
- Measures to prevent bank erosion and gully formation in the floodplain as a result of flows reentering the channel under the Setback Levee Alternative should be designed.

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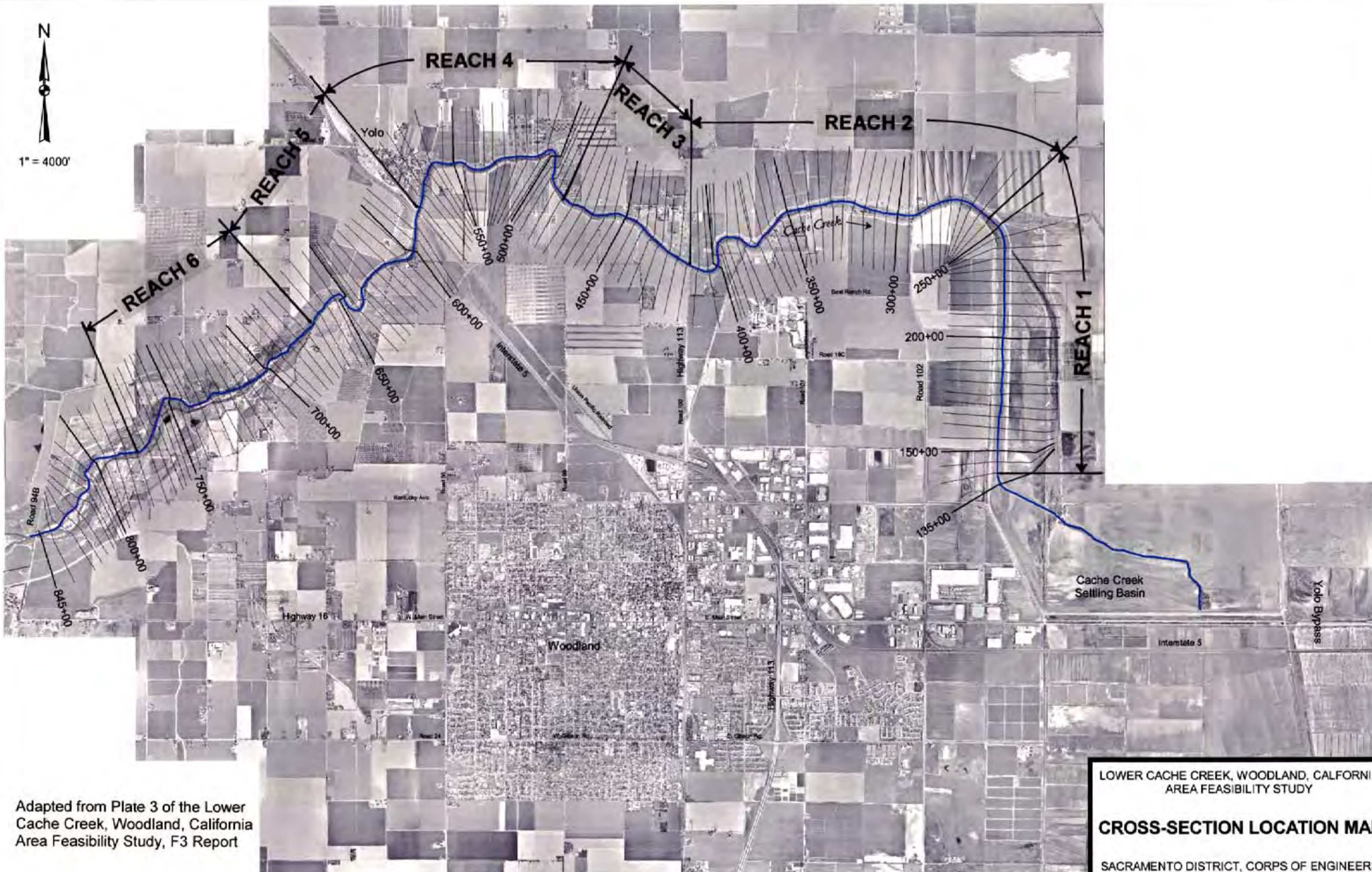


Adapted from Plate 3 of the Lower Cache Creek, Woodland, California Area Feasibility Study, F3 Report

LOWER CACHE CREEK, WOODLAND, CALFORNIA
AREA FEASIBILITY STUDY

CROSS-SECTION LOCATION MAP

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
FEBRUARY 2001

Figure 1

Cache Creek
Longitudinal Profiles

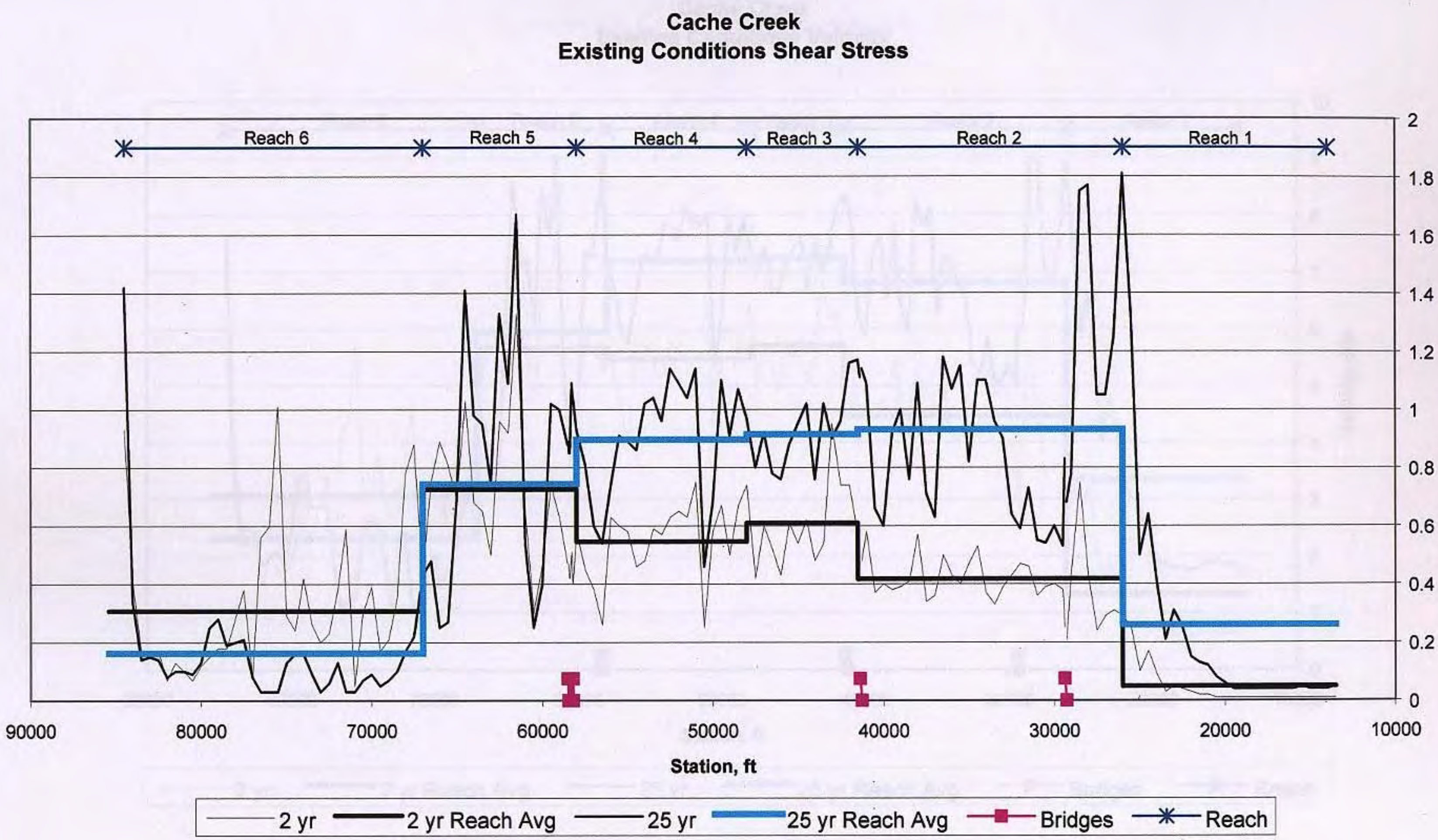
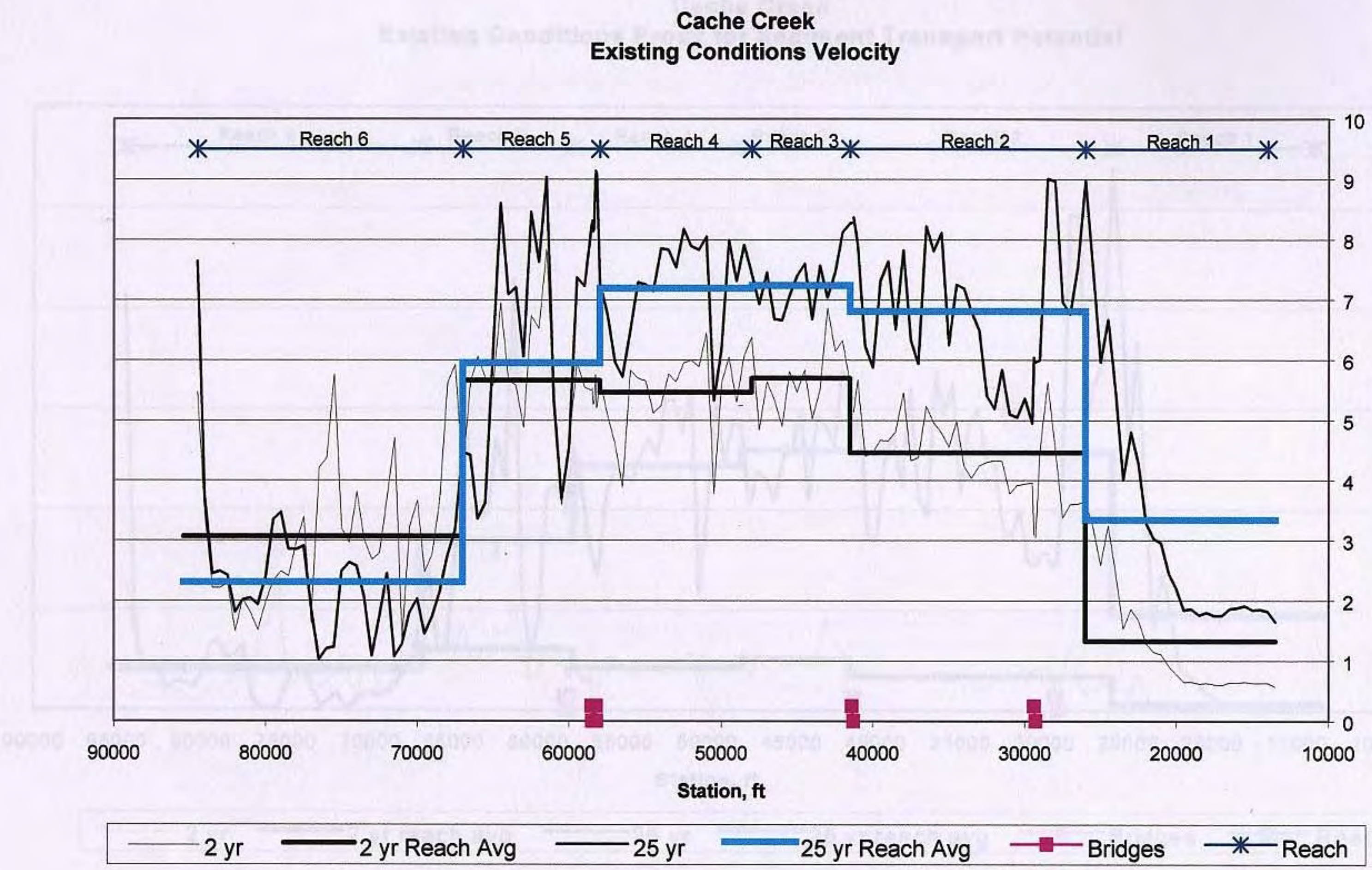
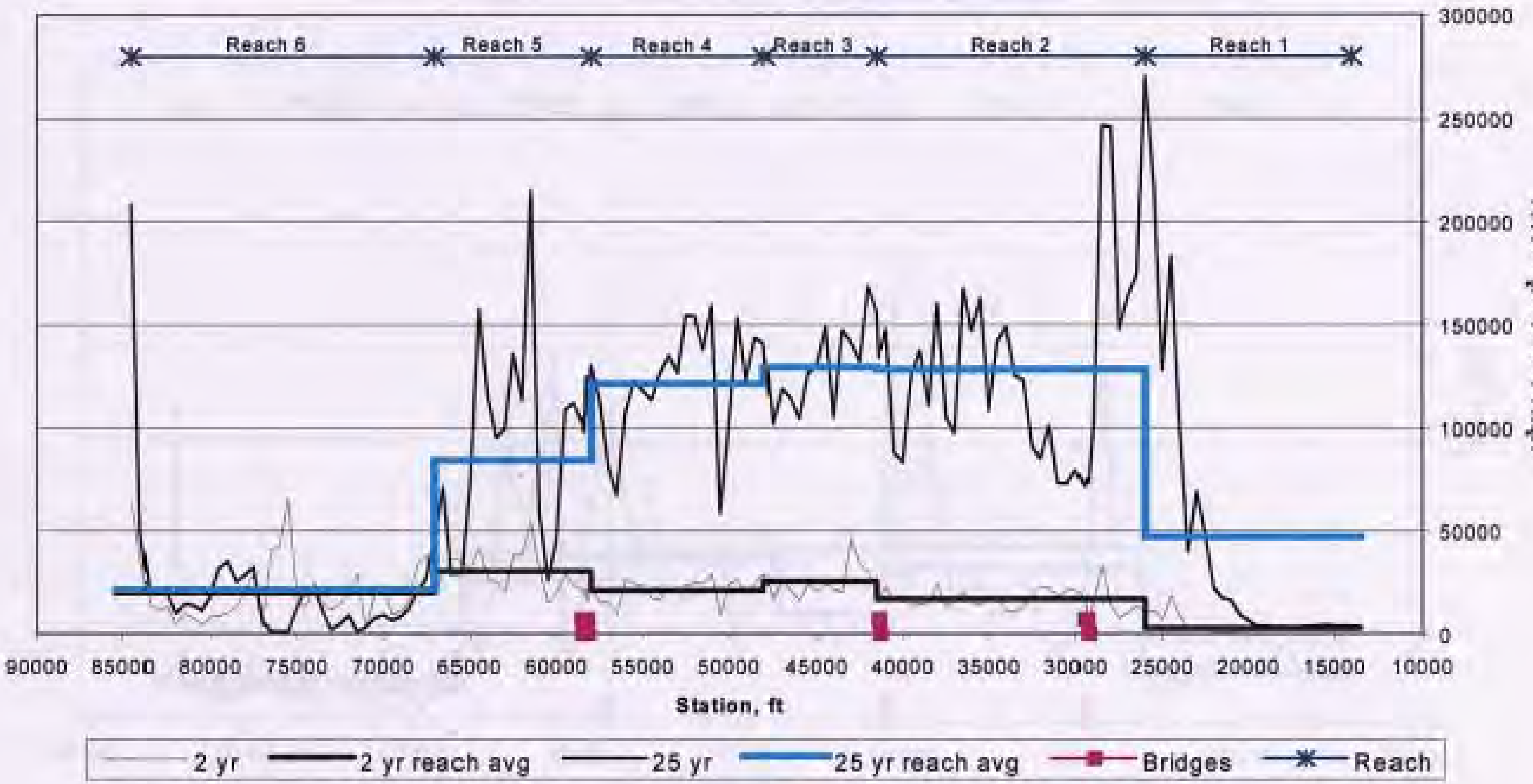

Cache Creek
Existing Conditions Shear Stress
Reach 6
Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Shear, lbs/ft^2
90000
80000
70000
60000
50000
40000
30000
20000
10000
Station, ft
2 yr
2 yr Reach Avg
25 yr
25 yr Reach Avg
Bridges
Reach

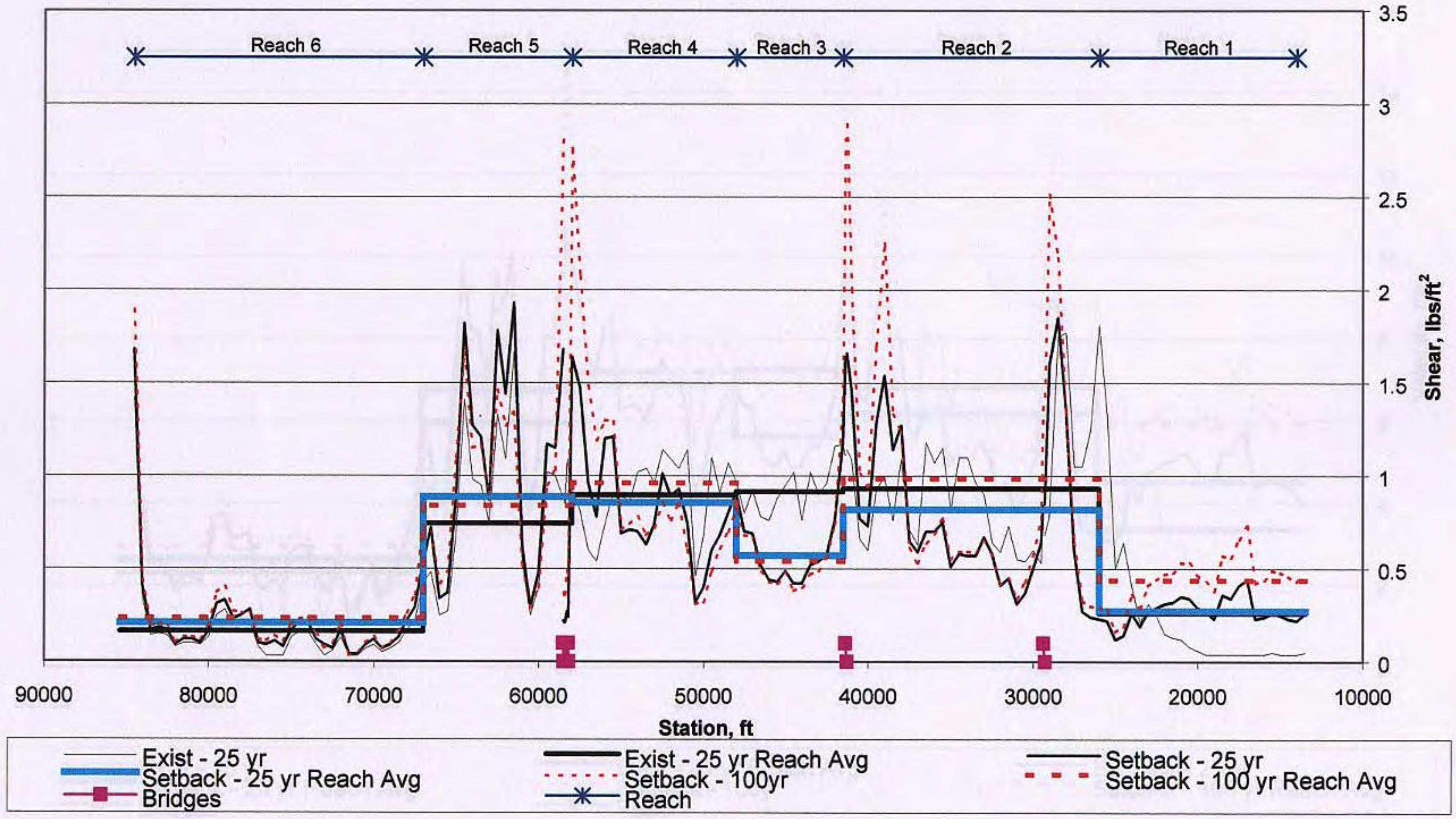
Figure 3


Cache Creek
Existing Conditions Velocity
Reach 6
Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
Velocity, ft/s
Station, ft
10
9
8
7
6
5
4
3
2
1
0
90000
80000
70000
60000
50000
40000
30000
20000
10000
2 yr
2 yr Reach Avg
25 yr
25 yr Reach Avg
Bridges
Reach

Cache Creek
Existing Conditions Proxy for Sediment Transport Potential

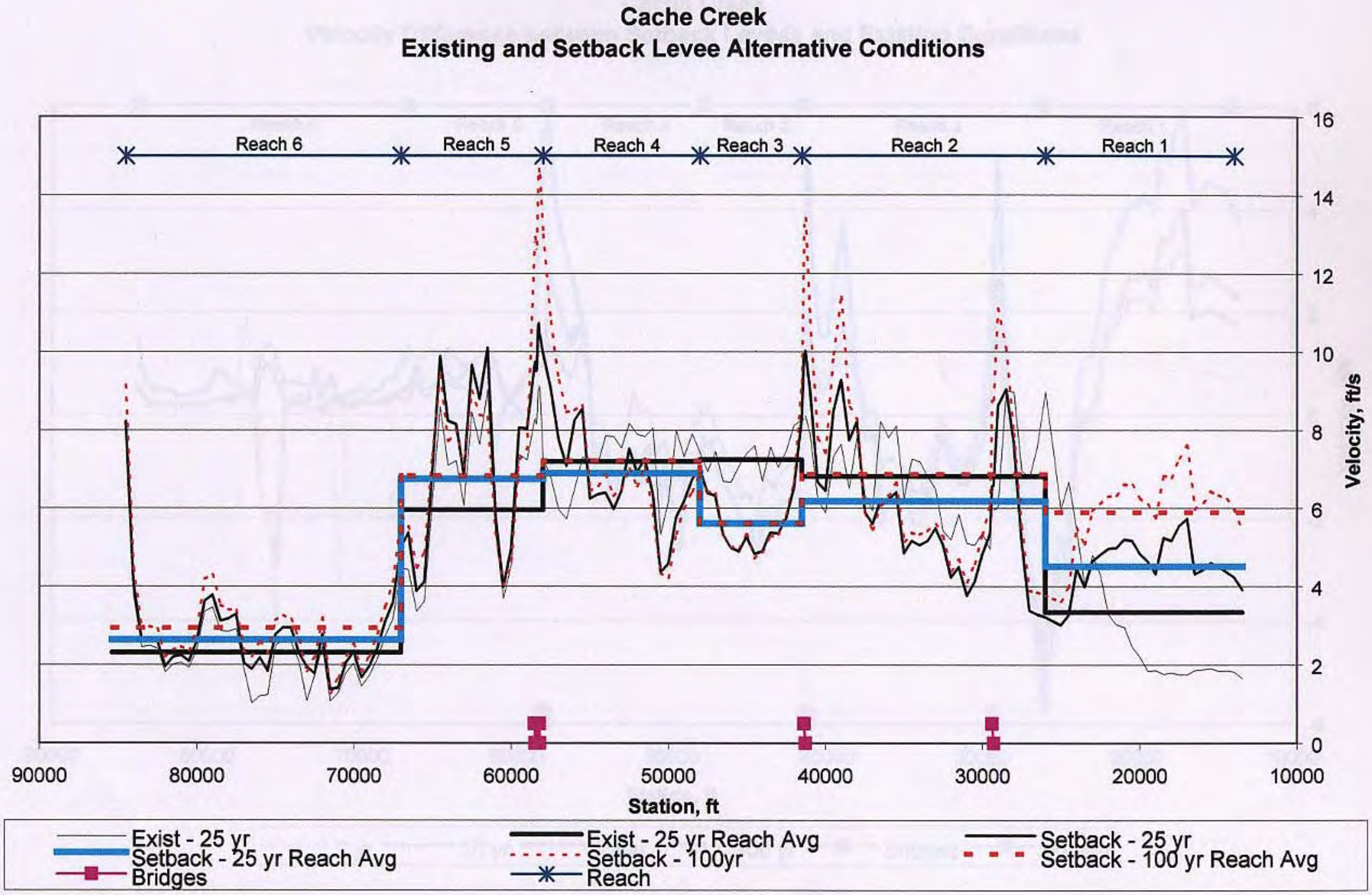


Cache Creek
Existing and Setback Levee Alternative Conditions



nhc

Figure 6


Cache Creek
Existing and Setback Levee Alternative Conditions
Reach 6
Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
16
14
12
10
8
6
4
2
0
Velocity, ft/s
90000
80000
70000
60000
50000
40000
30000
20000
10000
Station, ft
Exist - 25 yr
Setback - 25 yr Reach Avg
Bridges
Exist - 25 yr Reach Avg
Setback - 100yr
Reach
Setback - 25 yr
Setback - 100 yr Reach Avg

Cache Creek
Velocity Difference between Setback Levees and Existing Conditions

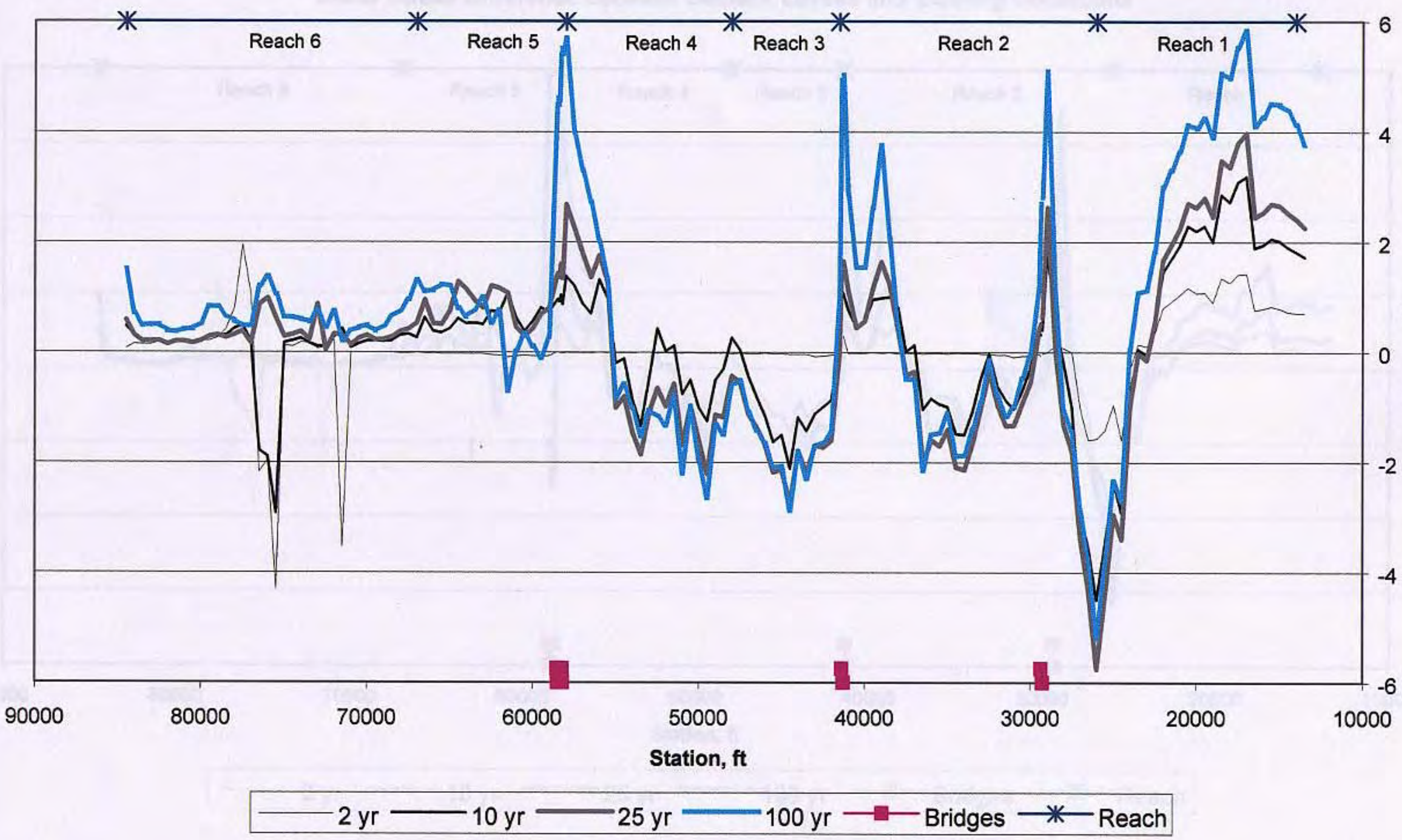


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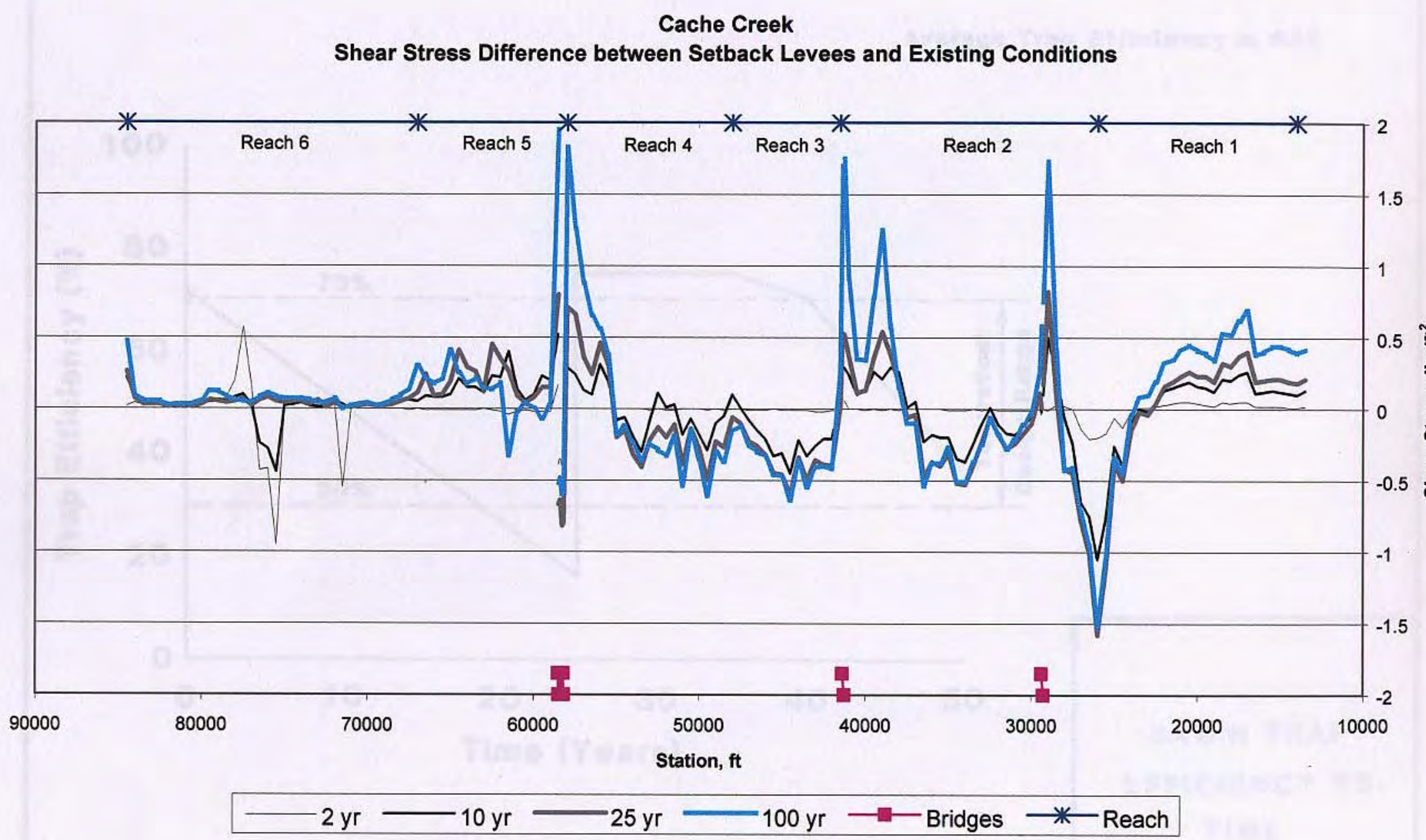
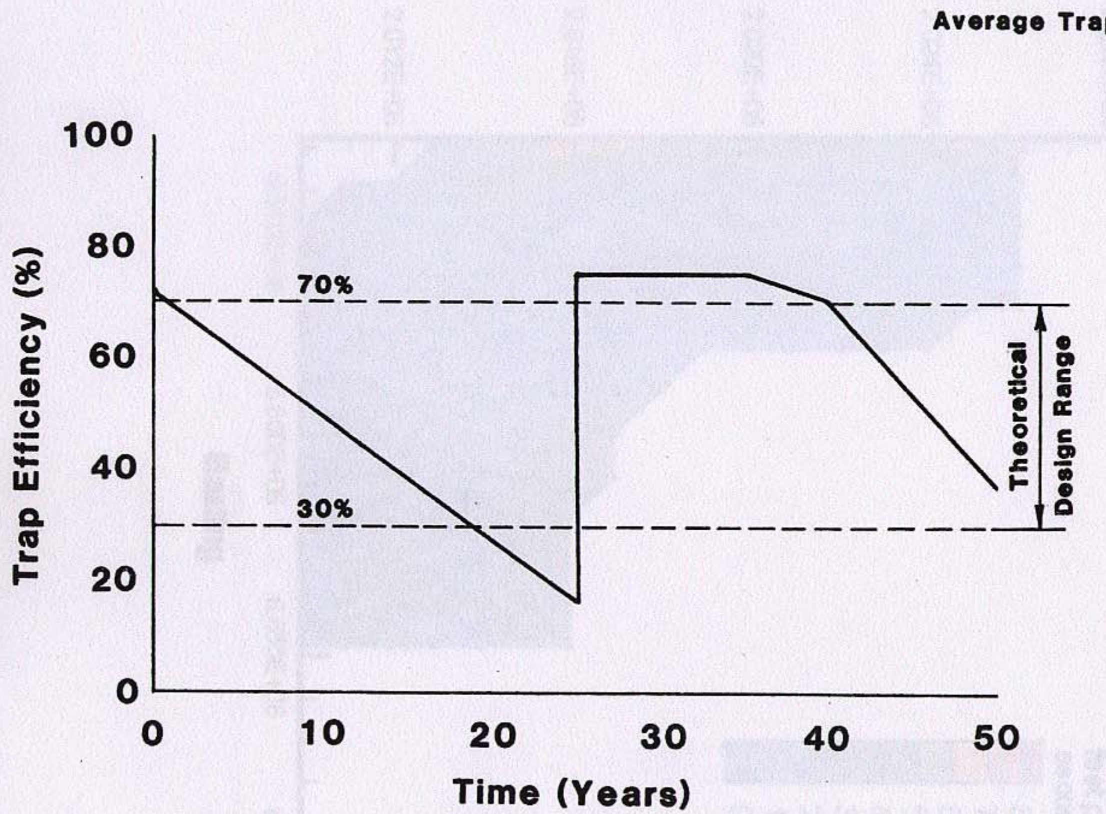
Figure 8

Lower Cache Creek
Qualitative Geomorphic and Channel Assessment

September 12, 2001

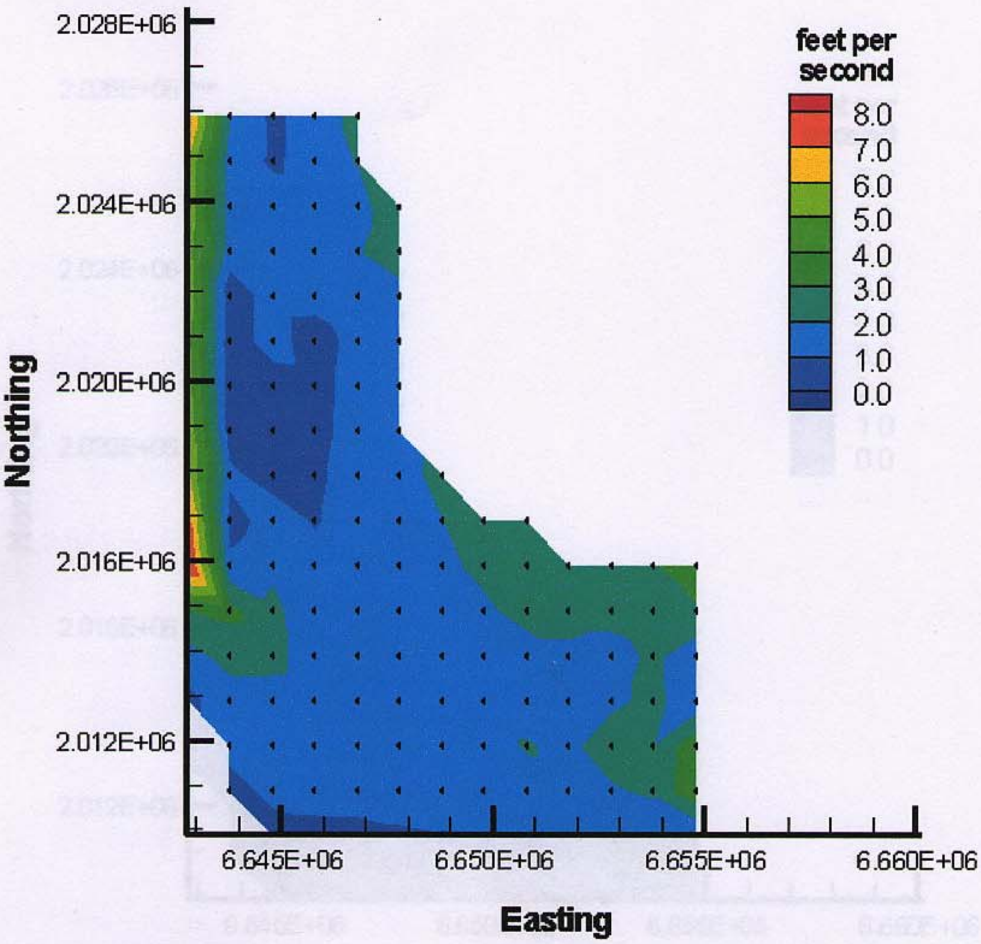


Cache Creek
Shear Stress Difference between Setback Levees and Existing Conditions
Reach 6
Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Shear Stress, lbs/ft^2
90000
80000
70000
60000
50000
40000
30000
20000
10000
Station, ft
2 yr
10 yr
25 yr
100 yr
Bridges
Reach

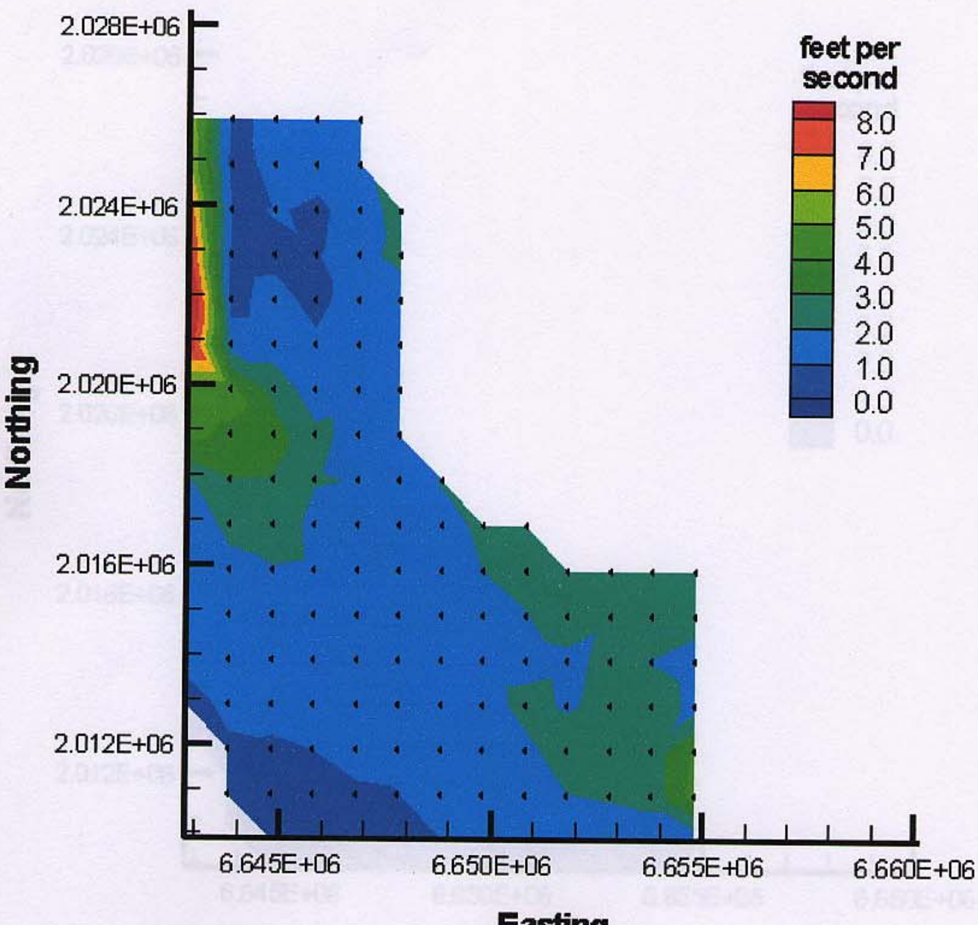


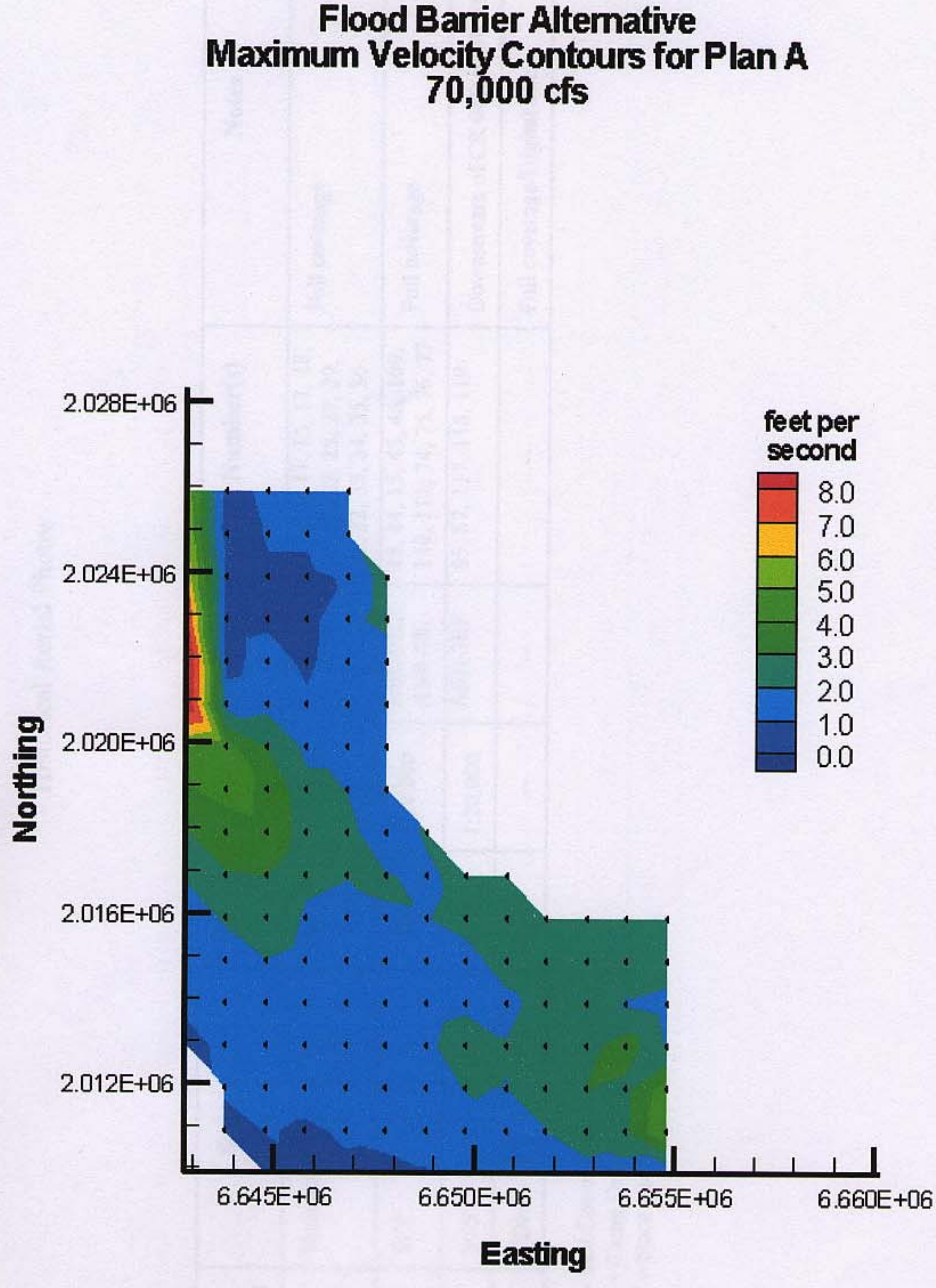
BASIN TRAP EFFICIENCY VS. TIME

Existing Conditions
Maximum Velocity Contours
53,000 cfs



Flood Barrier Alternative
Maximum Velocity Contours for Plan A
53,000 cfs





Flood Barrier Alternative
Maximum Velocity Contours for Plan A
70,000 cfs
feet per second
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2.028E+06
2.024E+06
2.020E+06
2.016E+06
2.012E+06
Northing
6.645E+06
6.650E+06
6.655E+06
6.660E+06
Easting

Historical Aerial Photos

Aerial Photo Date	Source	B&W/ Color	Scale	Series	Print Number(s)	Notes
1937	National Archives	B&W	1:20,000	--	5, 7, 13, 11, 15, 17, 18, 19, 21, 23, 25, 27, 29, 31, 32, 33, 34, 35, 36	Full coverage
1952	SCS	B&W	1:20,000	ABB-3K, ABB-5K	13, 14, 15, 45, 46, 109, 110, 111; 74, 75, 76, 77	Full coverage
1964	SCS	B&W	1:20,000	ABB-3EE	85, 87, 117, 118, 119	Downstream of CR 94B to SR 113
2000	CDM	B&W	--	--	--	Full coverage/Digital File

Notes: SCS = Soil Conservation Service
CDM = Camp Dresser McKee
B&W = black and white

Historical Topographic Maps

Map Name	Author	Edition	Surveyed	Scale	Contour Interval (feet)	Notes
Madison	USGS	1968	1953	1:24,000	5	Photorevised with 1968 aerial photographs
Grays Bend	USGS	1953	1953	1:24,000	5	
Woodland	USGS	1981	1952	1:24,000	5	Photorevised with 1981 aerial photographs
Madison	USGS	1980	1953	1:24,000	5	Photorevised with 1980 aerial photographs
Grays Bend	USGS	1975	1953	1:24,000	5	Photorevised with 1968 and 1975 aerial photographs
Woodland	USGS	1952	1952	1:24,000	5	
Madison	USGS	1953	1953	1:24,000	5	
Woodland	USGS	1968	1952	1:24,000	5	Photorevised with 1968 aerial photographs

Lower Cache Creek Reach Average Characteristics

Reach	Active Top Width				Max Flow Depth			
	Existing Cond 2-year Flow	Prop Cond 2-year Flow	Existing Cond 100-year Flow	Prop Cond 100-year Flow	Existing Cond 2-year Flow	Prop Cond 2-year Flow	Existing Cond 100-year Flow	Prop Cond 100-year Flow
1	592	602	624	649	17.0	17.4	19.6	23.8
2	199	212	415	420	19.8	20.3	30.6	31.7
3	135	136	338	354	19.8	20.0	35.0	37.0
4	128	128	327	318	21.7	21.8	38.9	38.1
5	170	171	432	460	19.5	19.6	38.0	40.5
6	767	777	1255	1292	13.7	13.8	25.7	29.2

Reach	Mean Flow Depth*				Energy Slope**			
	Existing Cond 2-year Flow	Prop Cond 2-year Flow	Existing Cond 100-year Flow	Prop Cond 100-year Flow	Existing Cond 2-year Flow	Prop Cond 2-year Flow	Existing Cond 100-year Flow	Prop Cond 100-year Flow
1	9.0	9.2	10.8	14.6	0.00008	0.00013	0.00040	0.00052
2	12.7	12.6	14.4	15.3	0.00062	0.00060	0.00119	0.00120
3	13.7	13.8	16.0	17.3	0.00082	0.00078	0.00101	0.00056
4	15.2	15.2	16.9	16.7	0.00067	0.00066	0.00095	0.00101
5	13.0	13.0	18.6	20.1	0.00101	0.00101	0.00079	0.00099
6	6.6	6.7	14.4	17.4	0.00072	0.00072	0.00018	0.00022

Reach	Channel Velocity			
	Existing Cond 2-year Flow	Prop Cond 2-year Flow	Existing Cond 100-year Flow	Prop Cond 100-year Flow
1	1.3	2.0	3.3	5.9
2	4.5	4.3	6.8	6.9
3	5.7	5.6	7.2	5.6
4	5.5	5.4	7.2	7.2
5	5.7	5.6	6.1	7.0
6	3.1	3.1	2.3	2.9

* Channel hydraulic depth
** Total energy slope
Note: Differences between the existing and proposed conditions for the 2-year peak discharges are likely artifacts in the model

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix J

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX J

(Not Used)

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix K

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX K

Cost Estimates

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX K

Cost Estimates

APPENDIX K

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COST ESTIMATES

Appendix K presents cost estimates developed for the plans evaluated in the feasibility study. Estimates were developed for five preliminary plans and three sub-plans and used to select two plans for further study. The two selected plans were then evaluated in terms of several design flows to allow project net benefits to be optimized for each plan.

Based upon the results of the screening of the preliminary plans and several refinements, the Lower Cache Creek Flood Barrier (LCCFB) Plan and the Modified Wide Setback Levee (MWSL) Plan were analyzed in more detailed evaluation. The costs for various design flows for each of these plans are presented in Tables K-1 through K-14.

Cost estimates of the right-of-way required for the selected plans were developed from data (cost per acre values) for the land use types found in the project area developed by the Corps Acquisition Branch. For preliminary planning purposes, market data (recent sales and current listings) of properties similar to those in the project area were examined to develop the cost per acre by land use values used in the study. The cost of lands and damages was assumed to be $3,500 per acre in the preliminary screening phase. Right-of-way costs were refined to evaluate the LCCFB and MWSL Plans and are indicated in the Real Estate Plan (Appendix F).

Non-Federal and Federal administrative costs to acquire the necessary real estate interests required for the LCCFB and MWSL Plans have been included in the draft feasibility report. These costs are based upon recent DWR experience with real estate acquisitions, costs, plus estimated Federal administrative review costs. These administrative costs were not considered in the preliminary screening phase.

Costs for Fish and Wildlife mitigation are based upon field surveys of the types and amounts of habitat affected by the respective plans multiplied by mitigation ratios and unit costs for various types of mitigation. Mitigation ratios were developed from consultations with Fish and Wildlife staff; unit costs are based upon recent Corps experience on other projects in the Sacramento area.

Cost estimates for Cultural Resource Preservation, Engineering, and Construction Management were assumed to be 1 percent, 12 percent and 8.5 percent, respectively, of the construction plus mitigation costs (Total Construction Cost) for the evaluation of both the preliminary and final plans. Cultural Resources Preservation costs do not include data recovery costs, which are expected to be small and will be determined at a later date.

While the costs for these plans 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 would be negligible and 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). Crown widths will be refined for the selected plan, and related effects will be described in the Final Feasibility Report/EIS-EIR. Analyses of the effects of levee crown widths up to 20 feet are included in Appendixes F and the Draft EIS/EIR and are shown in Tables K-15 and K-16.

Table K-1

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

53,000 cfs Design with Inlet Weir (Elev. 45') 2000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	**LANDS AND DAMAGES**[1]	1	LS	8,577,420				**8,577,400**
02	**RELOCATIONS**							
	Utilities (3% of total construction cost)	3	%	610,746				610,700
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Building Floodproofing (Raising Homes)	25	EA	60,000.00	1,500,000	525,000	35%	2,025,000
	County Road 19B Raising							
	AC (asphalt concrete)	0	Ton	50.00	0	0	20%	0
	Aggregate Base Class II	0	Ton	20.00	0	0	20%	0
	Aggregate Subbase	0	Ton	15.00	0	0	20%	0
	Pulverize and Blend	0	SY	3.00	0	0	20%	0
	Striping	0	LF	1.50	0	0	20%	0
	Clear & Grub	0	AC	1,500.00	0	0	20%	0
	Culvert (18")	20	LF	35.00	700	140	20%	800
	Headwalls (sacked concrete slope protection)	1.2	CY	500.00	600.00	120	20%	700
	County Road 97A Raising							
	AC (asphalt concrete)	292	Ton	50.00	14,600	2,920	20%	17,500
	Aggregate Base Class II	874	Ton	20.00	17,480	3,496	20%	21,000
	Aggregate Subbase	0	Ton	15.00	0	0	20%	0
	Pulverize and Blend	208	SY	3.00	624	125	20%	700
	Striping	1,506	LF	1.50	2,259	452	20%	2,700
	Clear & Grub	0.23	AC	1,500.00	345	69	20%	400
	Culvert (36")	60	LF	85.00	5,100	1,020	20%	6,100
	Headwalls (sacked concrete slope protection)	1.3	CY	500.00	650.00	130	20%	800
	State Highway 16 Raising							
	AC (asphalt concrete)	670	Ton	50.00	33,500	6,700	20%	40,200
	Aggregate Base Class II	2,513	Ton	20.00	50,260	10,052	20%	60,300
	Aggregate Subbase	432	Ton	15.00	6,480	1,296	20%	7,800
	Pulverize and Blend	3,080	SY	3.00	9,240	1,848	20%	11,100
	Striping	2,310	LF	1.50	3,465	693	20%	4,200
	Clear & Grub	0.35	AC	1,500.00	525	105	20%	600
	Culvert (60")	80	LF	150.00	12,000	2,400	20%	14,400
	Headwalls (sacked concrete slope protection)	3.6	CY	500.00	1,800.00	360	20%	2,200
	County Road 99 Raising							

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-1
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

53,000 cfs Design with Inlet Weir (Elev. 45') 2000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	AC (asphalt concrete)	667	Ton	50.00	33,350	6,670	20%	40,000
	Aggregate Base Class II	2,001	Ton	20.00	40,020	8,004	20%	48,000
	Aggregate Subbase	7,165	Ton	15.00	107,475	21,495	20%	129,000
	Pulverize and Blend	4,089	SY	3.00	12,267	2,453	20%	14,700
	Striping	3,450	LF	1.50	5,175	1,035	20%	6,200
	Clear & Grub	0.52	AC	1,500.00	780	156	20%	900
	Culvert (2-60")	160	LF	150.00	24,000	4,800	20%	28,800
	Headwalls (sacked concrete slope protection)	6.0	CY	500.00	3,000.00	600	20%	3,600
	Frontage Road Dubach Field							
	AC (asphalt concrete)	131	Ton	50.00	6,550	1,310	20%	7,900
	Aggregate Base Class II	261	Ton	20.00	5,220	1,044	20%	6,300
	Aggregate Subbase	6,356	Ton	15.00	95,340	19,068	20%	114,400
	Pulverize and Blend	978	SY	3.00	2,934	587	20%	3,500
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	Culvert (3-60")	120	LF	150.00	18,000	3,600	20%	21,600
	Headwalls (sacked concrete slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Churchill Downs Raising							
	AC (asphalt concrete)	387	Ton	50.00	19,350	3,870	20%	23,200
	Aggregate Base Class II	1,450	Ton	20.00	29,000	5,800	20%	34,800
	Aggregate Subbase	1,363	Ton	15.00	20,445	4,089	20%	24,500
	Pulverize and Blend	1,778	SY	3.00	5,334	1,067	20%	6,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	County Road 101 (Pioneer) Raising							
	AC (asphalt concrete)	1,044	Ton	50.00	52,200	10,440	20%	62,600
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	17,896	Ton	15.00	268,440	53,688	20%	322,100
	Pulverize and Blend	6,400	SY	3.00	19,200	3,840	20%	23,000
	Striping	5,400	LF	1.50	8,100	1,620	20%	9,700
	Clear & Grub	0.83	AC	1,500.00	1,245	249	20%	1,500
	Culvert (3-60")	240	LF	150.00	36,000	7,200	20%	43,200
	Headwalls (sacked concrete slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	County Road 102 Raising							
	AC (asphalt concrete)	2,480	Ton	50.00	124,000	24,800	20%	148,800
	Aggregate Base Class II	8,280	Ton	20.00	165,600	33,120	20%	198,700
	Aggregate Subbase	36,164	Ton	15.00	542,460	108,492	20%	651,000
	Pulverize and Blend	8,440	SY	3.00	25,320	5,064	20%	30,400

Table K-1
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

53,000 cfs Design with Inlet Weir (Elev. 45') 2000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Striping	5,700	LF	1.50	8,550	1,710	20%	10,300
	Clear & Grub	2	AC	1,500.00	3,000	600	20%	3,600
	Culvert (3-60")	360	LF	150.00	54,000	10,800	20%	64,800
	Headwalls (sacked concrete slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Total Relocations							**5,257,100**
06	**FISH AND WILDLIFE MITIGATION**[2]	1	LS	1,353,000.00	1,353,000	244,000	18%	1,597,000
08	**ROADS**							
	Levee Patrol Roads - Levee (4" aggregate base)	8,876	TON	20.00	177,520	35,504	20%	213,000
09	**CHANNELS AND CANALS**							
	Mobilization & Demobilization	1	LS	250,000.00				0
	Clearing and Grubbing	31	AC	1,500.00	46,500.00	9,300	20%	55,800
	Excavation	133,334	CY	5.00	666,670	133,334	20%	800,000
	Seeding	27	AC	2,500.00	67,500	13,500	20%	81,000
	Reinforced Concrete Pipe (60")	1,350	LF	150.00	202,500	40,500	20%	243,000
	Bore and Jack (60" RCP, I-5))	750	LF	1,000.00	750,000	150,000	20%	900,000
	Bore and Jack (60" RCP, SH 113)	600	LF	1,000.00	600,000	120,000	20%	720,000
	Inlet and Outlet Structures (I-5 and SH-113)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Box Culvert (West Levee into Settling Basin 3'x3')	150	LF	300.00	45,000	9,000	20%	54,000
	Box Culvert (LCCFB to City Drain, 3'x3')	1,800	LF	300.00	540,000	108,000	20%	648,000
	Inlet and Outlet Structures (West Levee, City Drain)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Closure Structure (Slide Gates) for Box Culverts	2	EA	20,000.00	40,000	8,000	20%	48,000
	Flap Gates (for Box Culverts)	2	EA	5,500.00	11,000	2,200	20%	13,200
	Total Channels and Canals							**3,620,600**
11	**LEVEES AND FLOODWALLS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Stop Log Structure - County Road 102							
	Concrete	61	CY	500.00	30,500	6,100	20%	36,600
	Reinforcing Steel	4,183	LB	0.80	3,346	669	20%	4,000
	Stop Log Structure - County Road 101 (Pioneer)							

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-1
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

53,000 cfs Design with Inlet Weir (Elev. 45') 2000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Concrete	0	CY	500.00	0	0	20%	0
	Reinforcing Steel	0	LB	0.80	0	0	20%	0
	Stop Log Structure - Highway 113							
	Concrete	120	CY	500.00	60,000	12,000	20%	72,000
	Reinforcing Steel	8,229	LB	0.80	6,583	1,317	20%	7,900
	Stop Log Structure - Frontage Rd. Dubach Field							
	Concrete	67	CY	500.00	33,500	6,700	20%	40,200
	Reinforcing Steel	4,595	LB	0.80	3,676	735	20%	4,400
	Stop Log Structure - Railroad Crossing (I-5)							
	Concrete	89	CY	500.00	44,500	8,900	20%	53,400
	Reinforcing Steel	6,103	LB	0.80	4,882	976	20%	5,900
	Stop Log Structure - County Road 99							
	Concrete	74	CY	500.00	37,000	7,400	20%	44,400
	Reinforcing Steel	5,075	LB	0.80	4,060	812	20%	4,900
	Levee--New Construction							
	Mobilization & Demobilization	1	LS	25,000.00	25,000	5,000	20%	30,000
	Levee Embankment	309,433	CY	5.00	1,547,165	309,433	20%	1,856,600
	Excavation for Inspection Trench	55,515	CY	5.00	277,575	55,515	20%	333,100
	Removal of Settling Basin West Levee (3000')	83,000	CY	2.50	207,500	41,500	20%	249,000
	Removal of Training Levee (Settling Basin) (5250')	166,250	CY	2.50	415,625	83,125	20%	498,800
	Clearing and Grubbing	49.0	AC	1,000.00	49,000	9,800	20%	58,800
	Stripping (6 Inches)	41,030	CY	1.50	61,545	12,309	20%	73,900
	Rip rap/Stone Slope Protection (water side of levee)	40,607	TON	28.00	1,136,996	227,399	20%	1,364,400
	Bedding (for Slope protection)	14,695	TON	22.00	323,290	64,658	20%	387,900
	Slope Protection Cover (Soil)	56,518	CY	5.00	282,590	56,518	20%	339,100
	Seeding	33.8	AC	2,500.00	84,500	16,900	20%	101,400
	Slurry Wall (from CR101 to west levee)	55200	SF	5.80	320,160	64,032	20%	384,200
	Rip rap/Stone Slope Protection (1500' of RR near I-5)	2,250	TON	28.00	63,000	12,600	20%	75,600
	Bedding (for Slope protection)	775	TON	22.00	17,050	3,410	20%	20,500
	West Levee Improvements							
	Slope Embankment (from 2:1 to 3:1)	52,270	CY	5.00	261,350	52,270	20%	313,600
	Rip rap/Stone Slope Protection	50,010	TON	28.00	1,400,280	280,056	20%	1,680,300
	Bedding (for Slope protection)	16,968	TON	22.00	373,296	74,659	20%	448,000

Table K-1
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

53,000 cfs Design with Inlet Weir (Elev. 45') 2000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing	8.3	AC	1,000.00	8,300	1,660	20%	10,000
	Stripping (6 inches)	6661.0	CY	1.50	9,992	1,998	20%	12,000
	Slope Protection Cover (Soil)	33,328	CY	5.00	166,640	33,328	20%	200,000
	Seeding	7.5	AC	2,500.00	18,750	3,750	20%	22,500
	Rip rap/Stone Slope Protection - I-5 (n/s of LCCFB)	3,910	TON	28.00	109,480	21,896	20%	131,400
	Bedding (for Slope protection)	1,347	TON	22.00	29,634	5,927	20%	35,600
	Total Levee -- New Construction							**9,150,400**
15	**FLOOD CONTROL AND DIVERSION STRUCTURES**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Inlet Weir (2000 ft long)							
	Roller Compacted Concrete	8,743	CY	100.00	874,300	174,860	20%	1,049,200
	Conventional Concrete	1,778	CY	500.00	889,000	177,800	20%	1,066,800
	Rip rap/Stone Slope Protection	5,940	TON	28.00	166,320	33,264	20%	199,600
	Geotextile Filter Fabric	6,667	SY	3.00	20,001	4,000	20%	24,000
	Gravel Backfill	3,486	TON	22.00	76,692	15,338	20%	92,000
	Compacted Structural Backfill	1,186	CY	10.00	11,860	2,372	20%	14,200
	Excavation	5,333	CY	5.00	26,665	5,333	20%	32,000
	Total Levee -- New Construction							**2,727,800**
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							**22,565,900**
18	**CULTURAL RESOURCE PRESERVATION**	1	%					**225,700**
20	**PERMANENT OPERATING EQUIPMENT**							
	Flood Warning System	1	LS	$1,000,000.00	1,000,000	200,000	20%	**1,200,000**
30	**PLANNING, ENGINEERING & DESIGN**	12	%					**2,707,900**
31	**CONSTRUCTION MANAGEMENT**	8.5	%					**1,918,100**
	TOTAL FIRST COST							**37,195,000**

Table K-1
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

INVESTMENT COST

53,000 cfs Design with Inlet Weir (Elev. 45’) 2000’ long, Ultimate Outlet Weir (Elev. 41’)

Description	Estimated Quantity	Unit	Total Cost $
INTEREST DURING CONSTRUCTION			
Interest Rate	6.125	%	
Construction Period	2	YR	
Project First Costs			37,195,000
Interest during Construction			
At midyear (year 1.5, and .5)			2,530,000
Outlays 60% first year, 40% second year			
TOTAL INVESTMENT COST			39,725,400

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		2,564,400
OPERATION AND MAINTENANCE				
LCCOB				48,000
Flood Warning System				25,000
County road damages				25,000
TOTAL ANNUAL COST				2,662,400

Table K-2

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

70,000 cfs Design with Inlet Weir (Elev. 45') 2500' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	**LANDS AND DAMAGES**[1]	1	LS	8,577,420.00				**8,577,400**
02	**RELOCATIONS**							
	Utilities (3% of total construction cost)	3	%	670,725.00				670,700
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Building Floodproofing (Raising Homes)	25	EA	60,000.00	1,500,000	525,000	35%	2,025,000
	County Road 19B Raising							
	AC (asphalt concrete)	218	Ton	50.00	10,900	2,180	20%	13,100
	Aggregate Base Class II	0	Ton	20.00	0	0	20%	0
	Aggregate Subbase	42	Ton	15.00	630	126	20%	800
	Pulverize and Blend	667	SY	3.00	2,001	400	20%	2,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0	AC	1,500.00	0	0	20%	0
	Culvert (18")	20	LF	35.00	700	140	20%	800
	Headwalls (sacked concrete Slope protection)	1.2	CY	500.00	600.00	120	20%	700
	County Road 97A Raising							
	AC (asphalt concrete)	389	Ton	50.00	19,450	3,890	20%	23,300
	Aggregate Base Class II	1,166	Ton	20.00	23,320	4,664	20%	28,000
	Aggregate Subbase	704	Ton	15.00	10,560	2,112	20%	12,700
	Pulverize and Blend	2,680	SY	3.00	8,040	1,608	20%	9,600
	Striping	2,010	LF	1.50	3,015	603	20%	3,600
	Clear & Grub	0.31	AC	1,500.00	465	93	20%	600
	Culvert (36")	60	LF	85.00	5,100	1,020	20%	6,100
	Headwalls (sacked concrete Slope protection)	1.3	CY	500.00	650.00	130	20%	800
	State Highway 16 Raising							
	AC (asphalt concrete)	836	Ton	50.00	41,800	8,360	20%	50,200
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	2,420	Ton	15.00	36,300	7,260	20%	43,600
	Pulverize and Blend	3,840	SY	3.00	11,520	2,304	20%	13,800
	Striping	2,880	LF	1.50	4,320	864	20%	5,200
	Clear & Grub	0.44	AC	1,500.00	660	132	20%	800
	Culvert (60")	80	LF	150.00	12,000	2,400	20%	14,400
	Headwalls (sacked concrete Slope protection)	3.6	CY	500.00	1,800.00	360	20%	2,200
	County Road 99 Raising							

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-2
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

70,000 cfs Design with Inlet Weir (Elev. 45') 2500' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	AC (asphalt concrete)	667	Ton	50.00	33,350	6,670	20%	40,000
	Aggregate Base Class II	2,001	Ton	20.00	40,020	8,004	20%	48,000
	Aggregate Subbase	7,165	Ton	15.00	107,475	21,495	20%	129,000
	Pulverize and Blend	4,089	SY	3.00	12,267	2,453	20%	14,700
	Striping	3,450	LF	1.50	5,175	1,035	20%	6,200
	Clear & Grub	0.52	AC	1,500.00	780	156	20%	900
	Culvert (2-60")	160	LF	150.00	24,000	4,800	20%	28,800
	Headwalls (sacked concrete Slope protection)	6.0	CY	500.00	3,000.00	600	20%	3,600
	Frontage Road Dubach Field							
	AC (asphalt concrete)	131	Ton	50.00	6,550	1,310	20%	7,900
	Aggregate Base Class II	261	Ton	20.00	5,220	1,044	20%	6,300
	Aggregate Subbase	6,356	Ton	15.00	95,340	19,068	20%	114,400
	Pulverize and Blend	978	SY	3.00	2,934	587	20%	3,500
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	Culvert (3-60")	120	LF	150.00	18,000	3,600	20%	21,600
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Churchill Downs Raising							
	AC (asphalt concrete)	387	Ton	50.00	19,350	3,870	20%	23,200
	Aggregate Base Class II	1,450	Ton	20.00	29,000	5,800	20%	34,800
	Aggregate Subbase	1,363	Ton	15.00	20,445	4,089	20%	24,500
	Pulverize and Blend	1,778	SY	3.00	5,334	1,067	20%	6,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	County Road 101 (Pioneer) Raising							
	AC (asphalt concrete)	1,044	Ton	50.00	52,200	10,440	20%	62,600
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	17,896	Ton	15.00	268,440	53,688	20%	322,100
	Pulverize and Blend	6,400	SY	3.00	19,200	3,840	20%	23,000
	Striping	5,400	LF	1.50	8,100	1,620	20%	9,700
	Clear & Grub	0.83	AC	1,500.00	1,245	249	20%	1,500
	Culvert (3-60")	240	LF	150.00	36,000	7,200	20%	43,200
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	County Road 102 Raising							
	AC (asphalt concrete)	2,480	Ton	50.00	124,000	24,800	20%	148,800
	Aggregate Base Class II	8,280	Ton	20.00	165,600	33,120	20%	198,700
	Aggregate Subbase	36,164	Ton	15.00	542,460	108,492	20%	651,000

Table K-2
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

70,000 cfs Design with Inlet Weir (Elev. 45') 2500' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Pulverize and Blend	8,440	SY	3.00	25,320	5,064	20%	30,400
	Striping	5,700	LF	1.50	8,550	1,710	20%	10,300
	Clear & Grub	2	AC	1,500.00	2,610	522	20%	3,100
	Culvert (3-60")	360	LF	150.00	54,000	10,800	20%	64,800
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Total Relocations							**5,435,200**
06	**FISH AND WILDLIFE MITIGATION**[2]	1	LS	1,353,000.00	1,353,000	244,000	18%	**1,597,000**
08	**ROADS**							
	Levee Patrol Roads - Levee (4" aggregate base)	9,296	TON	20.00	185,920	37,184	20%	**223,100**
09	**CHANNELS AND CANALS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Clearing and Grubbing	31	AC	1,500.00	46,500.00	9,300	20%	55,800
	Excavation	133,334	CY	5.00	666,670	133,334	20%	800,000
	Seeding	27	AC	2,500.00	67,500	13,500	20%	81,000
	Reinforced Concrete Pipe (60")	1,350	LF	150.00	202,500	40,500	20%	243,000
	Bore and Jack (60" RCP, I-5))	750	LF	1,000.00	750,000	150,000	20%	900,000
	Bore and Jack (60" RCP, SH 113)	600	LF	1,000.00	600,000	120,000	20%	720,000
	Inlet and Outlet Structures (I-5 and SH-113)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Box Culvert (West Levee into Settling Basin 3'x3')	150	LF	300.00	45,000	9,000	20%	54,000
	Box Culvert (LCCFB to City Drain, 3'x3')	1,800	LF	300.00	540,000	108,000	20%	648,000
	Inlet and Outlet Structures (West Levee, City Drain)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Closure Structure (Slide Gates) for Box Culverts	2	EA	20,000.00	40,000	8,000	20%	48,000
	Flap Gates (for Box Culverts)	2	EA	5,500.00	11,000	2,200	20%	13,200
	Total Channels and Canals							**3,870,600**
11	**LEVEES AND FLOODWALLS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Stop Log Structure - County Road 102							
	Concrete	74	CY	500.00	37,000	7,400	20%	44,400
	Reinforcing Steel	5,075	LB	0.80	4,060	812	20%	4,900

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-2
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

70,000 cfs Design with Inlet Weir (Elev. 45') 2500' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Stop Log Structure - County Road 101 (Pioneer)							
	Concrete	50	CY	500.00	25,000	5,000	20%	30,000
	Reinforcing Steel	3,429	LB	0.80	2,743	549	20%	3,300
	Stop Log Structure - Highway 113							
	Concrete	124	CY	500.00	62,000	12,400	20%	74,400
	Reinforcing Steel	8,503	LB	0.80	6,802	1,360	20%	8,200
	Stop Log Structure - Frontage Rd. Dubach Field							
	Concrete	72	CY	500.00	36,000	7,200	20%	43,200
	Reinforcing Steel	4,938	LB	0.80	3,950	790	20%	4,700
	Stop Log Structure - Railroad Crossing (I-5)							
	Concrete	94	CY	500.00	47,000	9,400	20%	56,400
	Reinforcing Steel	6,446	LB	0.80	5,157	1,031	20%	6,200
	Stop Log Structure - County Road 99							
	Concrete	79	CY	500.00	39,500	7,900	20%	47,400
	Reinforcing Steel	5,418	LB	0.80	4,334	867	20%	5,200
	Levee--New Construction							
	Mobilization & Demobilization	1	LS	25,000.00	25,000	5,000	20%	30,000
	Levee Embankment	391,967	CY	5.00	1,959,835	391,967	20%	2,351,800
	Excavation for Inspection Trench	66,081	CY	5.00	330,405	66,081	20%	396,500
	Removal of Settling Basin West Levee (3000')	83,000	CY	2.50	207,500	41,500	20%	249,000
	Removal of Training Levee (Settling Basin) (5250')	166,250	CY	2.50	415,625	83,125	20%	498,800
	Clearing and Grubbing	59.0	AC	1,000.00	59,000	11,800	20%	70,800
	Stripping (6 Inches)	47,663	CY	1.50	71,495	14,299	20%	85,800
	Slope Protection (water side of levee)	50,773	TON	28.00	1,421,644	284,329	20%	1,706,000
	Bedding (for Slope protection)	17,309	TON	22.00	380,798	76,160	20%	457,000
	Slope Protection Cover (Soil)	56,518	CY	5.00	282,590	56,518	20%	339,100
	Seeding	28.1	AC	2,500.00	70,250	14,050	20%	84,300
	Slurry Wall (from CR101 to west levee)	55200	SF	5.80	320,160	64,032	20%	384,200
	Slope protection (1500' of railroad near I-5)	2,250	TON	28.00	63,000	12,600	20%	75,600
	Bedding (for Slope protection)	775	TON	22.00	17,050	3,410	20%	20,500
	West Levee Improvements							
	Slope Embankment (from 2:1 to 3:1)	52,270	CY	5.00	261,350	52,270	20%	313,600

Table K-2
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

70,000 cfs Design with Inlet Weir (Elev. 45') 2500' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Slope protection	50,010	TON	28.00	1,400,280	280,056	20%	1,680,300
	Bedding (for Slope protection)	16,968	TON	22.00	373,296	74,659	20%	448,000
	Clearing and Grubbing	8.3	AC	1,000.00	8,300	1,660	20%	10,000
	Stripping (6 inches)	6661.0	CY	1.50	9,992	1,998	20%	12,000
	Slope Protection Cover (Soil)	40,245	CY	5.00	201,225	40,245	20%	241,500
	Seeding	9.1	AC	2,500.00	22,750	4,550	20%	27,300
	Slope protection for I-5 (north and south of LCCFB)	3,910	TON	28.00	109,480	21,896	20%	131,400
	Bedding (for Slope protection)	1,347	TON	22.00	29,634	5,927	20%	35,600
	Total Levee -- New Construction							**10,227,400**
15	**FLOOD CONTROL AND DIVERSION STRUCTURES**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Inlet Weir (2500 ft long)							
	Roller Compacted Concrete	10,296	CY	100.00	1,029,600	205,920	20%	1,235,500
	Conventional Concrete	2,223	CY	500.00	1,111,500	222,300	20%	1,333,800
	Slope protection	7,425	TON	28.00	207,900	41,580	20%	249,500
	Geotextile Filter Fabric	8,334	SY	3.00	25,002	5,000	20%	30,000
	Gravel Backfill	4,367	TON	22.00	96,074	19,215	20%	115,300
	Compacted Structural Backfill	1,482	CY	10.00	14,820	2,964	20%	17,800
	Excavation	6,667	CY	5.00	33,335	6,667	20%	40,000
	Total Levee -- New Construction							**3,271,900**
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							**24,625,200**
18	**CULTURAL RESOURCE PRESERVATION**	1	%					**246,300**
20	**PERMANENT OPERATING EQUIPMENT**							
	Flood Warning System	1	LS	$1,000,000.00	1,000,000	200,000	20%	**1,200,000**
30	**PLANNING, ENGINEERING & DESIGN**	12	%					**2,955,000**
31	**CONSTRUCTION MANAGEMENT**	8.5	%					**2,093,100**
	TOTAL FIRST COST							**39,697,000**

Table K-2
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

INVESTMENT COST

70,000 cfs Design with Inlet Weir (Elev. 45') 2500' long, Ultimate Outlet Weir (Elev. 41')

Description	Estimated Quantity	Unit	Total Cost $
INTEREST DURING CONSTRUCTION			
Interest Rate	6.125	%	
Construction Period	2	YR	
Project First Costs			39,697,000
Interest during Construction			
At midyear (year 1.5, and .5)			2,700,600
Outlays 60% first year, 40% second year			
TOTAL INVESTMENT COST			42,397,600

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		2,736,000
OPERATION AND MAINTENANCE				
LCCOB				48,000
Flood Warning System				25,000
County road damages				25,000
TOTAL ANNUAL COST				2,834,900

Table K-3

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
01	**LANDS AND DAMAGES**[1]	1	LS	8,577,420				**8,577,400**
02	**RELOCATIONS**							
	Utilities (3% of total construction cost)	3	%	701,322				701,300
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Building Floodproofing (Raising Homes)	25	EA	60,000.00	1,500,000	525,000	35%	2,025,000
	County Road 19B Raising							
	AC (asphalt concrete)	218	Ton	50.00	10,900	2,180	20%	13,100
	Aggregate Base Class II	0	Ton	20.00	0	0	20%	0
	Aggregate Subbase	42	Ton	15.00	630	126	20%	800
	Pulverize and Blend	667	SY	3.00	2,001	400	20%	2,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0	AC	1,500.00	0	0	20%	0
	Culvert (18")	20	LF	35.00	700	140	20%	800
	Headwalls (sacked concrete Slope protection)	1.2	CY	500.00	600.00	120	20%	700
	County Road 97A Raising							
	AC (asphalt concrete)	389	Ton	50.00	19,450	3,890	20%	23,300
	Aggregate Base Class II	1,166	Ton	20.00	23,320	4,664	20%	28,000
	Aggregate Subbase	704	Ton	15.00	10,560	2,112	20%	12,700
	Pulverize and Blend	2,680	SY	3.00	8,040	1,608	20%	9,600
	Striping	2,010	LF	1.50	3,015	603	20%	3,600
	Clear & Grub	0.31	AC	1,500.00	465	93	20%	600
	Culvert (36")	60	LF	85.00	5,100	1,020	20%	6,100
	Headwalls (sacked concrete Slope protection)	1.3	CY	500.00	650.00	130	20%	800
	State Highway 16 Raising							
	AC (asphalt concrete)	836	Ton	50.00	41,800	8,360	20%	50,200
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	2,420	Ton	15.00	36,300	7,260	20%	43,600
	Pulverize and Blend	3,840	SY	3.00	11,520	2,304	20%	13,800
	Striping	2,880	LF	1.50	4,320	864	20%	5,200
	Clear & Grub	0.44	AC	1,500.00	660	132	20%	800
	Culvert (60")	80	LF	150.00	12,000	2,400	20%	14,400
	Headwalls (sacked concrete Slope protection)	3.6	CY	500.00	1,800.00	360	20%	2,200
	County Road 99 Raising							

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-3
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	AC (asphalt concrete)	667	Ton	50.00	33,350	6,670	20%	40,000
	Aggregate Base Class II	2,001	Ton	20.00	40,020	8,004	20%	48,000
	Aggregate Subbase	7,165	Ton	15.00	107,475	21,495	20%	129,000
	Pulverize and Blend	4,089	SY	3.00	12,267	2,453	20%	14,700
	Striping	3,450	LF	1.50	5,175	1,035	20%	6,200
	Clear & Grub	0.52	AC	1,500.00	780	156	20%	900
	Culvert (2-60")	160	LF	150.00	24,000	4,800	20%	28,800
	Headwalls (sacked concrete Slope protection)	6.0	CY	500.00	3,000.00	600	20%	3,600
	Frontage Road Dubach Field							
	AC (asphalt concrete)	131	Ton	50.00	6,550	1,310	20%	7,900
	Aggregate Base Class II	261	Ton	20.00	5,220	1,044	20%	6,300
	Aggregate Subbase	6,356	Ton	15.00	95,340	19,068	20%	114,400
	Pulverize and Blend	978	SY	3.00	2,934	587	20%	3,500
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	Culvert (3-60")	120	LF	150.00	18,000	3,600	20%	21,600
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Churchill Downs Raising							
	AC (asphalt concrete)	387	Ton	50.00	19,350	3,870	20%	23,200
	Aggregate Base Class II	1,450	Ton	20.00	29,000	5,800	20%	34,800
	Aggregate Subbase	1,363	Ton	15.00	20,445	4,089	20%	24,500
	Pulverize and Blend	1,778	SY	3.00	5,334	1,067	20%	6,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	County Road 101 (Pioneer) Raising							
	AC (asphalt concrete)	1,044	Ton	50.00	52,200	10,440	20%	62,600
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	17,896	Ton	15.00	268,440	53,688	20%	322,100
	Pulverize and Blend	6,400	SY	3.00	19,200	3,840	20%	23,000
	Striping	5,400	LF	1.50	8,100	1,620	20%	9,700
	Clear & Grub	0.83	AC	1,500.00	1,245	249	20%	1,500
	Culvert (3-60")	240	LF	150.00	36,000	7,200	20%	43,200
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	County Road 102 Raising							
	AC (asphalt concrete)	2,480	Ton	50.00	124,000	24,800	20%	148,800
	Aggregate Base Class II	8,280	Ton	20.00	165,600	33,120	20%	198,700
	Aggregate Subbase	36,164	Ton	15.00	542,460	108,492	20%	651,000

Table K-3
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	Pulverize and Blend	8,440	SY	3.00	25,320	5,064	20%	30,400
	Striping	5,700	LF	1.50	8,550	1,710	20%	10,300
	Clear & Grub	2	AC	1,500.00	2,610	522	20%	3,100
	Culvert (3-60")	360	LF	150.00	54,000	10,800	20%	64,800
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Total Relocations							**5,465,800**
06	**FISH AND WILDLIFE MITIGATION[2]**	1	LS	1,353,000.00	1,353,000	244,000	18%	**1,597,000**
08	**ROADS**							
	Levee Patrol Roads - Levee (4" aggregate base)	9,296	TON	20.00	185,920	37,184	20%	**223,100**
09	**CHANNELS AND CANALS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Clearing and Grubbing	31	AC	1,500.00	46,500.00	9,300	20%	55,800
	Excavation	133,334	CY	5.00	666,670	133,334	20%	800,000
	Seeding	27	AC	2,500.00	67,500	13,500	20%	81,000
	Reinforced Concrete Pipe (60")	1,350	LF	150.00	202,500	40,500	20%	243,000
	Bore and Jack (60" RCP, I-5))	750	LF	1,000.00	750,000	150,000	20%	900,000
	Bore and Jack (60" RCP, SH 113)	600	LF	1,000.00	600,000	120,000	20%	720,000
	Inlet and Outlet Structures (I-5 and SH-113)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Box Culvert (West Levee into Settling Basin 3'x3')	150	LF	300.00	45,000	9,000	20%	54,000
	Box Culvert (LCCFB to City Drain, 3'x3')	1,800	LF	300.00	540,000	108,000	20%	648,000
	Inlet and Outlet Structures (West Levee, City Drain)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Closure Structure (Slide Gates) for Box Culverts	2	EA	20,000.00	40,000	8,000	20%	48,000
	Flap Gates (for Box Culverts)	2	EA	5,500.00	11,000	2,200	20%	13,200
	Total Channels and Canals							**3,870,600**
11	**LEVEES AND FLOODWALLS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Stop Log Structure - County Road 102							
	Concrete	74	CY	500.00	37,000	7,400	20%	44,400
	Reinforcing Steel	5,075	LB	0.80	4,060	812	20%	4,900

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-3
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	Stop Log Structure - County Road 101 (Pioneer)							
	Concrete	50	CY	500.00	25,000	5,000	20%	30,000
	Reinforcing Steel	3,429	LB	0.80	2,743	549	20%	3,300
	Stop Log Structure - Highway 113							
	Concrete	124	CY	500.00	62,000	12,400	20%	74,400
	Reinforcing Steel	8,503	LB	0.80	6,802	1,360	20%	8,200
	Stop Log Structure - Frontage Rd. Dubach Field							
	Concrete	72	CY	500.00	36,000	7,200	20%	43,200
	Reinforcing Steel	4,938	LB	0.80	3,950	790	20%	4,700
	Stop Log Structure - Railroad Crossing (I-5)							
	Concrete	94	CY	500.00	47,000	9,400	20%	56,400
	Reinforcing Steel	6,446	LB	0.80	5,157	1,031	20%	6,200
	Stop Log Structure - County Road 99							
	Concrete	79	CY	500.00	39,500	7,900	20%	47,400
	Reinforcing Steel	5,418	LB	0.80	4,334	867	20%	5,200
	Levee--New Construction							
	Mobilization & Demobilization	1	LS	25,000.00	25,000	5,000	20%	30,000
	Levee Embankment	440,995	CY	5.00	2,204,975	440,995	20%	2,646,000
	Excavation for Inspection Trench	72,922	CY	5.00	364,610	72,922	20%	437,500
	Removal of Settling Basin West Levee (3000')	83,000	CY	2.50	207,500	41,500	20%	249,000
	Removal of Training Levee (Settling Basin) (5250')	166,250	CY	2.50	415,625	83,125	20%	498,800
	Clearing and Grubbing	62.0	AC	1,000.00	62,000	12,400	20%	74,400
	Stripping (6 Inches)	49,428	CY	1.50	74,142	14,828	20%	89,000
	Slope Protection (water side of levee)	53,405	TON	28.00	1,495,340	299,068	20%	1,794,400
	Bedding (for Slope protection)	18,206	TON	22.00	400,532	80,106	20%	480,600
	Slope Protection Cover (Soil)	56,518	CY	5.00	282,590	56,518	20%	339,100
	Seeding	34	AC	2,500.00	85,000	17,000	20%	102,000
	Slurry Wall (from CR101 to west levee)	55200	SF	5.80	320,160	64,032	20%	384,200
	Slope protection (1500' of railroad near I-5)	2,250	TON	28.00	63,000	12,600	20%	75,600
	Bedding (for Slope protection)	775	TON	22.00	17,050	3,410	20%	20,500

Table K-3
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	West Levee Improvements							
	Slope Embankment (from 2:1 to 3:1)	52,270	CY	5.00	261,350	52,270	20%	313,600
	Slope protection	50,010	TON	28.00	1,400,280	280,056	20%	1,680,300
	Bedding (for Slope protection)	16,968	TON	22.00	373,296	74,659	20%	448,000
	Clearing and Grubbing	8.3	AC	1,000.00	8,300	1,660	20%	10,000
	Stripping (6 inches)	6661.0	CY	1.50	9,992	1,998	20%	12,000
	Slope Protection Cover (Soil)	43,099	CY	5.00	215,495	43,099	20%	258,600
	Seeding	9.7	AC	2,500.00	24,250	4,850	20%	29,100
	Slope protection for I-5 (north and south of LCCFB)	3,910	TON	28.00	109,480	21,896	20%	131,400
	Bedding (for Slope protection)	1,347	TON	22.00	29,634	5,927	20%	35,600
	Total Levee -- New Construction							**10,718,000**
15	**FLOOD CONTROL AND DIVERSION STRUCTURES**							
	Mobilization & Demobilization	1	LS	250,000.00	250,000	50,000	20%	300,000
	Inlet Weir (3000 ft long)							
	Roller Compacted Concrete	11,850	CY	100.00	1,185,000	237,000	20%	1,422,000
	Conventional Concrete	2,667	CY	500.00	1,333,500	266,700	20%	1,600,200
	Slope protection	8,910	TON	22.00	196,020	39,204	20%	235,200
	Geotextile Filter Fabric	10,000	SY	3.00	30,000	6,000	20%	36,000
	Gravel Backfill	5,248	TON	22.00	115,456	23,091	20%	138,500
	Compacted Structural Backfill	1,778	CY	10.00	17,780	3,556	20%	21,300
	Excavation	8,000	CY	5.00	40,000	8,000	20%	48,000
	Total Levee -- New Construction							**3,801,200**
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							**25,675,700**
18	**CULTURAL RESOURCE PRESERVATION**	1	%					**256,800**
20	**PERMANENT OPERATING EQUIPMENT**							
	Flood Warning System	1	LS	$1,000,000.00	1,000,000	200,000	20%	**1,200,000**

Table K-3
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
30	**PLANNING, ENGINEERING & DESIGN**	12	%					**3,081,100**
31	**CONSTRUCTION MANAGEMENT**	8.5	%					**2,182,400**
	TOTAL FIRST COST							**40,973,400**

Table K-3
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN (NED PLAN)

INVESTMENT COST

78,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Description	**Estimated Quantity**	**Unit**	**Total Cost $**
INTEREST DURING CONSTRUCTION			
Interest Rate	6.125	%	
Construction Period	2	YR	
Project First Costs			40,973,400
Interest during Construction			
At midyear (year 1.5, and .5)			2,787,400
Outlays 60% first year, 40% second year			
TOTAL INVESTMENT COST			43,760,800

ANNUAL COST

Description	**Estimated Quantity**	**Unit**	**Unit Cost $**	**Total Cost $**
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		2,824,900
OPERATION AND MAINTENANCE				
LCCOB				48,000
Flood Warning System				25,000
County road damages				25,000
TOTAL ANNUAL COST				2,922,900

Table K-4

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

91,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
01	**LANDS AND DAMAGES[1]**	1	LS	8,577,420.00				**8,577,400**
02	**RELOCATIONS**							
	Utilities (3% of total construction cost)	3	%	759,033.00				759,000
	Mobilization & Demobilization	1	LS	250,000.00	250,000	50,000	20%	300,000
	Building Floodproofing (Raising Homes)	25	EA	60,000.00	1,500,000	525,000	35%	2,025,000
	County Road 19B Raising							
	AC (asphalt concrete)	221	Ton	50.00	11,050	2,210	20%	13,300
	Aggregate Base Class II	623	Ton	20.00	12,460	2,492	20%	15,000
	Aggregate Subbase	1,703	Ton	15.00	25,545	5,109	20%	30,700
	Pulverize and Blend	1,267	SY	2.65	3,358	672	20%	4,000
	Striping	2,280	LF	1.00	2,280	456	20%	2,700
	Clear & Grub	0	AC	1,500.00	0	0	20%	0
	Culvert (18")	20	LF	35.00	700	140	20%	800
	Headwalls (sacked concrete slope protection)	1.2	CY	500.00	600	120	20%	700
	County Road 97A Raising							
	AC (asphalt concrete)	482	Ton	50.00	24,100	4,820	20%	28,900
	Aggregate Base Class II	1,444	Ton	20.00	28,880	5,776	20%	34,700
	Aggregate Subbase	2,092	Ton	15.00	31,380	6,276	20%	37,700
	Pulverize and Blend	3,320	SY	2.65	8,798	1,760	20%	10,600
	Striping	2,490	LF	1.00	2,490	498	20%	3,000
	Clear & Grub	0.38	AC	1,500.00	570	114	20%	700
	Culvert (36")	60	LF	85.00	5,100	1,020	20%	6,100
	Headwalls (sacked concrete slope protection)	1.3	CY	500.00	650	130	20%	800
	State Highway 16 Raising							
	AC (asphalt concrete)	1,001	Ton	50.00	50,050	10,010	20%	60,100
	Aggregate Base Class II	3,752	Ton	20.00	75,040	15,008	20%	90,000
	Aggregate Subbase	5,151	Ton	15.00	77,265	15,453	20%	92,700
	Pulverize and Blend	4,089	SY	2.65	10,836	2,167	20%	13,000
	Striping	3,450	LF	1.00	3,450	690	20%	4,100
	Clear & Grub	0.52	AC	1,500.00	780	156	20%	900
	Culvert (60")	80	LF	150.00	12,000	2,400	20%	14,400
	Headwalls (sacked concrete slope protection)	3.6	CY	500.00	1,800	360	20%	2,200
	County Road 99 Raising							

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-4
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

91,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	AC (asphalt concrete)	667	Ton	50.00	33,350	6,670	20%	40,000
	Aggregate Base Class II	2,001	Ton	20.00	40,020	8,004	20%	48,000
	Aggregate Subbase	7,165	Ton	15.00	107,475	21,495	20%	129,000
	Pulverize and Blend	4,089	SY	2.65	10,836	2,167	20%	13,000
	Striping	3,450	LF	1.00	3,450	690	20%	4,100
	Clear & Grub	0.52	AC	1,500.00	780	156	20%	900
	Culvert (2-60")	160	LF	150.00	24,000	4,800	20%	28,800
	Headwalls (sacked concrete slope protection)	6.0	CY	500.00	3,000	600	20%	3,600
	Frontage Road Dubach Field							
	AC (asphalt concrete)	131	Ton	50.00	6,550	1,310	20%	7,900
	Aggregate Base Class II	261	Ton	20.00	5,220	1,044	20%	6,300
	Aggregate Subbase	6,356	Ton	15.00	95,340	19,068	20%	114,400
	Pulverize and Blend	978	SY	2.65	2,592	518	20%	3,100
	Striping	1,200	LF	1.00	1,200	240	20%	1,400
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	Culvert (3-60")	120	LF	150.00	18,000	3,600	20%	21,600
	Headwalls (sacked concrete slope protection)	9.0	CY	500.00	4,500	900	20%	5,400
	Churchill Downs Raising							
	AC (asphalt concrete)	387	Ton	50.00	19,350	3,870	20%	23,200
	Aggregate Base Class II	1,450	Ton	20.00	29,000	5,800	20%	34,800
	Aggregate Subbase	1,363	Ton	15.00	20,445	4,089	20%	24,500
	Pulverize and Blend	1,778	SY	2.65	4,712	942	20%	5,700
	Striping	1,200	LF	1.00	1,200	240	20%	1,400
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	County Road 101 (Pioneer) Raising							
	AC (asphalt concrete)	1,044	Ton	50.00	52,200	10,440	20%	62,600
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	17,896	Ton	15.00	268,440	53,688	20%	322,100
	Pulverize and Blend	6,400	SY	2.65	16,960	3,392	20%	20,400
	Striping	5,400	LF	1.00	5,400	1,080	20%	6,500
	Clear & Grub	0.83	AC	1,500.00	1,245	249	20%	1,500
	Culvert (3-60")	240	LF	150.00	36,000	7,200	20%	43,200
	Headwalls (sacked concrete slope protection)	9.0	CY	500.00	4,500	900	20%	5,400
	County Road 102 Raising							
	AC (asphalt concrete)	2,480	Ton	50.00	124,000	24,800	20%	148,800
	Aggregate Base Class II	8,280	Ton	20.00	165,600	33,120	20%	198,700
	Aggregate Subbase	36,164	Ton	15.00	542,460	108,492	20%	651,000

Table K-4
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

91,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	Pulverize and Blend	8,440	SY	2.65	22,366	4,473	20%	26,800
	Striping	5,700	LF	1.00	5,700	1,140	20%	6,800
	Clear & Grub	2	AC	1,500.00	2,610	522	20%	3,100
	Culvert (3-60")	360	LF	150.00	54,000	10,800	20%	64,800
	Headwalls (sacked concrete slope protection)	9.0	CY	500.00	4,500	900	20%	5,400
	Total Relocations							**5,711,100**
06	**FISH AND WILDLIFE MITIGATION**[2]	1	LS	1,353,000.00	1.353.000	244,000	18%	**1,597,000**
08	**ROADS**							
	Levee Patrol Roads - Levee (4" aggregate base)	9,296	TON	20.00	185,920	37,184	20%	**223,100**
09	**CHANNELS AND CANALS**							
	Mobilization & Demobilization	1	LS	250,000.00	250,000	50,000	20%	300,000
	Clearing and Grubbing	31	AC	1,500.00	46,500	9,300	20%	55,800
	Excavation	133,334	CY	5.00	666,670	133,334	20%	800,000
	Seeding	27	AC	2,500.00	67,500	13,500	20%	81,000
	Reinforced Concrete Pipe (60")	1,350	LF	150.00	202,500	40,500	20%	243,000
	Bore and Jack (60" RCP, I-5))	750	LF	1,000.00	750,000	150,000	20%	900,000
	Bore and Jack (60" RCP, SH 113)	600	LF	1,000.00	600,000	120,000	20%	720,000
	Inlet and Outlet Structures (I-5 and SH-113)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Box Culvert (West Levee into Settling Basin 3'x3')	150	LF	300.00	45,000	9,000	20%	54,000
	Box Culvert (LCCFB to City Drain, 3'x3')	1,800	LF	300.00	540,000	108,000	20%	648,000
	Inlet and Outlet Structures (West Levee, City Drain)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Closure Structure (Slide Gates) for Box Culverts	2	EA	20,000.00	40,000	8,000	20%	48,000
	Flap Gates (for Box Culverts)	2	EA	5,500.00	11,000	2,200	20%	13,200
	Total Channels and Canals							**3,920,600**
11	**LEVEES AND FLOODWALLS**							
	Mobilization & Demobilization	1	LS	250,000.00	250,000	50,000	20%	300,000
	Stop Log Structure - County Road 102							
	Concrete	82	CY	500.00	41,000	8,200	20%	49,200
	Reinforcing Steel	5,620.00	LB	0.80	4,496	899	20%	5,400

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-4
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

91,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	Stop Log Structure - County Road 101 (Pioneer)							
	Concrete	61	CY	500.00	30,500	6,100	20%	36,600
	Reinforcing Steel	4,180	LB	0.80	3,344	669	20%	4,000
	Stop Log Structure - Highway 113							
	Concrete	128	CY	500.00	64,000	12,800	20%	76,800
	Reinforcing Steel	8,780	LB	0.80	7,024	1,405	20%	8,400
	Stop Log Structure - Frontage Rd. Dubach Field							
	Concrete	75	CY	500.00	37,500	7,500	20%	45,000
	Reinforcing Steel	5,150	LB	0.80	4,120	824	20%	4,900
	Stop Log Structure - Railroad Crossing (I-5)							
	Concrete	104	CY	500.00	52,000	10,400	20%	62,400
	Reinforcing Steel	7,130	LB	0.80	5,704	1,141	20%	6,800
	Stop Log Structure - County Road 99							
	Concrete	83	CY	500.00	41,500	8,300	20%	49,800
	Reinforcing Steel	5,690	LB	0.80	4,552	910	20%	5,500
	Levee--New Construction							
	Levee Embankment	466,296	CY	5.00	2,331,480	466,296	20%	2,797,800
	Excavation for Inspection Trench	77,472	CY	5.00	387,360	77,472	20%	464,800
	Removal of Settling Basin West Levee (3000')	83,000	CY	2.50	207,500	41,500	20%	249,000
	Removal of Training Levee (Settling Basin) (5250')	166,250	CY	2.50	415,625	83,125	20%	498,800
	Clearing and Grubbing	60.0	AC	1,000.00	60,000	12,000	20%	72,000
	Stripping (6 Inches)	48,335	CY	1.50	72,503	14,501	20%	87,000
	Slope Protection (water side of levee)	140,040	TON	22.00	3,080,880	616,176	20%	3,697,100
	Bedding (for riprap)	17,904	TON	22.00	393,888	78,778	20%	472,700
	Slope Protection Cover (Soil)	56,518	CY	5.00	282,590	56,518	20%	339,100
	Seeding	41.8	AC	2,500.00	104,500	20,900	20%	125,400
	Slurry Wall (from CR101 to west levee)	55200	SF	5.80	320,160	64,032	20%	384,200
	Slope Protection (1500' of railroad near I-5)	2,350	TON	22.00	51,700	10,340	20%	62,000
	Bedding (for riprap)	810	TON	22.00	17,820	3,564	20%	21,400
	West Levee Improvements							
	Slope Embankment (from 2:1 to 3:1)	52,270	CY	5.00	261,350	52,270	20%	313,600

Table K-4
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

91,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost, $
	Slope Protection	50,010	TON	22.00	1,100,220	220,044	20%	1,320,300
	Bedding (for slope protection)	16,968	TON	22.00	373,296	74,659	20%	448,000
	Clearing and Grubbing	8.3	AC	1,000.00	8,300	1,660	20%	10,000
	Stripping (6 inches)	6661	CY	1.50	9,992	1,998	20%	12,000
	Slope Protection Cover (Soil)	44,080	CY	5.00	220,400	44,080	20%	264,500
	Seeding	9.9	AC	2,500.00	24,750	4,950	20%	29,700
	Slope Protection for I-5 (north and south of LCCFB)	2,250	TON	22.00	49,500	9,900	20%	59,400
	Bedding (for slope protection)	775	TON	22.00	17,050	3,410	20%	20,500
	Total Levee -- New Construction							**12,404,100**
15	**FLOOD CONTROL AND DIVERSION STRUCTURES**							
	Mobilization & Demobilization	1	LS	250,000.00	250,000	50,000	20%	300,000
	Inlet Weir (3000 ft long)							
	Roller Compacted Concrete	11,850	CY	100.00	1,185,000	237,000	20%	1,422,000
	Conventional Concrete	2,667	CY	500.00	1,333,500	266,700	20%	1,600,200
	Slope Protection	8,910	TON	22.00	196,020	39,204	20%	235,200
	Geotextile Filter Fabric	10,000	SY	3.00	30,000	6,000	20%	36,000
	Gravel Backfill	5,248	TON	22.00	115,456	23,091	20%	138,500
	Compacted Structural Backfill	1,778	CY	10.00	17,780	3,556	20%	21,300
	Excavation	8,000	CY	5.00	40,000	8,000	20%	48,000
	Total Levee -- New Construction							**3,801,200**
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							**27,657,100**
18	**CULTURAL RESOURCE PRESERVATION**	1	%					**276,600**
20	**PERMANENT OPERATING EQUIPMENT**							
	Flood Warning System	1	LS	$1,000,000.00	1,000,000	200,000	20%	**1,200,000**
30	**PLANNING, ENGINEERING & DESIGN**	12	%					**3,318,900**
31	**CONSTRUCTION MANAGEMENT**	8.5	%					**235,900**
	TOTAL FIRST COST							**43,380,900**

Table K-4
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN

INVESTMENT COST

91,000 cfs Design with Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41')

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				43,380,900
Interest during Construction				
At midyear (year 1.5, and .5)				2,951,000
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				46,332,000

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		2,990,900
OPERATION AND MAINTENANCE				
LCCOB				48,000
Flood Warning System				25,000
County road damages				25,000
TOTAL ANNUAL COST				3,088,900

Table K-5

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

50,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	25,485,050				25,485,100
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,160,000				2,160,000
	Road Realignments							
	County Roads 17B, 97A, and 97B							
	Mobilization & Demobilization	1	LS	66,500				66,500
	Asphaltic Concrete	1,310	TON	50	65,500	13,100	20%	78,600
	Aggregate Base, Class II	3,920	TON	20	78,400	15,680	20%	94,100
	Aggregate Subbase	50,090	TON	15	751,350	150,270	20%	901,600
	Demolish Existing Road	4,660	SY	4	18,640	3,728	20%	22,400
	Pulverize and Blend	41,940	SY	3	125,820	25,164	20%	151,000
	Striping	9,000	LF	1.50	13,500	2,700	20%	16,200
	Clear and Grubb	5.4	AC	1,500	8,100	1,620	20%	9,700
	Guard Rail	2,400	LF	35	84,000	16,800	20%	100,800
	Total Road Realignments							1,440,900
	Total Relocations							3,600,900
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	34,800,000				34,800,000
08	ROADS							
	Mobilization & Demobilization	1	LS	34,300				34,300
	Patrol Roads (4" aggregate base)	28,600	TON	20	572,000	114,400	20%	686,400
	Total Project Roads							720,700
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	990,000				990,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	45.7	AC	5,000	228,500	45,700	20%	274,200
	Clearing and Grubbing (in overbank for rip rap)	22.5	AC	1,500	33,750	6,750	20%	40,500
	Excavation (Layback channel slope and for rip rap)	156,900	CY	5	784,500	156,900	20%	941,400
	Rip Rap	354,300	TON	28	9,920,400	1,984,080	20%	11,904,500

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.
[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-5
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

50,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Bedding (for riprap)	102,400	TON	21	2,150,400	430,080	20%	2,580,500
	Stripping (for rip rap, 6")	54,200	CY	10	542,000	108,400	20%	650,400
	Gabions	15,870	CY	125	1,983,750	396,750	20%	2,380,500
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200
	Total Creek Channels							20,138,200
	Toe Drain							
	Excavation	51,000	CY	2	102,000	20,400	20%	122,400
	Reinforced Concrete Inlet and Outlet Transitions	227	CY	500	113,500	22,700	20%	136,200
	24"-Diameter RCP	2,000	LF	40	80,000	16,000	20%	96,000
	Seeding	3	AC	2,500	7,500	1,500	20%	9,000
	Total Toe Drain							363,600
	Total Channels and Canals							21,491,800
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	560,000				560,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	77,680	CY	1.50	116,520	23,304	20%	139,800
	Excavation (Includes training levee)	611,000	CY	2	1,222,000	244,400	20%	1,466,400
	Total Degradation of Levees							1,606,200
	Levee--New Construction							
	Levee Embankment	645,700	CY	5	3,228,500	645,700	20%	3,874,200
	Excavation for Inspection Trench	180,700	CY	5	903,500	180,700	20%	1,084,200
	Slurry Wall	494,000	SF	5.80	2,865,200	573,040	20%	3,438,200
	Clearing and Grubbing	65.5	AC	1,000	65,500	13,100	20%	78,600
	Stripping (6 Inches)	52,820	CY	1.50	79,230	15,846	20%	95,100
	Seeding	45.7	AC	2,500	114,250	22,850	20%	137,100
	Total Construction of New Levees							8,707,400
	Levee--Improvements							
	Mobilization & Demobilization	1	LS	15,000	15,000	3,000	20%	18,000
	Sheet Pile	10,400	SF	15	156,000	31,200	20%	187,200

Table K-5
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

50,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Total Levee Improvements							205,200
	Total Levees							11,078,800
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							71,692,200
18	CULTURAL RESOURCE PRESERVATION	1	%					716,900
30	PLANNING, ENGINEERING & DESIGN	12	%					8,603,100
31	CONSTRUCTION MANAGEMENT	8.5	%					6,093,800
	TOTAL FIRST COST							**112,591,100**

Table K-5
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

INVESTMENT COST

50,000k cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				112,591,100
Interest during Construction				
At midyear (year 1.5, and .5)				7,659,400
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				120,250,500

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		7,762,700
OPERATION AND MAINTENANCE				
Allowance (from DWR)				485,000
TOTAL ANNUAL COST				8,247,700

Table K-6

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	25,485,050				25,485,100
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,382,000				2,382,000
	Road Realignments							
	County Roads 17B, 97A, and 97B							
	Mobilization & Demobilization	1	LS	68,500				68,500
	Asphaltic Concrete	1,310	TON	50	65,500	13,100	20%	78,600
	Aggregate Base, Class II	3,920	TON	20	78,400	15,680	20%	94,100
	Aggregate Subbase	50,090	TON	15	751,350	150,270	20%	901,600
	Demolish Existing Road	4,660	SY	4	18,640	3,728	20%	22,400
	Pulverize and Blend	41,940	SY	3	125,820	25,164	20%	151,000
	Striping	9,000	LF	1.50	13,500	2,700	20%	16,200
	Clear and Grubb	5.4	AC	1,500	8,100	1,620	20%	9,700
	Guard Rail	2,400	LF	35	84,000	16,800	20%	100,800
	Total Road Realignments							1,442,900
	Total Relocations							3,824,900
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	34,800,000				34,800,000
08	ROADS							
	Mobilization & Demobilization	1	LS	34,500				34,500
	Patrol Roads (4" aggregate base)	28,600	TON	20	572,000	114,400	20%	686,400
	Total Roads							720,900
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	1,000,000				1,000,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	46.2	AC	5,000	231,000	46,200	20%	277,200
	Clearing and Grubbing (in overbank for rip rap)	22.6	AC	1,500	33,900	6,780	20%	40,700

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.
[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-6
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Excavation (Layback channel slope and for rip rap)	158,300	CY	5	791,500	158,300	20%	949,800
	Rip Rap	360,200	TON	28	10,085,600	2,017,120	20%	12,102,700
	Bedding (for riprap)	104,000	TON	21	2,184,000	436,800	20%	2,620,800
	Stripping (for rip rap, 6")	54,600	CY	10	546,000	109,200	20%	655,200
	Gabions	15,870	CY	125	1,983,750	396,750	20%	2,380,500
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200
	Total Creek Channels							20,393,100
	Toe Drain							
	Excavation	51,000	CY	2	102,000	20,400	20%	122,400
	Reinforced Concrete Inlet and Outlet Transitions	227	CY	500	113,500	22,700	20%	136,200
	24"-Diameter RCP	2,000	LF	40	80,000	16,000	20%	96,000
	Seeding	3	AC	2,500	7,500	1,500	20%	9,000
	Total Toe Drain							363,600
	Total Channels and Canals							21,756,700
11	LEVEES AND FLOODWALLS							
	Mobilization and Demobilization	1	LS	890,000				890,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	101,000	CY	1.50	151,500	30,300	20%	181,800
	Excavation (Includes training levee)	911,000	CY	2	1,822,000	364,400	20%	2,186,400
	Total Degradation of Levees							2,368,200
	Levee--New Construction							
	Levee Embankment	1,060,450	CY	5	5,302,250	1,060,450	20%	6,362,700
	Excavation for Inspection Trench	222,240	CY	5	1,111,200	222,240	20%	1,333,400
	Slurry Wall	494,000	SF	5.80	2,865,200	573,040	20%	3,438,200
	Clearing and Grubbing	89.6	AC	1,000	89,600	17,920	20%	107,500
	Stripping (6 Inches)	77,840	CY	1.50	116,760	23,352	20%	140,100
	Seeding	70.7	AC	2,500	176,750	35,350	20%	212,100
	Total Construction of New Levees							11,594,000

Table K-6
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Levee--Improvements							
	Levee Embankment	23,800	CY	5	119,000	23,800	20%	142,800
	Sheet Pile	42,400	SF	15	636,000	127,200	20%	763,200
	Excavation for Inspection Trench	34,790	CY	5	173,950	34,790	20%	208,700
	Clearing and Grubbing	6.9	AC	1,000	6,900	1,380	20%	8,300
	Stripping (6 Inches)	15,410	CY	1.50	23,115	4,623	20%	27,700
	Seeding	3.1	AC	2,500	7,750	1,550	20%	9,300
	Total Levee--Improvements							1,160,000
	Total Levees							16,012,200
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							77,114,700
18	CULTURAL RESOURCE PRESERVATION	1	%					771,100
30	PLANNING, ENGINEERING & DESIGN	12	%					9,253,800
31	CONSTRUCTION MANAGEMENT	8.5	%					6,554,700
	TOTAL FIRST COST							**119,179,400**

Table K-6
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

INVESTMENT COST

70,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				119,179,400
Interest during Construction				
At midyear (year 1.5, and .5)				8,107,700
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				127,287,100

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		8,216,900
OPERATION AND MAINTENANCE				
Allowance (from DWR)				485,000
TOTAL ANNUAL COST				8,701,900

Table K-7

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

90,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	25,485,050				25,485,100
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	3,285,000				3,285,000
	Bridges							
	Mobilization & Demobilization	1	LS	830,000				830,000
	County Road 102 Bridge Replacement	15,000	SF	125	1,875,000	375,000	20%	2,250,000
	State Highway 113 Bridge Replacement	20,000	SF	125	2,500,000	500,000	20%	3,000,000
	County Road 99W Bridge Enlargement	11,020	SF	125	1,377,500	275,500	20%	1,653,000
	Interstate 5 Southbound Bridge Enlargement	14,400	SF	150	2,160,000	432,000	20%	2,592,000
	Interstate 5 Northbound Bridge Enlargement	12,000	SF	150	1,800,000	360,000	20%	2,160,000
	Excavation of Bridge Abutment/Causeway	41,667	CY	5	208,335	41,667	20%	250,000
	Pulverize and Blend	31,800	SY	3	95,400	19,080	20%	114,500
	Clear and Grub	7	AC	1,000	7,400	1,480	20%	8,900
	Remove Concrete Pavement	3,490	CY	80	279,200	55,840	20%	335,000
	Raise Bridge Ramps--Concrete	4,980	CY	100	498,000	99,600	20%	597,600
	Raise Bridge Ramps--Asphaltic Concrete	7,830	TON	50	391,500	78,300	20%	469,800
	Raise Bridge Ramps--Aggregate Base, Class II	24,440	TON	20	488,800	97,760	20%	586,600
	Raise Bridge Ramps--Embankment	105,480	TON	15	1,582,200	316,440	20%	1,898,600
	Striping	23,850	LF	1.50	35,775	7,155	20%	42,900
	Total Bridges							16,788,900
	Road Realignments							
	County Roads 17B, 97A, and 97B							
	Mobilization & Demobilization	1	LS	105,000				105,000
	Asphaltic Concrete	2,068	TON	50	103,400	20,680	20%	124,100
	Aggregate Base, Class II	6,200	TON	20	124,000	24,800	20%	148,800
	Aggregate Subbase	82,068	TON	15	1,231,020	246,204	20%	1,477,200
	Demolish Existing Road	5,860	SY	4	23,440	4,688	20%	28,100
	Pulverize and Blend	68,400	SY	3	205,200	41,040	20%	246,200
	Stripping	14,250	LF	1.50	21,375	4,275	20%	25,700
	Clear and Grubb	8.0	AC	1,500	12,000	2,400	20%	14,400

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-7
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

90,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Guard Rail	4,400	LF	35	154,000	30,800	20%	184,800
	Total Road Realignments							2,354,300
	Total Relocations							22,428,200
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	34,800,000				34,800,000
08	ROADS							
	Mobilization & Demobilization	1	LS	205,000				205,000
	Patrol Roads (4" aggregate base)	28,600	TON	20	572,000	114,400	20%	686,400
	Bridges							
	Railroad Bridge Replacement	500	LF	5,500	2,750,000	550,000	20%	3,300,000
	Railroad Ballast	180	CY	60	10,800	2,160	20%	13,000
	Railroad Ties	1,070	LF	8	8,560	1,712	20%	10,300
	Railroad Track	800	LF	135	108,000	21,600	20%	129,600
	Total Bridges							3,452,900
	Total Roads							4,344,300
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	1,170,000				1,170,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	49.7	AC	5,000	248,500	49,700	20%	298,200
	Clearing and Grubbing (in overbank for rip rap)	26.0	AC	1,500	39,000	7,800	20%	46,800
	Excavation (Layback channel slope and for rip rap)	169,700	CY	5	848,500	169,700	20%	1,018,200
	Rip Rap	398,700	TON	28	11,163,600	2,232,720	20%	13,396,300
	Bedding (for riprap)	115,200	TON	21	2,419,200	483,840	20%	2,903,000
	Stripping (for rip rap, 6")	60,200	CY	10	602,000	120,400	20%	722,400
	Gabions	15,870	CY	125	1,983,750	396,750	20%	2,380,500
	Concrete Lining	9,210	CY	275	2,532,750	506,550	20%	3,039,300
	Total Creek Channels							23,804,700

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-7
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

90,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Toe Drain							
	Excavation	51,000	CY	2	102,000	20,400	20%	122,400
	Reinforced Concrete Inlet and Outlet Transitions	227	CY	500	113,500	22,700	20%	136,200
	24"-Diameter RCP	2,000	LF	40	80,000	16,000	20%	96,000
	Seeding	3	AC	2,500	7,500	1,500	20%	9,000
	Total Toe Drain							363,600
	Total Channels and Canals							25,338,300
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	1,190,000				1,190,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	101,000	CY	1.50	151,500	30,300	20%	181,800
	Excavation (Includes training levee)	911,000	CY	2	1,822,000	364,400	20%	2,186,400
	Total Degradation of Levees							2,368,200
	Levee--New Construction							
	Levee Embankment	1,315,700	CY	5	6,578,500	1,315,700	20%	7,894,200
	Excavation for Inspection Trench	260,235	CY	5	1,301,175	260,235	20%	1,561,400
	Slurry Wall	494,000	SF	5.80	2,865,200	573,040	20%	3,438,200
	Clearing and Grubbing	103.3	AC	1,000	103,300	20,660	20%	124,000
	Stripping (6 Inches)	83,299	CY	1.50	124,949	24,990	20%	149,900
	Seeding	80.6	AC	2,500	201,500	40,300	20%	241,800
	Total Construction of New Levees							13,409,500
	Levee--Improvements							
	Levee Embankment	70,900	CY	5	354,500	70,900	20%	425,400
	Sheet Pile	59,680	SF	15	895,200	179,040	20%	1,074,200
	Excavation for Inspection Trench	50,200	CY	5	251,000	50,200	20%	301,200
	Clearing and Grubbing	9.6	AC	1,000	9,600	1,920	20%	11,500
	Stripping (6 Inches)	21,600	CY	1.50	32,400	6,480	20%	38,900
	Seeding	5.1	AC	2,500	12,750	2,550	20%	15,300
	Total Levee--Improvements							1,866,500

Table K-7
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

90,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Levee--Improvements to Settling Basin							
	Levee Embankment	141,800	CY	5	709,000	141,800	20%	850,800
	Rip Rap (Stock Pile and Reset)	87,000	TON	15	1,305,000	261,000	20%	1,566,000
	Bedding (for riprap)	2,450	TON	22	53,900	10,780	20%	64,700
								2,481,500
	Total Levees							21,315,700
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							108,226,500
18	CULTURAL RESOURCE PRESERVATION	1	%					1,082,300
30	PLANNING, ENGINEERING & DESIGN	12	%					12,987,200
31	CONSTRUCTION MANAGEMENT	8.5	%					9,199,300
	TOTAL FIRST COST							**156,980,400**

Table K-7
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
NARROW SETBACK LEVEE PLAN

INVESTMENT COST

90,000k cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				156,980,400
Interest during Construction				
At midyear (year 1.5, and .5)				10,679,100
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				167,659,500

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		10,823,100
OPERATION AND MAINTENANCE				
Allowance (from DWR)				485,000
TOTAL ANNUAL COST				11,308,100

Table K-8

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

50,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	57,612,850				57,612,900
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	1,434,000				1,434,000
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50	183,000	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20	219,400	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15	282,450	56,490	20%	338,900
	Demolish Existing Road	0	SY	4	0	0	20%	0
	Pulverize and Blend	0	SY	3	0	0	20%	0
	Stripping	25,200	LF	1.50	37,800	7,560	20%	45,400
	Clear and Grubb	11.6	AC	1,500	17,400	3,480	20%	20,900
	Guard Rail	0	LF	35	0	0	20%	0
	Right of Way	11.6	AC	3,500	40,600	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							2,417,800
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	20,500,000				20,500,000
08	ROADS							
	Mobilization & Demobilization	1	LS	34,500				34,500
	Patrol Roads (4" aggregate base)	28,800	TON	20	576,000	115,200	20%	691,200
	Total Roads							725,700
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	505,000				505,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	15.9	AC	5,000	79,500	15,900	20%	95,400
	Clearing and Grubbing (in overbank for rip rap)	19.4	AC	1,500	29,100	5,820	20%	34,900
	Excavation (Layback channel slope and for rip rap)	31,600	CY	5	158,000	31,600	20%	189,600

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.
[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-8
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

50,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Rip Rap	183,200	TON	28	5,129,600	1,025,920	20%	6,155,500
	Bedding (for riprap)	55,400	TON	21	1,163,400	232,680	20%	1,396,100
	Stripping (for rip rap, 6")	28,500	CY	10	285,000	57,000	20%	342,000
	Gabions	0	CY	125	0	0	20%	0
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200
	Total Creek Channels							9,579,700
	Toe Drain							
	Excavation	184,500	CY	2	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							10,951,400
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	705,000				705,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	99,700	CY	1.50	149,550	29,910	20%	179,500
	Excavation (Includes training levee)	930,200	CY	2	1,860,400	372,080	20%	2,232,500
	Total Degradation of Levees							2,412,000
	Levee--New Construction							
	Levee Embankment	941,700	CY	5	4,708,500	941,700	20%	5,650,200
	Excavation for Inspection Trench	250,100	CY	5	1,250,500	250,100	20%	1,500,600
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	89.2	AC	1,000	89,200	17,840	20%	107,000
	Stripping (6 Inches)	71,970	CY	1.50	107,955	21,591	20%	129,500
	Seeding	67.0	AC	2,500	167,500	33,500	20%	201,000
	Total Construction of New Levees							11,733,000
	Levee--Improvements							
	Mobilization & Demobilization		LS	25,000	0	0	20%	0

Table K-8
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

50,000k cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Levee Embankment	1,020	CY	5	5,100	1,020	20%	6,100
	Sheet Pile	0	SF	15	0	0	20%	0
	Excavation for Inspection Trench	700	CY	5	3,500	700	20%	4,200
	Clearing and Grubbing	0.1	AC	1,000	100	20	20%	100
	Stripping (6 Inches)	230	CY	1.50	345	69	20%	400
	Seeding	0.1	AC	2,500	250	50	20%	300
	Total Levee--Improvements							11,100
	Total Levees							14,861,100
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							49,456,000
18	CULTURAL RESOURCE PRESERVATION	1	%					494,600
30	PLANNING, ENGINEERING & DESIGN	12	%					5,934,700
31	CONSTRUCTION MANAGEMENT	8.5	%					4,203,800
	TOTAL FIRST COST							**117,702,000**

Table K-8
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

INVESTMENT COST

50,000k cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				117,702,000
Interest during Construction				
At midyear (year 1.5, and .5)				8,007,100
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				125,709,100

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		8,115,000
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				8,530,000

Table K-9

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	57,612,850				57,612,900
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	1,566,000				1,566,000
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50	183,000	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20	219,400	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15	282,450	56,490	20%	338,900
	Demolish Existing Road	0	SY	4	0	0	20%	0
	Pulverize and Blend	0	SY	3	0	0	20%	0
	Striping	25,200	LF	1.50	37,800	7,560	20%	45,400
	Clear and Grubb	11.6	AC	1,500	17,400	3,480	20%	20,900
	Guard Rail	0	LF	35	0	0	20%	0
	Right of Way	11.6	AC	3,500	40,600	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							2,549,800
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	20,500,000				20,500,000
08	ROADS							
	Mobilization & Demobilization	1	LS	34,500				34,500
	Patrol Roads (4" aggregate base)	28,800	TON	20	576,000	115,200	20%	691,200
	Total Roads							725,700
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	50,500				50,500
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	15.9	AC	5,000	79,500	15,900	20%	95,400
	Clearing and Grubbing (in overbank for rip rap)	19.4	AC	1,500	29,100	5,820	20%	34,900
	Excavation (Layback channel slope and for rip rap)	31,600	CY	5	158,000	31,600	20%	189,600

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.
[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-9
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Rip Rap	183,200	TON	28	5,129,600	1,025,920	20%	6,155,500
	Bedding (for riprap)	55,400	TON	21	1,163,400	232,680	20%	1,396,100
	Stripping (for rip rap, 6")	28,500	CY	10	285,000	57,000	20%	342,000
	Gabions	0	CY	125	0	0	20%	0
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200
	Total Creek Channels							9,579,700
	Toe Drain							
	Excavation	184,500	CY	2	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							10,496,900
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	920,000				920,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	123,000	CY	1.50	184,500	36,900	20%	221,400
	Excavation (Includes training levee)	1,230,900	CY	2	2,461,800	492,360	20%	2,954,200
	Total Degradation of Levees							3,175,600
	Levee--New Construction							
	Levee Embankment	1,438,700	CY	5	7,193,500	1,438,700	20%	8,632,200
	Excavation for Inspection Trench	277,300	CY	5	1,386,500	277,300	20%	1,663,800
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	113.1	AC	1,000	113,100	22,620	20%	135,700
	Stripping (6 Inches)	91,230	CY	1.50	136,845	27,369	20%	164,200
	Seeding	89.3	AC	2,500	223,250	44,650	20%	267,900
	Total Construction of New Levees							15,008,500
	Levee--Improvements							
	Mobilization & Demobilization		LS	25,000	0	0	20%	0

Table K-9
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Levee Embankment	14,500	CY	5	72,500	14,500	20%	87,000
	Sheet Pile	0	SF	15	0	0	20%	0
	Excavation for Inspection Trench	13,200	CY	5	66,000	13,200	20%	79,200
	Clearing and Grubbing	2.9	AC	1,000	2,900	580	20%	3,500
	Stripping (6 Inches)	4,050	CY	1.50	6,075	1,215	20%	7,300
	Seeding	1.4	AC	2,500	3,500	700	20%	4,200
	Total Levee--Improvements							181,200
	Total Levees							19,285,300
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							53,557,700
18	CULTURAL RESOURCE PRESERVATION	1	%					535,600
30	PLANNING, ENGINEERING & DESIGN	12	%					6,426,900
31	CONSTRUCTION MANAGEMENT	8.5	%					4,552,400
	TOTAL FIRST COST							**122,685,500**

Table K-9
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

INVESTMENT COST

70,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				122,685,500
Interest during Construction				
At midyear (year 1.5, and .5)				8,346,200
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				131,031,700

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		8,458,600
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				8,873,600

Table K-10

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	57,612,850				57,612,900
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,052,000				2,052,000
	Bridges							
	Mobilization & Demobilization	1	LS	515,000				515,000
	County Road 102 Bridge Replacement	15,000	SF	125	1,875,000	375,000	20%	2,250,000
	State Highway 113 Bridge Replacement	20,000	SF	125	2,500,000	500,000	20%	3,000,000
	County Road 99W Bridge Enlargement	0	SF	125	0	0	20%	0
	Interstate 5 Southbound Bridge Replacement	13,200	SF	150	1,980,000	396,000	20%	2,376,000
	Interstate 5 Northbound Bridge Enlargement	0	SF	150	0	0	20%	0
	Excavation of Bridge Abutment/Causeway	0	CY	5	0	0	20%	0
	Pulverize and Blend	20,600	SY	3	61,800	12,360	20%	74,200
	Clear and Grub	5	AC	1,000	4,800	960	20%	5,800
	Remove Concrete Pavement	0	CY	80	0	0	20%	0
	Raise Bridge Ramps--Concrete Pavement	0	CY	100	0	0	20%	0
	Raise Bridge Ramps--Asphaltic Concrete	5,940	TON	50	297,000	59,400	20%	356,400
	Raise Bridge Ramps--Aggregate Base, Class II	19,870	TON	20	397,400	79,480	20%	476,900
	Raise Bridge Ramps--Embankment	66,770	TON	15	1,001,550	200,310	20%	1,201,900
	Striping	15,450	LF	1.50	23,175	4,635	20%	27,800
	Total Bridges							10,284,000
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50	183,000	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20	219,400	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15	282,450	56,490	20%	338,900
	Demolish Existing Road	0	SY	4	0	0	20%	0
	Pulverize and Blend	0	SY	3	0	0	20%	0
	Striping	25,200	LF	1.50	37,800	7,560	20%	45,400
	Clear and Grubb	11.6	AC	1,500	17,400	3,480	20%	20,900

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-10
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Guard Rail	0	LF	35	0	0	20%	0
	Right of Way	11.6	AC	3,500	40,600	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							13,319,800
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	20,500,000				20,500,000
08	ROADS							
	Mobilization & Demobilization	1	LS	34,500				34,500
	Patrol Roads (4" aggregate base)	28,800	TON	20	576,000	115,200	20%	691,200
	Bridges							
	Railroad Bridge Replacement	0	LF	5,500	0	0	20%	0
	Total Bridges							0
	Total Roads							725,700
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	520,000				520,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	15.9	AC	5,000	79,500	15,900	20%	95,400
	Clearing and Grubbing (in overbank for rip rap)	19.4	AC	1,500	29,100	5,820	20%	34,900
	Excavation (Layback channel slope and for rip rap)	31,600	CY	5	158,000	31,600	20%	189,600
	Rip Rap	183,200	TON	28	5,129,600	1,025,920	20%	6,155,500
	Bedding (for riprap)	55,400	TON	21	1,163,400	232,680	20%	1,396,100
	Stripping (for rip rap, 6")	28,500	CY	10	285,000	57,000	20%	342,000
	Gabions	0	CY	125	0	0	20%	0
	Concrete Lining	4,910	CY	275	1,350,250	270,050	20%	1,620,300
	Total Creek Channels							9,833,800
	Toe Drain							

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-10
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Excavation	184,500	CY	2	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							11,220,500
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	1,175,000				1,175,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	123,000	CY	1.50	184,500	36,900	20%	221,400
	Excavation (Includes training levee)	1,230,900	CY	2	2,461,800	492,360	20%	2,954,200
	Total Degradation of Levees							3,175,600
	Levee--New Construction							
	Levee Embankment	1,823,500	CY	5	9,117,500	1,823,500	20%	10,941,000
	Excavation for Inspection Trench	297,000	CY	5	1,485,000	297,000	20%	1,782,000
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	131.1	AC	1,000	131,100	26,220	20%	157,300
	Stripping (6 Inches)	105,800	CY	1.50	158,700	31,740	20%	190,400
	Seeding	105.6	AC	2,500	264,000	52,800	20%	316,800
	Total Construction of New Levees							17,532,200
	Levee--Improvements							
	Levee Embankment	24,500	CY	5	122,500	24,500	20%	147,000
	Sheet Pile	0	SF	15	0	0	20%	0
	Excavation for Inspection Trench	13,500	CY	5	67,500	13,500	20%	81,000
	Clearing and Grubbing	2.9	AC	1,000	2,900	580	20%	3,500
	Stripping (6 Inches)	6,450	CY	1.50	9,675	1,935	20%	11,600
	Seeding	1.6	AC	2,500	4,000	800	20%	4,800
	Total Levee--Improvements							247,900

Table K-10
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Levee--Improvements to Settling Basin							
	Levee Embankment	141,800	CY	5	709,000	141,800	20%	850,800
	Rip Rap (Stock Pile and Reset)	87,000	TON	15	1,305,000	261,000	20%	1,566,000
	Bedding (for riprap)	2,450	TON	22	53,900	10,780	20%	64,700
								2,481,500
	Total Levees							24,612,200
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							70,378,200
18	CULTURAL RESOURCE PRESERVATION	1	%					703,800
30	PLANNING, ENGINEERING & DESIGN	12	%					8,445,400
31	CONSTRUCTION MANAGEMENT	8.5	%					5,982,100
	TOTAL FIRST COST							**143,122,400**

Table K-10
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
WIDE SETBACK LEVEE PLAN

INVESTMENT COST

90,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				143,122,400
Interest during Construction				
At midyear (year 1.5, and .5)				9,736,400
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				152,858,800

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		9,867,600
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				10,282,600

Table K-11

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

50,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	48,647,300				48,647,300
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,385,000				2,385,000
	Bridges							
	Mobilization & Demobilization	1	LS	1,975,000				1,975,000
	County Road 102 Bridge Replacement	30,000	SF	125	3,750,000	750,000	20%	4,500,000
	State Highway 113 Bridge Replacement	50,000	SF	125	6,250,000	1,250,000	20%	7,500,000
	County Road 99W Bridge Enlargement	38,000	SF	125	4,750,000	950,000	20%	5,700,000
	Interstate 5 Southbound Bridge Enlargement	48,000	SF	150	7,200,000	1,440,000	20%	8,640,000
	Interstate 5 Northbound Bridge Enlargement	40,000	SF	150	6,000,000	1,200,000	20%	7,200,000
	Excavation of Bridge Abutment/Causeway	41,667	CY	5	208,335	41,667	20%	250,000
	Pulverize and Blend	31,800	SY	3	95,400	19,080	20%	114,500
	Clear and Grub	7	AC	1,000	7,400	1,480	20%	8,900
	Remove Concrete Pavement	3,490	CY	80	279,200	55,840	20%	335,000
	Raise Bridge Ramps--Concrete Pavement	4,980	CY	100	498,000	99,600	20%	597,600
	Raise Bridge Ramps--Asphaltic Concrete	7,830	TON	50	391,500	78,300	20%	469,800
	Raise Bridge Ramps--Aggregate Base, Class II	24,440	TON	20	488,800	97,760	20%	586,600
	Raise Bridge Ramps--Embankment	105,480	TON	15	1,582,200	316,440	20%	1,898,600
	Striping	23,850	LF	1.50	35,775	7,155	20%	42,900
	Total Bridges							39,818,900
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50	183,000	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20	219,400	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15	282,450	56,490	20%	338,900
	Demolish Existing Road	0	SY	4	0	0	20%	0
	Pulverize and Blend	0	SY	3	0	0	20%	0
	Stripping	25,200	LF	1.50	37,800	7,560	20%	45,400

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-11
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

50,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clear and Grubb	11.6	AC	1,500	17,400	3,480	20%	20,900
	Guard Rail	0	LF	35	0	0	20%	0
	Right of Way	11.6	AC	3,500	40,600	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							43,187,700
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	9,901,000				9,901,000
08	ROADS							
	Mobilization & Demobilization	1	LS	395,000				395,000
	Patrol Roads (4" aggregate base)	28,800	TON	20	576,000	115,200	20%	691,200
	Bridges							
	Railroad Bridge Replacement	1,000	LF	5,500	5,500,000	1,100,000	20%	6,600,000
	Railroad Ballast	180	CY	60	10,800	2,160	20%	13,000
	Railroad Ties	1,070	LF	8	8,560	1,712	20%	10,300
	Railroad Track	800	LF	135	108,000	21,600	20%	129,600
	Total Bridges							6,752,900
	Total Roads							7,839,100
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	235,000				235,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	4.7	AC	5,000	23,500	4,700	20%	28,200
	Clearing and Grubbing (in overbank for rip rap)	0.2	AC	1,500	300	60	20%	400
	Excavation (Layback channel slope and for rip rap)	12,000	CY	5	60,000	12,000	20%	72,000
	Rip Rap	26,100	TON	28	730,800	146,160	20%	877,000
	Bedding (for riprap)	7,000	TON	21	147,000	29,400	20%	176,400
	Stripping (for rip rap, 6")	4,000	CY	10	40,000	8,000	20%	48,000
	Gabions	1,500	CY	125	187,500	37,500	20%	225,000
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-11
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

50,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing (for Hardpoints)	1.7	AC	3,750	6,375	1,275	20%	7,700
	Excavation (for Hardpoints)	40,000	CY	5	200,000	40,000	20%	240,000
	Stone (for Hardpoints)	31,700	TON	22	697,400	139,480	20%	836,900
	Total Creek Channels							3,877,800
	Toe Drain							
	Excavation	184,500	CY	2	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							4,979,500
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	700,000				700,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	86,100	CY	1.50	129,150	25,830	20%	155,000
	Excavation (Includes training levee)	861,600	CY	2	1,723,200	344,640	20%	2,067,800
	Total Degradation of Levees							2,222,800
	Levee--New Construction							
	Levee Embankment	941,700	CY	5	4,708,500	941,700	20%	5,650,200
	Excavation for Inspection Trench	250,100	CY	5	1,250,500	250,100	20%	1,500,600
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	89.2	AC	1,000	89,200	17,840	20%	107,000
	Stripping (6 Inches)	71,970	CY	1.50	107,955	21,591	20%	129,500
	Seeding	67.0	AC	2,500	167,500	33,500	20%	201,000
	Total Construction of New Levees							11,733,000
	Levee--Improvements							
	Levee Embankment	1,020	CY	5	5,100	1,020	20%	6,100
	Sheet Pile	0	SF	15	0	0	20%	0

Table K-11
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

50,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Excavation for Inspection Trench	700	CY	5	3,500	700	20%	4,200
	Clearing and Grubbing	0.1	AC	1,000	100	20	20%	100
	Stripping (6 Inches)	230	CY	1.50	345	69	20%	400
	Seeding	0.1	AC	2,500	250	50	20%	300
	Total Levee--Improvements							11,100
	Total Levees							14,666,900
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							80,574,200
18	CULTURAL RESOURCE PRESERVATION	1	%					805,700
30	PLANNING, ENGINEERING & DESIGN	12	%					9,668,900
31	CONSTRUCTION MANAGEMENT	8.5	%					6,848,800
	TOTAL FIRST COST							**146,544,900**

Table K-11
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

INVESTMENT COST

50,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				146,544,900
Interest during Construction				
At midyear (year 1.5, and .5)				9,969,300
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				156,514,200

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		10,103,600
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				10,518,600

Table K-12

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	48,647,300				48,647,300
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,505,000				2,505,000
	Bridges							
	Mobilization & Demobilization	1	LS	1,975,000				1,975,000
	County Road 102 Bridge Replacement	30,000	SF	125	3,750,000	750,000	20%	4,500,000
	State Highway 113 Bridge Replacement	50,000	SF	125	6,250,000	1,250,000	20%	7,500,000
	County Road 99W Bridge Enlargement	38,000	SF	125	4,750,000	950,000	20%	5,700,000
	Interstate 5 Southbound Bridge Enlargement	48,000	SF	150	7,200,000	1,440,000	20%	8,640,000
	Interstate 5 Northbound Bridge Enlargement	40,000	SF	150	6,000,000	1,200,000	20%	7,200,000
	Excavation of Bridge Abutment/Causeway	41,667	CY	5	208,335	41,667	20%	250,000
	Pulverize and Blend	31,800	SY	3	95,400	19,080	20%	114,500
	Clear and Grub	7	AC	1,000	7,400	1,480	20%	8,900
	Remove Concrete Pavement	3,490	CY	80	279,200	55,840	20%	335,000
	Raise Bridge Ramps--Concrete Pavement	4,980	CY	100	498,000	99,600	20%	597,600
	Raise Bridge Ramps--Asphaltic Concrete	7,830	TON	50	391,500	78,300	20%	469,800
	Raise Bridge Ramps--Aggregate Base, Class II	24,440	TON	20	488,800	97,760	20%	586,600
	Raise Bridge Ramps--Embankment	105,480	TON	15	1,582,200	316,440	20%	1,898,600
	Striping	23,850	LF	1.50	35,775	7,155	20%	42,900
	Total Bridges							39,818,900
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50	183,000	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20	219,400	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15	282,450	56,490	20%	338,900
	Demolish Existing Road	0	SY	4	0	0	20%	0
	Pulverize and Blend	0	SY	3	0	0	20%	0
	Striping	25,200	LF	1.50	37,800	7,560	20%	45,400
	Clear and Grubb	11.6	AC	1,500	17,400	3,480	20%	20,900

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-12
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Guard Rail	0	LF	35	0	0	20%	0
	Right of Way	11.6	AC	3,500	40,600	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							43,307,700
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	9,901,000				9,901,000
08	ROADS							
	Mobilization & Demobilization	1	LS	395,000				395,000
	Patrol Roads (4" aggregate base)	28,600	TON	20	572,000	114,400	20%	686,400
	Bridges							
	Railroad Bridge Replacement	1,000	LF	5,500	5,500,000	1,100,000	20%	6,600,000
	Railroad Ballast	180	CY	60	10,800	2,160	20%	13,000
	Railroad Ties	1,070	LF	8	8,560	1,712	20%	10,300
	Railroad Track	800	LF	135	108,000	21,600	20%	129,600
	Total Bridges							6,752,900
	Total Roads							7,834,300
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	235,000				235,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	4.7	AC	5,000	23,500	4,700	20%	28,200
	Clearing and Grubbing (in overbank for rip rap)	0.2	AC	1,500	300	60	20%	400
	Excavation (Layback channel slope and for rip rap)	12,000	CY	5	60,000	12,000	20%	72,000
	Rip Rap	26,100	TON	28	730,800	146,160	20%	877,000
	Bedding (for riprap)	7,000	TON	21	147,000	29,400	20%	176,400
	Stripping (for rip rap, 6")	4,000	CY	10	40,000	8,000	20%	48,000
	Gabions	1,500	CY	125	187,500	37,500	20%	225,000
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-12
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing (for Hardpoints)	1.7	AC	3,750	6,375	1,275	20%	7,700
	Excavation (for Hardpoints)	40,000	CY	5	200,000	40,000	20%	240,000
	Stone (for Hardpoints)	31,700	TON	22	697,400	139,480	20%	836,900
	Total Creek Channels							3,877,800
	Toe Drain							
	Excavation	184,500	CY	2	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							4,979,500
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	870,000				870,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	86,100	CY	1.50	129,150	25,830	20%	155,000
	Excavation (Includes training levee)	861,600	CY	2	1,723,200	344,640	20%	2,067,800
	Total Degradation of Levees							2,222,800
	Levee--New Construction							
	Levee Embankment	1,438,700	CY	5	7,193,500	1,438,700	20%	8,632,200
	Excavation for Inspection Trench	277,300	CY	5	1,386,500	277,300	20%	1,663,800
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	113.1	AC	1,000	113,100	22,620	20%	135,700
	Stripping (6 Inches)	91,230	CY	1.50	136,845	27,369	20%	164,200
	Seeding	89.3	AC	2,500	223,250	44,650	20%	267,900
	Total Construction of New Levees							15,008,500
	Levee--Improvements							
	Levee Embankment	14,500	CY	5	72,500	14,500	20%	87,000
	Sheet Pile	0	SF	15	0	0	20%	0
	Excavation for Inspection Trench	13,200	CY	5	66,000	13,200	20%	79,200

Table K-12
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

70,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing	2.9	AC	1,000	2,900	580	20%	3,500
	Stripping (6 Inches)	4,050	CY	1.50	6,075	1,215	20%	7,300
	Seeding	1.4	AC	2,500	3,500	700	20%	4,200
	Total Levee--Improvements							181,200
	Total Levees							18,282,500
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							84,305,000
18	CULTURAL RESOURCE PRESERVATION	1	%					843,100
30	PLANNING, ENGINEERING & DESIGN	12	%					10,116,600
31	CONSTRUCTION MANAGEMENT	8.5	%					7,165,900
	TOTAL FIRST COST							**151,077,900**

Table K-12
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

INVESTMENT COST

70,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				151,077,900
Interest during Construction				
At midyear (year 1.5, and .5)				10,277,600
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				161,355,500

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		10,416,100
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				10,831,100

Table K-13

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	48,647,300				48,647,300
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,505,000				2,505,000
	Bridges							
	Mobilization & Demobilization	1	LS	1,975,000				1,975,000
	County Road 102 Bridge Replacement	30,000	SF	125.00	3,750,000.00	750,000	20%	4,500,000
	State Highway 113 Bridge Replacement	50,000	SF	125.00	6,250,000.00	1,250,000	20%	7,500,000
	County Road 99W Bridge Enlargement	38,000	SF	125.00	4,750,000	950,000	20%	5,700,000
	Interstate 5 Southbound Bridge Enlargement	48,000	SF	150.00	7,200,000	1,440,000	20%	8,640,000
	Interstate 5 Northbound Bridge Enlargement	40,000	SF	150.00	6,000,000	1,200,000	20%	7,200,000
	Excavation of Bridge Abutment/Causeway	41,667	CY	5.00	208,335	41,667	20%	250,000
	Pulverize and Blend	31,800	SY	3.00	95,400	19,080	20%	114,500
	Clear and Grub	7	AC	1,000.00	7,400	1,480	20%	8,900
	Remove Concrete Pavement	3,490	CY	80.00	279,200	55,840	20%	335,000
	Raise Bridge Ramps--Concrete Pavement	4,980	CY	100.00	498,000	99,600	20%	597,600
	Raise Bridge Ramps--Asphaltic Concrete	7,830	TON	50.00	391,500	78,300	20%	469,800
	Raise Bridge Ramps--Aggregate Base, Class II	24,440	TON	20.00	488,800	97,760	20%	586,600
	Raise Bridge Ramps--Embankment	105,480	TON	15.00	1,582,200	316,440	20%	1,898,600
	Striping	23,850	LF	1.50	35,775	7,155	20%	42,900
	Total Bridges							39,818,900
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50.00	183,000.00	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20.00	219,400.00	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15.00	282,450.00	56,490	20%	338,900
	Demolish Existing Road	0	SY	4.00	0.00	0	20%	0
	Pulverize and Blend	0	SY	3.00	0.00	0	20%	0
	Striping	25,200	LF	1.50	37,800.00	7,560	20%	45,400

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-13
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clear and Grubb	11.6	AC	1,500.00	17,400.00	3,480	20%	20,900
	Guard Rail	0	LF	35.00	0.00	0	20%	0
	Right of Way	11.6	AC	3,500.00	40,600.00	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							43,307,700
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	9,901,000				9,901,000
08	ROADS							
	Mobilization & Demobilization	1	LS	395,000				395,000
	Patrol Roads (4" aggregate base)	28,600	TON	20.00	572,000	114,400	20%	686,400
	Bridges							
	Railroad Bridge Replacement	1,000	LF	5,500.00	5,500,000	1,100,000	20%	6,600,000
	Railroad Ballast	180	CY	60.00	10,800	2,160	20%	13,000
	Railroad Ties	1,070	LF	8.00	8,560	1,712	20%	10,300
	Railroad Track	800	LF	135.00	108,000	21,600	20%	129,600
	Total Bridges							6,752,900
	Total Roads							7,834,300
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	235,000				235,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	4.7	AC	5,000.00	23,500.00	4,700	20%	28,200
	Clearing and Grubbing (in overbank for rip rap)	0.2	AC	1,500.00	300.00	60	20%	400
	Excavation (Layback channel slope and for rip rap)	12,000	CY	5.00	60,000	12,000	20%	72,000
	Rip Rap	26,100	TON	28.00	730,800	146,160	20%	877,000
	Bedding (for riprap)	7,000	TON	21.00	147,000	29,400	20%	176,400
	Stripping (for rip rap, 6")	4,000	CY	10.00	40,000	8,000	20%	48,000
	Gabions	1,500	CY	125.00	187,500	37,500	20%	225,000
	Concrete Lining	4,140	CY	275.00	1,138,500	227,700	20%	1,366,200

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-13
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing (for Hardpoints)	1.7	AC	3,750.00	6,375	1,275	20%	7,700
	Excavation (for Hardpoints)	40,000	CY	5.00	200,000	40,000	20%	240,000
	Stone (for Hardpoints)	31,700	TON	22.00	697,400	139,480	20%	836,900
	Total Creek Channels							3,877,800
	Toe Drain							
	Excavation	184,500	CY	2.00	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500.00	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40.00	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500.00	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							4,979,500
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	930,000				930,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	86,100	CY	1.50	129,150	25,830	20%	155,000
	Excavation (Includes training levee)	861,600	CY	2.00	1,723,200	344,640	20%	2,067,800
	Total Degradation of Levees							2,222,800
	Levee--New Construction							
	Levee Embankment	1,631,100	CY	5.00	8,155,500	1,631,100	20%	9,786,600
	Excavation for Inspection Trench	277,300	CY	5.00	1,386,500	277,300	20%	1,663,800
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	113.1	AC	1,000.00	113,100	22,620	20%	135,700
	Stripping (6 Inches)	91,230	CY	1.50	136,845	27,369	20%	164,200
	Seeding	89.3	AC	2,500.00	223,250	44,650	20%	267,900
	Total Construction of New Levees							16,162,900
	Levee--Improvements							
	Levee Embankment	19,500	CY	5.00	97,500	19,500	20%	117,000
	Sheet Pile	0	SF	15.00	0	0	20%	0
	Excavation for Inspection Trench	13,350	CY	5.00	66,750	13,350	20%	80,100

Table K-13
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing	2.9	AC	1,000.00	2,900	580	20%	3,500
	Stripping (6 Inches)	5,250	CY	1.50	7,875	1,575	20%	9,500
	Seeding	1.5	AC	2,500.00	3,750	750	20%	4,500
	Total Levee--Improvements							214,600
	Total Levees							19,530,300
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							85,552,800
18	CULTURAL RESOURCE PRESERVATION	1	%					855,500
30	PLANNING, ENGINEERING & DESIGN	12	%					10,266,300
31	CONSTRUCTION MANAGEMENT	8.5	%					7,272,000
	TOTAL FIRST COST							**152,593,000**

Table K-13
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

INVESTMENT COST

78,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				152,593,900
Interest during Construction				
At midyear (year 1.5, and .5)				10,380,800
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				162,974,700

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		10,520,700
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				10,935,700

Table K-14

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	48,647,300				48,647,300
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,685,000				2,685,000
	Bridges							
	Mobilization & Demobilization	1	LS	1,975,000				1,975,000
	County Road 102 Bridge Replacement	30,000	SF	125	3,750,000	750,000	20%	4,500,000
	State Highway 113 Bridge Replacement	50,000	SF	125	6,250,000	1,250,000	20%	7,500,000
	County Road 99W Bridge Enlargement	38,000	SF	125	4,750,000	950,000	20%	5,700,000
	Interstate 5 Southbound Bridge Enlargement	48,000	SF	150	7,200,000	1,440,000	20%	8,640,000
	Interstate 5 Northbound Bridge Enlargement	40,000	SF	150	6,000,000	1,200,000	20%	7,200,000
	Excavation of Bridge Abutment/Causeway	41,667	CY	5	208,335	41,667	20%	250,000
	Pulverize and Blend	31,800	SY	3	95,400	19,080	20%	114,500
	Clear and Grub	7	AC	1,000	7,400	1,480	20%	8,900
	Remove Concrete Pavement	3,490	CY	80	279,200	55,840	20%	335,000
	Raise Bridge Ramps--Concrete Pavement	4,980	CY	100	498,000	99,600	20%	597,600
	Raise Bridge Ramps--Asphaltic Concrete	7,830	TON	50	391,500	78,300	20%	469,800
	Raise Bridge Ramps--Aggregate Base, Class II	24,440	TON	20	488,800	97,760	20%	586,600
	Raise Bridge Ramps--Embankment	105,480	TON	15	1,582,200	316,440	20%	1,898,600
	Striping	23,850	LF	1.50	35,775	7,155	20%	42,900
	Total Bridges							39,818,900
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50	183,000	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20	219,400	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15	282,450	56,490	20%	338,900
	Demolish Existing Road	0	SY	4	0	0	20%	0
	Pulverize and Blend	0	SY	3	0	0	20%	0
	Striping	25,200	LF	1.50	37,800	7,560	20%	45,400
	Clear and Grubb	11.6	AC	1,500	17,400	3,480	20%	20,900

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-14
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Guard Rail	0	LF	35	0	0	20%	0
	Right of Way	11.6	AC	3,500	40,600	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							43,487,700
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	9,901,000				9,901,000
08	ROADS							
	Mobilization & Demobilization	1	LS	395,000				395,000
	Patrol Roads (4" aggregate base)	28,800	TON	20	576,000	115,200	20%	691,200
	Bridges							
	Railroad Bridge Replacement	1,000	LF	5,500	5,500,000	1,100,000	20%	6,600,000
	Railroad Ballast	180	CY	60	10,800	2,160	20%	13,000
	Railroad Ties	1,070	LF	8	8,560	1,712	20%	10,300
	Railroad Track	800	LF	135	108,000	21,600	20%	129,600
	Total Bridges							6,752,900
	Total Roads							7,839,100
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	235,000				235,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	4.7	AC	5,000	23,500	4,700	20%	28,200
	Clearing and Grubbing (in overbank for rip rap)	0.2	AC	1,500	300	60	20%	400
	Excavation (Layback channel slope and for rip rap)	12,000	CY	5	60,000	12,000	20%	72,000
	Rip Rap	26,100	TON	28	730,800	146,160	20%	877,000
	Bedding (for riprap)	7,000	TON	21	147,000	29,400	20%	176,400
	Stripping (for rip rap, 6")	4,000	CY	10	40,000	8,000	20%	48,000
	Gabions	1,500	CY	125	187,500	37,500	20%	225,000
	Concrete Lining	4,140	CY	275	1,138,500	227,700	20%	1,366,200

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-14
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing (for Hardpoints)	1.7	AC	3,750	6,375	1,275	20%	7,700
	Excavation (for Hardpoints)	40,000	CY	5	200,000	40,000	20%	240,000
	Stone (for Hardpoints)	31,700	TON	22	697,400	139,480	20%	836,900
	Total Creek Channels							3,877,800
	Toe Drain							
	Excavation	184,500	CY	2	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							4,979,500
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	1,125,000				1,125,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	86,100	CY	1.50	129,150	25,830	20%	155,000
	Excavation (Includes training levee)	861,600	CY	2	1,723,200	344,640	20%	2,067,800
	Total Degradation of Levees							2,222,800
	Levee--New Construction							
	Levee Embankment	1,823,500	CY	5	9,117,500	1,823,500	20%	10,941,000
	Excavation for Inspection Trench	297,000	CY	5	1,485,000	297,000	20%	1,782,000
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	131.1	AC	1,000	131,100	26,220	20%	157,300
	Stripping (6 Inches)	105,800	CY	1.50	158,700	31,740	20%	190,400
	Seeding	105.6	AC	2,500	264,000	52,800	20%	316,800
	Total Construction of New Levees							17,532,200
	Levee--Improvements							
	Levee Embankment	24,500	CY	5	122,500	24,500	20%	147,000
	Sheet Pile	0	SF	15	0	0	20%	0

Table K-14
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

90,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Excavation for Inspection Trench	13,500	CY	5	67,500	13,500	20%	81,000
	Clearing and Grubbing	2.9	AC	1,000	2,900	580	20%	3,500
	Stripping (6 Inches)	6,450	CY	1.50	9,675	1,935	20%	11,600
	Seeding	1.6	AC	2,500	4,000	800	20%	4,800
	Total Levee--Improvements							247,900
	Levee--Improvements to Settling Basin							
	Levee Embankment	141,800	CY	5	709,000	141,800	20%	850,800
	Rip Rap (Stock Pile and Reset)	87,000	TON	15	1,305,000	261,000	20%	1,566,000
	Bedding (for riprap)	2,450	TON	22	53,900	10,780	20%	64,700
								2,481,500
	Total Levees							23,609,400
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							89,816,700
18	CULTURAL RESOURCE PRESERVATION	1	%					898,200
30	PLANNING, ENGINEERING & DESIGN	12	%					10,778,000
31	CONSTRUCTION MANAGEMENT	8.5	%					7,634,400
	TOTAL FIRST COST							**157,774,600**

Table K-14
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN

INVESTMENT COST

90,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				157,774,600
Interest during Construction				
At midyear (year 1.5, and .5)				10,733,200
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				168,507,800

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		10,877,900
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				11,292,900

Table K-15

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	**LANDS AND DAMAGES**[1]	1	LS	8,745,420				8,745,400
02	**RELOCATIONS**							
	Utilities (3% of total construction cost)	3	%	715,008				715,000
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Building Floodproofing (Raising Homes)	25	EA	60,000.00	1,500,000	525,000	35%	2,025,000
	County Road 19B Raising							
	AC (asphalt concrete)	218	Ton	50.00	10,900	2,180	20%	13,100
	Aggregate Base Class II	0	Ton	20.00	0	0	20%	0
	Aggregate Subbase	42	Ton	15.00	630	126	20%	800
	Pulverize and Blend	667	SY	3.00	2,001	400	20%	2,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0	AC	1,500.00	0	0	20%	0
	Culvert (18")	20	LF	35.00	700	140	20%	800
	Headwalls (sacked concrete Slope protection)	1.2	CY	500.00	600.00	120	20%	700
	County Road 97A Raising							
	AC (asphalt concrete)	389	Ton	50.00	19,450	3,890	20%	23,300
	Aggregate Base Class II	1,166	Ton	20.00	23,320	4,664	20%	28,000
	Aggregate Subbase	704	Ton	15.00	10,560	2,112	20%	12,700
	Pulverize and Blend	2,680	SY	3.00	8,040	1,608	20%	9,600
	Striping	2,010	LF	1.50	3,015	603	20%	3,600
	Clear & Grub	0.31	AC	1,500.00	465	93	20%	600
	Culvert (36")	60	LF	85.00	5,100	1,020	20%	6,100
	Headwalls (sacked concrete Slope protection)	1.3	CY	500.00	650.00	130	20%	800
	State Highway 16 Raising							
	AC (asphalt concrete)	836	Ton	50.00	41,800	8,360	20%	50,200
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	2,420	Ton	15.00	36,300	7,260	20%	43,600
	Pulverize and Blend	3,840	SY	3.00	11,520	2,304	20%	13,800
	Striping	2,880	LF	1.50	4,320	864	20%	5,200

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-15
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clear & Grub	0.44	AC	1,500.00	660	132	20%	800
	Culvert (60")	80	LF	150.00	12,000	2,400	20%	14,400
	Headwalls (sacked concrete Slope protection)	3.6	CY	500.00	1,800.00	360	20%	2,200
	County Road 99 Raising							
	AC (asphalt concrete)	667	Ton	50.00	33,350	6,670	20%	40,000
	Aggregate Base Class II	2,001	Ton	20.00	40,020	8,004	20%	48,000
	Aggregate Subbase	7,165	Ton	15.00	107,475	21,495	20%	129,000
	Pulverize and Blend	4,089	SY	3.00	12,267	2,453	20%	14,700
	Striping	3,450	LF	1.50	5,175	1,035	20%	6,200
	Clear & Grub	0.52	AC	1,500.00	780	156	20%	900
	Culvert (2-60")	160	LF	150.00	24,000	4,800	20%	28,800
	Headwalls (sacked concrete Slope protection)	6.0	CY	500.00	3,000.00	600	20%	3,600
	Frontage Road Dubach Field							
	AC (asphalt concrete)	131	Ton	50.00	6,550	1,310	20%	7,900
	Aggregate Base Class II	261	Ton	20.00	5,220	1,044	20%	6,300
	Aggregate Subbase	6,356	Ton	15.00	95,340	19,068	20%	114,400
	Pulverize and Blend	978	SY	3.00	2,934	587	20%	3,500
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	Culvert (3-60")	120	LF	150.00	18,000	3,600	20%	21,600
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Churchill Downs Raising							
	AC (asphalt concrete)	387	Ton	50.00	19,350	3,870	20%	23,200
	Aggregate Base Class II	1,450	Ton	20.00	29,000	5,800	20%	34,800
	Aggregate Subbase	1,363	Ton	15.00	20,445	4,089	20%	24,500
	Pulverize and Blend	1,778	SY	3.00	5,334	1,067	20%	6,400
	Striping	1,200	LF	1.50	1,800	360	20%	2,200
	Clear & Grub	0.18	AC	1,500.00	270	54	20%	300
	County Road 101 (Pioneer) Raising							
	AC (asphalt concrete)	1,044	Ton	50.00	52,200	10,440	20%	62,600
	Aggregate Base Class II	3,132	Ton	20.00	62,640	12,528	20%	75,200
	Aggregate Subbase	17,896	Ton	15.00	268,440	53,688	20%	322,100
	Pulverize and Blend	6,400	SY	3.00	19,200	3,840	20%	23,000
	Striping	5,400	LF	1.50	8,100	1,620	20%	9,700
	Clear & Grub	0.83	AC	1,500.00	1,245	249	20%	1,500

Table K-15
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Culvert (3-60")	240	LF	150.00	36,000	7,200	20%	43,200
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	County Road 102 Raising							
	AC (asphalt concrete)	2,480	Ton	50.00	124,000	24,800	20%	148,800
	Aggregate Base Class II	8,280	Ton	20.00	165,600	33,120	20%	198,700
	Aggregate Subbase	36,164	Ton	15.00	542,460	108,492	20%	651,000
	Pulverize and Blend	8,440	SY	3.00	25,320	5,064	20%	30,400
	Striping	5,700	LF	1.50	8,550	1,710	20%	10,300
	Clear & Grub	2	AC	1,500.00	2,610	522	20%	3,100
	Culvert (3-60")	360	LF	150.00	54,000	10,800	20%	64,800
	Headwalls (sacked concrete Slope protection)	9.0	CY	500.00	4,500.00	900	20%	5,400
	Total Relocations							**5,479,500**
06	**FISH AND WILDLIFE MITIGATION**[2]	1	LS	1,597,000				**1,597,000**
08	**ROADS**							
	Levee Patrol Roads - Levee (4" aggregate base)	15,494	TON	20.00	309,880	61,976	20%	**371,900**
09	**CHANNELS AND CANALS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Clearing and Grubbing	31	AC	1,500.00	46,500.00	9,300	20%	55,800
	Excavation	133,334	CY	5.00	666,670	133,334	20%	800,000
	Seeding	27	AC	2,500.00	67,500	13,500	20%	81,000
	Reinforced Concrete Pipe (60")	1,350	LF	150.00	202,500	40,500	20%	243,000
	Bore and Jack (60" RCP, I-5))	750	LF	1,000.00	750,000	150,000	20%	900,000
	Bore and Jack (60" RCP, SH 113)	600	LF	1,000.00	600,000	120,000	20%	720,000
	Inlet and Outlet Structures (I-5 and SH-113)	4	EA	6,000.00	24,000	4,800	20%	28,800
	Box Culvert (West Levee into Settling Basin 3'x3')	150	LF	300.00	45,000	9,000	20%	54,000
	Box Culvert (LCCFB to City Drain, 3'x3')	1,800	LF	300.00	540,000	108,000	20%	648,000
	Inlet and Outlet Structures (West Levee, City Drain)	4	EA	6,000.00	24,000	4,800	20%	28,800

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-15
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Closure Structure (Slide Gates) for Box Culverts	2	EA	20,000.00	40,000	8,000	20%	48,000
	Flap Gates (for Box Culverts)	2	EA	5,500.00	11,000	2,200	20%	13,200
	Total Channels and Canals							**3,870,600**
11	**LEVEES AND FLOODWALLS**							
	Mobilization & Demobilization	1	LS	250,000.00				250,000
	Stop Log Structure - County Road 102							
	Concrete	79	CY	500.00	39,500	7,900	20%	47,400
	Reinforcing Steel	5,420	LB	0.80	4,336	867	20%	5,200
	Stop Log Structure - County Road 101 (Pioneer)							
	Concrete	55	CY	500.00	27,500	5,500	20%	33,000
	Reinforcing Steel	3,800	LB	0.80	3,040	608	20%	3,600
	Stop Log Structure - Highway 113							
	Concrete	130	CY	500.00	65,000	13,000	20%	78,000
	Reinforcing Steel	8,850	LB	0.80	7,080	1,416	20%	8,500
	Stop Log Structure - Frontage Rd. Dubach Field							
	Concrete	77	CY	500.00	38,500	7,700	20%	46,200
	Reinforcing Steel	5,300	LB	0.80	4,240	848	20%	5,100
	Stop Log Structure - Railroad Crossing (I-5)							
	Concrete	100	CY	500.00	50,000	10,000	20%	60,000
	Reinforcing Steel	6,800	LB	0.80	5,440	1,088	20%	6,500
	Stop Log Structure - County Road 99							
	Concrete	85	CY	500.00	42,500	8,500	20%	51,000
	Reinforcing Steel	5,775	LB	0.80	4,620	924	20%	5,500
	Levee--New Construction							
	Mobilization & Demobilization	1	LS	25,000.00	25,000	5,000	20%	30,000
	Levee Embankment	483,286	CY	5.00	2,416,430	483,286	20%	2,899,700
	Excavation for Inspection Trench	72,922	CY	5.00	364,610	72,922	20%	437,500
	Removal of Settling Basin West Levee (3000')	83,000	CY	2.50	207,500	41,500	20%	249,000
	Removal of Training Levee (Settling Basin) (5250')	166,250	CY	2.50	415,625	83,125	20%	498,800

Table K-15
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Clearing and Grubbing	74.0	AC	1,000.00	74,000	14,800	20%	88,800
	Stripping (6 Inches)	59,206	CY	1.50	88,809	17,762	20%	106,600
	Slope Protection (water side of levee)	53,405	TON	28.00	1,495,340	299,068	20%	1,794,400
	Bedding (for Slope protection)	18,206	TON	22.00	400,532	80,106	20%	480,600
	Slope Protection Cover (Soil)	56,518	CY	5.00	282,590	56,518	20%	339,100
	Seeding	34	AC	2,500.00	85,000	17,000	20%	102,000
	Slurry Wall (from CR101 to west levee)	55200	SF	5.80	320,160	64,032	20%	384,200
	Slope protection (1500' of railroad near I-5)	2,250	TON	28.00	63,000	12,600	20%	75,600
	Bedding (for Slope protection)	775	TON	22.00	17,050	3,410	20%	20,500
	West Levee Improvements							
	Slope Embankment (from 2:1 to 3:1)	52,270	CY	5.00	261,350	52,270	20%	313,600
	Slope protection	50,010	TON	28.00	1,400,280	280,056	20%	1,680,300
	Bedding (for Slope protection)	16,968	TON	22.00	373,296	74,659	20%	448,000
	Clearing and Grubbing	8.3	AC	1,000.00	8,300	1,660	20%	10,000
	Stripping (6 inches)	6661.0	CY	1.50	9,992	1,998	20%	12,000
	Slope Protection Cover (Soil)	43,099	CY	5.00	215,495	43,099	20%	258,600
	Seeding	9.7	AC	2,500.00	24,250	4,850	20%	29,100
	Slope protection for I-5 (north and south of LCCFB)	3,910	TON	28.00	109,480	21,896	20%	131,400
	Bedding (for Slope protection)	1,347	TON	22.00	29,634	5,927	20%	35,600
	Total Levee -- New Construction							**11,025,400**
15	**FLOOD CONTROL AND DIVERSION STRUCTURES**							
	Mobilization & Demobilization	1	LS	250,000.00	250,000	50,000	20%	300,000
	Inlet Weir (3000 ft long)							
	Roller Compacted Concrete	11,850	CY	100.00	1,185,000	237,000	20%	1,422,000
	Conventional Concrete	2,667	CY	500.00	1,333,500	266,700	20%	1,600,200
	Slope protection	8,910	TON	22.00	196,020	39,204	20%	235,200
	Geotextile Filter Fabric	10,000	SY	3.00	30,000	6,000	20%	36,000
	Gravel Backfill	5,248	TON	22.00	115,456	23,091	20%	138,500

Table K-15
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Compacted Structural Backfill	1,778	CY	10.00	17,780	3,556	20%	21,300
	Excavation	8,000	CY	5.00	40,000	8,000	20%	48,000
	Total Levee -- New Construction							**3,801,200**
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							**26,145,600**
18	**CULTURAL RESOURCE PRESERVATION**	1	%					**261,500**
20	**PERMANENT OPERATING EQUIPMENT**							
	Flood Warning System	1	LS	$1,000,000.00	1,000,000	200,000	20%	**1,200,000**
30	**PLANNING, ENGINEERING & DESIGN**	12	%					**3,137,500**
31	**CONSTRUCTION MANAGEMENT**	8.5	%					**2,222,400**
	TOTAL FIRST COST							**41,712,400**

Table K-15
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
LOWER CACHE CREEK FLOOD BARRIER PLAN
WITH 20-FOOT LEVEE CROWN

INVESTMENT COST

78,000 cfs Inlet Weir (Elev. 45') 3000' long, Ultimate Outlet Weir (Elev. 41') with 20-Foot Levee Crown

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				41,712,400
Interest during Construction				
At midyear (year 1.5, and .5)				2,837,700
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				44,550,100

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		2,875,900
OPERATION AND MAINTENANCE				
LCCFB				48,000
Flood Warning System				25,000
County Road Damages				25,000
TOTAL ANNUAL COST				2,973,900

Table K-16

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
01	LANDS AND DAMAGES[1]	1	LS	48,810,300				48,810,300
02	RELOCATIONS							
	Utilities (3% of Total First Cost)	3	%	2,505,000				2,505,000
	Bridges							
	Mobilization & Demobilization	1	LS	1,975,000				1,975,000
	County Road 102 Bridge Replacement	30,000	SF	125.00	3,750,000.00	750,000	20%	4,500,000
	State Highway 113 Bridge Replacement	50,000	SF	125.00	6,250,000.00	1,250,000	20%	7,500,000
	County Road 99W Bridge Enlargement	38,000	SF	125.00	4,750,000	950,000	20%	5,700,000
	Interstate 5 Southbound Bridge Enlargement	48,000	SF	150.00	7,200,000	1,440,000	20%	8,640,000
	Interstate 5 Northbound Bridge Enlargement	40,000	SF	150.00	6,000,000	1,200,000	20%	7,200,000
	Excavation of Bridge Abutment/Causeway	41,667	CY	5.00	208,335	41,667	20%	250,000
	Pulverize and Blend	31,800	SY	3.00	95,400	19,080	20%	114,500
	Clear and Grub	7	AC	1,000.00	7,400	1,480	20%	8,900
	Remove Concrete Pavement	3,490	CY	80.00	279,200	55,840	20%	335,000
	Raise Bridge Ramps--Concrete Pavement	4,980	CY	100.00	498,000	99,600	20%	597,600
	Raise Bridge Ramps--Asphaltic Concrete	7,830	TON	50.00	391,500	78,300	20%	469,800
	Raise Bridge Ramps--Aggregate Base, Class II	24,440	TON	20.00	488,800	97,760	20%	586,600
	Raise Bridge Ramps--Embankment	105,480	TON	15.00	1,582,200	316,440	20%	1,898,600
	Striping	23,850	LF	1.50	35,775	7,155	20%	42,900
	Total Bridges							39,818,900
	Road Realignments							
	County Roads 17, 18, 18A and 97A							
	Mobilization & Demobilization	1	LS	47,000				47,000
	Asphaltic Concrete	3,660	TON	50.00	183,000.00	36,600	20%	219,600
	Aggregate Base, Class II	10,970	TON	20.00	219,400.00	43,880	20%	263,300
	Aggregate Subbase	18,830	TON	15.00	282,450.00	56,490	20%	338,900
	Demolish Existing Road	0	SY	4.00	0.00	0	20%	0
	Pulverize and Blend	0	SY	3.00	0.00	0	20%	0

[1]Lands and damages costs are detailed in Appendix F, Real Estate Plan.

Table K-16
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Striping	25,200	LF	1.50	37,800.00	7,560	20%	45,400
	Clear and Grubb	11.6	AC	1,500.00	17,400.00	3,480	20%	20,900
	Guard Rail	0	LF	35.00	0.00	0	20%	0
	Right of Way	11.6	AC	3,500.00	40,600.00	8,120	20%	48,700
	Total Road Realignments							983,800
	Total Relocations							43,307,700
06	FISH AND WILDLIFE MITIGATION[2]	1	LS	9,901,000				9,901,000
08	ROADS							
	Mobilization & Demobilization	1	LS	395,000				395,000
	Patrol Roads (4" aggregate base)	47,970	TON	20.00	959,400	191,880	20%	1,151,300
	Bridges							
	Railroad Bridge Replacement	1,000	LF	5,500.00	5,500,000	1,100,000	20%	6,600,000
	Railroad Ballast	180	CY	60.00	10,800	2,160	20%	13,000
	Railroad Ties	1,070	LF	8.00	8,560	1,712	20%	10,300
	Railroad Track	800	LF	135.00	108,000	21,600	20%	129,600
	Total Bridges							6,752,900
	Total Roads							8,299,200
09	CHANNELS AND CANALS							
	Mobilization & Demobilization	1	LS	235,000				235,000
	Creek							
	Clearing and Grubbing (in-channel for rip rap)	4.7	AC	5,000.00	23,500.00	4,700	20%	28,200
	Clearing and Grubbing (in overbank for rip rap)	0.2	AC	1,500.00	300.00	60	20%	400
	Excavation (Layback channel slope and for rip rap)	12,000	CY	5.00	60,000	12,000	20%	72,000
	Rip Rap	26,100	TON	28.00	730,800	146,160	20%	877,000
	Bedding (for riprap)	7,000	TON	21.00	147,000	29,400	20%	176,400

[2]Fish and wildlife mitigation costs are detailed in Appendix I of the EIS/EIR.

Table K-16
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Stripping (for rip rap, 6")	4,000	CY	10.00	40,000	8,000	20%	48,000
	Gabions	1,500	CY	125.00	187,500	37,500	20%	225,000
	Concrete Lining	4,140	CY	275.00	1,138,500	227,700	20%	1,366,200
	Clearing and Grubbing (for Hardpoints)	1.7	AC	3,750.00	6,375	1,275	20%	7,700
	Excavation (for Hardpoints)	40,000	CY	5.00	200,000	40,000	20%	240,000
	Stone (for Hardpoints)	31,700	TON	22.00	697,400	139,480	20%	836,900
	Total Creek Channels							3,877,800
	Toe Drain							
	Excavation	184,500	CY	2.00	369,000	73,800	20%	442,800
	Reinforced Concrete Inlet and Outlet Transitions	337	CY	500.00	168,500	33,700	20%	202,200
	24"-Diameter RCP	4,000	LF	40.00	160,000	32,000	20%	192,000
	Seeding	9.9	AC	2,500.00	24,750	4,950	20%	29,700
	Total Toe Drain							866,700
	Total Channels and Canals							4,979,500
11	LEVEES AND FLOODWALLS							
	Mobilization & Demobilization	1	LS	930,000				930,000
	Degradation of Existing Levees							
	Stripping (6 Inches)	86,100	CY	1.50	129,150	25,830	20%	155,000
	Excavation (Includes training levee)	861,600	CY	2.00	1,723,200	344,640	20%	2,067,800
	Total Degradation of Levees							2,222,800
	Levee--New Construction							
	Levee Embankment	1,940,229	CY	5.00	9,701,145	1,940,229	20%	11,641,400
	Excavation for Inspection Trench	277,300	CY	5.00	1,386,500	277,300	20%	1,663,800
	Slurry Wall	595500	SF	5.80	3,453,900	690,780	20%	4,144,700
	Clearing and Grubbing	132	AC	1,000.00	131,500	26,300	20%	157,800
	Stripping (6 Inches)	112,072	CY	1.50	168,108	33,622	20%	201,700
	Seeding	89.3	AC	2,500.00	223,250	44,650	20%	267,900
	Total Construction of New Levees							18,077,300

Table K-16
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN
WITH 20-FOOT LEVEE CROWN

78,000 cfs Design

Acct. No.	Description	Estimated Quantity	Unit	Unit Cost $	Extended Cost $	Contingency $	%	Total Cost $
	Levee--Improvements							
	Levee Embankment	22,710	CY	5.00	113,548	22,710	20%	136,300
	Sheet Pile	0	SF	15.00	0	0	20%	0
	Excavation for Inspection Trench	13,350	CY	5.00	66,750	13,350	20%	80,100
	Clearing and Grubbing	3.0	AC	1,000.00	2,950	590	20%	3,500
	Stripping (6 Inches)	6,488	CY	1.50	9,731	1,946	20%	11,700
	Seeding	1.5	AC	2,500.00	3,750	750	20%	4,500
	Total Levee--Improvements							236,100
	Total Levees							21,466,200
	TOTAL CONSTRUCTION COSTS (excludes Lands & Damages)							87,953,600
18	CULTURAL RESOURCE PRESERVATION	1	%					879,500
30	PLANNING, ENGINEERING & DESIGN	12	%					10,554,400
31	CONSTRUCTION MANAGEMENT	8.5	%					7,476,100
	TOTAL FIRST COST							**155,673,900**

Table K-16
(Continued)

PRELIMINARY CURRENT WORKING ESTIMATE
MODIFIED WIDE SETBACK LEVEE PLAN
WITH 20-FOOT LEVEE CROWN

INVESTMENT COST

78,000 cfs

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST DURING CONSTRUCTION				
Interest Rate	6.125	%		
Construction Period	2	YR		
Project First Costs				155,673,900
Interest during Construction				
At midyear (year 1.5, and .5)				10,590,300
Outlays 60% first year, 40% second year				
TOTAL INVESTMENT COST				166,264,200

ANNUAL COST

Description	Estimated Quantity	Unit	Unit Cost $	Total Cost $
INTEREST AND AMORTIZATION				
Interest Rate	6.125	%		
Amortization Period	50.0	YR		10,733,000
OPERATION AND MAINTENANCE				
Allowance (from DWR)				415,000
TOTAL ANNUAL COST				11,148,000

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

Appendix L

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

DRAFT FEASIBILITY REPORT
FOR POTENTIAL FLOOD DAMAGE
REDUCTION PROJECT

APPENDIX L

Evaluation of Potential Flooding from Cache Creek

WEST
YOST
& ASSOCIATES
Consulting Engineers

MEMORANDUM

DATE: March 24, 1995 Project No: 052-94-02

TO: Bert Bangsberg, PG&E Properties

FROM: James Yost, West Yost & Associates

SUBJECT: PG&E Properties — Conaway Ranch
Evaluation of Potential Flooding from Cache Creek

West Yost & Associates (WYA) has performed an investigation of the potential for flooding of the Conaway Ranch area from the 100-year flood flow from Cache Creek. The Corps of Engineers has identified the potential for significant flooding from Cache Creek in their study of Cache Creek contained in the "Draft Reconnaissance Report, Westside Tributaries to Yolo Bypass, California," March 1994. This WYA investigation relies entirely on flow information contained within the Corps Reconnaissance Report, and on topographic information developed by WYA field surveys and from available mapping. The Corps' study identified a peak flood flow of 32,600 cfs breaking out of the banks of Cache Creek and flowing in a southeasterly direction across north Woodland toward the northwest corner of the Conaway Ranch property. The attached Figure A shows the area of resulting flooding determined by the Corps study. The extent of flooding depicted by the Corps is limited by the extent of their study area which stopped just west of the Conaway Ranch.

WYA's assignment was to determine the expected sequence of flooding as the flood wave progressed to the east toward lower elevations on the Conaway Ranch west of the Yolo Bypass Levees. To aid in identifying how the flood wave will progress to the south and east from the eastern end of the Corps study, WYA conducted a limited field survey to identify the extent of existing flood barriers such as the Sacramento Northern Railroad, Cache Creek Settling Basin Levees, Interstate Highway 5 (I-5), City of Woodland's Wastewater Treatment Plant and Ponds, Conaway Ranch's Highline Canal, Road 25, and Willow Slough channel banks. These existing barriers are shown on Plate 1 along with spot elevations at critical locations.

These barriers were identified using the USGS Quad Map for the area and from field investigations. Most of these barriers are earthen berms located on the upper part of Conaway Ranch that create temporary barriers that will slow the southeast advance of the flood flow. It is assumed that, except for the Cache Creek Settling Basin levees, these raised land areas create temporary barriers that will be inundated and ultimately washed out as the flood wave progresses. The exact reaction of these areas of fill to the advancing flood wave is not known, however it is expected that they all will be overtopped and they will not be able to retain the volume of flood water escaping Cache Creek. To identify the worst flooding potential, a conservatively high estimate was made that all the flood water will reach the lower Conaway Ranch and that its volume will fill low lying areas west of the Yolo Bypass and north of the Willow Slough Bypass Levees.

Since the Corps study was finalized, Mr. Joe Countryman of Murray, Burns and Keinlen has reviewed the study results and has estimated the maximum flow rates reaching Conaway Ranch would be in the range of 20,000 cfs to 28,000 cfs with associated volumes of 25,000 acre-feet to 43,000 acre-feet. The Corps study did not analyze flood volumes and additional studies in this area will probably reduce those maximum estimated values.

WYA has prepared a series of figures that depict the probable progression of flooding from Cache Creek from the vicinity of Road 102 to the ultimate inundation of low lying areas of Conaway Ranch. As described above, Figure A shows the extent of flooding from the flows escaping the banks of Cache Creek during the 100 year flood as defined by the Corps. This figure shows the anticipated flooded area within the Corps study area limit which was just east of Road 102, about one mile west of the Conaway Ranch boundary along Road 103. It is expected that the majority of the flood water will be north of I-5 and the Sacramento Northern Railroad. The railroad forms a barrier to the flood flow at a relatively constant grade at elevation 33 feet.

Figure B shows that the first area to be inundated will be north of the railroad and west of the levee for the Cache Creek Settling Basin. The Settling Basin levees which rise up to elevation 48 feet, will not be overtopped by the flood flows that have escaped upstream from Cache Creek. Therefore, the flood water will be forced to proceed to the south and over the railroad once the area north of the tracks is filled to elevation 33 feet. There will be some water moving to the east along I-5 as shown by the arrow on Figure B.

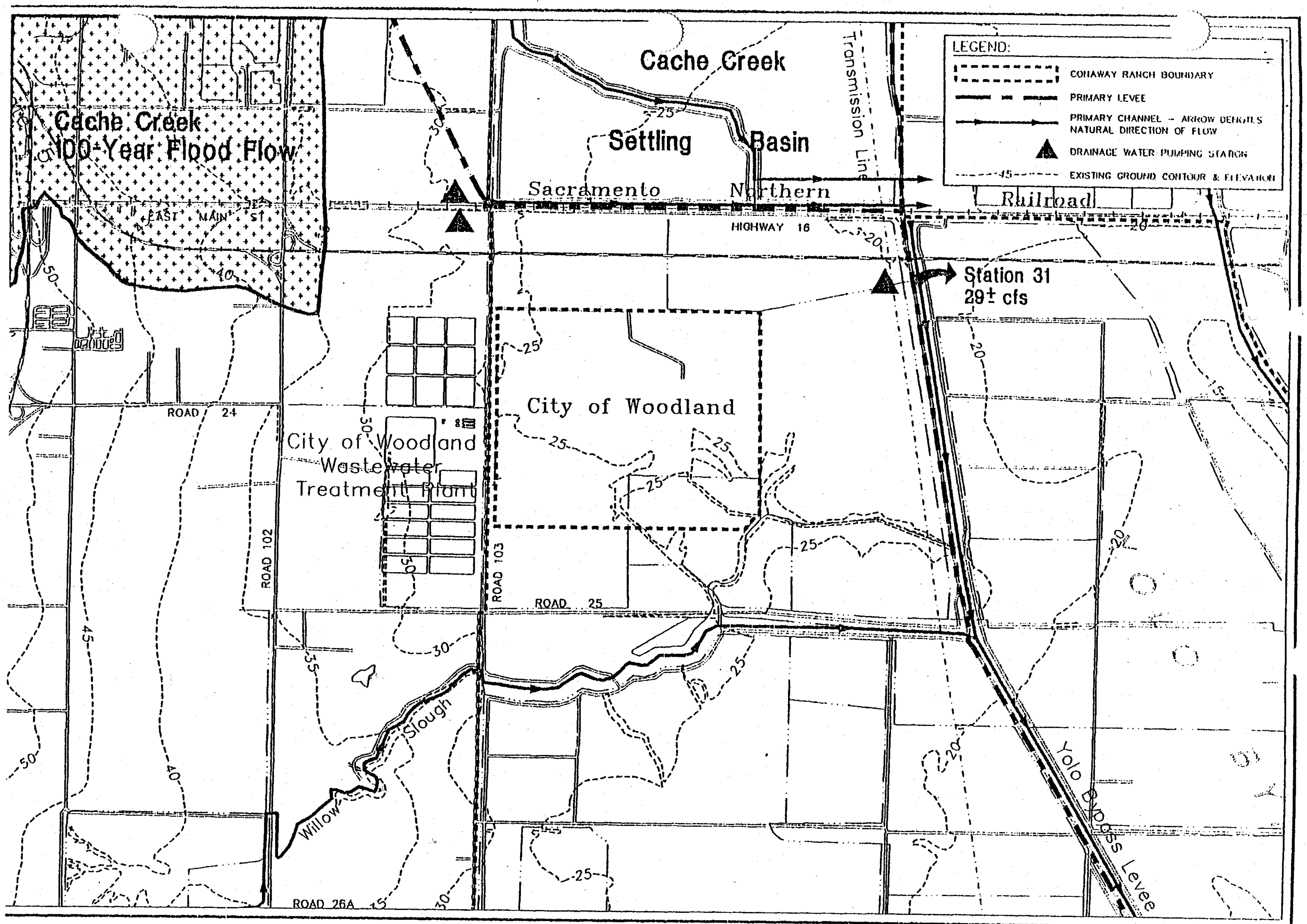
After the railroad has been overtopped, it is expected that the flood waters will fill the area between the railroad and I-5 before overtopping the Conaway Ranch Highline Canal at elevation 31 feet, as shown in Figure C. It is also expected that some water will overtop I-5 and flow eastward in the roadside ditches along I-5. Note also on Figure C that the flood water is expected to flow east into the area bounded by I-5 and Highway 16 and the western levee of the Yolo Bypass, and then pond and cross I-5, flooding Conaway Ranch south of I-5.

The next areas expected to fill with flood waters are the area between the Railroad and I-5, and the area west of the Highline Canal, south of I-5 and north of the berms along the northern boundary of the City of Woodland's Wastewater Treatment Plant (WWTP) as shown on Figure D. The berm at the WWTP is at elevation 32 feet, while the Highline Canal berm is at elevation 31 feet. It is expected that the flood flow will be directed onto the Conaway Ranch by overtopping the Highline Canal on the west and from flows across I-5 on the north. It is expected that the Highline Canal berm will fail allowing significant flows onto the Ranch before the northern berms at the WWTP are overtopped and fail.

Willow Slough and the southern reach of the Highline Canal along Willow Slough create another temporary barrier to the advancing floodwater. It is expected that the Ranch area south of Willow Slough will not be flooded until the area north of Willow Slough floods above elevation 32 feet. Figure E shows the inundation up to elevation 32 feet of the northern 2,100 acres of the Conaway Ranch and the City of Woodland's 900 acres of wastewater disposal fields leased to Contadina. It also shows that the area west and south of the wastewater treatment plant is inundated. The water is then expected to overtop the southern reach of the Highline Canal and the Willow Slough berms and flow to the south as shown in Figure F. It is anticipated that the berms will be washed out, creating significant flow areas to allow the flooding of the main portion of the Ranch south of Willow Slough and north of the Willow Slough Bypass Levees.

The Willow Slough Bypass Levees at the south end of Conaway Ranch are at elevation 30 feet and are tied into the Yolo Bypass Levees. Based on USGS topographic maps, there is sufficient volume behind the Willow Slough Bypass and Yolo Bypass levees to store the anticipated flood volume of between 25,000 and 43,000 acre-feet. The water is expected to pond behind these levees and rise to a maximum elevation of between 22.5 feet and 25.1 feet. Plate 2 shows the anticipated extent of ponding on the Conaway Ranch property. This will inundate a portion of the Yolo County Landfill, but the City of Davis Wastewater Treatment Plant located just north of the Willow Slough Bypass levee is not expected to be inundated by this ponding.

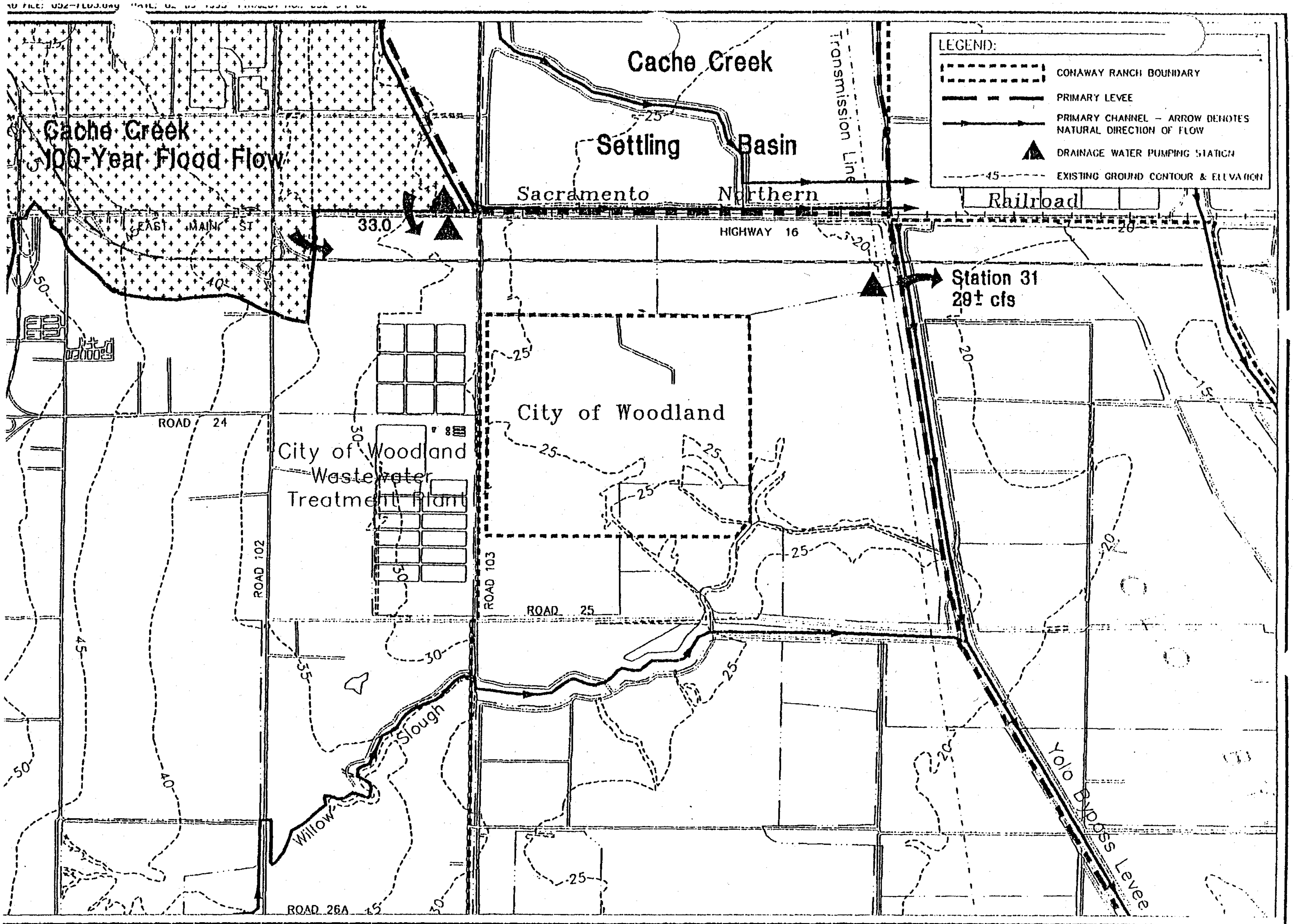
JAY:mk



WEST YOST & ASSOCIATES

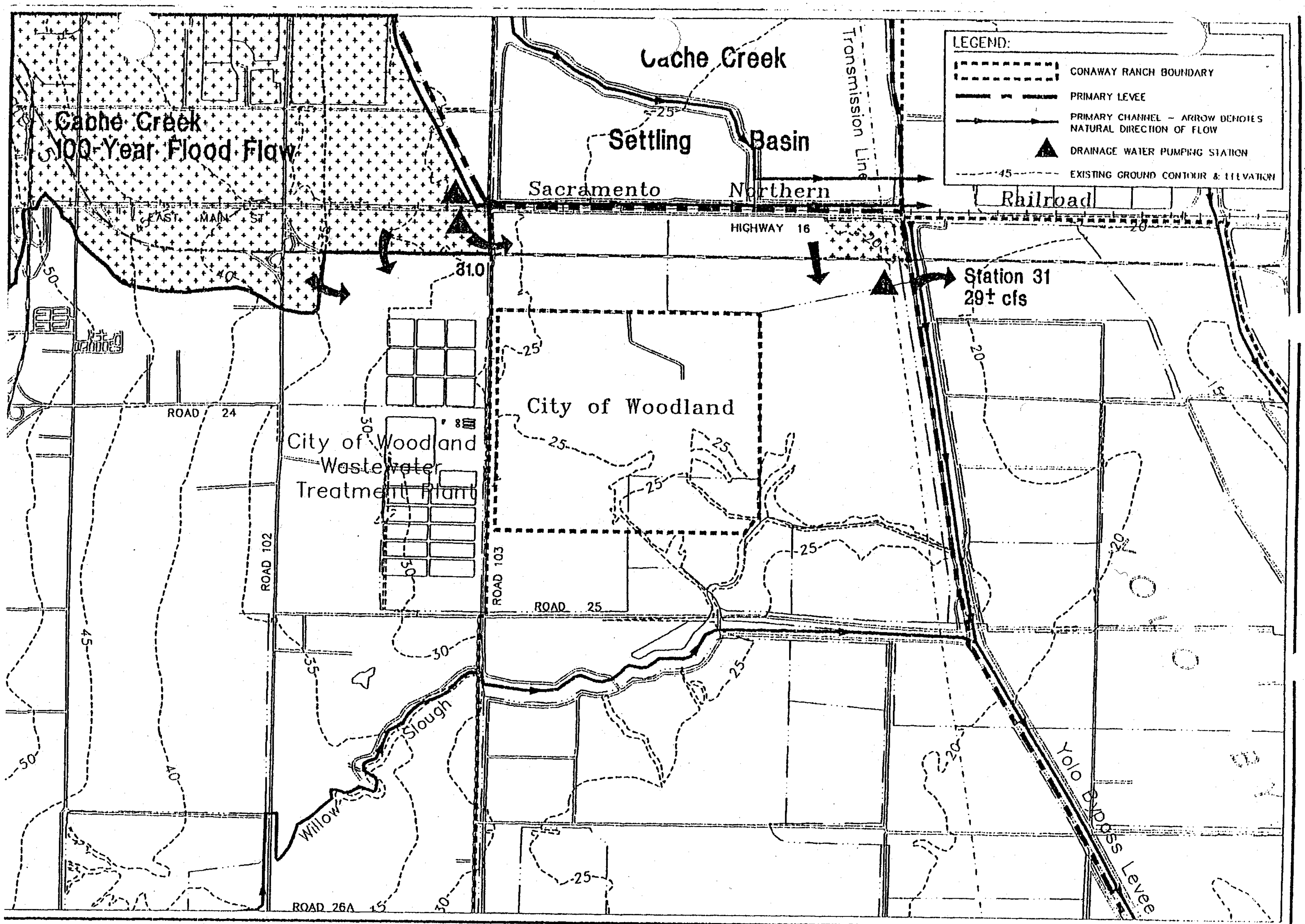
Anticipated Sequence of Flooding From 100 Year Flow in Cache Creek

Figure A



Anticipated Sequence of Flooding From 100 Year Flow in Cache Creek

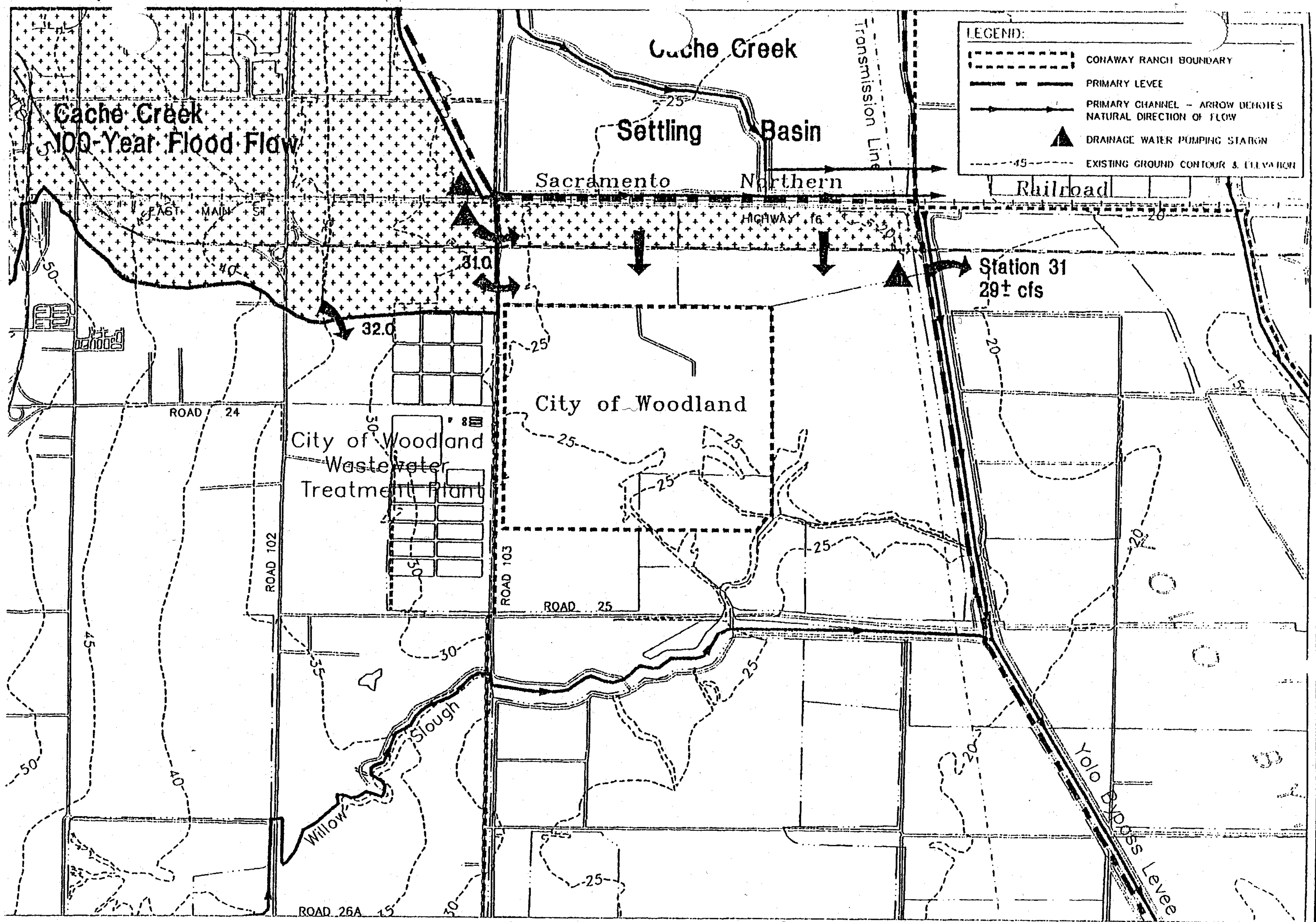
Figure B



WEST YOST & ASSOCIATES

Anticipated Sequence of Flooding
From 100 Year Flow in Cache Creek

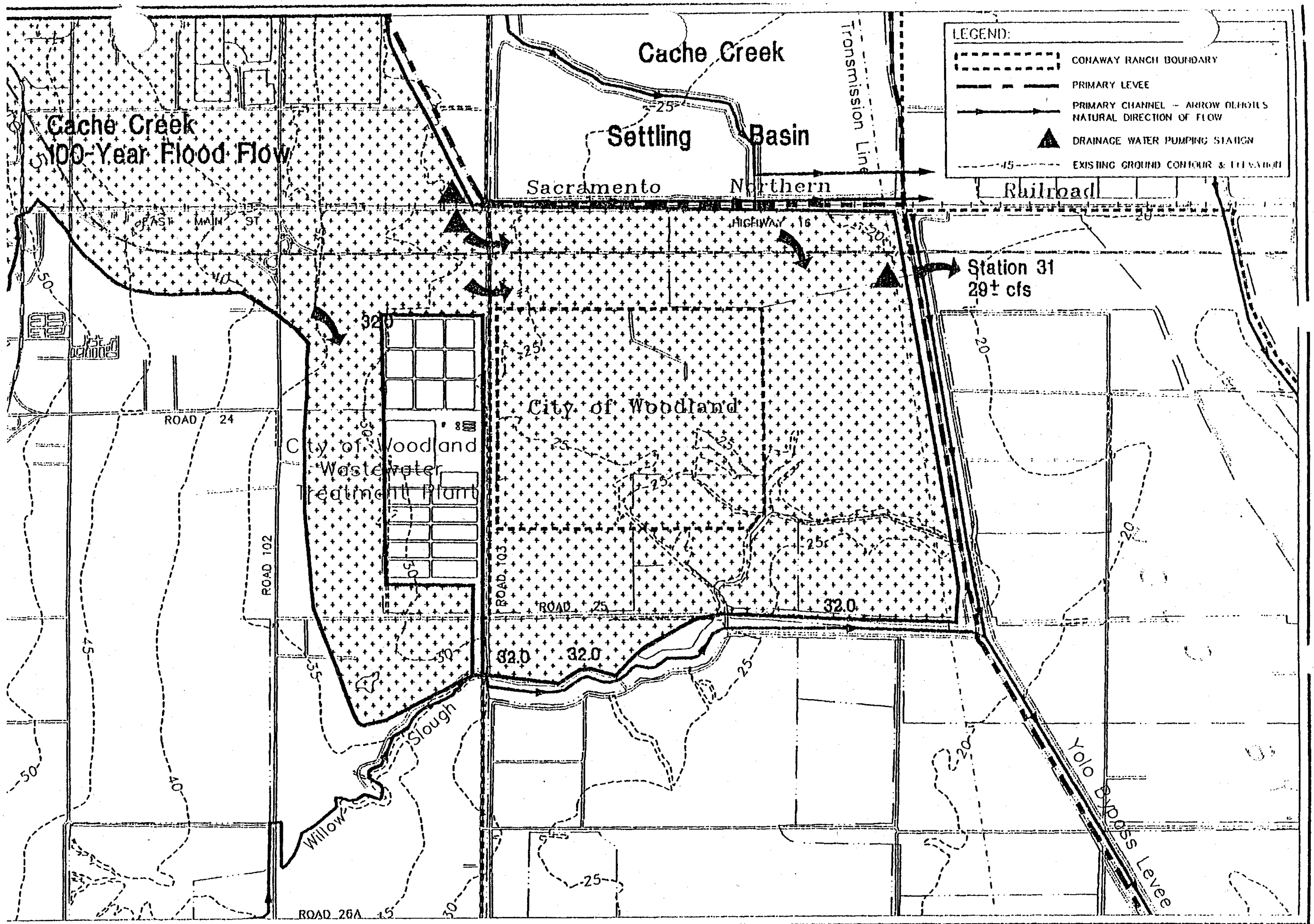
Figure C



Anticipated Sequence of Flooding From 100 Year Flow in Cache Creek

Figure D

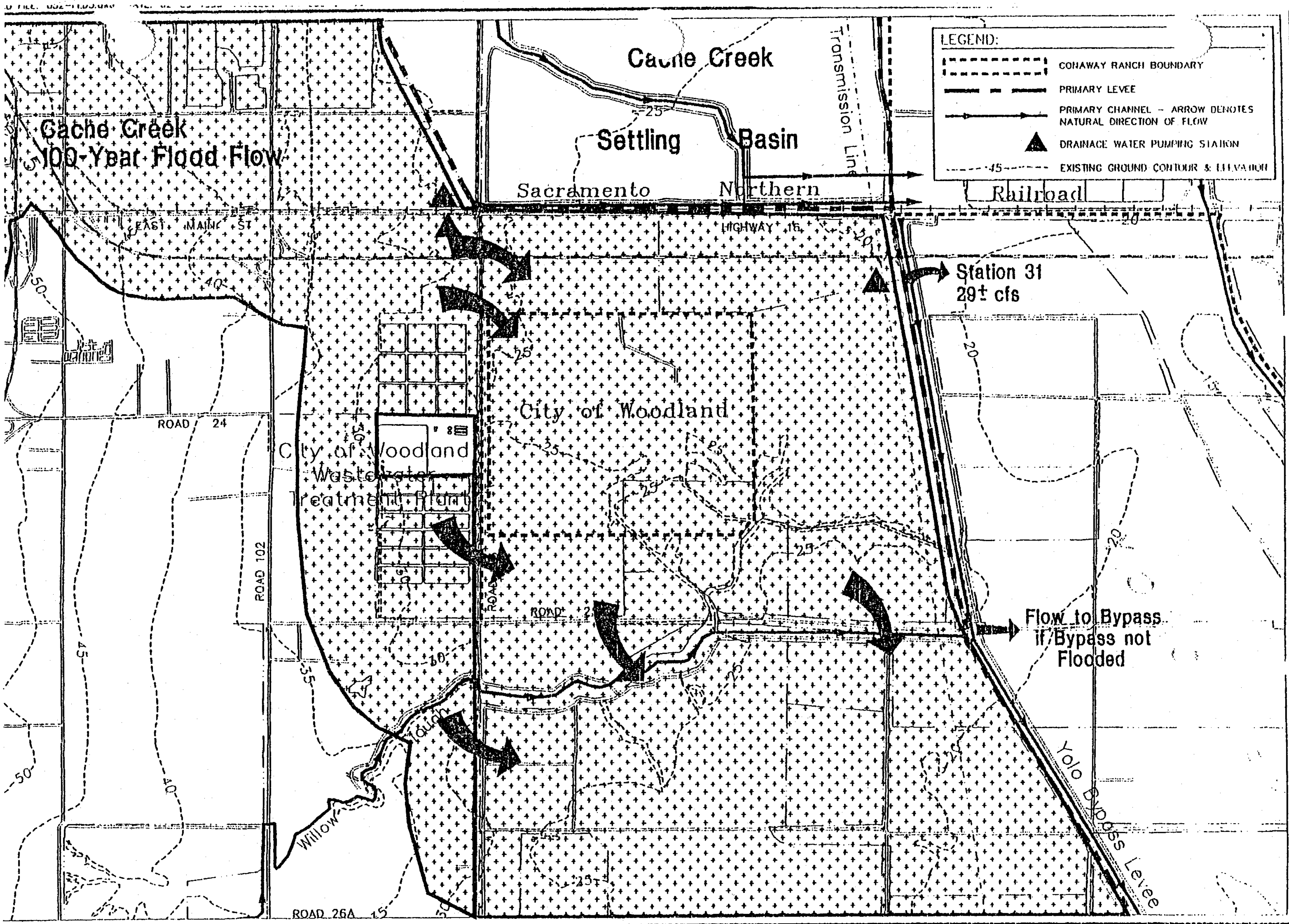
WEST YOST & ASSOCIATES



WEST
YOST
& ASSOCIATES

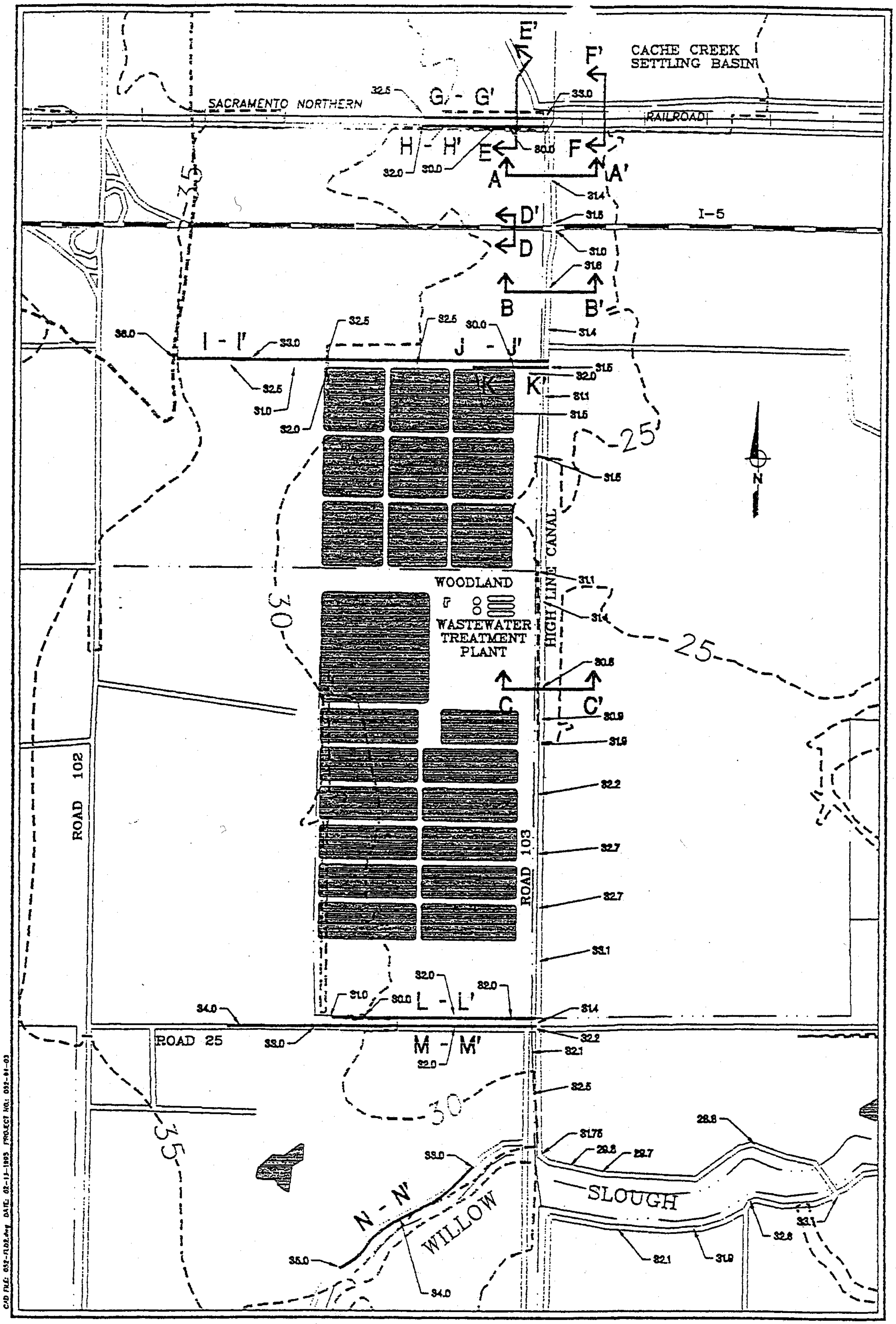
Anticipated Sequence of Flooding
From 100 Year Flow in Cache Creek

Figure E



Anticipated Sequence of Flooding
From 100 Year Flow in Cache Creek

Figure F



WEST YOST

Supplemental Field Survey Spot Elevations

Scale 1" = 1300'

Plate 1.

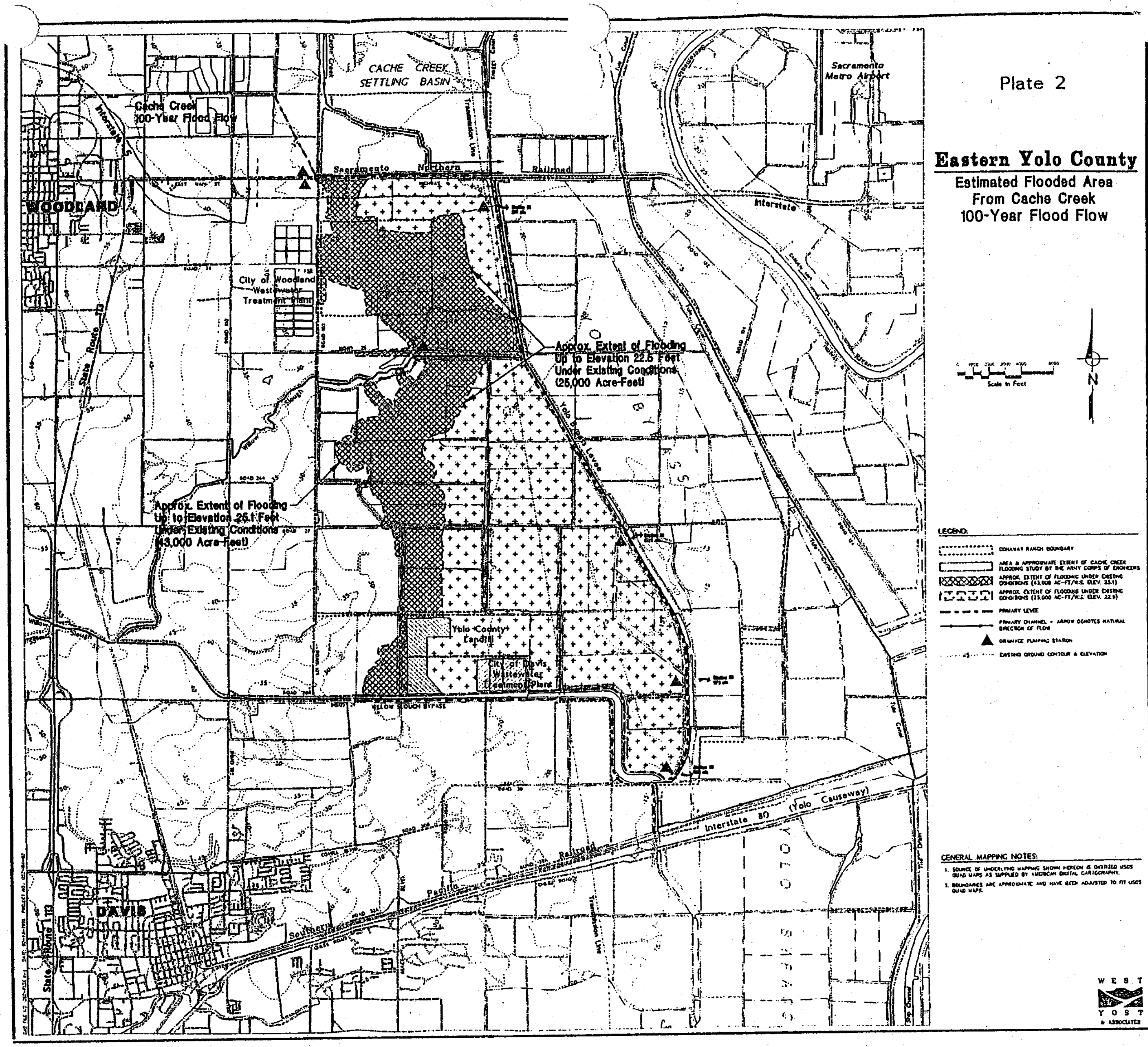


Plate 2

Eastern Yolo County

Estimated Flooded Area From Cache Creek 100-Year Flood Flow