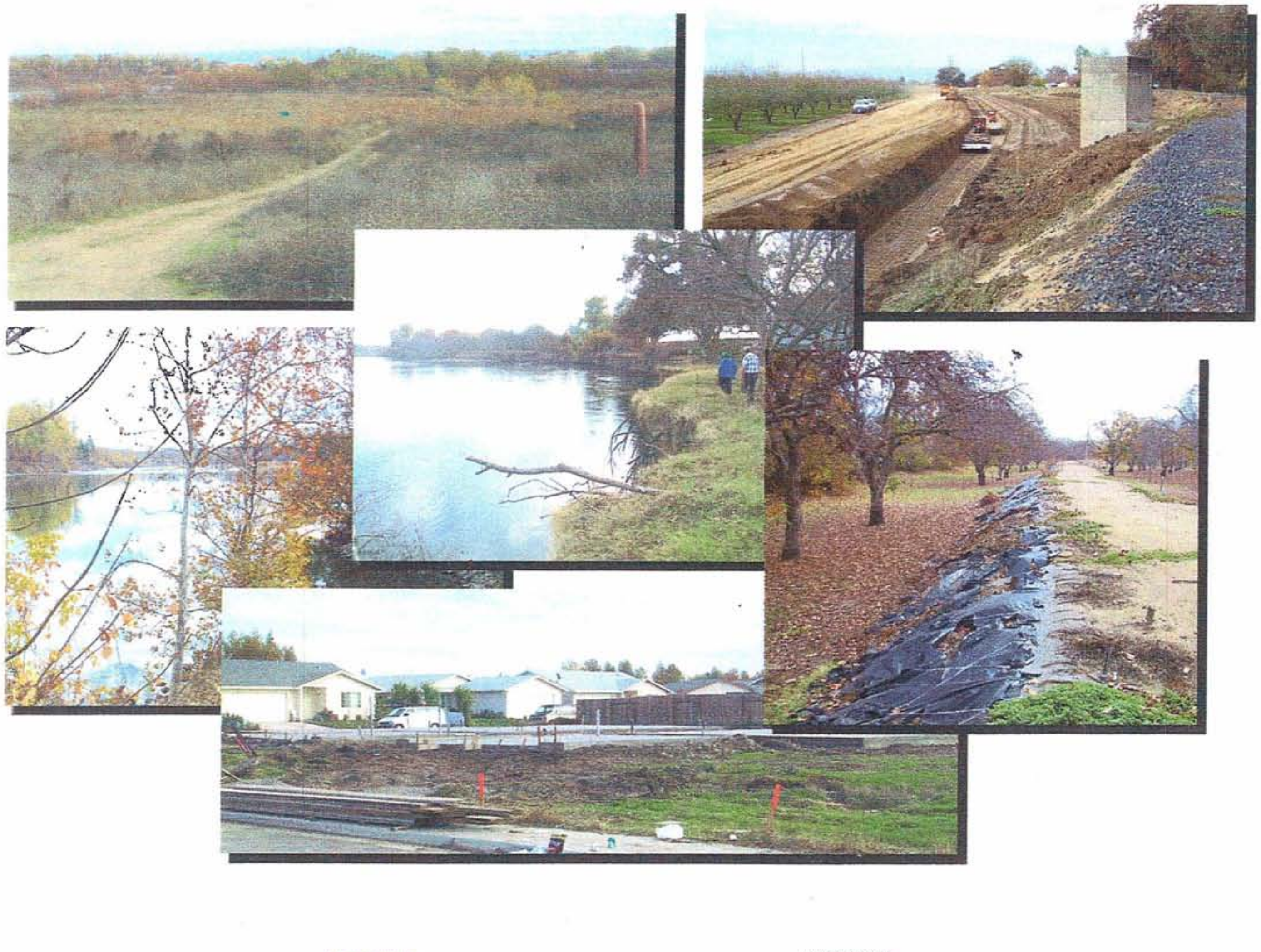
Hamilton City Flood Damage Reduction and Ecosystem Restoration, California

Appendixes

July 2004



Sacramento and San Joaquin River Basins
Comprehensive Study

US Army Corps of Engineers
Sacramento District

CALIFORNIA
BAY-DELTA AUTHORITY

LIST OF APPENDIXES*

APPENDIX A: Supplemental Plan Formulation

Supplemental Plan Formulation Information

Overview

This appendix provides supplemental information regarding the planning process conducted as part of the Hamilton City Feasibility Study. In order to keep the main report succinct, additional detail is presented in this appendix. Topics discussed are:

- Flood Fighting
- Ecosystem Plan Formulation Methodology
- Passive vs. Active Ecosystem Restoration
- Floodplain Reconnection
- Guiding Principles
- Ecosystem Restoration Alternatives

Relation to the Planning Process

The following section describes how each of these topics relates to the plan formulation process.

A-1: Flood Fighting

Information on both known and forecasted flood fighting costs and historic performance will be used to refine the without project condition, specifically, to adjust the estimated equivalent annual damages to account for costs associated with flood fighting activities and to adjust the without project levee performance to reflect flood fighting. This will allow for a more accurate evaluation of each alternative plan, when each is considered against the without-project condition. Two write-ups are included: without-project costs for flood fighting, and the methodology to incorporate flood fighting into the assessment of without-project levee performance and economic damages.

A-2: Ecosystem Plan Formulation Methodology

This description sets forth the basic formulation methodology followed for formulation and comparison of alternative plans.

A-3: Passive vs. Active Ecosystem Restoration

This information contributes to formulation and comparison of alternative plans. Each of these basic approaches was identified when measures were developed and considered. At the measures screening stage of plan formulation, there was a strong indication that, despite the higher cost of active restoration, passive restoration would not be as effective in attaining the desired benefits. Consequently, passive restoration was screened out as a measure and the alternative plans that were formulated included active restoration. To better substantiate this initial screening, a more detailed comparison of the two approaches was undertaken.

A-4: Floodplain Reconnection

This information contributes to the evaluation of alternative plans. By understanding the anticipated effects of reconnecting the river to the floodplain, benefits of doing so can be identified and quantified.

A-5: Guiding Principles

This information presents the detailed description of the Guiding Principles that were developed as part of the overall Comprehensive Study.

A-6: Ecosystem Restoration Alternatives

This section describes the ecosystem restoration alternative plans.

Supplemental Information

Following are full discussions of each topic.

A-1: Flood Fighting

Flood Fighting

Incorporate Flood Fighting into the Assessment of Without-Project Levee Performance and Economic Damages

Incorporating Flood Fighting Into the Hamilton City HEC-FDA Analysis

The U.S. Army Corps of Engineers and The Reclamation Board of the State of California have conducted a feasibility study to develop and evaluate potential alternative plans to reduce flood damages and restore the ecosystem along the Sacramento River near Hamilton City. An existing private levee, constructed by landowners in about 1904 and known as the "J" levee, provides some flood protection to the town and surrounding area. The "J" levee is not constructed to any formal engineering standards and is largely made of silty sand. Since the construction of Shasta Dam in 1945, flooding in Hamilton City due to problems with the "J" levee has occurred only once (1974) causing about $50,000 in damage and about $22,000 in levee repair costs (current year dollars). Although the levee has never "failed" from over topping or catastrophic failure, it has been spared only because of very extensive flood fighting, most notably in 1983, 1986, 1995, 1997, and 1998. If floodfighting had not been successful during these events, significant damage and potential loss of life would have likely occurred within Hamilton City.

Problem

The problem confronting the Study Team is how to incorporate floodfighting into the HEC-FDA analysis, which is used to develop estimates of damage reduction due to plans (i.e., benefits) and project performance statistics indicating the relative performance of alternative plans. One of the key inputs into the HEC-FDA model are levee failure assumptions, but these are based upon the physical characteristics of levees and not floodfighting actions taken to protect those levees. Thus, the HEC-FDA does not explicitly take into account floodfighting efforts. As a result, estimates of benefits and project performance statistics are likely to be biased without accounting for floodfighting. In addition, floodfighting is very expensive; therefore its costs need to be incorporated into the overall benefit/cost analysis. And, finally, to the extent that alternative plans rely upon HEC-FDA statistics to define the size of structures, then these plans may be biased as well. For example, the primary objective of the Hamilton City study is to provide ecosystem restoration, which will likely involve breaching the existing "J" levee and replacing it with a setback levee further from the river. The key question is: what will be the height of this "replacement" levee? Will it be the same as the existing levee (albeit very weak levee), or will the new levee height be based upon HEC-FDA project performance statistics? In other words, HEC-FDA project performance statistics can be used to define a *functionally equivalent levee* that will likely be much lower than the existing "J" levee. The problem is further complicated because estimating the probability of a successful floodfight is very difficult.

HEC-FDA

HEC-FDA is the Corps' primary flood damage reduction model, which integrates hydrologic, hydraulic, and geotechnical engineering and economic data for the formulation and evaluation of flood damage reduction plans. The program incorporates risk analysis by quantifying uncertainties in the hydrologic, hydraulic, geotechnical and economics data utilizing Monte Carlo simulation. The two primary outputs from HEC-FDA include expected annual damage estimates and project performance statistics. Expected annual flood damage is the average of all possible damage values, taking into account all expected flood events and associated hydrologic, hydraulic, geotechnical and economic uncertainties. Project performance statistics provide information concerning the risk within an area of annual (or long-term) flooding and the ability to safely pass flood events of given magnitudes. These statistics describe the hydraulic performance of a plan incorporating geotechnical levee failure assumptions. These include *expected annual exceedance probability* (the annual probability of having a damaging flood event in a given year, such as a levee failure), *long-term risk* (the chance of having one or more damaging events over a period of time), and *conditional non-exceedance probability* (the probability of containing specific flood events and avoiding damage).

HEC-FDA Geotechnical Inputs

Geotechnical specialists are responsible for developing *levee failure curves* that depict the probability of levee failure as water surface elevations rise in the channel. Typically, the probability of failure increases as water surface elevations approach the top of a levee, although the shape of the curve are dependent upon many variables, such as construction materials, adequacy of maintenance, wind/waves, etc. Although the curves can be defined with many points, typically the most important points include the probable non-failure point (PNP), the probable failure point (PFP) and the top of levee (TOP). The NFP is the water surface elevation at which there is about a 15% chance of levee failure and the PFP is the water surface elevation with about an 85% chance of levee failure.

The "J" levee failure curve used for the Northern impact area (which includes the town of Hamilton City) is shown in Table A-1.1 and the actual FDA data input screen is shown in Figure A-1.1, including the plot of the levee failure curve.[1] As can be seen in the plot, within HEC-FDA points below the PNP are assumed to have 0 probability of levee failure and points above the PFP are assumed to have 100% of levee failure. This levee failure curve is based upon the physical characteristics of the "J" levee and does not reflect changes that might be attributable to flood fighting.

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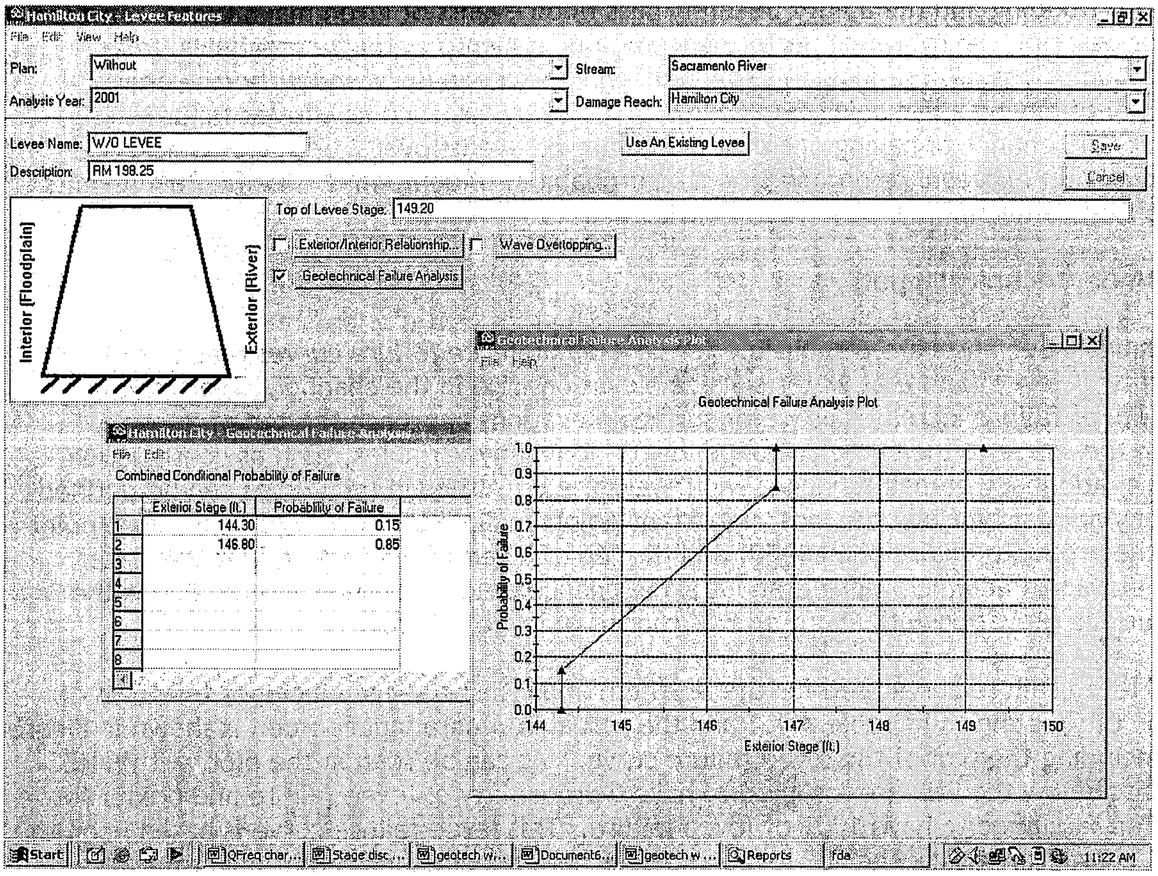
[1] There are 2 other impact areas that were analyzed in the Hamilton City analysis (Southern #1 and Southern #2), but because these are primarily agricultural areas this paper focuses upon the Northern impact area that includes the town itself.

Table A-1.1: Northern Impact Area Levee Failure Curves

Levee Failure Curve	Northern Impact Area (No Floodfighting)
Top of Levee (TOL)	149.2
Probable Failure Point (PFP)	146.8
Probable Non-Failure Point (PNP)	144.3

Figure A-1.1: Northern Impact Area Levee Failure Curve FDA Input Screen



Plan: Without

Analysis Year: 2001

Stream: Sacramento River

Damage Reach: Hamilton City

Levee Name: W/O LEVEE

Description: RM 198.25

Top of Levee Stage: 149.20

Combined Conditional Probability of Failure

	Exterior Stage (ft.)	Probability of Failure
1	144.30	0.15
2	146.80	0.85
3		
4		
5		
6		
7		
8		

Table A-1.2: Northern Impact Area Project Performance Statistics Without Project

Impact Area	Annual Exceedance Probability (Expected)	Long Term Risk (Years)			Conditional Non-Exceedance Probability by Events					
		10	25	50	10%	4%	2%	1%	0.40%	0.20%
Northern (No Floodfighting)	0.1160	0.7086	0.9542	0.9979	0.4805	0.0881	0.0240	0.0054	0.0005	0.0001

HEC-FDA Results—Assuming No Floodfighting

Table A-1.2 presents the Hamilton City project performance statistics obtained from FDA, assuming no floodfighting. In other words, the levee failure curve shown in Table A-1.1 was input into HEC-FDA with no changes. For example, in Table A-1.2, the expected annual exceedance probability is estimated to be 0.1160, indicating that there is about a 12 percent chance of a damaging flood event along that particular river reach in any given year.

For long-time residents of Hamilton City, this 12 percent chance of flooding annually may seem exaggerated because the town has not suffered major flooding in the last 30 years or so even though severe flood events have occurred, most recently in 1997. The reason the town has not flooded is because of floodfighting—significant local, state and federal resources are typically used to combat flood events in Hamilton City so that the levee has not failed. If these events were not flood fought, then the chance of failure would have been greater, probably to what is indicated by the HEC-FDA AEP results. The equivalent annual damage estimate (without project conditions) for this impact area is about $418,000 (October 2002 price levels), assuming no floodfighting.

If floodfighting were to be assumed in the analysis (primarily by adjusting the levee failure curve as described below), then it's likely that the annual exceedance and equivalent annual damage estimates would be somewhat lower. However, the costs of floodfighting would have to be added to the EAD estimate.

Suggested Procedure to Adjust FDA Analysis For Floodfighting Efforts

To adjust the HEC-FDA analysis for floodfighting requires that the levee failure curve be modified somehow to reflect social actions taken to protect the levee (patrolling, sandbagging, plastic sheathing, boil repairs, etc.). These actions are not typically included in the levee failure curve, which primarily reflects the physical characteristics of the levee.[2] Modifications to the levee failure curve would most likely include raising the PNP and PFP to reflect floodfighting efforts.

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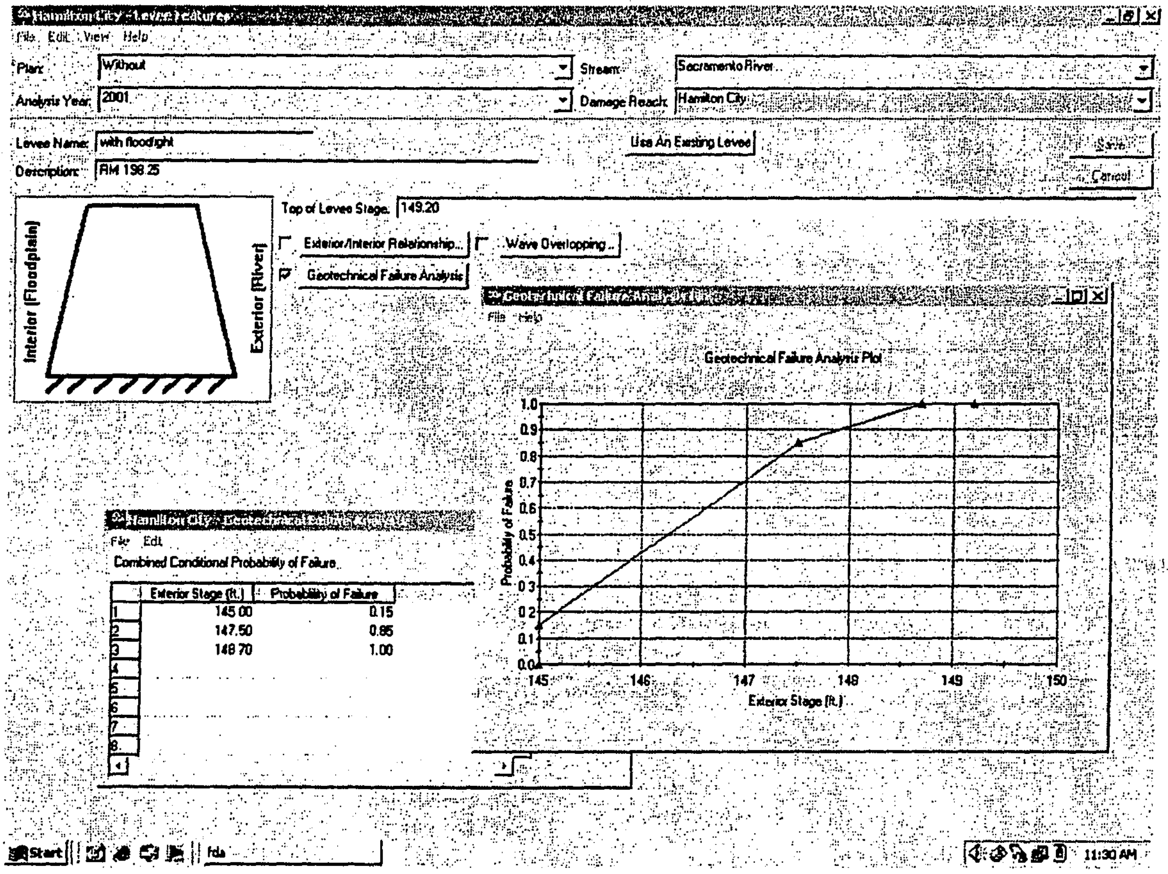
[2] Geotechnical specialists might argue that these actions should *not* be included in a levee failure curve because of the inherent uncertainties whether or not they will be successful.

The Hamilton City Study team met to discuss how the levee failure curve could (and whether it should) be modified. The focus of the meeting was upon the PFP of 146.80 (Table A-1.1). It was mentioned that the "J" Levee safely passed the 1997 event through extensive floodfighting. The maximum river stage at the Hamilton City gage (just upstream of the Gianella bridge) in 1997 was 147.92 (National Geodetic Vertical Datum). This was the highest recorded stage in the past 20 years. The estimated stage at the Northern index point for the 1997 event was 147.5. Thus, it was decided to change the without project PFP of 146.8 to 147.5 since the levee seemed able to withstand this type of event—with floodfighting. The PNP was increased an equivalent distance (0.7 feet) from 144.3 to 145.0, since it is reasonable to assume floodfighting would be at least as effective at a lower river stage. In addition to raising the PNP and PFP values, it was also decided to add another point on the levee failure curve for input into HEC-FDA. This point was one-half foot less than the top of levee (148.70) and it was assigned a probability of failure of 99%. The purpose of this point was to provide more definition to the levee failure curve. Table A-1.3 compares the levee failure curves under both scenarios—no floodfighting vs floodfighting. Figure A-1.2 shows the FDA levee failure curve input screen.

Table A-1.3: Northern Impact Area Levee Failure Curves

Levee Failure Curve	Northern (No Floodfighting)	Northern (With Floodfighting)
Top of Levee (TOL)	149.20	149.20
Additional point (.99 prob failure)	n.a.	148.70
Probable Failure Point (PFP)	146.80	147.50
Probable Non-Failure Point (PNP)	144.30	145.00

Figure A-1.2: Northern Impact Area Levee Failure Curve (With Floodfighting) FDA Input Screen



Plan: Without

Stream: Sacramento River

Analysis Year: 2001

Damage Reach: Hamilton City

Levee Name: with floodfight

Description: RM 198.25

Top of Levee Stage: 149.20

Combined Conditional Probability of Failure

	Exterior Stage (ft.)	Probability of Failure
1	145.00	0.15
2	147.50	0.85
3	148.70	1.00
4		
5		
6		
7		
8		

HEC-FDA Results—Assuming Floodfighting

Tables A-1.4 and A-1.5 display the HEC-FDA results for the without project analysis for the Hamilton City impact area, floodfighting vs no floodfighting. The only difference within HEC-FDA for these 2 analyses is the levee failure curves shown in Table A-1.3. For project performance (Table A-1.4)), expected annual probability declines from .1160 to .0860. This implies that assuming floodfighting is successful, we can decrease the probability of levee failure from about a 1 in 9 chance in any given year to a 1 in 12 chance in any given year. Equivalent annual damage is also reduced from $418,000 to $397,000, again assuming that floodfighting improves the function of the levee. This reduction in EAD would be more than offset by the significant costs associated with floodfighting.

Table 4
Northern Impact Area Project Performance Statistics
Floodfighting vs. No Floodfighting
Without Project

Impact Area	Annual Exceedance Probability (Expected)	Long Term Risk (Years)			Conditional Non-Exceedance Probability by Events					
		10	25	50	10%	4%	2%	1%	0.40%	0.20%
Northern (No Floodfighting)	0.1160	0.7086	0.9542	0.9979	0.4805	0.0881	0.0240	0.0054	0.0005	0.0001
Northern (With Floodfighting)	0.0860	0.5929	0.8942	0.9888	0.6628	0.2157	0.0956	0.0349	0.0057	0.0006

Table 5
Northern Impact Area Equivalent Annual Damage Estimates
Floodfighting vs. No Floodfighting
Without Project
(October 2003 Prices)

Impact Area	Equivalent Annual Damage
Northern (No Floodfighting)	$438,000
Northern (With Floodfighting)	$406,000

A-2: Ecosystem Plan Formulation Methodology

ECOSYSTEM PLAN FORMULATION METHODOLOGY

The ecosystem restoration planning and evaluation methodology consists of coordination with resource agencies to ensure consistency among restoration approaches, development of an existing condition inventory, projection of with-project restoration benefits, and calculation of the relative habitat value of outputs between alternative restoration plans. Coordination with groups and agencies doing restoration work in the study area began early in the study process. The inventory of existing habitat consisted of generating a Geographic Information System (GIS) database of the study area including vegetation, elevation, topography, soils, and hydraulics/hydrology layers. With-project vegetation was projected using reference site restoration habitat percentages projected to the entire study area. Evaluation of habitat values was calculated using United States Fish and Wildlife Service (USFWS) Habitat Evaluation Procedures (HEP). These HEP models selected were developed by the USFWS and include: *Red-tailed hawk, Habitat Suitability Index Models: Riparian Forest, Habitat Suitability Index Models: Scrub-shrub Cover Type for Riparian Areas.* Cost Effective/Incremental Cost Analysis (CE/ICA) was used to compare restoration alternatives to better inform the selection of a restoration plan.

Coordination

The existing condition inventory and projected restoration methodology were developed through extensive coordination with the USFWS, California Department of Fish and Game (DFG), National Oceanic and Atmospheric Administration (NOAA) Fisheries, The Nature Conservancy (TNC), Sacramento River Partners, and Sacramento River Preservation Trust. Coordination began early in the study process and has continued throughout study development. Numerous meetings were held to gain agreement on the characterization of the existing conditions, as well as defining the problems and potential restoration opportunities of the area, exchange data, information, ideas, and generate a project that could be supported. In addition, coordination with Calfed has been ongoing throughout the study process and specifically includes the review and input of the Independent Review Panel established specifically with Calfed for this study.

Existing Information

GIS based mapping has been developed for the study area. The study area is bounded by the Sacramento River to the east and the Glenn-Colusa Canal to the west and extends about two miles north and six miles south of Hamilton City. The area includes the private lands, DFG, USFWS, and other public lands. GIS layers include; aerial photographs, topography, soils, elevation, vegetation, hydraulics, and hydrological information.

Historic black and white aerial photography for the area was taken in 1948 and copied from U.C. Davis archives. Ayers and Associates provided updated black and white aerials of the area for 1995 and color aerial photos were taken in 2002.

Topography and elevations of the area were gathered from Comprehensive Study topography and elevation data. Soil information was collected from the Glenn County soil surveys (Begg, 1968).

Regional hydrologic and hydraulic information was developed in 2001 as part of Sacramento & San Joaquin River Basins Comprehensive Study. The information was refined to reflect site-specific conditions in the Hamilton City area in 2003.

For initial vegetation mapping, the classification system was adapted from Holland's (1986) *Preliminary Descriptions of the Terrestrial Vegetation of California.* Existing vegetation acreages were calculated from Glenn County land use files. The classification was subsequently simplified to conform to available habitat suitability index (HIS) models to be used in the habitat evaluation procedure for existing and predicted habitat. The final classification used the following habitat types:

- Riparian forest
- Scrub
- Oak Savannah
- Grassland
- Orchard/Grain

Habitat Prediction

The projected with-project conditions were determined using a model developed by The Nature Conservancy for projected vegetation for the RX Ranch reference site (see Zone A4 on the Restoration Zones map). The model used 4 GIS data layers to predict the acreage of converted vegetation types; existing vegetation, the soil type, elevation, and topography. Glenn County soil surveys (Begg, 1968) were initially used to project restoration vegetation potential. These soils maps were found to be non-specific. On the RX Ranch area 27 soil cores were sampled by CSU Chico Biology Department under contract to TNC over the 259-acre area to develop site-specific soil maps. The predicted vegetation acres at the RX Ranch were converted to percentages. The vegetation categories were combined to describe more general habitat types to project to the entire study area and facilitate the use of HEP models for habitat quality prediction. The percentages calculated for the RX Ranch reference site are summarized in Table A1. The predicted habitat percentages within the RX Ranch reference site were then projected to the entire study area with the exception of Zones A1 and I (see Restoration Zones map). Due to the elevation of these zones, TNC determined that these zones would likely support predominantly savannah habitat and therefore the conversion of orchard/grain in zones A1 and I was to 100% savannah.

Table A-2.1: Vegetation Composition Based on Soil Type, Elevation, and Topography (TNC RX Ranch Restoration Site)

Vegetation Type	Percent
Scrub	18
Riparian	73
Grassland	5
Oak Savannah	4
Total	100

The main assumption underlying the projected with-project condition is that the vegetation composition of restored areas would be similar to the vegetation composition at the restoration reference site within the study area.

Additional assumptions of the vegetation projections were:

- Vegetation that is currently native habitat in an area under the No-Action Alternative would not change under any of the alternatives, however, the value of riparian and scrub habitat would increase if flooding is introduced to the zone and associated benefits of nearby restoration,
- Where restoration is proposed, all orchard, grain, or hay habitat would be completely converted to native habitat,
- Orchards not proposed for restoration (the south-western section of the study area) would remain in orchard but would include the purchase of flowage easements,
- All potential restoration areas would be actively (as opposed to passively) restored, although there is a potential for some minimal passive restoration test sites
- The period of analysis is 50 years.

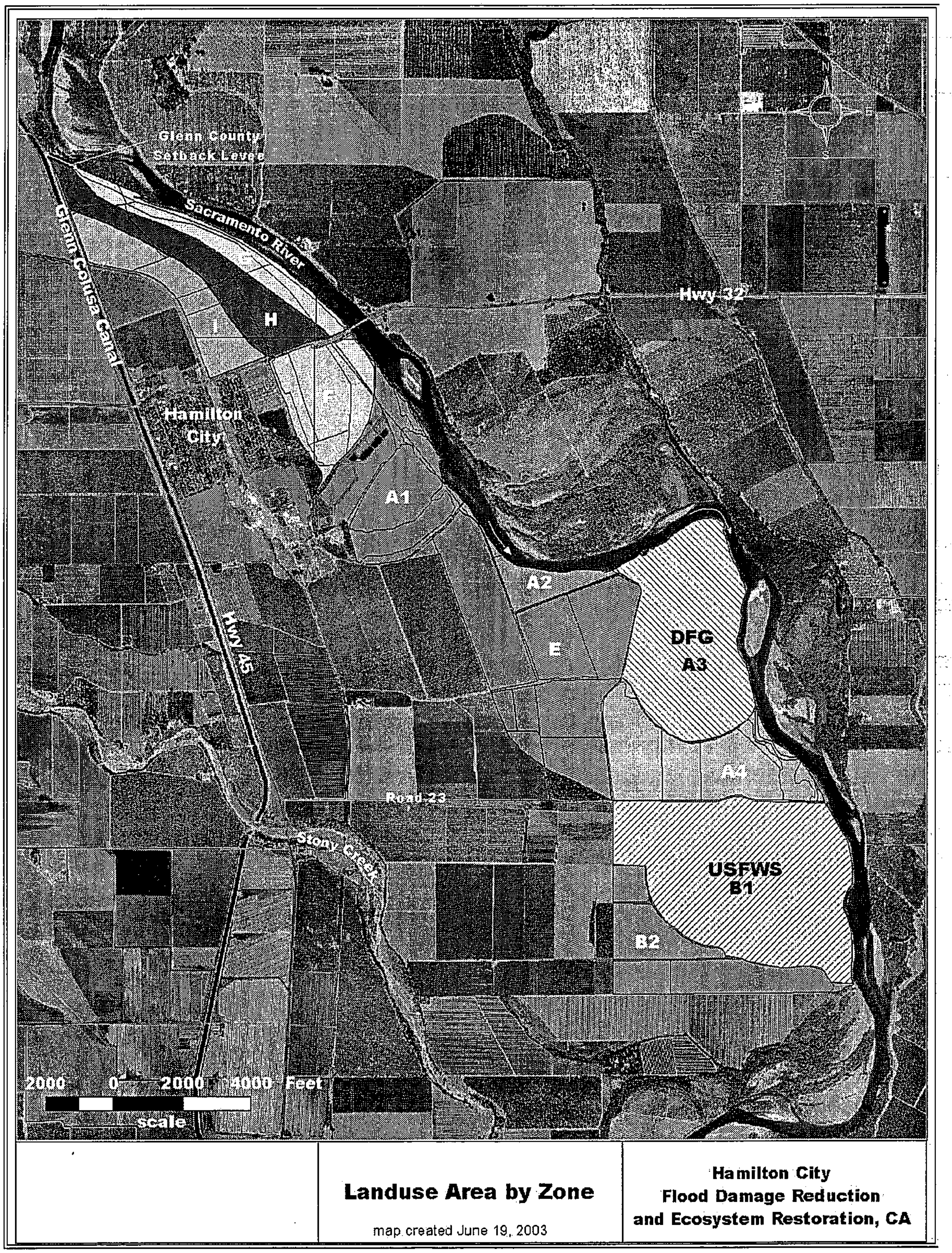


Figure A-2.1 Habitat Valuation (Future with- vs without-project)

The existing ecosystem values and predicted benefits of each alternative were characterized in terms of the assessment methodology called HEP. The HEP methodology, in widespread use since first developed by the USFWS in the early 1980's, compares the suitability of habitat conditions in the study area for a particular species or habitat to ideal conditions for that same species or habitat. HEP takes into account both the quality and quantity of habitat by multiplying a habitat or species-specific numerical HSI by the aerial extent of the habitat under consideration. The HSI value, which varies from 0 to 1 ("0" represents no value as habitat, while "1" represents ideal habitat), is multiplied by acreage to yield habitat units. Habitat units serve as a quantitative expression of environmental output.

We began by evaluating the existing information collected and selected the following HEP models/cover type:

- red-tailed hawk/grassland
- scrub-shrub/scrub
- red-tailed hawk/orchard and grain
- riparian forest/riparian forest
- red-tailed hawk/savannah

These HEP models selected were developed by the USFWS and include: *Red-tailed hawk, Habitat Suitability Index Models: Riparian Forest, Habitat Suitability Index Models: Scrub-shrub Cover Type for Riparian Areas*. The red-tailed hawk, scrub-shrub, and riparian forest models requirements seemed to best fit the river conditions expected with the restoration. Much of the study area is in orchard. In selecting the models it was important to be aware that an orchard could potentially give you high numbers if the wrong models were selected. The red tail hawk seemed the most appropriate when applied to the savannah, grassland, and orchard habitats. The biggest adjustment made to the models was to include a floodplain variable which considered plant germination, shaded riverine aquatic (SRA), large woody debris (LWD), and natural banks when the models were applied to the riparian and scrub habitat. These habitats account for approximately 91% of the potentially restored area and the floodplain variable better reflected the improved function of restoring flooding to the floodplain on these two habitat types.

Historically, rivers in the Central Valley had large floodplains. Over time rivers were leveed and floodplain habitat was converted to agricultural land. Floodplain habitat were productive agricultural areas due to the many years of fine sediment and nutrient buildup. As a result, riparian habitat has become restricted to narrow bands within or adjacent to the levees. The loss of the natural floodplain has caused a loss of features which are typically found in a healthy sustainable riparian corridor such as: 1) colonization of woody plants such as cottonwood and willows; 2) shaded riverine aquatic habitat establishment; 3) supply of large woody debris; and 4) establishment of natural banks. An active floodplain enables these four components to exist within a riparian area. Areas hydrologically connected to the main channel received a 1.0 rating and areas not hydrologically connected to the main channel received a 0.0 rating.

For ease of planning, the study area was split into nine potential restoration zones (see Restoration Zones map). These zones are the potential building blocks for various alternatives. The existing condition HEP was done for these zones and were combined together for each of the different alternatives. The restoration area was inventoried by the HEP team, which included USFWS and Study Team members, and measured in terms of habitat variables (e.g. tree density, habitat complexity, etc) critical to supporting the life requisites of the red tailed hawk, scrub-shrub, and the riparian forest. Using the USFWS HEP models, HSI values were calculated for each habitat type within each zone, which was then multiplied by zone-habitat acreage to yield the number of habitat units for both the future with- and without-project conditions.

In each zone, the expected number of habitat units to occur in the future without the restoration project was subtracted from the number of habitat units expected with a restoration project. This difference represents the "benefits" due to the site restoration. The habitat units were converted to average annual habitat units (AAHU's) to reflect the fact that full ecosystem benefits would not occur immediately. AAHU's for each preliminary ecosystem restoration alternative are displayed on Table A-2.2.

Table A-2.2: With and Without -Project Vegetation Acreages and Associated Average Annual Habitat Units

Summary by Alternative

Alternative 1

Total	Acres			Increase in Habitat Acres	Increase in AAHU
	Without	With	Change		
Riparian	97.1	955.7	858.5	858.5	843.6
Grassland	83.7	145.6	61.9	61.9	63.3
Savannah	0.0	140.4	140.4	140.4	136.9
Scrub	0.0	227.1	227.1	227.1	219.1
Orchard	1,288.0	0.0	-1,288.0	-	-479.6
Total	**1,468.8**	**1,468.8**	**0.0**	**1,288.0**	**783.3**

Alternative 4

Total	Acres			Increase in Habitat Acres	Increase in AAHU
	Without	With	Change		
Riparian	94.1	780.3	686.3	686.3	682.1
Grassland	83.6	133.6	50.0	50.0	51.4
Savannah	0.0	130.8	130.8	130.8	127.5
Scrub	0.0	183.9	183.9	183.9	177.4
Orchard	1,050.9	0.0	-1,050.9	-	-396.6
Total	**1,228.6**	**1,228.6**	**0.0**	**1,050.9**	**641.8**

Alternative 5

Total	Acres			Increase in Habitat Acres	Increase in AAHU
	Without	With	Change		
Riparian	109.8	1,215.8	1,105.9	1,105.9	1,072.9
Grassland	84.8	163.4	78.7	78.7	80.1
Savannah	0.0	154.6	154.6	154.6	150.8

Scrub	0.0	291.3	291.3	291.3	281.1
Orchard	1,630.5	0.0	-1,630.5	-	-599.7
Total	1,825.1	1,825.1	0.0	1,630.5	985.2

Alternative 6

Total	Acres			Increase in	Increase in AAHU
	Without	With	Change	Habitat Acres	
Riparian	97.1	1,093.7	996.6	996.6	965.1
Grassland	84.6	155.1	70.4	70.4	71.8
Savannah	0.0	147.9	147.9	147.9	144.3
Scrub	0.0	261.2	261.2	261.2	252.1
Orchard	1,476.2	0.0	-1,476.2	-	-545.6
Total	**1,657.9**	**1,657.9**	**0.0**	**1,476.2**	**887.6**

Alternatives Analysis

In accordance with current Corps policy for ecosystem restoration projects, restoration outputs are measured in non-monetary units. The outputs in this study have been measured using average annual habitat units discussed and displayed above. Cost effectiveness and incremental analysis are used to compare the dollars invested vs., in this case, the average annual habitat unit outputs to better determine which level of investment is desirable and affordable. Cost effective analysis identifies the least cost solution for each possible level of output as well as those solutions which provide more output for equal or less cost than others. Subsequent incremental cost analysis evaluates how the cost of increases as output increases. CE/ICA consists of comparing the costs and outputs of alternative plans, identifying plans that are, first, not cost effective; and second, not cost efficient. Best buys are the subset of the cost effective plans that are the most efficient plans, at producing output as project scale is increased - they provide the greatest increase in output for the least increase in cost. By identifying the cost and output differences across cost effective solutions, planners can then decide which level of output is worth the cost. While cost effectiveness and incremental cost analysis will not identify an optimal solution, they do organize and present information that can facilitate the informed selection of a single solution.

Next Steps

The original plant design developed by The Nature Conservancy in 2001 provided a blueprint for which the Corps was able to extract the initial plant community acres and designations for the purposes of hydrologic modeling. The initial restoration communities were developed using TNC's best judgement and knowledge of the Project area in addition to a limited number of soil cores for the area. In 2003 The Nature Conservancy provided the Corps with a detailed soils and restoration community-level plan for the 246-acre RX Ranch located in the southern end of the Project area. This information was used to extrapolate a more fine-tuned community-level plan for the entire Project area.

The next steps in preparing the restoration design for the Project are as follows. Detailed soil sampling and synthesis of data on groundwater and topographic data throughout the remaining Project area is needed. This information will allow the development of the detailed plant community designs for the entire Project area. Accordingly, there will be adjustments made in the final proposed restoration communities between the initial TNC recommended communities and the communities to be derived from the detailed topographic, groundwater, and soils data that are yet to be collected.

A-3: Passive vs. Active Ecosystem Restoration

PASSIVE VS. ACTIVE ECOSYSTEM RESTORATION

Habitat restoration can be both passive and active. Passive restoration is a technique whereby the restoration area is left in a condition conducive to natural recruitment of native vegetation with little or no intervention. Active restoration is restoring natural habitats by active measures such as site preparation, native plant species propagation and planting, weed control, and supplemental irrigation. Both techniques have both habitat and financial benefits and costs.

PASSIVE RESTORATION

General Considerations

The theory behind passive restoration is that by simply reducing or eliminating the sources of degradation, habitat recovery will occur over time. Passive restoration focuses on the removal of a stressor or stressors that have contributed to system decline. The main intervention techniques utilized in passive restoration are the exclusion of livestock or removal of roads that serve as weed corridors. One of the major benefits of passive restoration is the low cost. The risk of restoration failure, however, is potentially substantial. Some factors that may indicate potential failure of a passive restoration site include:

- Competition from non-native species for sunlight and moisture (Adams et al. 1992, Danielson and Halvorson 1991),
- Seed predation and girdling of young trees associated with rodents (Knudsen 1984, Griffin 1980),
- Browse pressure from herbivores (insects, rabbits, and deer) (Griffin 1971), or
- The combination of these factors (Griffin 1971, 1976, Knudsen 1984, McCreary 1990).

Weeds may be the most important biological risk factor because they compete fiercely with natives for sun and water. In addition, the weed cover provides ideal habitat for rodents (Chouinard et al., 1999), which in turn can girdle young trees or consume seeds and acorns.

At passive sites, shade and other factors lead to weeds out-competing native species. Even in active restoration sites, without weed control, weeds out-compete the natives and success can drop by up to 50%. In addition, the unbroken cover of passive restoration areas results in a much higher usage by rodent populations, which significantly reduces the survival of native species.

Figure A-3.1 shows the potential restoration areas, or zones, in the study area. The Sacramento River Partners (SRP) have developed a Riparian Restoration Plan for the Pine Creek Unit, adjacent to the study area and identified as Zone A3 in Figure 1. SRP surveyed the nearby vegetation and identified an elevation of 128 feet above sea level (approximately the 2-year floodplain). Areas exposed to river processes below this elevation appeared to be dominated by natural recruitment. SRP further determined that given the current conditions of the area and despite the cessation of agricultural practices nearly nine years ago, natural recruitment on the area is likely to be limited because of the higher elevation, lower available surface soil moisture, and heavy weed competition.

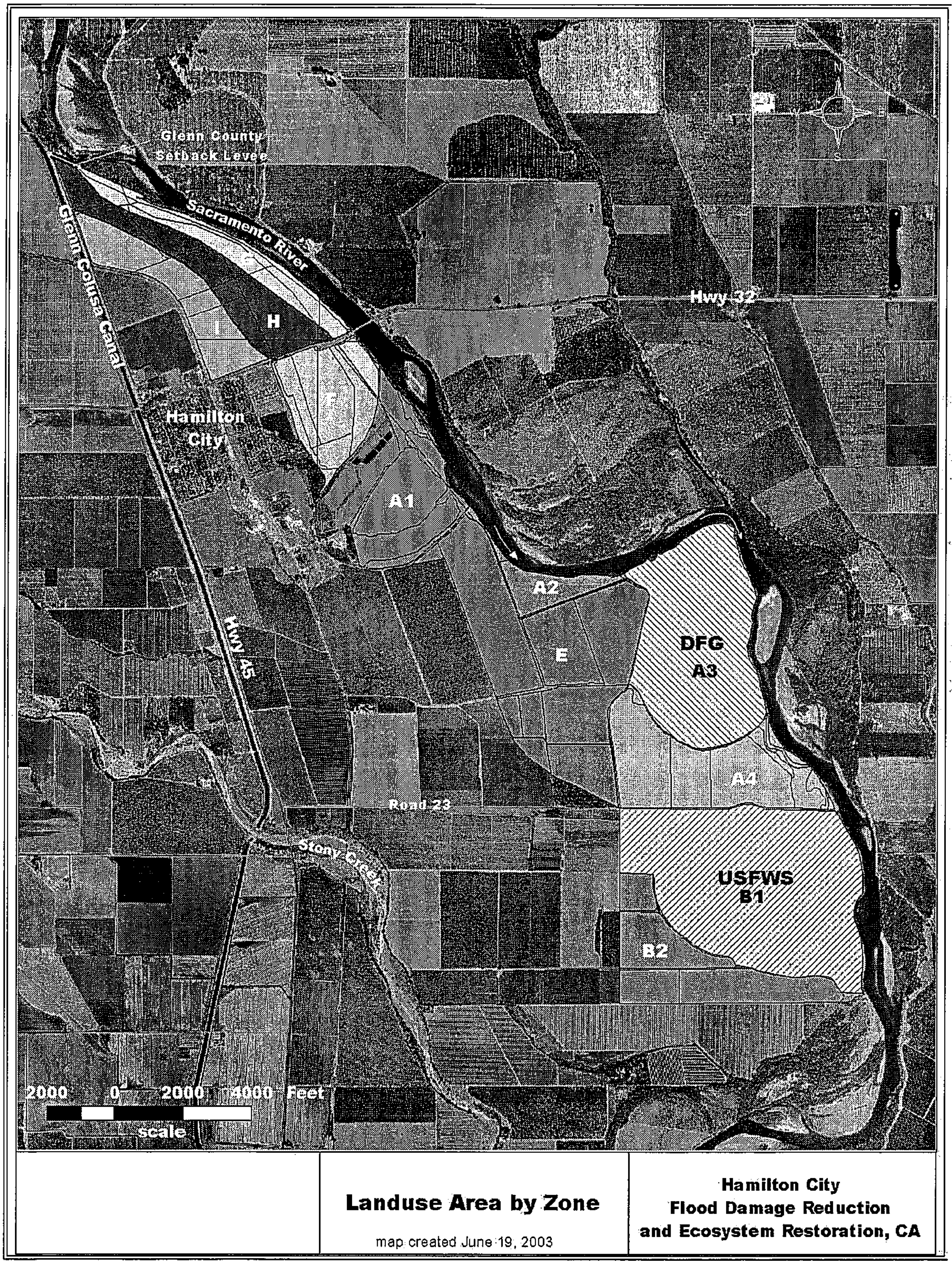


Figure A-3.1: Potential Restoration Area Zones.

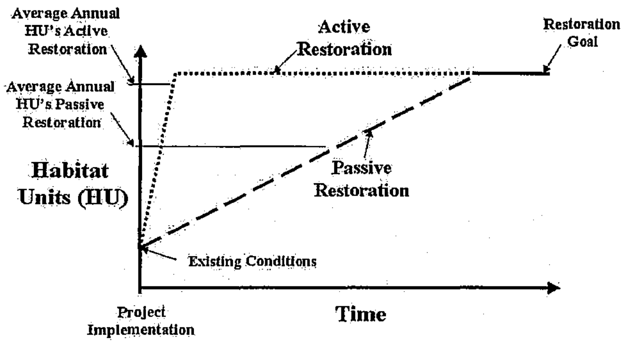
Therefore, undesirable non-native plants are likely to dominate, leaving the site devoid of native vegetation (and desirable wildlife habitat) for decades. Passive restoration was, therefore, unfeasible for the Unit.

Since passive restoration depends fundamentally on natural processes, achieving the established restoration objective often can take many years. In restoration areas along the Sacramento River, research by The Nature Conservancy has shown that although natural regeneration occurred on some of the restoration areas, the regeneration rate was less than that of the active restoration rates. Thus a longer period of time, possibly decades, is necessary to capture the full benefits of restoration at passive sites. Due to the risk of failure, there is also a possibility of not being able to capture the benefits at all. This lag in achieving the restoration goal is depicted in Figure A-3.2.

Habitat benefits are quantified in Habitat Units. Habitat Units are developed using US Fish and Wildlife Service Habitat Evaluation Procedure (HEP) Models to express the quality of both existing and predicted habitat. The expected number of habitat units to occur in the future in the absence of the restoration project was subtracted from the number of habitat units (between the with- and without-project conditions) represents the "benefits" due to the site restoration.

As shown, since the passive restoration takes longer to achieve the restoration goal, the average annual increase in habitat units is usually less than for active restoration. Passive restoration, saves up front costs by not planting and has reduced long term operation and maintenance costs, however, the potential risk of failure with passive restoration and the delayed benefits over time further diminishes the potential savings of passive restoration.

Figure A-3.2: Passive vs. Active Habitat Units



Feasibility Study Analysis

For the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study analysis, the 2-year floodplain (comparable to the 128-foot elevation identified by SPR) was used as a general marker for potential passive restoration areas. The cost savings of passive restoration (as opposed to active) within the study area could be substantial and worth the potential risks associated with passive restoration. The cost of orchard removal and the cost of fencing would still apply; however, the potential cost savings from not planting and maintaining the restoration area could be quite substantial. The following table identifies the acres by zone that are within the 2-year floodplain for the study area and potential cost savings associated with passive restoration.

Table A-3.1: Potential Passive Restoration Within the 2-Year Floodplain

		Increase in		Ac Within	Orchard	Potential
Zone	Cost[1]	Habitat Acres	Cost/Acre	2-yr FP	Removal	Cost Savings
A1	854,050	90	9500	80	80000	680,000
A2	453,970	58	7875	16	16000	109,993
A4	1,981,761	252	7872	252	251700	1,729,747
E	4,220,486	535	7885	0	0	0
F	1,215,838	154	7878	0	0	0
G	810,491	103	7835	0	0	0
H	1,491,690	189	7903	0	0	0
I	1,490,265	157	9500	0	0	0
Total	12,518,551	1,538		348	488100	2,519,740

[1] These estimates only include the costs to remove orchards, plant, irrigate, and monitor for three years. The costs do not include contouring, if necessary, breaching of the "J" levee, EDSA, and fencing.

Application of this approach to the study area shows a potential passive restoration area of 348 acres and a potential cost savings of $2.5 million. This cost savings is potentially significant however the risk of failure of passive restoration within the study area is substantial. Several studies on the Sacramento River (Alpert et al. 1999, Baird, 1989, Laycock, 1995, Peterson, unpubl.,) have indicated that planting, irrigating, and weed control are all required for successful restoration of riparian vegetation due to the high risk that non-native species would out-compete native species. This would seem to indicate that there is a high risk of failure with passive restoration in the study area.

ACTIVE RESTORATION

General Considerations

Active restoration is restoring natural habitats by active measures such as planting trees and shrubs or removing exotic plants and animals from a native landscape or waterway. Active planting can effectively accelerate the natural recovery process. Active strategies for restoration include orchard removal, non-native species eradication, planting riparian, scrub, savannah, and grassland habitats, providing irrigation, fencing, and contouring for flow. The following costs for active restoration include the costs to remove orchards, plant, irrigate, and monitor for three years. The costs do not include contouring, if necessary, breaching of the "J" levee, EDSA, and fencing.

Table A-3.2: Potential Active Restoration

Zone	Cost	Increase in Habitat Acres	Cost/Acre
A1	854,050	90	9500
A2	453,970	58	7875
A4	1,981,761	252	7872
E	4,220,486	535	7885
F	1,215,838	154	7878
G	810,491	103	7835
H	1,491,690	189	7903
I	1,490,265	157	9500
Total	12,518,551	1,538	

Active restoration costs more up front, in this case $12.5 million, but provides benefits within the first two years of establishment. In fact the Point Reyes Bird Observatory (PRBO) has done surveys of restored areas which showed benefits to passerine bird species two years after planting and full restoration benefits captured as early as 3-4 years. In contrast, passive restoration may take up to 20 years, if at all; to become a restored area that demonstrates beneficial uses to bird and other species.

Feasibility Study Analysis

While a little more difficult to calculate in dollars, this time delay of beneficial results has a cost as well. Habitat units are used to calculate habitat quality over the life of the project. The habitat units were converted to average annual habitat units (AAHU's) to reflect the fact that full ecosystem benefits would not occur immediately. The maximum potential average annual habitat units for the project are displayed in Table A-3.3. These AAHU's would be reduced with a delay in the restoration over time. This demonstrates the detrimental effect that passive restoration will have on habitat quality, ultimately reducing the overall benefits of the project.

Table A-3.3: Potential Habitat Units

Habitat Types	Increase in AAHU
Riparian	1,072.9
Grassland	80.1
Savannah	305.3
Scrub	281.1
Orchard	-654.6
Total	1,084.8

CONCLUSIONS

For the Hamilton City Feasibility Study, the assumption will be to use active restoration because of the risks associated with using passive restoration. Restoration areas will have to be further surveyed during the pre-construction, engineering, and design phase of project development. Site-specific indications of risk and potential for passive vs. active restoration will be identified based on the presence of non-natives, hydrology, and soils.

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A-4: Floodplain Reconnection

FLOODPLAIN RECONNECTION

The Hamilton City Study area contains important natural resources characteristic of the Sacramento Valley. Historically this section of the river periodically overflowed its banks and spilled out onto a broad floodplain. As the land became developed for agricultural production, landowners have constructed private levees such as the J levee protecting the Hamilton City area. Currently the "J" levee does not adequately protect the lands or the town but does sever the Sacramento River from its historic floodplain. Relatively frequent flooding is ecologically significant and has many benefits including the establishment and sustainability of riparian vegetation and associated components. More specifically, the establishment of riparian vegetation and associated components has the benefits of allowing for (a) colonization of woody plants such as cottonwoods and willows, (b) establishment of shaded riverine aquatic (SRA) cover, (c) establishment of large woody debris (LWD), and (d) establishment of natural banks, all of which would ultimately benefit a variety of aquatic and terrestrial animal species. Over time periodic inundation of the floodplain allows for the continued regeneration of the riparian community through seed dispersal, removal of senescent vegetation and establishment of pioneer species.

An array of alternative plans to reduce flood damages and restore the ecosystem are being developed and evaluated during the study. Each alternative plan consists of one or more measures. Potential measures include, but are not limited to constructing a new levee along an alignment setback from the river, and restoration of native vegetation and habitats.

(a) Colonization of woody species such as cottonwood and willows

The disturbance pattern of flooding in riparian areas assists in creating a mosaic of vegetation patterns, while other environmental influences such as light, temperature and humidity create a transition zone between riparian and adjacent grasslands, wetlands or meadow areas (Gregory et al. 1989). Dynamics of the river/stream channel interact closely with the vegetation structure. Early stages of riparian plant development are mainly determined by the hydrologic regime and energy in the riparian corridor (USACE 2001). Habitat complexity created by vegetative layers, including various woody species, contributes to the diversity of wildlife. In the Central Valley, riparian forests that exhibit good structure (older, taller vegetation), regeneration, and high vegetative diversity (particularly if plant species are native) also exhibit increased bird diversity and nesting success (PRBO 1995).

Riparian corridors form links among many portions of the landscape and, consequently, contain high levels of biodiversity. The high diversity of riparian plants is thought to be related to, among other factors, the intensity and frequency of floods and small-scale variations in topography and soils as a result of lateral migration of river channels (USACE 2001). The migration capacity of plants along riparian corridors is also an important factor in explaining the high biodiversity observed along stream/river channels (USACE 2001).

(b) Establishment of SRA Cover

SRA Cover is defined as the unique, nearshore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat (USFWS 1992). Key attributes of this aquatic area include (a) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (b) the water containing variable amounts of woody debris, such as leaves, logs, branches, and roots, often substantial detritus, and variable water velocities, depths, and flows (USFWS 1992). These attributes provide a highly productive and complex land-water interface which supports an array of fish and wildlife species adapted to this habitat. Subsequently, the U.S. Fish and Wildlife Service has designated SRA cover as a Resource Category 1 under its Mitigation Policy, which designates that the habitat is unique and irreplaceable on a national basis or in the ecoregion of the Central Valley and warrants no loss of existing habitat value (USFWS 1981). Overhanging vegetation shades and cools the water and surroundings, helping provide thermal refuges in an otherwise exposed environment (USACE 2001). Roots and debris are colonization sites for algae and macroinvertebrates, and organic matter is eaten by macroinvertebrates. Many organisms take refuge from predators and currents among the roots, rocks, and other structures. Also, entire trees, which periodically become dislodged from the adjacent eroding banks, often contribute to the instream structure of SRA cover.

Setback levees allow for the growth of SRA Cover on banks which would benefit fishes. Overhanging or fallen trees or branches on banks is important to the survival of many fish species. River productivity is increased by the organic materials and energy input from terrestrial vegetation. This vegetation provides food and habitat which in turn serves as food for numerous bird species and several fish species such as Chinook salmon and steelhead trout (Hydrozoology 1976 in USFWS 1992; Sekulich and Bjornn 1977 in USFWS 1992). It also provides shaded escape cover for fish, feeding perches for birds such as belted kingfisher, and nesting and resting areas for birds such as heron, egrets, and wood ducks (USFWS 1992).

SRA cover is important to several federally listed species, such as the threatened Sacramento splittail and delta smelt. Shallow, flooded areas are important to the survival and recovery of the splittail. Because they require flooded vegetation for spawning and rearing, they are frequently found in areas subject to flooding. Delta smelt spawn in shallow, fresh or slightly brackish water upstream of the mixing zone. Most spawning happens in tidally-influenced backwater sloughs and channel edgewaters. SRA refugia is important to both the Sacramento splittail and the delta smelt as they allow these species to evade predators, resist detrimental transport from the system, and rear in more productive areas. Refugia are provided by biological factors such as flooded, overhanging, emergent, and aquatic vegetation (USFWS 2000b).

(c) Establishment of Large Woody Debris

Large woody debris is generally described as fallen riparian wood pieces that exhibit both large size (e.g., often less than 15 feet in length or greater than 18 inches in diameter) and high complexity, such as occurs when an entire mature tree, including root mass, is undermined by erosion and falls into the river (USFWS 2000a)

Large woody debris can to store inorganic sediment and organic matter, while also serving as in-water cover for fish (USFWS 2000). This is important, because to contribute habitat (inorganic sediment) or energy to the food web of a stream reach (organic matter), the material must first be retained in the channel where it can function and be processed (Murphy and Meehan 1991 in USFWS 2000a; Gregory et al. 1991 in USFWS 2000a; Bisson et al. 1987 in USFWS 2000a). Large pieces of debris are generally able to store higher quantities of sediment and organic material than other kinds of structures, such as boulders or exposed root systems (Bisson et al. 1987 in USFWS 2000a). Smaller woody debris, such as branches, sticks, and twigs which create sieve-like accumulations, are the most efficient structures for retaining leaves (Gregory et al. 1991 in USFWS 2000a; Murphy and Meehan 1991 in USFWS 2000a) is important. From a biological perspective, streams require complex arrays of different woody debris sizes to maximize benefits from organic matter retention (Gregory et al. 1991 in USFWS 2000a). Woody material (dead snags, fallen debris and a diversity of mature and young vegetation) on the banks and bar surfaces of riparian areas provides sites for seed accumulation, germination, propagation and regeneration of plants. Taken together, the structural complexity and improved ecosystem functioning riparian ecosystems translate into higher species diversity and abundance of all wildlife.

Perhaps no other structural component of the environment is as important to salmon habitat as is large woody debris (NRC 1996 in USFWS 2000a). Numerous reviews of the biological role of large woody debris in streams of the Pacific Northwest have concluded it plays a key role in physical habitat formation, sediment and organic-matter storage, and in maintaining a high degree of habitat complexity in stream channels (e.g., NRC 1996; Sedell et al. 1990; Bisson et al. 1987 in USFWS 2000a). In large rivers such as the Sacramento River, debris often provides essential salmonid habitat by "capping" side channels, and causing scour holes, velocity breaks, and other habitat complexities in the shallower river braids (Murphy and Meehan 1991 in USFWS 2000a). Deposited debris is also capable of increasing channel width, producing mid-channel bars, and facilitating development of meander cut-offs (Keller and Swanson 1979 in USFWS 2000a). Large woody debris provides habitat complexity, protecting fish from predation, excessive competition and physical displacement (Dolloff 1994 in USFWS 2000a).

Furthermore, complex near-shore areas enhanced by wood are particularly critical as refuge areas during floods (Gregory et al. 1991 in USFWS 2000a; Dolloff 1994 in USFWS 2000a). During floods and other large-scale severe disturbances, large woody debris can diversify hydraulic forces and maintain structural complexity, thereby providing fish with important shelter areas (Shirvell 1990 in USFWS 2000a). Such diversity and provision of refugia may be critically important along the Sacramento River, due to its extensive channelization and disconnection from historical floodplain where critical refuge and rearing habitat were formerly provided.

(d) Establishment of natural banks

A setback levee at Hamilton City would allow creation of natural banks. Several wildlife species use natural banks for cover and reproduction. For example, the bank swallow, a State listed threatened species, feeds predominantly over open riparian areas, and uses holes dug in cliffs and vertical river banks for cover (Zeiner et al. 1988-90a). Also, the belted kingfisher, a resident species, usually excavates a nest in a steep earthen bank of sandy, or otherwise friable, soil, and the nest near water (Zeiner et al. 1988-90a). The American mink, a semi-aquatic mammal, uses most aquatic habitats. It forages along waterways such as rivers and streams, and uses existing cavities and burrows in wetland and riparian vegetation for cover, and dens in burrows under trees, snags, stumps, logs, and rocks near water (Zeiner et al. 1988-90b). Western pond turtles utilize rivers and streams with emergent aquatic vegetation and deep pools with undercut banks for escape, and prefer partially submerged rocks and logs, open mud banks, matted floating vegetation or sandbars in and along rivers and streams for basking (Holland 1994). Amphibians and reptiles often hibernate in submerged nearshore muddy, debris- covered substrates, and also use woody debris and leaf litter which washes up on river shorelines as cover.

The riverine littoral zone is most often characterized as the river bank from the edge of the water to the top of the bank, and may include active bars, shelves, and islands within the channel (Hupp and Osterkamp 1985 in USACE 2001). Compared to riprapped or channelized rivers, areas with natural stream banks show greater concentrations of several important organic and inorganic nutrients (Dahm et al. 1987). The upper portions of the bank, forested with riparian vegetation species, and overhanging vegetation, exposed roots, rocks, and debris provide excellent habitat structure along the mid- and upper-portions of the bank. The lowest portion of the bank and shelves are usually barren sediments that are exposed at low river stages (USACE 2001). This zone is unique because it provides constant contact between the aquatic and terrestrial portions of the riparian corridor and is directly affected by river level fluctuations and currents. High river stages inundate the entire littoral zone and provide fish and other aquatic species access to resources of the upper littoral zone. Conversely, low river stages remove access to refuge, food, and spawning areas for fish and aquatic species when the higher elevation areas become exposed. However, periods of low water are necessary in order to allow terrestrial plants and animals to recover from inundation (USACE 2001). The diversity and abundance of species tend to be greatest at this edge between two the aquatic and terrestrial habitats (Odum 1978 in USACE 2001). Edges and their ecotones are usually richer in wildlife than adjoining areas because the species inhabit multiple ecotypes (Thomas, Maser, and Rodiek 1980 in USACE 2001).

Summary

The Hamilton City area provides a great opportunity to remove constraints that prevent the river from connecting with its floodplain and to create new areas where natural processes and habitat can be restored. The U.S. Army Corps of Engineers and The Reclamation Board, sponsors of the Hamilton City Study have the opportunity to significantly contribute to the on-going restoration efforts by others by being the only two agencies with authority to alter the flood management features to both improve flood protection for Hamilton City and to restore natural ecological processes in this area.

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A-5: Guiding Principles

Guiding Principles

A set of basic principles is needed to ensure that changes to the flood management system integrate flood damage reduction and ecosystem restoration, while considering system-wide implications of those changes. The Guiding Principles were designed in response to this need to (1) promote coordination and partnerships for the public good, (2) reduce or eliminate conflicts, and (3) serve as a guide for modifications to the flood management system. They were established and refined through agency coordination and public outreach to address the wide range of stakeholder concerns to integrate flood damage reduction and ecosystem restoration, and to ensure a system-wide approach in evaluating proposed changes. These principles will guide the planning of changes to the flood management system and will be applied to future studies and projects regardless of their aerial extent or level of detail. The Guiding Principles will apply to anyone planning projects that modify effect of the flood management system. Projects should demonstrate that they are consistent with the Guiding Principles. In addition to compliance with the Guiding Principles, each project will be subject to site-specific environmental documentation and mitigation requirements.

Each of the Guiding Principles supports a system-wide approach for project planning. The Sacramento and San Joaquin rivers function as hydrologic systems, and ecosystem needs are tied to hydrologic processes. Accordingly, one must approach these rivers as complete systems when considering flood damage reduction and ecosystem restoration objectives. The fact that these rivers have not been consistently treated as comprehensive systems in the past has led to some of the problems that are experienced today. Focusing on flood management within limited reaches without full consideration of hydraulic effects in reaches both upstream and downstream has resulted in modifications to the system that have shifted local problems to other reaches. Likewise, the cumulative impacts of modifications to the system have contributed to a general decline in the health of the ecosystem. The cumulative impacts of habitat restoration projects can also reduce flood conveyance. It is important to ensure that the integrity and continuity of the system is maintained and enhanced to allow the river system to function in a manner where flood management and the ecosystem are compatible.

The following Guiding Principles are integral to achieving a system-wide approach to flood damage reduction and ecosystem restoration along the Sacramento and San Joaquin rivers.

1) Recognize that public safety is the primary purpose of the flood management system. Proposed changes to the flood management systems must not compromise public safety. The flood management systems for the Sacramento and San Joaquin River basins were authorized, designed, and are operated to protect public safety. Public safety considerations include the transportation and communications infrastructure necessary to accommodate an effective emergency response program. Since flooding often results in widespread economic and social hardships, it is recognized that protection of public safety is the primary purpose of the flood management systems. Public safety means increased security for people, infrastructure, and agricultural production.

2) Promote effective floodplain management. The floodplains of the Sacramento and San Joaquin rivers include overflow areas that store and convey large volumes of floodwater during flood events. This storage contributes to the flood protection of downstream property. All projects proposing modifications to the flood management system should consider the benefits of the roles of the floodplain in flood management and maintaining ecosystem processes. It is important to recognize that floodplains can be managed to further

reduce damages and to avoid future damages without changing flood frequencies or modifying existing uses. It is essential to encourage and promote effective floodplain planning and management practices that improve public safety, reduce the susceptibility to damaging floods, preserve agriculture and habitat, and restore degraded ecosystems in the floodplain. Effective floodplain management involves actions that remove or modify damageable property; adapt land uses to be more compatible with flooding; influence future project decisions that benefit social, agricultural, and environmental values; and discourage development in areas with high flood risk. A clear communication of residual risk in those areas protected by structural features of the flood management system will encourage improved floodplain management practices.

3) Recognize the value of agriculture. Future projects will take into account individual and cumulative impacts of project development on agriculture and other open space lands, the flood damage reduction and ecosystem benefits of these lands, the economic and environmental effects on crop production, and the effects on associated service industries, infrastructure, and local communities. Agricultural lands in the Central Valley contribute significantly to the economy and quality of life in the region, the state, and the nation, and provide essential habitat components for many important species. Agricultural and open space lands offer substantial benefits in protecting natural values and in incurring lower monetary flood damages than more intensive land uses.

4) Avoid hydraulic and hydrologic impacts. The hydrology and hydraulics of the Sacramento and San Joaquin rivers and associated floodplains and ecosystems will be considered as complete systems at local and watershed levels. Studies clearly demonstrate that the hydrologic and hydraulic characteristics of the waterways and associated floodplains and ecosystems of each river basin represent a complete and interconnected system, and that changes to one part of the system will change other parts of the system. Future projects will be evaluated individually and cumulatively to ensure that there are no significant hydraulic effects to other lands and communities along the system and to ensure compatibility with local and regional flood damage reduction and ecosystem restoration goals. In working towards the restoration of a dynamic river system, some effects may be considered either beneficial or adverse, depending upon what is being affected. Each proposed project will undergo assessment for its potential effect on all aspects of the flow regime (flood magnitude, timing, duration, frequency, and rate of change) that affect natural functions such as sediment supply, transport and deposition processes, and channel cross-sectional and planform changes, as well as man-made and natural resources, upstream and downstream of project sites. Hydrologic evaluations will take into account the best available information on the effects and uncertainties of potential climate changes.

5) Plan system conveyance capacity that is compatible with all intended uses. Future projects that modify system conveyance capacity will utilize a watershed approach to establish system conveyance capacities that are compatible with release rates for reservoirs and functional geomorphic and biological processes. Modifications to conveyance capacities should account for effects of restored habitat.

6) Provide for sediment continuity. Management of sediment throughout the river systems is critical for maintaining the ecosystem and flood damage reduction functions of the river corridor. Providing for more natural movement of sediment through a river system will balance areas of erosion and deposition and support the dynamic habitat changes that characterize a healthy, self-sustaining riverine ecosystem. Future projects should be

consistent with an integrated flood management design, including sediment inputs, that provides a balanced sediment budget within the channel to benefit geomorphic processes and riparian habitats, maintains the integrity of the design capacity, and reduces maintenance costs.

7) Use an ecosystem approach to restore and sustain the health, productivity, and diversity of the floodplain corridors. The ecosystem approach restores and sustains the health, productivity, and biological diversity of ecosystems by factoring in a full range of ecological components in project planning. The ecosystem approach recognizes and seeks to address the problems of habitat fragmentation and the piecemeal restoration and mitigation previously applied in addressing natural resources. Ecosystem restoration uses a systems view in assessing and addressing restoration needs and opportunities and in formulating and evaluating alternatives. Biotic resources are dependent on, and functionally related to, other ecosystem components. Recognition of the interconnectedness and dynamics of natural systems interwoven with human activities in the landscape is integral to this process. The philosophy behind ecosystem restoration promotes consideration of the effects of decisions over the long term and incorporates the ecosystem approach. Future projects will consider the needs of native aquatic, wetland, and terrestrial communities to improve the potential for their long-term survival as self-sustaining, functioning systems.

8) Optimize use of existing facilities. Significant contributions to both flood damage reduction and ecosystem restoration may be attainable through integrated or facility-specific reservoir re-operation, integrated use of public land for multiple purposes, and protection and management of existing high-value habitats within the flood management system. Therefore, the operation and management of existing facilities could be optimized to reasonably maximize system benefits and minimize the need for new facilities. Presently, there is a substantial array of facilities that directly or indirectly contribute to flood management and/or ecosystem health along the Sacramento and San Joaquin rivers. The objectives of the general design, construction, and operation of these facilities is to meet the needs of the immediate impact area or limited resource targets. At the time these facilities were constructed, it was not possible to measure or take into account effects that may have occurred in other areas of the river system. Because of their design and information available at the time of their construction, many existing facilities do not achieve their full potential for providing ecosystem benefits. The system-wide models can be used to evaluate system-wide effects.

9) Integrate with the CALFED Bay-Delta Program and other programs. Future projects should consider the status and objectives of ongoing flood management and ecosystem restoration programs, including, but not limited to CALFED, to ensure awareness of other planning efforts and prevent unintentional conflicts in designs or duplication of efforts. Projects need to recognize and support the CALFED single blueprint for ecosystem restoration and species recovery in the Bay-Delta and its watershed. To the extent possible, projects should integrate and adopt those CALFED ERP goals, objectives, targets and programmatic actions associated with the flood management system of the Sacramento and San Joaquin rivers, and incorporate conservation measures from the CALFED Multi-Species Conservation Strategy (MSCS). In that context, future projects will give priority to those actions that provide benefits for both flood damage reduction and ecosystem restoration. The CALFED science program and CALFED's considerable institutional and administrative framework was established to expand and communicate relevant, unbiased scientific knowledge, monitor performance, implement an adaptive management process, and measure progress. Future

projects should build upon the CALFED ERP, rather than develop independent, parallel restoration programs, and implement applicable portions of the CALFED ERP to the extent of potential non-Federal sponsor interest. Additionally, future projects should take into account the floodplain areas and conveyance capacities needed by major regional planning efforts such as the San Joaquin River Management Plan (SJRMP) and the Sacramento River Conservation Area Forum (SRCAF).

10) Promote multi-purpose projects to improve flood management and ecosystem restoration. Proposals for modifying the flood management system for the primary purpose of either flood damage reduction or ecosystem restoration should consider opportunities for benefiting more than a single purpose. Multiple-purpose projects are more effective, considering costs and resource conservation. Projects that include both flood damage reduction and ecosystem restoration (as well as other potential purposes) will foster partnering, reduce conflicts, and serve the overall public interest. In accordance with State law, projects with multiple-purposes are eligible for increased State cost sharing.

11) Protect infrastructure. Future modifications to the flood management system should consider direct and indirect impacts to infrastructure, including, but not limited to transportation (highways, railroads, navigation), communications, utility, and water transport systems. Transportation corridors and facilities are necessary for economic viability, emergency/evacuation response, and public safety. Potential impacts to infrastructure could limit future options and could result in unintended consequences.

A-6: Ecosystem Restoration Alternatives

ECOSYSTEM RESTORATION ALTERNATIVES

PLANNING ZONES

To facilitate formulation and evaluation of alternative plans, the study area was divided into a number of areas, or zones. Twelve zones were used for the economic analysis and nine zones for the ecosystem analysis.

Economic Zones

The zones used in the economic analysis are shown in **Figure A-6.1**. The flood damage conditions in each zone were varied depending on the management measures included in a given alternative plan. Conditions in a zone could remain unchanged (i.e., same as the future without-project condition), the zone could be protected by a new levee, the zone could be converted from agriculture to native habitat (eliminating most flood damages), or a flowage easement could be purchased within the zone to compensate for induced flooding (caused by breaching the existing private levee). A more complete discussion of how the zones were used in the economic analysis is included in the Economic Appendix.

Ecosystem Zones

The zones used in the ecosystem analysis are shown in Figure A-6.2. Zones E, F, G, H, and I are the same as used for the economic analysis. Zones A1, A2, A4, and B2 are sub- areas within the economic zones A and B. Zones A3 and B1 are California Department of Fish and Game (DFG) and U.S. Fish and Wildlife Service (USFWS) lands. These lands were assumed to be restored under the No Action alternative and were not used in the formulation of the other alternative plans. More information about how the zones were used in the ecosystem analysis is described in the paper, "Ecosystem Restoration Planning and Evaluation Methodology," which is included in the Plan Formulation Appendix.

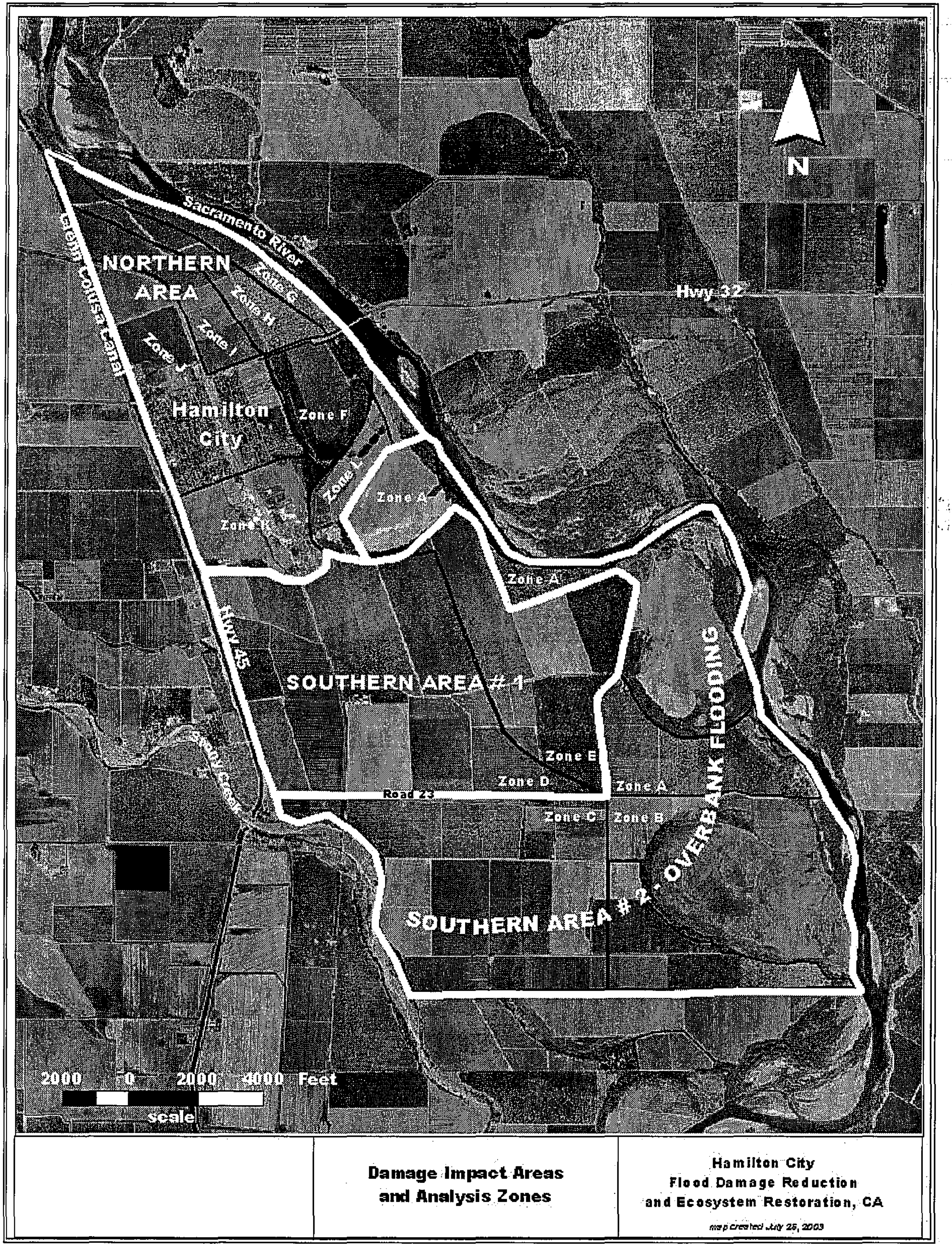


Figure A-6.1: Economic Zones

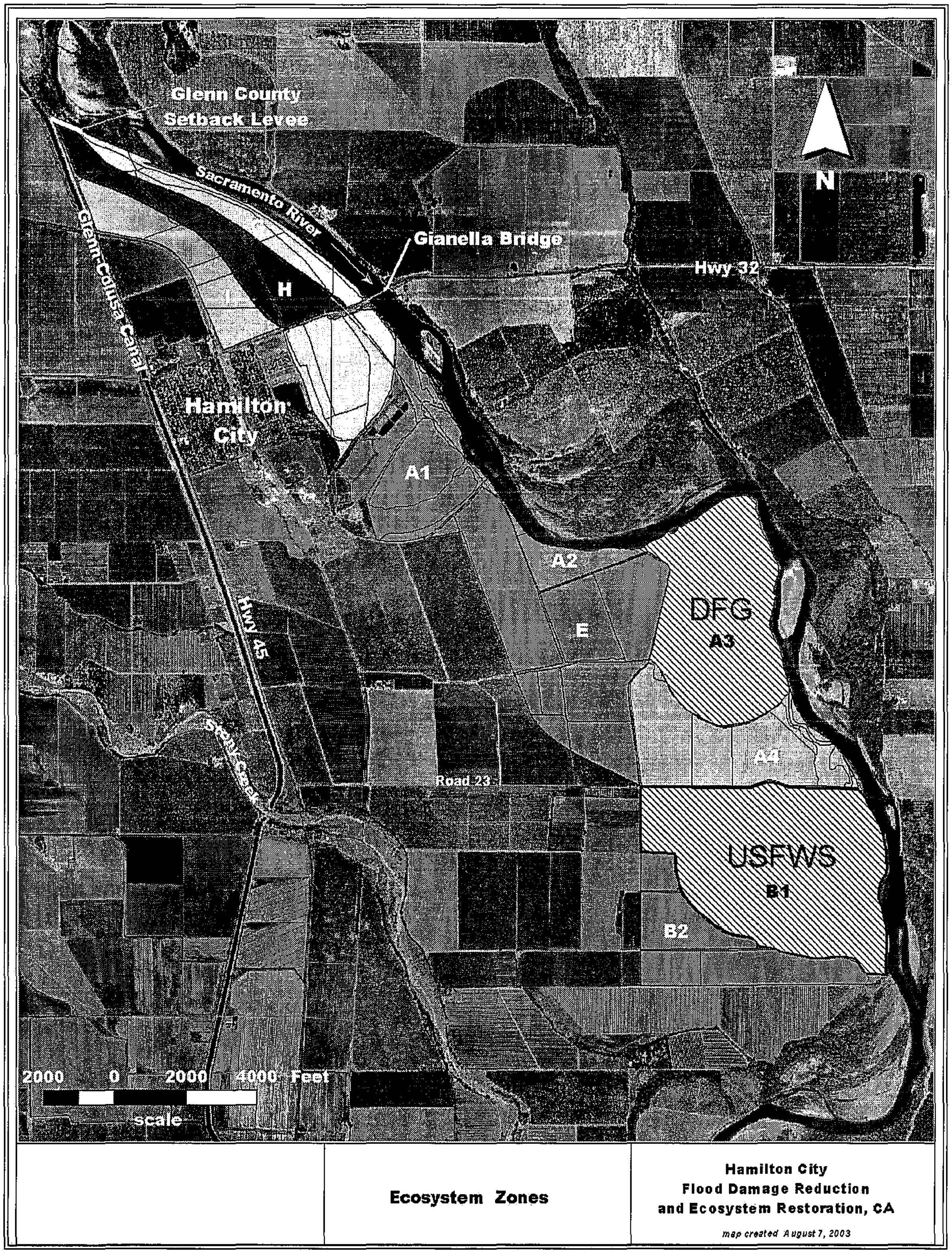


Figure A-6.2: Ecosystem Zones

DESCRIPTION OF PRELIMINARY ECOSYSTEM RESTORATION ALTERNATIVE PLANS

A preliminary array of alternative plans was developed by creating various combinations of the measures retained during the measures screening process. The array of preliminary plans, including No Action, is described below. Alternatives 1, 5 and 6 were retained for further consideration and referred to as the Final Array of Ecosystem Restoration alternative plans.

No-Action

The No-Action alternative assumes that no project would be implemented by the federal government or by local interests to achieve the planning objectives. The No Action plan is shown in **Figure A-6.3**. Critical assumptions in defining the No-Action alternative include:

- The "J" levee would continue to be privately owned. Some periodic maintenance could be expected to occur as limited funding allows. The "J" levee would remain in relatively poor geotechnical condition. No improved method of flood protection would be accomplished because the community and county, who in past years has expended its flood control budget protecting Hamilton City, would not likely have enough funding to implement a project on their own.
- Extensive flood fighting of the "J" levee would continue to be necessary to maintain the integrity of the levee when water levels rise in the Sacramento River.
- The existing level of flood protection would not change. Although with flood fighting the "J" levee has historically passed high flood events, statistically it only has about a 66 percent chance of passing a 10-year event assuming significant flood fighting efforts. This would also equate to a 90 percent chance of passing an event smaller than a 10-year event. Another way to state this is that on an annual basis, the community currently has about a 9 percent chance of flooding in any given year, again assuming flood-fighting efforts.
- Erosion of the levee toe at the northern end of the "J" levee would continue, but the Glenn County backup levee would maintain the flood control function of the "J" levee.
- Hydrologic and hydraulic conditions in the study area would remain similar to existing conditions with no significant changes.
- Agricultural crops and production in the study area would remain similar to existing conditions.
- Future development in the study area was estimated to be limited to the build-out of homes in a new subdivision on the east side of Hamilton City (scheduled for completion in 2004) and construction of an adjacent middle school (assumed completion in 2010).
- TNC property within the study area would remain in agricultural production, as would other privately owned agricultural lands. Neither funds nor permits are in place to allow for restoration work to occur.
- The DFG and USFWS lands in the study area would be restored with native habitat.
- Glenn County would continue to flood fight the Glenn-Colusa Irrigation District (GCID) canal berm at a low spot north of the study area.
- The problems and opportunities in the study area would remain unresolved.

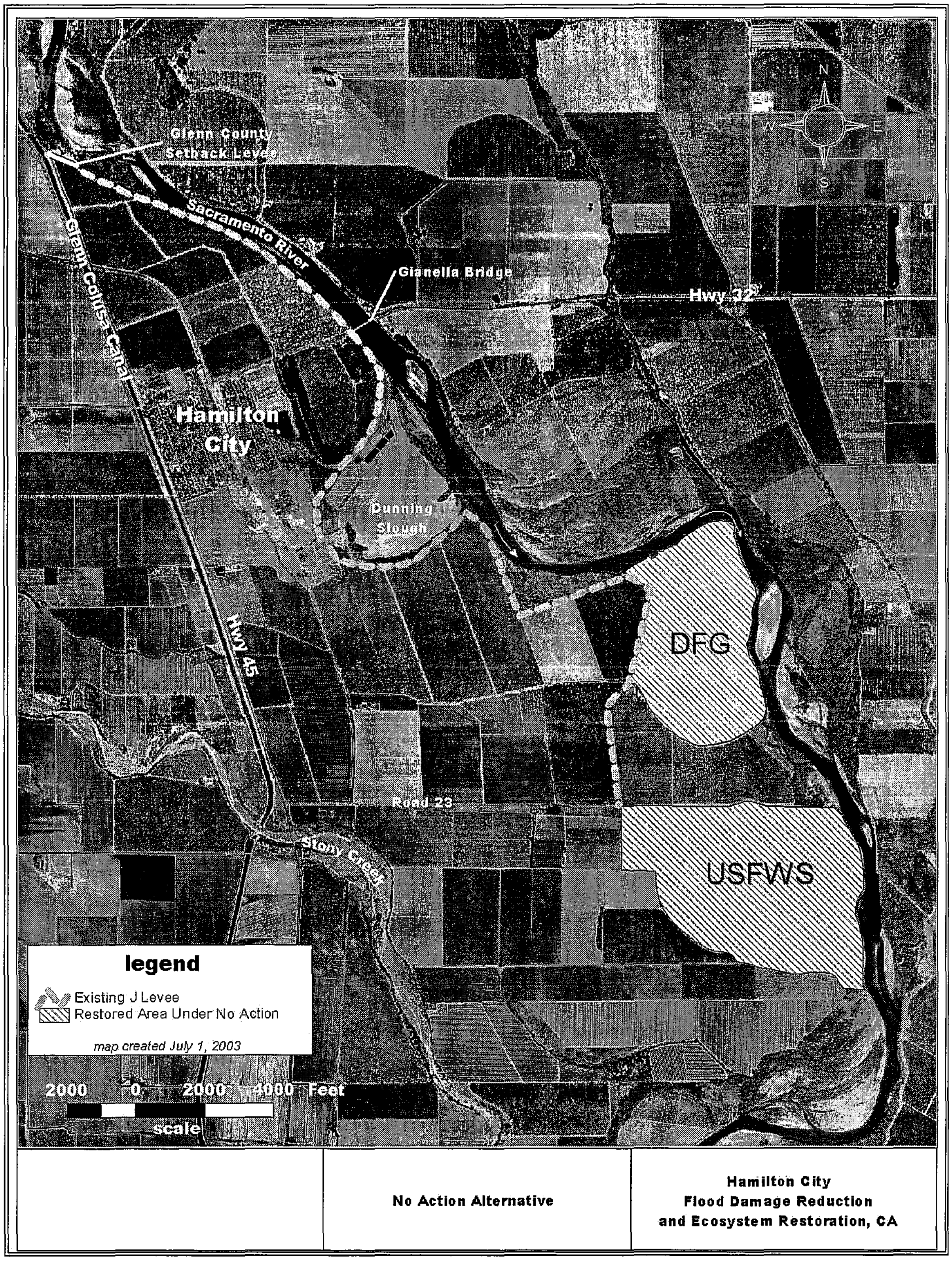


Figure A-6.3: No Action Alternative

- Glenn County would continue to operate the existing flood warning system and utilize the existing emergency preparedness plan.
- The State of California has the responsibility to operate and maintain the Chico Landing to Red Bluff Project. Any future placement of rock as part of that project would need to consider a jeopardy opinion issued by the U.S. Fish and Wildlife Service that pertains to the valley elderberry long-horned beetle and includes the study area.
- A small portion of the urban area of Hamilton City is within the FEMA 100 year floodplain and the structures within this area have been elevated above the FEMA 100-year floodplain. The unincorporated area of Glenn County, including Hamilton City, is enrolled in the National Flood Insurance Program, but does not have a Flood Mitigation Plan, both of which are requirements for applications for FEMA floodplain buyout programs. Glenn County has not considered participating in these buyout programs (Glenn County, pers. com., January 20, 2004) and it is unlikely to do so in the future.

Ecosystem Alternative 1 - Locally Developed Setback Levee.

This alternative is based on a levee alignment developed by the Hamilton City Community Services District and several landowners in the study area. This alternative consists of constructing a levee about 6.6 miles long and about 6 feet high, set back roughly 500 to 7,600 feet from the river, and removal of most of the existing "J" levee. It includes actively restoring about 1,300 acres of native habitat in Zones A1, A2 and A4, E, G, and B2, waterside of the setback levee. This alternative is shown in **Figure A-6.4.**

In order to accomplish ecosystem restoration, most of the existing "J" levee would be removed to reconnect the river to the floodplain. While this action would enable ecosystem restoration, it would lower the community's existing flood protection. The Federal and State governments would be obligated to mitigate the effect of removing the private levee that protects Hamilton City. In order to ensure that the replacement levee would have the same possibility of passing a flood as the existing "J" levee could with flood-fighting, the replacement levee would be of the same height as the existing "J" levee.

In order to compensate for degrading the "J" levee, it is important to consider existing rock on the "J" levee. The existing "J" levee has about 11,250 square feet of rock greater than 20 inches in diameter (450 feet long by about 25 feet high). This rock was placed during flood fighting efforts in 1997 because the levee was eroding. This rock was placed because the existing "J" levee is of poor quality and subject to erosion. A replacement levee would be constructed to Corps' standards, which, by itself, would be an improvement to the existing condition of the "J" levee, so this rock would not need to be replaced.

North of Highway 32, the levee alignment ties into the newly constructed Glenn County backup levee and runs roughly parallel to and about 500 feet to the west of the Sacramento River. At Highway 32, the levee ties into the existing approach to the Gianella Bridge. The highway would not need to be raised, but measures to protect the highway embankment and bridge from floodwaters would be necessary.

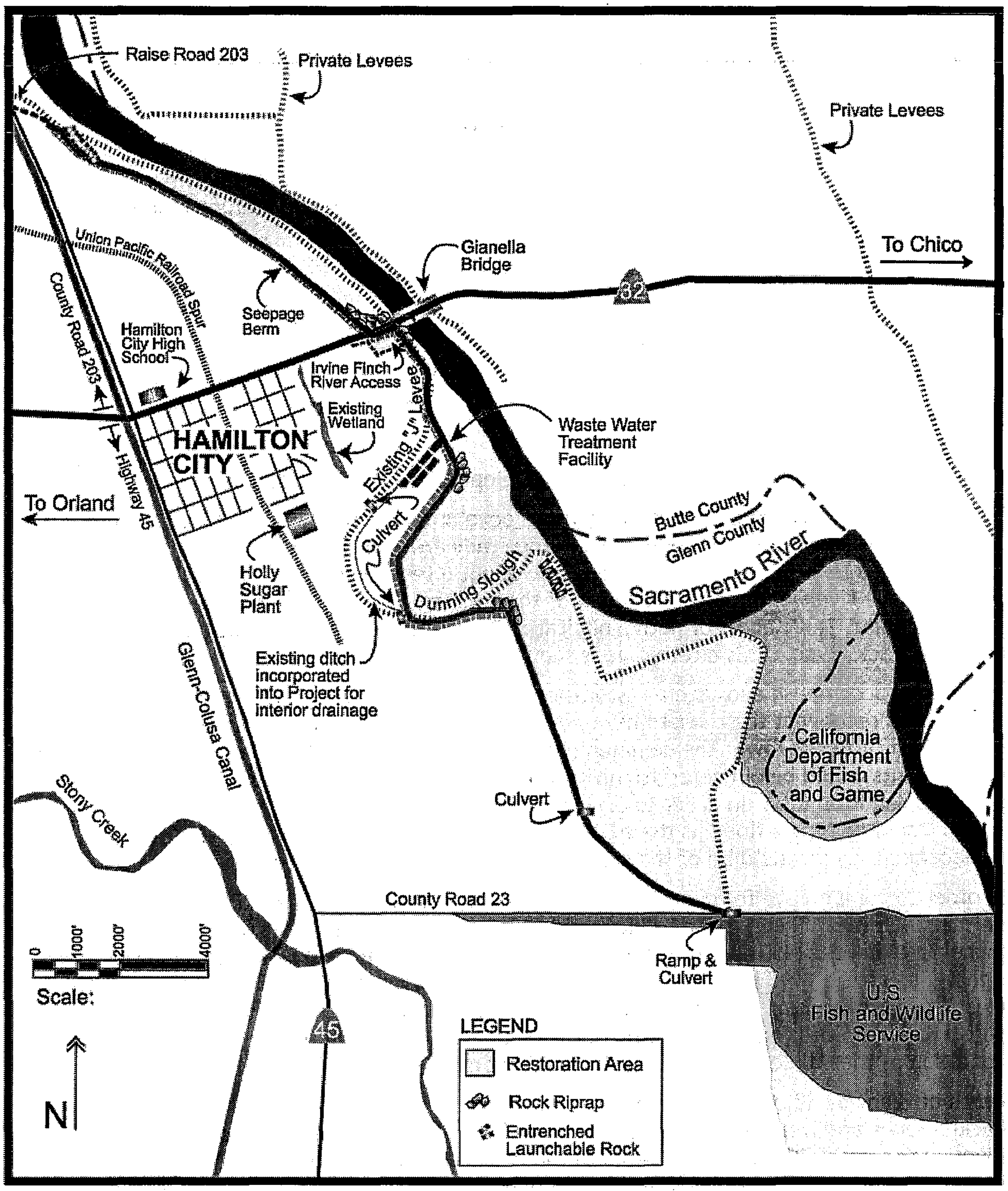


Figure A-6.4: Ecosystem Alternative 1 - Locally Developed Setback Levee

South of Highway 32, the alignment cuts across the easternmost section of the Irvine Finch River Access (just south of the highway), requiring modification of the River Access entrance and parking lot. The alignment also cuts across a portion of Dunning Slough providing protection to the Hamilton City wastewater treatment ponds, some abandoned holding ponds for the old Holly Sugar plant (in which the community would like to expand the treatment plant in the future), and a lime disposal pile. About 1,500 feet of rock would be placed on the setback levee in Dunning Slough as erosion protection.

South of Dunning Slough, the alignment roughly follows along the western edge of the habitat restoration area before turning east toward the southern end of the "J" levee at Road 23. The alignment ends at Road 23, not tying into high ground.

All lands to the waterside of the setback levee would be actively restored with a mixture of riparian, scrub, oak savannah, and grassland habitat (except the DFG and FWS lands, which are assumed to be restored under the without-project condition). The "J" levee would be removed, except for portions where it would serve to reduce velocities of the Sacramento River for establishment of newly planted habitat. Established riparian vegetation waterside of the existing "J" levee would be avoided wherever possible.

Many in the local community favor this alternative because it is located the greatest distance from Hamilton City of any of the alternatives and it protects the wastewater treatment plant and agricultural land south of town.

Erosion Control. Placement of rock (entrenched and revetment) was considered necessary at some points along the replacement levee to ensure the existing flood protection is not lessened and to offset potential scouring from changes in flows. Placement of rock would be as follows:

North end of the Project. Entrenched rock would be buried in a 1,500 foot-long trench in Zone G, parallel to County Road 203 and approximately 200 feet from the toe of the levee. When the river erodes away the bank at the location of the trench, the rock would fall and armor the bank preventing erosion beyond that point.

Highway 32 Gianella Bridge. Because a replacement levee would be set back from the existing "J" levee, the northern bridge abutment would be exposed to direct flows. It is not currently exposed to these direct flows, which could scour the abutment. In order to ensure that bridge is not compromised by the potential project, 1,000 feet of rock riprap would be placed on and around the abutment. Because this rock would be necessary to maintain the existing condition, it is considered a part of equitable replacement of the existing "J" levee.

Dunning Slough. Because a replacement levee would be set back from the existing "J" levee, a bend in the replacement levee would be exposed to overland flows from multiple angles, which could erode a replacement levee. In order to ensure that the replacement levee is not subject to this erosion, 500 feet of rock riprap would be placed along the levee at the bend. Because this rock would be necessary to maintain the existing condition, it is considered a part of equitable replacement of the existing "J" levee.

Southernmost extent. A replacement levee would not affect the existing erosion conditions south of Dunning Slough. It is assumed that the Chico Landing to Red Bluff Project (local site constructed in 1975-1976) would remain authorized and continue to be maintained. For the new levee to perform to the same level as the existing "J" levee, erosion control at the end of the levee would consist of planting significant amounts of vegetation (about 20 feet or so from the levee toe) to reduce velocities at the levee.

Hydraulic Effects. The alternative would reduce stages in the floodplains of the regions. Increases in water surface elevation would either occur in areas intended to be exposed to flooding (between the existing "J" levee and the setback levee) or would be contained in the river channel and would not constitute an adverse hydraulic impact.

Uncertainty. Average yearly river migration is 6 feet per year. However, the extreme northern and southern ends of the potential project area have experienced rates above that average. (Larson, Anderson, Avery, Dole, 2002.) The study area is also within the Sacramento River Chico Landing to Red Bluff Bank Protection Project limits that authorized placement of bank protection in areas of high erosion, which has constrained the river's ability to move. Based upon aerials from the past 100 years, risk of levee failure due to river meandering seems very low. This information is being refined through continuing hydraulic studies.

Accomplishments. This alternative plan would restore 1,300 acres of habitat and provide 783 AAHU's.

Preliminary Ecosystem Restoration Alternative #2 - Intermediate Setback Levee

This alternative consists of constructing a setback levee about 3.8 miles long and setback roughly 1,300 to 2,700 feet from the river, breaching the existing "J" levee in several locations, and actively restoring about 1,400 acres of native habitat. The levee alignment is shown in **Figure A-6.5**.

In order to accomplish ecosystem restoration north of Highway 32, the existing J levee would be breached to reconnect the river to the floodplain. While this action would enable ecosystem restoration, it would lower the community's existing flood protection. The Federal and State governments would be obligated to mitigate the impact of breaching the private levee that protects Hamilton City. In order to insure that the replacement levee would have the same possibility of passing a flood as the existing J levee can with flood fighting, the replacement levee would be of the same height as the existing J levee.

The existing J levee has about 11,250 square feet (450 feet long by about 25 feet high; greater than 20 inch diameter rock). This rock was placed during flood fighting efforts in 1997 because the levee was eroding at that location. This rock was placed because the existing J levee is of poor quality and subject to erosion. A replacement levee would be constructed to Corps standards, which itself would be an improvement to the existing condition of the J levee.

North of Highway 32 the levee alignment ties into high ground at the northern end of the "J" levee, about 2 miles north of Hamilton City. The levee runs southeast along the Glenn Colusa Canal Road until turning easterly and running roughly parallel to and about 1,300 feet to the west of the Sacramento River, following higher ground.

At the eastern edge of town, the levee alignment crosses Highway 32 and runs south alongside a new housing development. This alignment requires raising Highway 32 (soil embankment) and relocation of a remnant slough channel that provides storm water runoff detention and conveyance. At the south end of town, the levee wraps around the Holly Sugar plant and ties into high ground along Highway 45.

All lands to the waterside of the setback levee north of Dunning Slough would be actively restored with a mixture of riparian, scrub, oak savannah, and grassland habitat. Between Dunning Slough and Road 23, the same lands restored in Alternative 1 would be restored in this alternative. The "J" levee would be breached in a number of locations to allow overbank flooding of the floodplain. The breaches would be large enough and located in such a way as to not induce high velocity flows and excessive erosion.

Flowage easements would need to be purchased on agricultural lands adjacent to the project south of the Holly Sugar Plant and west of the "J" levee to compensate landowners for increased flooding due to the removal of most of the "J" levee.

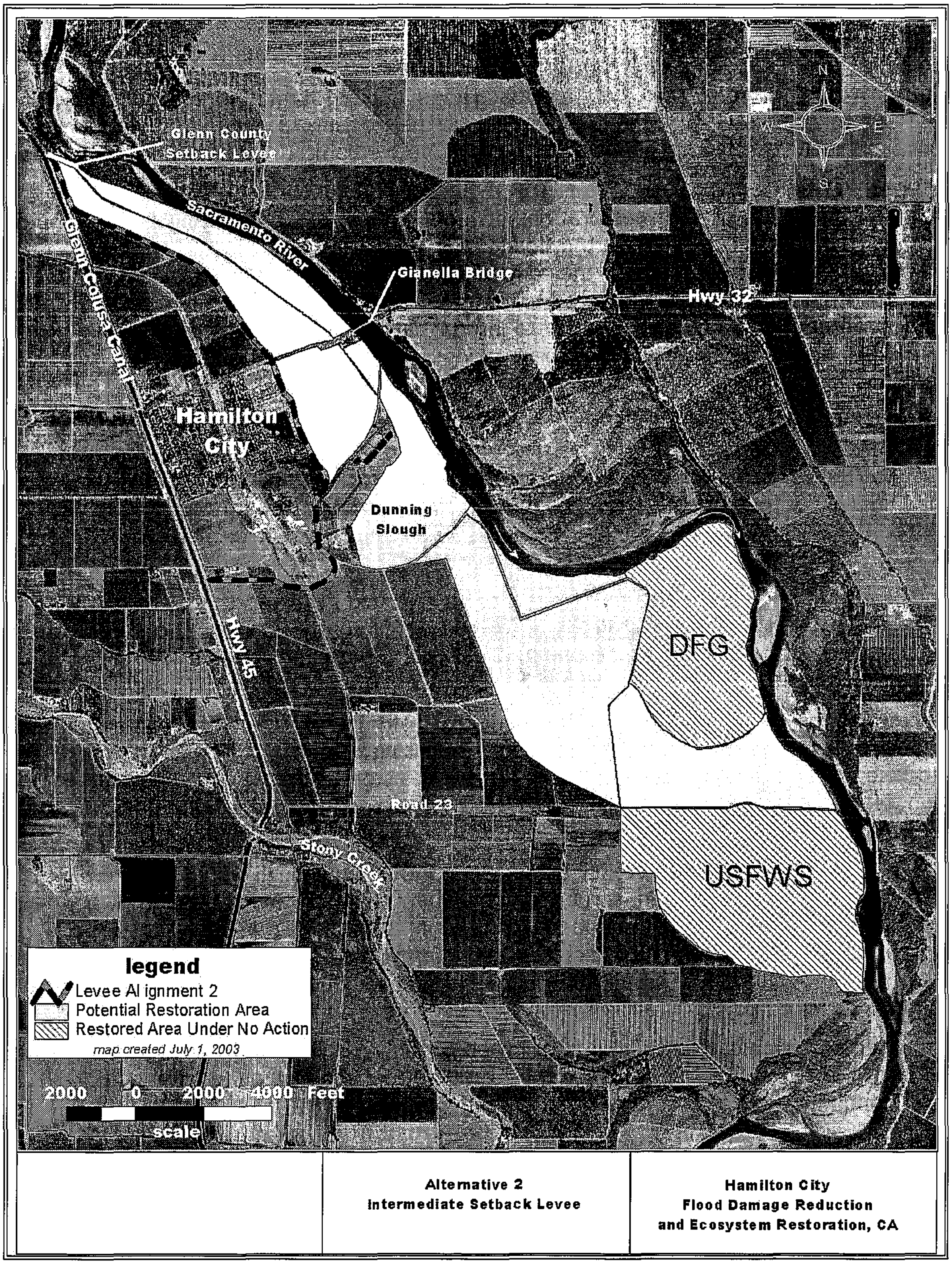


Figure A-6.5: Ecosystem Restoration Alternative #2 - Intermediate Setback Levee

Preliminary Ecosystem Restoration Alternative #3 - Ring Levee

This alternative consists of constructing a setback levee about 3.3 miles long and setback roughly 1,300 to 2,700 feet from the river, breaching the existing "J" levee in several locations, and actively restoring about 1,600 acres of native habitat. The levee alignment is shown in **Figure A-6.6**.

In order to accomplish ecosystem restoration north of Highway 32, the existing J levee would be breached to reconnect the river to the floodplain. While this action would enable ecosystem restoration, it would lower the community's existing flood protection. The Federal and State governments would be obligated to mitigate the impact of breaching the private levee that protects Hamilton City. In order to insure that the replacement levee would have the same possibility of passing a flood as the existing J levee can with flood fighting, the replacement levee would be of the same height as the existing J levee.

The existing J levee has about 11,250 square feet (450 feet long by about 25 feet high; greater than 20 inch diameter rock). This rock was placed during flood fighting efforts in 1997 because the levee was eroding at that location. This rock was placed because the existing J levee is of poor quality and subject to erosion. A replacement levee would be constructed to Corps standards, which itself would be an improvement to the existing condition of the J levee.

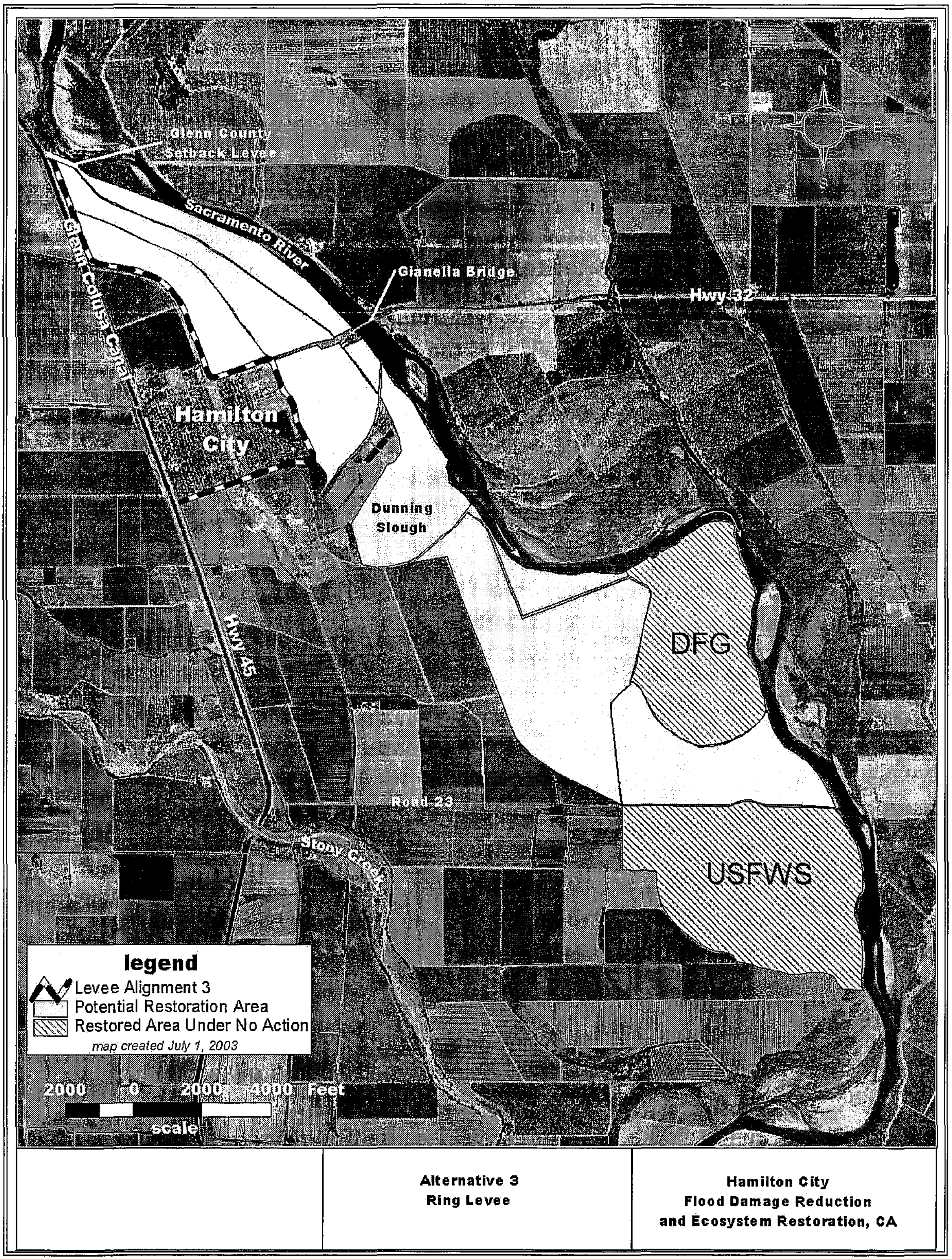
North of Highway 32 the levee alignment ties into high ground at the northern end of the "J" levee, about 2 miles north of Hamilton City. The levee runs southeast along the Glenn Colusa Canal Road until turning easterly and running parallel to the Union Pacific Railroad.

At the eastern edge of town, the levee alignment crosses Highway 32 and runs south alongside a new housing development. Similar to Alternative 2, this alignment requires raising Highway 32 (soil embankment) and relocation of a remnant slough channel that provides storm water runoff detention and conveyance. At the south end of town, the levee runs east and ties into high ground along Highway 45.

All lands to the waterside of the setback levee north of Dunning Slough would be actively restored with a mixture of riparian, scrub, oak savannah, and grassland habitat, except for the land nearest the railroad where oak savannah habitat would be restored due to the relative high elevation (and corresponding low frequency of flooding). Between Dunning Slough and Road 23, the same lands restored in Alternative 1 would be restored in this alternative. The "J" levee would be breached in a number of locations to allow overbank flooding of the floodplain. The breaches would be large enough and located in such a way as to not induce high velocity flows and excessive erosion.

Flowage easements would need to be purchased on agricultural lands adjacent to the project south of the Holly Sugar Plant and west of the "J" levee to compensate landowners for increased flooding due to the removal of most of the "J" levee.

Many in the local community dislike this alternative because it is located the closest to Hamilton City of any of the alternatives and it does not protect the wastewater treatment plant and agricultural land south of town. Because this alignment is the shortest of all alternatives, it has the lowest operation and maintenance cost.



Alternative 3
Ring Levee

Hamilton City
Flood Damage Reduction
and Ecosystem Restoration, CA

Figure A-6.6: Ecosystem Restoration Alternative #3 - Ring Levee

Ecosystem Alternative 4 - Locally Developed Setback Upstream of Dunning Slough Stopping at Road 23, Intermediate Setback Downstream of Dunning Slough

This alternative consists of constructing a levee about 4.1 miles long, about 6 feet high, set back roughly 500 to 2,700 feet from the river, removing most of the existing "J" levee, and actively restoring about 1,100 acres of native habitat. The levee alignment is shown in Figure 3-3. The levee alignment follows Alternative 1 in the north down to the southern end of Dunning Slough. At that point the alignment then wraps around the Holly Sugar Plant and ties into high ground along Highway 45. It protects the wastewater treatment plant and Holly Sugar plant, but not the agricultural lands south of town. The lands restored in this alternative would be the same as Alternative 1. This alternative is shown in **Figure A-6.7.**

The "J" levee would be removed, except for portions where it would serve to reduce velocities of the Sacramento River for establishment of newly planted habitat. Established riparian vegetation waterside of the existing "J" levee would be avoided wherever possible. Flowage easements would need to be purchased on agricultural lands adjacent to the project south of the Holly Sugar Plant and west of the "J" levee to compensate landowners for increased flooding due to the removal of most of the "J" levee.

Erosion Control. Erosion protection for this alternative would be the same as for Alternative 1, except that in Dunning Slough there would be 500 feet of rock.

Hydraulic Effects. See Alternative 1.

Uncertainty. See Alternative 1.

Accomplishments. This alternative plan would restore 1,100 acres of habitat and provide 642 AAHU's.

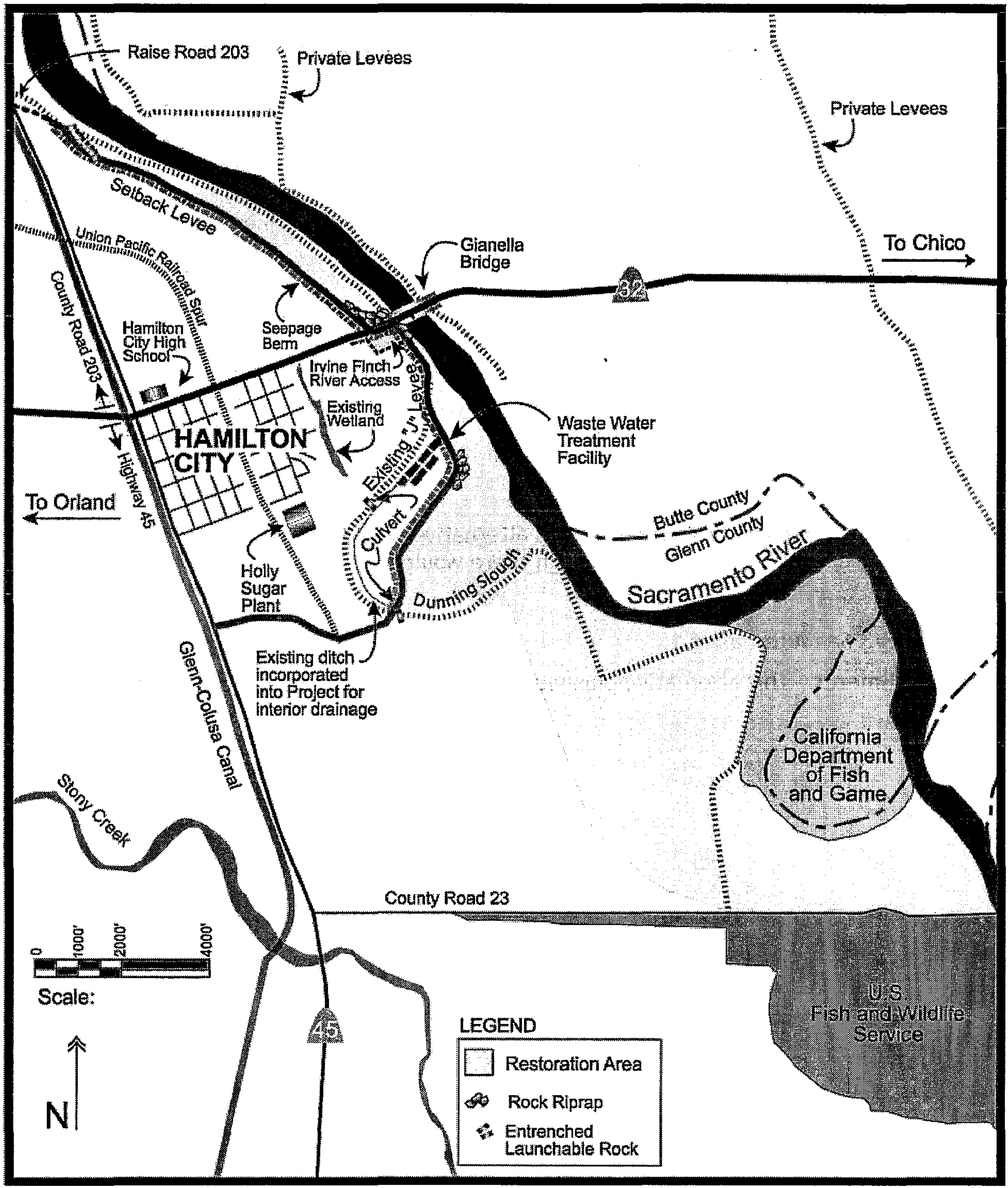


Figure A-6.7: Ecosystem Alternative 4 - Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Downstream of Dunning Slough

Ecosystem Alternative 5: Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough

This alternative plan consists of actively restoring about 1,600 acres of native vegetation, constructing a setback levee about 5.3 miles long, and about 6 feet high, and removing most of the existing "J" levee. The alternative plan is shown in **Figure A-6.8** and includes restoration of Zones A1, A2, and A4, B2, E, F, G, and H waterside of the setback levee.

The setback levee alignment begins about 2 miles north of Hamilton City, at the point where the northern end of the "J" levee ties into high ground. From there, the levee alignment runs southeast along County Road 203 until turning easterly and running roughly parallel to and about 1,300 feet to the west of the Sacramento River, following higher ground.

At the eastern edge of town, the levee alignment crosses Highway 32 and runs south alongside a new housing development (Palisades subdivision). This alignment requires raising Highway 32 (with soil embankment), protecting the highway and bridge (and possibly the water treatment plant) from erosion caused by floodwaters, and relocating a remnant slough that provides a small but significant emergent wetland habitat and also is used to detain and convey storm water runoff. At the south end of town, the alignment wraps around Dunning Slough and then roughly follows along the western edge of the habitat restoration area before turning east and ending at the southern end of the "J" levee at Road 23. This alignment does not tie into high ground and therefore allows some backwater flooding of agricultural lands, just as does the "J" levee.

Lands waterside of the new levee would be restored to native habitat. Approximately 1,600 acres of native habitat would be restored including; 1050 acres of riparian, 300 acres of scrub, 150 acres of savannah, and 100 acres of grassland. The "J" levee would be removed, except for portions where it would serve to reduce velocities of the Sacramento River for establishment of newly planted habitat. Established riparian vegetation waterside of the existing "J" levee would be avoided wherever possible. The removal of most of the "J" levee would allow periodic overbank flooding, increasing the ecosystem value of riparian and scrub habitat in the floodplain (periodic flooding was assumed not to affect the value of grassland and oak savannah habitat).

Native vegetation would be restored on lands waterside of the new levee. Restoration would also occur on the land directly east of Hamilton City between Highway 32 and Dunning Slough (Zone F) and land within Dunning Slough (Zone A1). Existing orchards in the proposed restoration areas would be removed and native vegetation planted. The native vegetation would predominantly be riparian species, but some scrub, oak savannah and grassland species would also be included, based on hydrologic, topographic, and soil conditions. An exception to this is the land in the middle of Dunning Slough (Zone A1), which is a relatively higher elevation than the rest of the restored area, and oak savannah vegetation is anticipated to be more appropriate for these lands.

Erosion Control. See Alternative 1.

Hydraulic Effects. See Alternative 1.

Accomplishments. This alternative plan would restore 1,600 acres of habitat and provide 937 AAHU's.

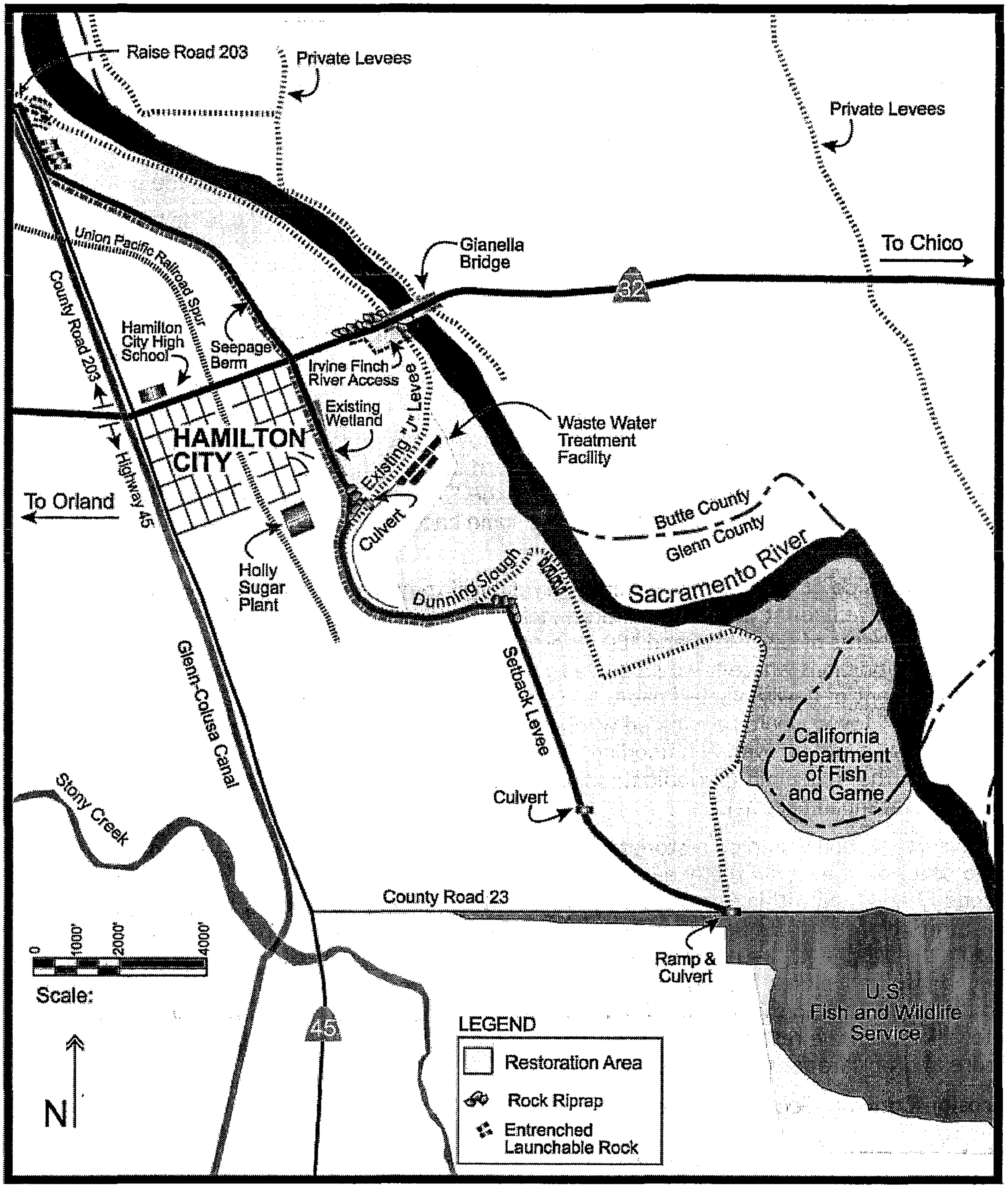


Figure A-6.8: Ecosystem Alternative 5 - Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough

Uncertainty. Please see the description for Alternative 1.

Ecosystem Alternative 6: Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32

This alternative plan consists of actively restoring about 1,500 acres of native vegetation, constructing a setback levee about 5.7 miles long, and about 6 feet high, and removal of most of the existing "J" levee. The alternative plan is shown in **Figure A-6.9** and includes Zones A1, A2, A4, B2 E, G, and H waterside of the setback levee.

North of Highway 32, the levee alignment ties into high ground at the northern end of the "J" levee, about 2 miles north of Hamilton City. The levee runs southeast along County Road 203 until turning easterly and running roughly parallel to and about 1,300 feet to the west of the Sacramento River, following higher ground.

At Highway 32, the levee turns east and runs parallel to the highway until tying into the approach to Gianella Bridge. The highway would not need to be raised in this alternative plan, but measures to protect the levee embankment and bridge from floodwaters would be necessary. South of Highway 32, the alignment follows the existing "J" Levee in order to minimize negative effects to the Irvine Finch River Access (just south of the highway). Some minor modifications to the River Access entrance and parking lot during levee construction may be required. The alignment also cuts across a portion of Dunning Slough providing protection to the Hamilton City wastewater treatment plant, some abandoned holding ponds for the old Holly Sugar plant (in which the community would like to expand the treatment plant in the future), and a lime disposal pile.

South of Dunning Slough, the alignment roughly follows along the western edge of the habitat restoration area before turning east and ending at the southern end of the "J" levee at Road 23. This alignment does not tie into high ground and therefore allows some backwater flooding of agricultural lands, just as does the "J" levee.

The restored area under this alternative is the same as the previous alternative, except that the land directly east of Hamilton City between Highway 32 and Dunning Slough (Zone F) would not be restored and the area south of Road 23 (Zone B2) would be restored. Existing orchards in the proposed restoration areas would be removed and native vegetation planted. The native vegetation would predominantly be riparian species, but some scrub, oak savannah and grassland species would also be included, based on hydrologic, topographic, and soil conditions. An exception is the land in the middle of Dunning Slough (Zone A1), which is relatively higher in elevation than the rest of the restored area and oak savannah vegetation is anticipated to be more appropriate for these lands.

The "J" levee would be removed, except for portions where it would serve to reduce velocities of the Sacramento River for establishment of newly planted habitat. Established riparian vegetation waterside of the existing "J" levee would be avoided wherever possible.

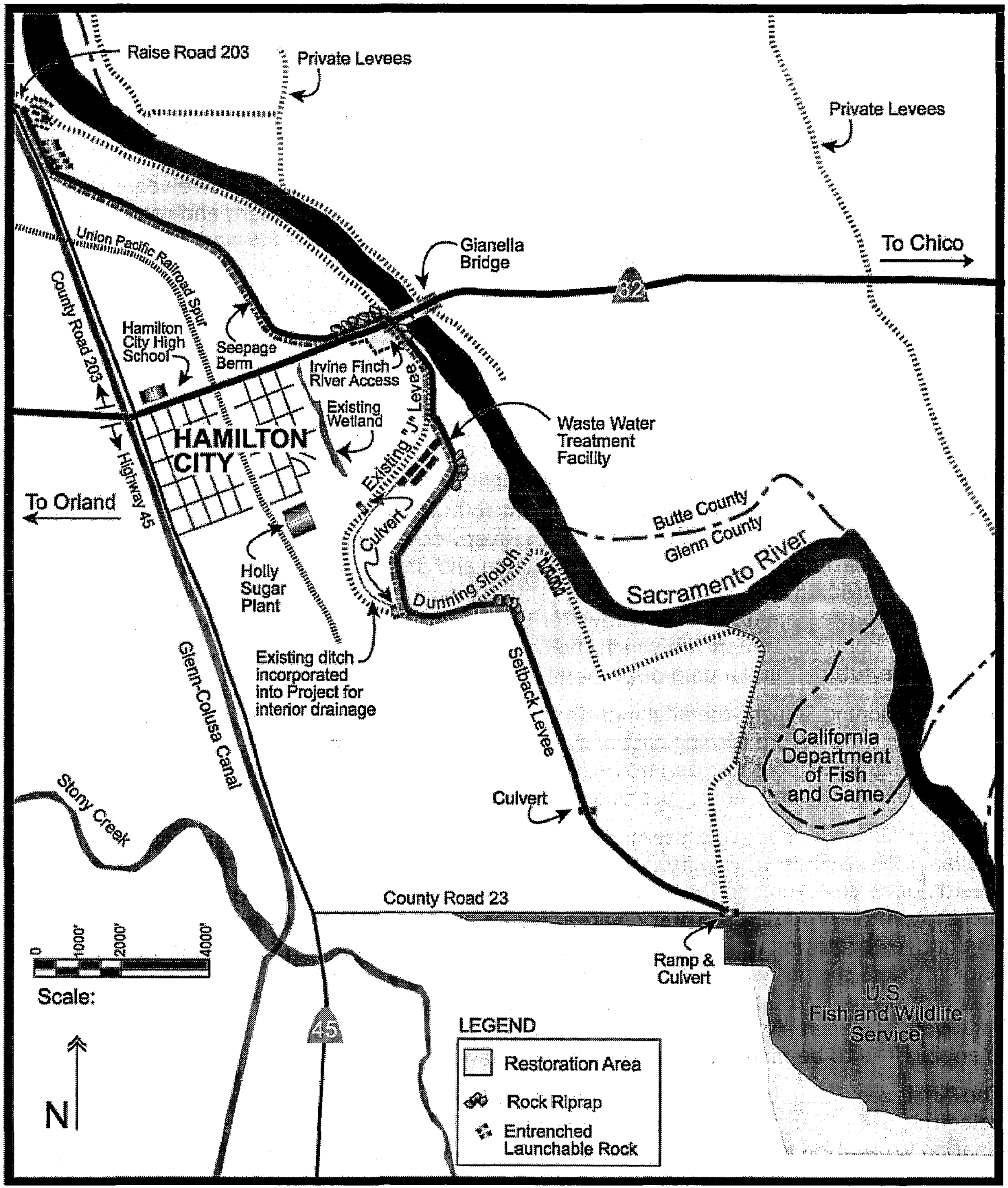


Figure A-6.9: Ecosystem Alternative 6 - Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32

Erosion Control. Erosion protection would be the same for this alternative as for Alternative 1.

Hydraulic Effects. See Alternative 1.

Accomplishments. This alternative plan would restore 1,500 acres and provide 888 AAHU's.

Uncertainty. Please see the description for alternative 1.

APPENDIX B: Environmental and Regulatory Agreement Documents

B.1: Endangered Species Appendix

Hamilton City Elderberry Survey
5/21/03

The area along the eastern bank of the levee (Canal Road) from just north of Wyo Avenue to the Southern Pacific Rail Line was surveyed for habitat for the Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*). A total of 41 blue elderberry (*Sambucus mexicana*) shrubs were found in this area. A total of 37 1-<3 inch stems, 36 3-<5 inch stems, and 53 5 inch or greater stems were found. 16 shrubs showed the presence of VELB exit holes.

The area near the wastewater treatment facility was also surveyed. At this site, a total of 66 shrubs were found. A total of 95 1-<3 inch stems, 93 3-<5 inch stems, and 71 5 inch or greater stems were found. 5 shrubs showed the presence of VELB exit holes. Due to the dense nature of vegetation at this site, some estimation was used by the U.S. Fish and Wildlife biologist in surveying this site.

Appendix B.1: Common and Scientific Names of Species Appearing in the Text

Species	Scientific Name
Plants	
alder	*Alnus spp*
black walnut	*Juglans californica*
blackberry	*Rubus discolor*
box elder	*Acer negundo*
Butte County (Shippee) meadowfoam	*Limnanthes floccosa ssp californica*
cottonwood	*Populus spp*
elderberry	*Sambucus spp*
Hoover's spurge	*Chamaesyce hooveri*
oak	*Quercus spp*
poison oak	*Toxicodendron diversilobum*
smartweed	*Polygonum amphibium var. stipulaceum*
swamp timothy	*Crypsis schoenides*
sycamore	*Platanus spp*
wild grapes	*Vitus californica*
wild rose	*Rosa wodsii var. ultramontana*
willow	*Salix spp*
Animals	
American shad	*Alosa sapidissima*
Anna's hummingbird	*Calypte anna*
bald eagle	*Haliaetus leucocephalus*
bank swallow	*Riparia riparia*
belted kingfisher	*Ceryle alcyon*
black crappie	*Pomoxis nigromaculatus*
black phoebes	*Sayornis nigricans*
black-headed grosbeak	*Pheucticus melanocephalus*
black-tailed deer	*odocoileus hemionus columbianus*
blacktailed hare	*Lepus californicus*
bluegill	*Lepomis macrochirus*
brown bullhead	*Ameiurus nebulosas*
brown trout	*Salmo trutta*
brush and cottontail rabbits	*Sylvilagus spp*
California newt	*Taricha torosa*
California quail	*Callipepla californica*
California red-legged frog	*Rana aurora draytonii*
Central Valley fall/late fall-run chinook salmon	*Oncorhynchus tshawytscha*
Central Valley spring-run chinook salmon	*Oncorhynchus tshawytscha*
Central Valley steelhead	*Oncorhynchus mykiss*
channel catfish	*Ictalurus punctatus*
chinook salmon	*Oncorhynchus tshawytscha*
common gartersnake	*Thamnophis sirtalis*
Conservancy fairy shrimp	*Branchinecta conservatio*
coyote	*Canis latrans*
deer	*Odocoileus spp*
delta smelt	*Hypomesus transpacificus*
double crested cormorant	*Phalacrocorax auritus*

Species	**Scientific Name**
egrets	*Egretta spp*
giant garter snake	*Thamnophis gigas*
gray fox	*Urocyon spp*
great egret	*Ardea alba*
greater sandhill crane	*Grus canadensis tabida*
green sturgeon	*Acipenser medirostris*
green sunfish	*Lepomis cyandelus*
heron	*Ardea spp*
house finches	*Carpodacus mexicanus*
king snake	*Lampropetis spp*
largemouth bass	*Micropterus salmoides*
little willow flycatcher	*Empidonax trailii brewsteri*
mink	*Mustela vison*
mourning dove	*Zenaida macroura*
muskrat	*Ondatra zibethicus*
northern oriole	*Icterus gabula*
Nuttall's woodpecker	*Picoides nuttallii*
opossum	*Didelphis virginiana*
osprey	*Pandion haliaetus*
otter	*Lutra lutra*
Pacific lamprey	*Lampetra tridentata*
Pacific tree frog	*Hyla regila*
prickly sculpin	*Cottus asper*
quail	*Callipepla spp*
raccoon	*Procyon lotor,*
rainbow trout	*Oncorhynchus mykiss*
red tail hawk	*Buteo jamaicensis*
red-shouldered hawk	*Buteo lineatus*
ring-necked pheasant	*Phasianus colchicus*
river otters	*lontra canadensis*
rufus sided towhee	*Pipilo erythrphthalmus*
Sacramento perch	*Archoplites interruptus*
Sacramento pike minnow	*Ptychchelius grandis*
Sacramento splittail	*Pogonichthys macrolepidotus*
Sacramento sucker	*Catostomus ccidentalis*
scrub jays	*Aphelocoma coerulescens*
slender salamander	*Batrachoseps attenuatus*
smallmouth bass	*Micropterus dolomieul*
snowy egret	*Egretta thula*
steelhead trout	*Oncorhynchus mykiss*
striped bass	*Morone saxatilis*
striped skunk	*Mephitis mephitis*
Swainson's hawk	*buteo swainsonii*
threespine stickleback	*Gasterosteus aculeatus aculeatus*
Tule perch	*Hysterocarpus traski*
valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
vernal pool fairy shrimp	*Branchinecta lynchi*
vernal pool tadpole shrimp	*Lepidurus packardi*
western aquatic gartersnake	*Thamnophis couchii*
Western fence lizard	*Sceloporus occidentalis*
western gray squirrel	*Sciurus griseus*
western kingbird	*Tyrannus verticalis*
western toad	*Bufo boreas*
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*

Species	**Scientific Name**
white catfish	*Ictalurus catus*
white crappie	*Pomoxis annularis*
white pelicans	*Pelecanus erythrorhynchos*
white sturgeon	*Acipenser transmontanus*
Wilson's warbler	*Wilsonia pusilla*
yellow bullhead	*Ameiurus natalis*
yellow warbler	*Dendroica petechia*

Federal Endangered and Threatened Species that may be affected by projects in Glenn County

Database Last Updated: October 21, 2003
Today's Date is: December 16, 2003

Listed Species

Invertebrates

Branchinecta conservatio - Conservancy fairy shrimp (E)

Branchinecta lynchi - vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus - valley elderberry longhorn beetle (T)

Lepidurus packardi - vernal pool tadpole shrimp (E)

Fish

Hypomesus transpacificus - delta smelt (T)

Oncorhynchus kisutch - coho salmon, So OR/No CA (T) (NMFS)

Oncorhynchus mykiss - Central Valley steelhead (T) (NMFS)

Oncorhynchus tshawytscha - Central Valley spring-run chinook salmon (T) (NMFS)

Amphibians

Rana aurora draytonii - California red-legged frog (T)

Reptiles

Thamnophis gigas - giant garter snake (T)

Birds

Haliaeetus leucocephalus - bald eagle (T)

Strix occidentalis caurina - northern spotted owl (T)

Plants

Chamaesyce hooveri - Hoover's spurge (T)

Orcuttia pilosa - hairy Orcutt grass (E)

Tuctoria greenei - Greene's tuctoria (=Orcutt grass) (E)

Candidate Species

Fish

Acipenser medirostris - green sturgeon (C)

Oncorhynchus tshawytscha - Central Valley fall/late fall-run chinook salmon (C) (NMFS)

Birds

Coccyzus americanus occidentalis - Western yellow-billed cuckoo (C)

Species of Concern

Invertebrates

Anthicus antiochensis - Antioch Dunes anthicid beetle (SC)

Anthicus sacramento - Sacramento anthicid beetle (SC)

Hydroporus leechi - Leech's skyline diving beetle (SC)

Linderiella occidentalis - California linderiella fairy shrimp (SC)

Fish

Lampetra ayresi - river lamprey (SC)

Lampetra tridentata - Pacific lamprey (SC)

Pogonichthys macrolepidotus - Sacramento splittail (SC)

Spirinchus thaleichthys - longfin smelt (SC)

Amphibians

Ascaphus truei - tailed frog (SC)

Rana boylii - foothill yellow-legged frog (SC)

Spea hammondii - western spadefoot toad (SC)

Reptiles

Clemmys marmorata marmorata - northwestern pond turtle (SC)

Birds

Accipiter gentilis - northern goshawk (SC)

Agelaius tricolor - tricolored blackbird (SC)

Amphispiza belli belli - Bell's sage sparrow (SC)

Athene cunicularia hypugaea - western burrowing owl (SC)

Baeolophus inornatus - oak titmouse (SLC)

Botaurus lentiginosus - American bittern (SC)

Branta canadensis leucopareia - Aleutian Canada goose (D)

Buteo regalis - ferruginous hawk (SC)

Buteo Swainsoni - Swainson's hawk (CA)

Carduelis lawrencei - Lawrence's goldfinch (SC)

Elanus leucurus - white-tailed (=black shouldered) kite (SC)

Empidonax traillii brewsteri - little willow flycatcher (CA)

Falco peregrinus anatum - American peregrine falcon (D)

Grus canadensis tabida - greater sandhill crane (CA)

Lanius ludovicianus - loggerhead shrike (SC)

Melanerpes lewis - Lewis' woodpecker (SC)

Numenius americanus - long-billed curlew (SC)

Otus flammeolus - flammulated owl (SC)

Picoides nuttallii - Nuttall's woodpecker (SLC)

Plegadis chihi - white-faced ibis (SC)

Riparia riparia - bank swallow (CA)

Selasphorus rufus - rufous hummingbird (SC)

Toxostoma redivivum - California thrasher (SC)

Mammals

Corynorhinus (=Plecotus) townsendii pallescens - pale Townsend's big-eared bat (SC)

Corynorhinus (=Plecotus) townsendii townsendii - Pacific western big-eared bat (SC)

Dipodomys californicus eximius - Marysville Heermann's kangaroo rat (SC)

Euderma maculatum - spotted bat (SC)

Myotis ciliolabrum - small-footed myotis bat (SC)

Myotis evotis - long-eared myotis bat (SC)

Myotis thysanodes - fringed myotis bat (SC)

Myotis volans - long-legged myotis bat (SC)

Myotis yumanensis - Yuma myotis bat (SC)

Perognathus inornatus - San Joaquin pocket mouse (SC)

Plants

Astragalus rattanii var jepsonianus - Jepson's milk-vetch (SLC)

Astragalus tener var. ferrisiae - Ferris's milk-vetch (SC)

Atriplex cordulata - heartscale (SC)

Atriplex depressa - brittlescale (SC)

Atriplex joaquiniana - San Joaquin spearscale (=saltbush) (SC)

Atriplex persistens - vernal pool (=persistent-fruited, Sacramento) saltbush (=smallscale, saltscale) (SC)

Brodiaea coronaria ssp. rosea - Indian Valley brodiaea (CA)

Chamaesyce ocellata ssp. rattanii - Stony Creek spurge (SLC)

Epilobium nivium - Snow Mountain willowherb (SC)

Epilobium oreganum - Grants Pass willowherb (SC)

Eriastrum brandegeae - Brandegee's woolly-star (=eriastrum) (SC)

Eriogonum nervulosum - Snow Mountain buckwheat (SC)

Fritillaria pluriflora - adobe lily (SC)

Hesperolinon drymarioides - drymaria dwarf-flax (=western flax) (SC)

Hesperolinon tehamense - Tehama dwarf-flax (SC)

Layia septentrionalis - Colusa layia (=Colusa tidytips) (SLC)

Lepidium latipes var. heckardii - Heckard's pepper-grass (SLC)

Sidalcea oregana ssp. hydrophila - water-loving checkermallow (=marsh checkerbloom) (SC)

Tropidocarpum capparideum - caper-fruited tropidocarpum (SC)

Species with Critical Habitat Proposed or Designated in this County

Central Valley fall/late fall-run chinook (C)

coho salmon, So OR/No CA (T)

northern spotted owl (T)

vernal pool invertebrates (X)

vernal pool plants (X)

winter-run chinook salmon (E)

Key:

(E) Endangered - Listed (in the Federal Register) as being in danger of extinction.

(T) Threatened - Listed as likely to become endangered within the foreseeable future.

(P) Proposed - Officially proposed (in the Federal Register) for listing as endangered or threatened.

(NMFS) Species under the Jurisdiction of the National Marine Fisheries Service. Consult with them directly about these species.

Critical Habitat - Area essential to the conservation of a species.

(PX) Proposed Critical Habitat - The species is already listed. Critical habitat is being proposed for it.

(C) Candidate - Candidate to become a proposed species.

(CA) Listed by the State of California but not by the Fish & Wildlife Service.

(D) Delisted - Species will be monitored for 5 years.

(SC) Species of Concern/(SLC) Species of Local Concern - Other species of concern to the Sacramento Fish & Wildlife Office.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

This is *not* an official list for formal consultation under the Endangered Species Act. *However, it may be used to update official lists.*

If you have a project that may affect endangered species, please contact the Endangered Species Division, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service.

TABLE B.1-1:
LISTED OR PROPOSED SPECIES POTENTIALLY PRESENT IN THE PROJECT AREA

Species	Status	California Distribution	Habitat Requirements	Occurrence in Project area
Federally-listed Species				
bald eagle	Fed-T CA-E	Nests primarily in Butte, Lassen Lake, Modoc, Siskiyou, Trinity, Shasta, and Plumas Counties; winters in Klamath Basin, Sacramento and San Joaquin Valleys, and along some foothill streams.	Coniferous forests within 1 mile of lakes, reservoirs, rivers, or creeks (nesting and roosting). Requires large, old-growth trees or snags in remote, mixed stands.	Found in area.
giant garter snake	Fed-T CA-T	Sacramento and San Joaquin Valleys from Butte County in the north to Kern County in the south. Extirpated from areas south of Fresno.	Permanent freshwater, especially sloughs, and marshes; requires dense and emergent vegetation for basking sites and small fish and amphibians for prey.	Not in project area.
CA red-legged frog	T	Occurs west of the Sierra-Cascade crest and along the Coast Ranges the entire length of the State, usually below 3,936 feet.	Quiet permanent and semi-permanent water in woods, forest clearings, meadows, and riparian areas. Shorelines with extensive emergent and submergent vegetation.	Not in project area.
critical habitat, winter-run chinook salmon	E	Sacramento River, tributaries, distributaries, and related riparian zones from Keswick Dam downstream to and including SF Bay.	Freshwater rivers and streams.	Found in project area.
winter-run chinook salmon	Fed-E CA-E	Sacramento River and tributaries; SF Bay/Delta estuary and open ocean.	Open ocean and cold (43°-56° F), clean, fast-flowing rivers with gravel bottoms.	Found in project area.
delta smelt	T	Delta estuary from Suisan Bay upstream to the Delta cross channel on the Sacramento River and south along the San Joaquin and Middle Rivers to the south end of Bacon Island.	Delta estuary and freshwater rivers and streams.	Not in project area.
Central Valley steelhead	T	Sacramento River and tributaries; SF Bay/Delta estuary and the open ocean.	Ocean and freshwater rivers and streams.	Found in project area.
Central Valley spring-run chinook salmon	T	Sacramento River and tributaries downstream to and including SF Bay to Golden Gate Bridge.	Ocean and freshwater rivers and streams.	Found in project area.
critical habitat, Central Valley spring-run chinook	T	Sacramento and San Joaquin Rivers and tributaries downstream to and including SF Bay to Golden Gate Bridge.	Ocean and freshwater rivers and streams.	Found in project area.
Sacramento splittail	T	Suisun Bay and the SF Bay-Delta and adjacent Sacramento River.	Requires flooded vegetation for spawning and rearing. Primarily a freshwater species, but can tolerate salinities as high as 10 to 18 parts per thousand (ppt).	Found in project area.

Species	Status	California Distribution	Habitat Requirements	Occurrence in Project area
Conservancy fairy shrimp	E	Found in certain areas of Tehama, Solano, Glenn, Merced, and northern Ventura Counties.	Associated with vernal pools that are large and have high turbidity.	Not in project area.
vernal pool tadpole shrimp	E	Central Valley from Tulare County to Shasta County, Merced and Alameda Counties, and Fremont.	Ephemeral freshwater habitats that contain clear to highly turbid water.	Not in project area.
vernal pool fairy shrimp	T	Shasta, Tulare, Solano, and San Benito Counties. Isolated populations in San Luis Obispo, northern Santa Barbara, and Riverside Counties.	Vernal pools with clear to tea-colored water, most commonly in grass or mud bottomed swales.	Not in project area.
valley elderberry longhorn beetle	T	Sacramento, American, San Joaquin, Kings, Kaweah, and Tule Rivers and their tributaries.	Elderberry scrubs (*Sambucus* spp.) in riparian areas.	Found in project area.
Butte County (Shippee) meadowfoam	E	Siskiyou, Trinity, Shasta, Butte, Lake, and Napa Counties.	Occurs mainly in wetlands in clay soil between 0 - 1000 feet.	Not in the project area.
hairy Orcutt grass	E	Tehama, Glenn, Butte, Stanislaus, Merced, and Madera Counties.	Occurs under vernally-flooded conditions in vernal-pool habitats.	Not in project area.
Greene's tuctoria	E	Shasta, Tehama, Butte, Stanislaus, and Merced Counties.	Vernal pools, valley and foothill grassland.	Not in project area.
Hoover's spurge	T	Tehama, Butte, Glenn, Stanislaus, and Tulare Counties.	Occurs in large, deep vernal pools among the rolling hills, remnant alluvial fans and depositional stream terraces at the base of the Sierra Nevada Foothills.	Not in project area.
State-listed Species				
Western yellow-billed cuckoo	CA-E	Cuckoos are closely associated with broadleaf riparian (i.e., streamside) forests.	Wide, dense riparian forests with a thick understory of willows for nesting sites; sites with a dominant cottonwood overstory are preferred for foraging; may avoid valley oak riparian habitats where scrub jays are abundant.	Found in project area.
bank swallow	CA-T	Banks of rivers, creeks, and lakes; seashores. Originally only nested in steep, sandy riverbanks, but have adapted to humans and now nest in the sides of man-made excavations.	Nests in bluffs or banks, usually adjacent to water, where the soil consists of sand or sandy loam to allow digging.	Found in project area.
Swainson's hawk	CA-T	Riparian habitats. Cottonwoods, oaks, sycamores, and large willow trees. A native grassland community provide foraging habitat.	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields.	Found in project area.

Endangered Species Table

Valley Elderberry Longhorn Beetle Survey Report

Surveyor's Names and Affiliations: Becky Victorine, USACE
Kim Turner, USFWS

Date: 6/10/03

Site Name: Hamilton City – Dunning Slough

Location: Glenn County, Dunning Slough area, south of the wastewater treatment plant located at the southeastern boundary of Hamilton City.

Length of survey: Approximately 1 mile

Land Uses (includes 1/8 mile radius): Wastewater treatment facility, storage shed facilities (abandoned?), orchard, disturbed ground

Dominant Plant Species Present: Walnut (*Juglans spp*), blue elderberry (*Sambucus mexicana*), poison oak (*Toxicodendron diversilobum*), blackberry (*Rubus discolor*), blessed milk thistle (*Silybum marianum*)

Habitat Description: Very dense corridor of mature elderberry shrubs with numerous branches intermixed with blackberry, walnut, wild grape (*Vitus californica*), and poison oak. Due to the dense nature of vegetation at this site, some estimation was used by the U.S. Fish and Wildlife biologist in surveying this portion of the site. In the southern half of the survey, elderberry shrubs were in distinct clumps with a relatively open canopy.

Elderberry Shrub Count Summary: A total of 66 blue elderberry shrubs were found in this area. A total of 95 1-<3 inch diameter stems, 93 3-<5 inch diameter stems, and 71 5 inch or greater diameter stems were found. 16 shrubs showed the presence of VELB exit holes.

Total Shrubs	**1-<3" stems**	**3-<5" stems**	**5" or greater**	**Shrubs showing presence of VELB exit holes**
66	95	93	71	5

Valley Elderberry Longhorn Beetle Survey Report

Surveyor's Names and Affiliations: Becky Victorine, USACE

Date: 5/21/03

Site Name: Hamilton City – North

Location: Glenn County, slightly northwest of Hamilton City. Eastern bank of the Canal Road levee from just north of Wyo Avenue south to the Southern Pacific Rail Line.

Length of survey: Approximately 1 mile

Land Uses (includes 1/8 mile radius): Agricultural; a walnut orchard, an abandoned walnut orchard, and an ecosystem restoration site

Dominant Plant Species Present: Walnut (*Juglans spp*), blue elderberry (*Sambucus mexicana*), oaks (*Quercus spp*)

Habitat Description: Corridor of mature elderberry shrubs with large and numerous (especially in the upper canopy) branches, with a relatively open, grassy understory. Biologically sensitive area flagged in a section of this area.

Elderberry Shrub Count Summary: A total of 41 blue elderberry shrubs were found in this area. A total of 37 1-<3 inch diameter stems, 36 3-<5 inch diameter stems, and 53 5 inch or greater diameter stems were found. 16 shrubs showed the presence of VELB exit holes.

Total Shrubs	**1-<3" stems**	**3-<5" stems**	**5" or greater**	**Shrubs showing presence of VELB exit holes**
41	37	36	53	16

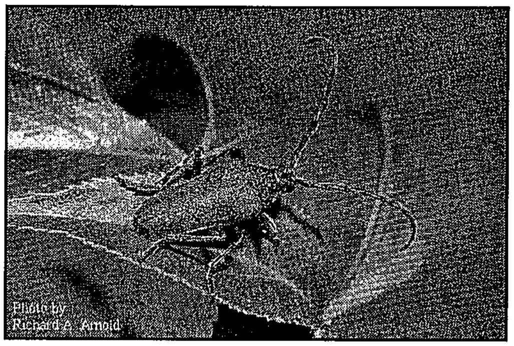
Hamilton City Elderberry Survey
5/21/03

The area along the eastern bank of the levee (Canal Road) from just north of Wyo Avenue to the Southern Pacific Rail Line was surveyed for habitat for the Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*). A total of 41 blue elderberry (*Sambucus mexicana*) shrubs were found in this area. A total of 37 1-<3 inch stems, 36 3-<5 inch stems, and 53 5 inch or greater stems were found. 16 shrubs showed the presence of VELB exit holes.

The area near the wastewater treatment facility was also surveyed. At this site, a total of 66 shrubs were found. A total of 95 1-<3 inch stems, 93 3-<5 inch stems, and 71 5 inch or greater stems were found. 5 shrubs showed the presence of VELB exit holes. Due to the dense nature of vegetation at this site, some estimation was used by the U.S. Fish and Wildlife biologist in surveying this site.

ELDERBERRY PLANTING AND MONITORING PLAN FOR THE VALLEY ELDERBERRY LONGHORN BEETLE

Hamilton City Flood Damage Reduction and Ecosystem Restoration



U.S. Army Corps of Engineers

March 2004

TABLE OF CONTENTS

1.0 INTRODUCTION

There is a desire by The Reclamation Board to work with Fish and Wildlife Service on a plan that would encourage elderberry plantings along the Sacramento River Corridor that would also allow incidental take of Valley Elderberry Beetle habitat during necessary maintenance of flood control facilities and during flood fights. There is potential with this project to demonstrate how such a plan can be successfully implemented.

The Reclamation Board as a partner in this study is willing to accommodate the plantings if the U.S. Fish and Wildlife service is willing to issue a take permit for the potential future flood fighting that may be required for the setback levee in the future.

Below is a list of generic maintenance and flood fighting requirements that may include vegetation removal, including the removal of elderberry bushes:

- Ability to access the entire length of levee for maintenance and flood fighting;
- Ability to access the entire length of the levee for large equipment to deliver and place flood fighting material, including rock;
- Ability to maintain hydraulic capacity by selective clearing of vegetation;
- Ability to remove vegetation from the levee and within 15 feet of levee toe;
- Ability to access to levee to clear bank and berm of vegetation in order to place rock riprap bank protection when erosion is encroaching into the projected levee slope.

Hamilton City is located in Glenn County, California, along the right bank of the Sacramento River, about 85 miles north of the City of Sacramento. The study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the East and the Glenn Colusa Canal to the west and extends about two miles north and six miles south of Hamilton City. Hamilton City has a population of about 2,000 people. Surrounding land use is primarily agricultural with fruit and nut orchards being the primary crops.

An existing private levee, constructed by landowners in about 1904 and known as the "J" levee, provides some flood protection to the town and surrounding area. The "J" levee, however, is not constructed to any formal engineering standards and is largely made of silty sand soil. It is extremely susceptible to erosion and flood fighting is necessary to prevent flooding when river levels rise. Since the construction of Shasta Dam in 1945, which significantly reduced the frequency of high flows in the Sacramento River, flooding in the Hamilton City area caused by the Sacramento River has occurred once (1974). In addition, extensive flood fighting has been necessary to avoid flooding in 1983, 1986, 1995, 1997, and 1998. Currently, the Sacramento River is actively eroding into the toe of the levee at the northern end of the study area. Glenn County has built a backup levee, about 1,000 feet in length, to protect the community in the event the toe erosion causes failure at the northern end of the "J" levee.

Native habitat and natural river function in the study area have been altered by construction of the "J" levee and conversion of the floodplain to agriculture and rural development. Construction of the "J" levee and hardening of the river bank and levee in several locations through the years (with rock or rubble) have constrained the ability of the river to erode and overflow its banks and promote propagation and succession of native vegetation. Conversion of the floodplain to agriculture and rural development has reduced the extent of native habitat to remnant patches along the river and in historic oxbows. These alterations to the ecosystem have greatly diminished the abundance, richness, and complexity of riparian, upland, and wetland habitat in the study area and the species dependent upon that habitat.

The objectives of the study are to reduce flood risk and flood damages and restore the riverine ecosystem along the right bank of the Sacramento River in and around Hamilton City.

Maximum area of potential affect for the study area is estimated to be 1,500 acres. Land ownership is currently held by a combination of private, State and Federal entities. Fee title and/or conservation and flood easements would likely be required to implement a selected project.

Given the extensive area of potential restoration, the Resource Agencies working in this area have expressed an interest in seeing native plant restoration to benefit threatened and endangered species including the potential planting of elderberry shrubs (*Sambucus* species) among the riparian and savannah habitat plantings which are planned for the area. Some elderberries do exist within the study area. The total elderberry shrubs located in the study area include for Hamilton City North;

Total Shrubs	**1-<3" stems**	**3-<5" stems**	**5" or greater**	**Shrubs showing presence of VELB exit holes**
41	37	36	53	16

And for Dunning Slough;

Total Shrubs	**1-<3" stems**	**3-<5" stems**	**5" or greater**	**Shrubs showing presence of VELB exit holes**
66	95	93	71	5

Survey summary sheets are attached (see attachment A). The elderberry shrubs in the study area can be avoided with the potential setback levee alignments currently being considered. The elderberry plantings that are proposed are not for mitigation purposes and are only being proposed for the restoration area for the benefit of threatened and endangered species. The potential plantings were formulated based on the following assumptions;

- Elderberry shrubs would be planted outside a 300 foot buffer as measured from the landside toe of the levee to the restoration area;
- Elderberry shrubs would be planted up to 5 every1,800 square feet where appropriate soils are found within the restoration area (maximum of 13,735 shrubs possible);
- Elderberry shrubs would be planted in riparian and savannah restoration areas;
- Elderberry shrubs would be planted in 10% of these restoration areas;
- Elderberry shrubs would be planted at an approximate ratio of 1/1,800 square feet.

Given the assumptions above the following table was developed for potential elderberry shrub plantings for the tentatively recommended alternative:

Alternative 6

Total	Acres			Increase in Habitat Acres	# Potential Elderberry Shrubs
	Without	With	Change		
Riparian	97.1	1,093.7	996.6	996.6	2392
Grassland	84.6	155.1	70.4	70.4	
Savannah	0.0	147.9	147.9	147.9	355
Scrub	0.0	261.2	261.2	261.2	
Orchard	1,476.2	0.0	-1,476.2	-	
Total	**1,657.9**	**1,657.9**	**0.0**	**1,476.2**	**2747**

Currently the Nature Conservancy owns most of the land that will be acquired for the setback levee and the restoration. The Corps will be involved in the restoration, planting, and establishment of the restoration for the first three years of establishment. After the three-year period the restoration responsibility along with a potential funding stream from TNC will be turned over to the non-federal sponsor. The monitoring guidelines in this document were prepared in accordance with the Service's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* and under the terms and conditions of the Service's 1999 *Programmatic Formal Consultation Permitting Projects with Relatively Small Effects on the Valley Elderberry Longhorn Beetle Within the Jurisdiction of the Sacramento Field Office, California.*

2.0 Establishment/Maintenance

An establishment and maintenance program will be a critical component of a successful revegetation program.

2.1 Regular Maintenance: The maintenance period for establishing the plants will be for 3 growing seasons after installation. Maintenance items will include: weed control, irrigating plants, planting upkeep, and some minor re-planting efforts. Monitoring and reporting of the project will be required for each year along with three yearly reports. Items to be included are:

2.1.1 Irrigation Program: The following schedule will form the basis of watering, to be adjusted to weather conditions during the establishment phase. It is important to note that irrigation schedules need to be adaptive to current weather conditions and that the following are meant as guidelines.

1. First Season: Start irrigation in April (or when soil moisture levels require irrigation), with twice weekly watering of 2 gallons per watering. Beginning in June (the hot season) increase volume to 3 gallons per watering. At beginning of September (the end of the hot season), reduce watering frequency to reflect lower water needs (e.g., 1 day per week with volume of 6 gallons per irrigation). End irrigation after October 31

2 Second Season: Start irrigation in mid April (when soil moisture levels require irrigation), with weekly watering of 10 gallons per watering. Beginning in June increase volume to 15 gallons per watering. At beginning of September, reduce watering frequency to every other week with volume of 30 gallons per irrigation. End irrigation after October 31.

3 Third Season: Start irrigation in mid April, with watering every other week of 30 gallons per watering. Beginning in June decrease frequency of watering to once every three weeks with a volume of 50 gallons per watering. At beginning of September, reduce watering frequency to once a month with volume of 100 gallons per irrigation. End irrigation after October 31.

Unusually hot, dry and windy weather may require additional irrigation. Maximum plant growth is achieved by limiting water stress on plants; however, deep infrequent watering should be the rule to supply adequate soil moisture in the desired deep root zone. Plant roots do not "seek" water; rather they grow and persist in areas that have adequate moisture, soil and oxygen.

2.1.2. Weed Control: During the establishment phase, a regular weed control program shall be implemented including the appropriate use of herbicides, mechanical, and hand weed control methods. The area immediately around each planting location will be kept free from weeds by herbicide application and by hand weeding.

Weeds in the aisles between the rows and in the rows between the plant locations will be controlled by mowing and by timed nonselective, pre-emergent and selective broadleaf herbicide applications in the first and second growing seasons. Timing is dependant on the growing conditions based on weather. Refer to section 5.5 for timing and and type of weed control measures needed for the various habitat types to be restored.

Alternate methods of weed control in conjunction with delayed planting will be evaluated during the PED phase for potential cost savings and improvement in habitat establishment.

Certain types of herbicides may be restricted in use due to proximity of sensitive crops such as cotton, grapes and pistachios. Also, endangered species restrictions for Valley

Elderberry longhorn beetle could limit herbicide use in certain areas. The following measures as appropriate will be used in areas where herbicide application limitations apply:

1. Use herbicides registered for use near sensitive crops. Application procedures and equipment are also subject to regulations, which must be followed.
2. Use mowing to control weeds. Additional mowing may be needed, up to once a month April through July.
3. Use Disking to control weeds. May be needed on regular basis April through July.
4. Delay seeding native grass seeds until the 3rd year of establishment, thereby allowing use of glyphosphate (Roundup) herbicide for weed control.
5. Utilize pre-emergent herbicides.

Pre- and post-seeding weed control is crucial. The timing of mowing and spraying are critical and usually occur in a very short time frame. For this reason it is desirable that the prime contractor apply the herbicide or perform the mowing rather than a subcontractor so that timing can be controlled. Since this relationship may fall outside of the control of the government, in order to motivate contractors, and provide for the additional weed control necessary if windows are missed, it is strongly recommended that the contract contain liquidated damages for missing herbicide application windows.

2.1.3. Replanting / Replacement: Mortality rates should be measured by planting area and by species. Replacement of plants will be required if mortality rates for any of the above are higher than 15 percent the first season, 25 percent the second season and 35 percent the third season. Replacement planting to original planting quantities will be required if the above mortality rates are exceeded. Species for replanting may be adjusted if mortality rates for individual species indicate they are not suited for certain areas. Past results indicate that an overall survival rate of 80% should be easily met for the entire Project area.

2.1.4. Monthly Maintenance Reports: Monthly records of maintenance activities and project conditions shall be kept. The monthly reports should include general weather and climate conditions, major events such as storms, fire, vandalism, herbivore browse, irrigation scheduling and quantity, weed growth and weed control activities and general description of plant performance. Monthly reports shall be submitted to the Corps on an ongoing monthly basis

2.1.4. Yearly Maintenance Reports: Compilation of monthly records of maintenance activities and project conditions will be required to be submitted to the Corps each December 1 in an annual, year-end report.

2.2. Monitoring: A simplified monitoring program shall be developed and implemented during the 3-year establishment period. All hand planted species in the irrigation rows should be monitored, as well as the grasslands to determine restoration establishment success. The monitoring program shall be developed and carried out by experienced biologists, and at a minimum consist of the following:

- Mortality rates
- Photographs (Permanent color photograph stations)
- Plant counts (by species and area)
- Sampling Plots and Transects
- Measurement and growth
- Yearly reports

3. Success Criteria

The following success criteria will be targeted:

- Minimum 65% survival of woody plants per "tile" and per species.
- Control of exotic weed species. (Long-term establishment and regeneration of native plants not threatened by exotic weeds)
- Successful introduction of native grasses and herbaceous vegetation. This should be defined as self-sustaining patches of native grass and herbaceous perennials established over a minimum 15% of the site.

Success will be measured by annual plant survival counts during the 3 year plant establishment period.

4. Post Establishment Operations and Maintenance

At the end of the three year establishment period, the Project will be turned over to the State for operations and maintenance for the life of the project. Infrastructure related to the restoration such as gates, locks, fences and maintenance access roads will be maintained in operational condition. Removal of trash and other unnatural debris will be encouraged.

In terms of vegetation management, post establishment operations and maintenance for the restoration aspects of the Project generally consist of benign neglect. Successful restoration is defined as sustained self-sufficiency of the native vegetation, therefore mowing, clearing, weeding and herbicide application will not be allowed unless called for as an adaptive management action to improve project performance or for Public Health and safety.

Yearly reports will be submitted to the USACE Sacramento District Engineer, Environmental Resources Branch and Landscape Architecture Unit. These reports will contain the checklist from the annual spring inspection. The reports will also contain photographs from set photographic monitoring points. Additional monitoring, though useful and is encouraged, will be at the discretion of the State, local sponsor and stakeholders.

Grazing within strict limitations should be allowed to mimic natural herbivore browse. Generally 5-10 years after establishment, the site can be grazed intensely for short periods of time up to 3 times per decade. Grazing can be managed to help control exotic weeds by carefully timing grazing.

The following uses may be permitted

hiking
bird watching
hunting
fishing
camping within limited designated camp grounds should also be allowed.
Access to the river for a boating (designated boat ramp)

The following uses shall not be permitted:

mountain biking
off road vehicle use

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

APR 1 2004

Mr. Wayne White, Field Supervisor
U.S. Fish and Wildlife Service
2800 Cottage Way, Suite W2605
Sacramento, California 95825-1846

Dear Mr. White:

This letter is our biological assessment for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project in Hamilton City, California. As part of the Hamilton City project, the lead agencies have begun informal consultation in accordance with Section 7 of the Endangered Species Act. The lead agencies requested and received a list of endangered, threatened, and proposed species from the U.S Fish and Wildlife Service. This list was dated April 11, 2001, and updated lists were received on October 21, 2003, and December 16, 2003 (Enclosure 1).

Special status species included on this list, but not found or not likely to be found in the study area, include Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, delta smelt, California red-legged frog, giant garter snake, greater sandhill crane, little willow flycatcher, Butte County (Shippee) meadowfoam, and Hoover's spurge Special status species potentially present in the study area include valley elderberry longhorn beetle, Central Valley fall/late fall-run chinook salmon, Central Valley spring-run chinook salmon, Central Valley steelhead, winter-run chinook salmon, bald eagle, bank swallow, Swainson's hawk, and western yellow-billed cuckoo.

Of these species, the bald eagle is a temporary visitor during the winter months. This species is not commonly found in the study area and would not even be potentially present during construction. Therefore, the bald eagle is not considered further in this biological assessment. The other three special status bird species that are potentially present in the study area are State listed only. We are currently consulting with NOAA Fisheries on the four anadromous fish species. The only species considered further in this biological assessment is the valley elderberry longhorn beetle. Information on habitat requirements, distribution, and possible occurrence of the beetle in the project area is included in Enclosure 2.

Hamilton City is located in Glenn County, California, along the right bank of the Sacramento River, about 85 miles north of the city of Sacramento. The study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the east and the Glenn Colusa Irrigation Canal to the west, and extends about 2 miles north and 6 miles south of Hamilton City. Hamilton City has a population of about 1,800 people Surrounding land use is primarily agricultural with fruit and nut orchards being the primary crops.

The proposed project (Combined Alternative 1) involves ecosystem restoration and flood damage reduction via a setback levee (Enclosure 3). The project features include constructing a setback levee approximately 6 miles long and set back from the river from 50 to 1,700 feet, restoring up to 1,500 acres of native vegetation between the setback levee and the river, and removing the existing levee and allowing the flood plain to flood without endangering the community of Hamilton City. Restored habitat types would include riparian, grassland, oak savannah, and scrub.

Existing elderberry shrubs provide potential habitat for the valley elderberry longhorn beetle. The beetle depends exclusively on the blue elderberry shrub for its habitat. Both the larvae and adults feed on the plant, and much of its 2-year life span is spent as larvae inside the stems of the plant. Elderberry shrubs are frequently found near the Sacramento River. The beetle occurs naturally in small populations. The beetle was recognized as a Federally threatened species because of loss and alteration of its habitat by agricultural expansion into riparian areas and flood control activities. Some elderberry shrubs do exist within the study area The elderberry shrubs in the study area are shown in Table 1.

Table 1. Elderberry Shrubs in the Study Area

Location	Total shrubs	1-<3" stems	3-<5" stems	5" or greater stems	Shrubs showing presence of beetle exit holes
Hamilton City North	41	37	36	53	16
Dunning Slough	66	95	93	71	5

The project could potentially have temporary effects on the valley elderberry longhorn beetle during construction. However, these potential effects would be avoided. The existing levee would be removed and the new levee constructed in a manner that would avoid effects to elderberry shrubs. During construction, vegetation (trees and shrubs) would be fenced and flagged for avoidance. No shrubs would be removed as a part of this project. With the measures taken to avoid effects to the beetle, potential adverse effects during construction would not be significant.

New areas of riparian woodland and savannah would be created within the restoration area. Within 10 percent of each of these habitat types, elderberry shrubs would be planted every 1,800 square feet. For this project, a total of 3,357 elderberry bushes would be planted. Therefore, the long-term effects on the beetle would be beneficial. Since the project would avoid short-term construction effects and long-term effects to the valley elderberry longhorn beetle would be beneficial, no mitigation would be required.

However, future operation and maintenance activities under the project may affect the elderberry shrubs that are planted or otherwise establish during the project's restoration activities. In addition, future flood fighting activities and other emergency work may affect the elderberry shrubs These activities are described in the "Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle" (Enclosure 4).

Although the overall effects to the beetle would be beneficial, it is the Corps' biological assessment that the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration Project may affect the Federally listed valley elderberry longhorn beetle due to future operation and maintenance and flood fighting activities. Therefore, we request initiation of formal Section 7 consultation for this project. We also request that a take permit for these future activities be included in the Biological Opinion to be prepared by your agency. If you have any questions, please contact Ms. Erin Taylor at (916) 557-6862, e-mail: Erin.A.Taylor@usace.army mil

Sincerely,

Mark C Charlton
Chief, Planning Division

Enclosures

Copies furnished with enclosures:
Mr. Richard Kuyper, U.S. Fish and Wildlife Service, 2800 Cottage Way, Suite W2605, Sacramento, California 95825-1846

ENCLOSURE 1 - Federal Endangered And Threatened Species That May Be Affected By Projects In Glenn County	See Appendix B1 - Endangered Species in Project Area
ENCLOSURE 2 - Listed Or Proposed Species Potentially Present In The Project Area	See Appendix B1 - Endangered Species Table
ENCLOSURE 3 - Project Description	See Main Report – Chapter 9 – Tentatively Recommended Plan
ENCLOSURE 4 – Elderberry Planting And Monitoring Plan For The Valley Elderberry Longhorn Beetle	See Appendix B1 - Elderberry Planting and Monitoring Plan for VELB

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

Mr. Michael Aceituno
National Marine Fisheries Service
Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

APR 1 2004

Dear Mr. Aceituno:

This letter is our biological assessment for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project in Hamilton City, California. As part of the Hamilton City project, the lead agencies have begun informal consultation in accordance with Section 7 of the Endangered Species Act. The lead agencies requested and received a list of endangered, threatened, and proposed species from the U S. Fish and Wildlife Service. This list was dated April 11, 2001, and updated lists were received on October 21, 2003, and December 16, 2003 (Enclosure 1). This letter includes a table summarizing the special status species, including information on habitat requirements, distribution, and possible occurrence in the project area (Enclosure 2).

Hamilton City is located in Glenn County, California, along the right bank of the Sacramento River, about 85 miles north of the city of Sacramento. The study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the east and the Glenn Colusa Irrigation Canal to the west, and extends about 2 miles north and 6 miles south of Hamilton City. Hamilton City has a population of about 1,800 people. Surrounding land use is primarily agricultural with fruit and nut orchards being the primary crops.

The proposed project (Combined Alternative 1) involves ecosystem restoration and flood damage reduction via a setback levee (Enclosure 3). The project features include constructing a setback levee approximately 6 miles long and set back from the river from 50 to 1,700 feet, restoring up to 1,500 acres of native vegetation between the setback levee and the river, and removing the existing levee and allowing the flood plain to flood without endangering the community of Hamilton City. Restored habitat types would include riparian, grassland, oak savannah, and scrub. This biological assessment describes potential effects of the project on Federally listed endangered and threatened fish species, as well as candidate fish species, under your agency's jurisdiction in the project area.

The Sacramento River supports four races of chinook salmon: fall-run, late fall-run, winter-run, and spring-run. In the Sacramento River, juvenile chinook salmon belonging to one or more of the four extant runs may be migrating in any month of the year. Of the four chinook salmon runs that use the river, the greatest concern is for the winter-run. In recent years, the winter-run has dwindled from an annual escapement of 80,000 adult fish to about 2,000, with a low of 191 winter-run chinook in 1991. Currently, the winter-run salmon is Federally listed as endangered, while the spring-run salmon is Federally listed as threatened. The fall/late fall salmon is a Federal candidate species. From December to August, the winter-run chinook salmon migrates to upstream areas where it spawns. From August to December, winter-run juveniles use the shaded riverine aquatic (SRA) cover along the river for feeding, resting, and escaping from predators. The NOAA Fisheries has classified the entire Sacramento River from Keswick Dam to San Francisco Bay as critical habitat for the winter-run chinook salmon.

Central Valley steelhead populations are all considered to be winter-run steelhead that typically spend 2 years rearing in fresh water before out-migrating to the ocean. Similar to chinook salmon, steelhead primarily use habitat in the area during the juvenile rearing period. During the warmer parts of the year, steelhead parr appear to prefer habitat with cover provided by rocky substrates, overhanging vegetation, large woody debris (LWD), and low light intensities. During the winter, when they are believed to be less active, juvenile steelhead use pools with large rocky substrates or LWD cover. In winter and spring when high flows inundate flood plains, backwaters, and side channels, these low-velocity areas may be important feeding areas and velocity refuge habitat for rearing juvenile steelhead and out-migrating smolts Rearing juvenile steelhead and out-migrating smolts may be present in the project area throughout the year. Adult steelhead require deep pools for resting during their upstream spawning migration. Some upstream migrants may use pools in the lower Sacramento River, where available.

Implementation of Combined Alternative 1 could result in short-term adverse effects on fish species present in the study area during construction. For example, orchard removal, infrastructure modification, and grading are construction activities that could result in minor temporary increases in sediment load to the river during a flood event. Increased input of sediment has the potential to increase turbidity, possibly reducing the feeding efficiency of juvenile and adult fish. However, because the Sacramento River is typically a turbid system, additional sediment input from project activity would be comparatively minimal, and would not have any noticeable effect relative to the overall condition of the river Furthermore, sediment input from construction sites would occur only during storm events.

Long-term effects to anadromous fish could result from the loss of habitat due to implementation of the project. Removal of the existing levee could affect small areas of important habitats such as SRA cover and riparian vegetation. The loss of trees could temporarily adversely affect fish by reducing the amount of shade and potential for instream woody debris. To avoid this loss, levee removal activities would avoid removal of riparian vegetation. Vegetation (trees and shrubs) would be fenced and flagged for avoidance. Construction would also be done in a manner to avoid in-water work The exception would be the placement of 100 feet of rock riprap below the water surface to protect the Gianella Bridge. This work would have a significant adverse effect on instream habitat for anadromous fish.

Removal of the existing levee would reestablish the natural connectivity between the river and its flood plain, which would greatly benefit anadromous fish by providing access to flood plain habitat. This improved access would also increase the risk of fish becoming stranded as floodwaters recede. However, the net effect would be beneficial.

Under Combined Alternative 1, the conversion of agricultural lands to riparian areas would result in long-term beneficial effects on fish in the Sacramento River. In this alternative, 1,500 acres of agricultural land would be converted. This alternative would contribute complexity to the aquatic environment, providing cover, food, and other habitat components for fish, including SRA and LWD.

Sacramento River, tributaries, distributaries, and related riparian zones from Keswick Dam downstream to and including San Francisco Bay are classified as critical habitat for the winter-run chinook salmon. From December through August, the winter-run chinook salmon migrates to upstream areas where it spawns. From August to December, winter-run juveniles us the SRA cover and LWD in the river for feeding, resting, and escaping from predators. This alternative would contribute to the sustainable creation of this habitat and would therefore benefit winter-run chinook salmon critical habitat.

Potential short-term effects would require mitigation to minimize these effects. The implementation of best management practices, such as preserving all existing vegetation, where possible, preparing an erosion and sediment control plan, and stabilizing and reseeding all disturbed soils with native grasses, would control sediments and reduce the potential water quality effects to fisheries to less than significant. If construction is conducted that may affect the salmon, it would be conducted within appropriate work windows approved by NOAA Fisheries. Working at these times would minimize potential effects to these species.

Although the overall effect of the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project on anadromous fish would be beneficial, there would initially b some adverse effects to these species and to critical habitat due to the placement of rock under the Gianella Bridge. Therefore, we request initiation of formal Section 7 consultation for these adverse effects to the Federally listed Sacramento River winter-run chinook salmon and its critical habitat, Central Valley spring-run chinook salmon, and Central Valley steelhead.

If you have any questions, please contact Ms. Erin Taylor, Environmental Manager, at (916) 557-6862, e-mail: Erin.A.Taylor@usace.army.mil. Thank you for your cooperation.

Sincerely,

Mark C. Charlton
Chief, Planning Division

Enclosures

ENCLOSURE 1 - Federal Endangered And Threatened Species That May Be Affected By Projects In Glenn County	See Appendix B1 - Endangered Species in Project Area
ENCLOSURE 2 - Special Status Anadromous Fish Species Potentially Present In The Project Area	See Appendix B1 - Endangered Species Table
ENCLOSURE 3 - Project Description	See Main Report – Chapter 9 – Tentatively Recommended Plan

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
1-1-04-F-0145

JUN 30 2004

Mr. Mark C. Charlton
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Formal Endangered Species Consultation on the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, Glenn County, California

Dear Mr. Charlton:

This document has been prepared in response to your April 1, 2004, request to initiate formal consultation with the U.S. Fish and Wildlife Service (Service) on the effects of the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, in Glenn County, California, on the threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (beetle). Your request was received by the Service on April 2, 2004. This document represents the Service's biological opinion on the effects of the proposed project on the threatened beetle, in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act).

The Service has reviewed the biological information submitted by the U.S. Army Corps of Engineers (Corps). The documentation describes the proposed project's effects on listed species. This biological opinion is in accordance with the standards established in the Service's July 9, 1999, *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (Conservation Guidelines). Based on our analysis, the Service has determined the proposed project will result in the establishment of a significant amount of habitat for the valley elderberry longhorn beetle that will be of long-term benefit to this listed animal, and any adverse effects will be temporary and relatively minor in nature.

The findings and requirements in this consultation are based on: (1) a site visit by Justin Ly of the Service and Annalena Bronson of the California Department of Water Resources on April 1, 2003; (2) the *Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle- Hamilton City Flood Damage Reduction and Ecosystem Restoration*, dated March, 2004;

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(3) the *Hamilton City Flood Damage Reduction and Ecosystem Restoration, California, Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report*, dated March, 2004; (4) the *Hamilton City Flood Damage Reduction and Ecosystem Restoration, California, Habitat Revegetation Report*, dated December, 2003; and, (5) numerous telephone conversations between the Corps and the Service.

Consultation History

April 1, 2003. A visit to the site by Justin Ly, of the Service and Annalena Bronson, of the California Department of Water Resources.

March 10, 2004. Erin Taylor of the Corps provided the draft Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle-Hamilton City Flood Damage Reduction and Ecosystem Restoration, dated January, 2004, to the Service.

March 19, 2004. Erin Taylor provided the final Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle- Hamilton City Flood Damage Reduction and Ecosystem Restoration, dated March, 2004, to the Service.

April 1, 2004. The Service received the request for formal section 7 consultation from the Corps.

Project Description

Hamilton City is located in Glenn County, California, along the west bank of the Sacramento River, approximately 85 miles north of the City of Sacramento. The proposed project area includes Hamilton City and the surrounding rural area, which comprises approximately 1,500 acres. The proposed action area is bounded by the Sacramento River to the East and the Glenn Colusa Canal to the west and extends approximately two miles north and six miles south of Hamilton City. Surrounding land use is primarily orchards. The objectives of the project are to reduce flood risk and flood damages and to restore the riverine ecosystem along the west bank of the Sacramento River in and around Hamilton City.

Flood protection to Hamilton City and the surrounding area is provided by the "J" levee, which is an existing private levee. Currently, the Sacramento River is actively eroding into the toe of the levee at the northern end of the proposed project area. Glenn County has built a backup levee, approximately 1,000 feet in length, to protect the community in the event the toe erosion causes failure at the northern end of the "J" levee.

Currently, there are approximately 107 elderberry shrubs (*Sambucus* species), with stems one inch or greater at ground level in the proposed action area. Of these 107 elderberry shrubs, 21 shrubs with stems one inch or greater at ground level have beetle exit holes. These elderberry shrubs can be avoided with the potential setback levee alignments currently being considered. However, there is potential for the 107 existing elderberry shrubs to be removed during future flood-fighting activities.

The Reclamation Board has identified the proposed project area as having a high level of potential for restoration. The Reclamation Board is seeking to plant a mix of native riparian vegetation, including a minimum of one elderberry shrub per 1,800 feet (2,747 elderberry shrubs) in order to benefit the listed beetle. The approximate 2,747 or more elderberry shrubs that are proposed for planting are not for mitigation purposes and are only proposed for the benefit of the beetle, and other threatened and endangered species. The Reclamation Board has stated that the addition of elderberry shrubs to the restoration project is dependent on the authorization for incidental take of all elderberry shrubs planted within the 1,500 acre proposed action area. This would include the loss of all elderberry shrub habitat that occurs in the action area in the future. The Reclamation Board is seeking incidental take of all elderberry shrubs that would result from future maintenance and operations activities and potential flood-fighting activities that may be required for the setback levee in the future. Flood-fighting activities have occurred in the project area in 1983, 1986, 1995, 1997, and 1998.

The Corps has indicated in the *Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle- Hamilton City Flood Damage Reduction and Ecosystem Restoration*, dated March, 2004, that the following maintenance and flood-fighting activities may occur within the proposed action area:

1. Maintain ability to access the entire length of levee (approximately 6 miles) for maintenance and flood-fighting;

2. Maintain ability to access the entire length of the levee for large equipment to deliver and place flood-fighting material, including rock;

3. Maintain ability to maintain hydraulic capacity by selective clearing of vegetation;

4. Maintain ability to remove vegetation from the levee and within 15 feet of levee toe;

5. Maintain ability to access the levee to clear bank and berm of vegetation in order to place rock riprap bank protection when erosion is encroaching into the projected levee slope.

The Corps would be involved in the restoration, planting, and establishment for the first three years of restoration. Land ownership would then be turned over to a non-Federal sponsor. The Corps would require that the non-Federal sponsor supply the lands, easements, and rights-of-way for the proposed project. The Reclamation Board is the Corp's non-Federal sponsor for only the flood control component of the project. The Reclamation Board has yet to identify a non-Federal sponsor for the restoration component of the project. Possible non-Federal sponsors include The Nature Conservancy, the California Department of Fish and Game, or CalFed. Maintenance of the restoration area would then become the non-Federal sponsor's responsibility. The Corps will not be able to implement the proposed project without a non-Federal restoration sponsor.

Proposed Conservation Measures

The following measures have been proposed by the Corps:

1. A minimum of one elderberry shrub would be planted per 1,800 square feet (2,747 elderberry shrubs);

2. The Corps would be involved in the restoration, planting, and establishment for the first three years of restoration. Land ownership would be turned over to The Nature Conservancy, the California Department of Fish and Game, CalFed, or another non-Federal sponsor after the first three years. The Corps will attempt to ensure that monitoring will be continued by the non-Federal sponsor after three years in accordance with the Service's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle.*

3. Flood-fighting activities are expected to occur in the future. If flood-fighting activities occur within the proposed action area, the Corps will restore the areas disturbed during flood-fighting activities with the original vegetation species mix. Flood fighting by the Corps is considered emergency work and falls under PL-84 99, which includes consultation with the Service. This future consultation would require that the previous vegetation be restored.

4. A Service-approved biologist familiar with elderberry shrubs shall be onsite during flood-fighting activities and have the authority to choose access routes. Access routes, staging areas, and all project activities should be chosen in a manner that will cause the least amount of damage to beetle habitat. Removal of elderberry shrubs should be limited to the minimum necessary to achieve the project goal.

Status of the Species

The beetle was listed as a threatened species under the Act on August 8, 1980 (45 FR 52803). Critical habitat for the species was designated and published at 50 CFR §17.95. Two areas along the American River in the Sacramento metropolitan area have been designated as critical habitat for the beetle. Critical habitat for this species has been designated along the lower American River at Goethe and Ancil Hoffman parks (American River Parkway Zone) and at the Sacramento Zone, an area about a half mile from the American River downstream from the American River Parkway Zone. In addition, an area along Putah Creek, Solano County, and the area west of Nimbus Dam along the American River Parkway, Sacramento County, are considered essential habitat, according to the Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984). These critical habitat and essential habitat areas within the American River parkway and Putah Creek support large numbers of mature elderberry shrubs with extensive evidence of use by the beetle.

The beetle is dependent on the elderberry, its host plant, which is a locally common component of the remaining riparian forests and savannah areas and, to a lesser extent, the mixed chaparralfoothill woodlands of the Central Valley. Use of the elderberry shrubs by the animal, a wood borer, is rarely apparent. Frequently but not exclusively, the only exterior evidence of the shrub's use by the beetle is an exit hole created by the larva just prior to the pupal stage. Observations made within elderberry shrubs along the Cosumnes River, in the Folsom Lake area, and near Blue Ravine in Folsom indicate that larval galleries can be found in elderberry stems with no evidence of exit holes; the larvae either succumb prior to constructing an exit hole or are not far enough along in the developmental process to construct an exit hole. Beetle larvae appear to be distributed in stems which are 1.0 inch or greater in diameter at ground level. The Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984) and Barr (1991) contain further details on the valley elderberry longhorn beetle's life history.

Population densities of the beetle are probably naturally low (Service 1984); and it has been suggested, based on the spatial distribution of occupied shrubs (Barr 1991), that the beetle is a poor disperser (Collinger *et al.* 2001). Low density and limited dispersal capability cause the beetle to be vulnerable to the negative effects of the isolation of small subpopulations due to habitat fragmentation.

When the beetle was listed as threatened in 1980, the species was known from less than 10 localities along the American River, the Merced River, and Putah Creek. By the time the Valley Elderberry Longhorn Beetle Recovery Plan was prepared in 1984, additional occupied localities had been found along the American River and Putah Creek. As of 2004, the California Natural Diversity Database (CNDDB) contained 190 occurrences for this species in 44 drainages throughout the Central Valley, from a location along the Sacramento River in Shasta County, southward to an area along Caliente Creek in Kern County (CNDDB 2004). Glenn County has 12 occurrences of the beetle (CNDDB 2004). The beetle continues to be threatened by habitat loss and fragmentation, predation by the non-native Argentine ants (*Linepithema humile*) (Holway 1995; Huxel 2000; Huxel and Hastings 1999; Huxel *et al.* 2001; Ward 1987), and possibly other factors such as pesticide drift, non-native plant invasion, improper burning regimes, off-road vehicle use, rip-rap bank protection projects, wood cutting, and over grazing by livestock (CNDDB 2004).

Environmental Baseline

Riparian forests, the primary habitat for the beetle, have been severely depleted throughout the Central Valley over the last two centuries as a result of expansive agricultural and urban development (Huxel *et al.* 2001; Katibah 1984; Roberts *et al.* 1977; Thompson 1961). Since colonization, these forests have been "...modified with a rapidity and completeness matched in few parts of the United States" (Thompson 1961). As of 1849, the rivers and larger streams of the Central Valley were largely undisturbed. They supported continuous bands of riparian woodland four to five miles in width along some major drainages such as the lower Sacramento River, and generally about two miles wide along the lesser streams (Thompson 1961). Most of the riverine floodplains supported riparian vegetation to about the 100-year flood line (Katibah 1984). A large human population influx occurred after 1849, however, and much of the Central Valley riparian habitat was rapidly converted to agriculture and used as a source of wood for fuel and construction to serve a wide area (Thompson 1961). By as early as 1868, riparian woodland had been severely affected in the Central Valley, as evidenced by the following excerpt:

> "This fine growth of timber which once graced our river [Sacramento], tempered the atmosphere, and gave protection to the adjoining plains from the sweeping winds, has entirely disappeared - the woodchopper's axe has stripped the river farms of nearly all the hard wood timber, and the owners are now obliged to rely upon the growth of willows for firewood." (Cronise 1868, in Thompson 1961).

The clearing of riparian forests for fuel and construction made this land available for agriculture (Thompson 1977). Natural levees bordering the rivers, once supporting vast tracts of riparian habitat, became prime agricultural land (Thompson 1961). As agriculture expanded in the Central Valley, needs for increased water supply and flood protection spurred water development and reclamation projects. Artificial levees, river channelization, dam building, water diversion, and heavy groundwater pumping further reduced riparian habitat to small, isolated fragments (Katibah 1984). In recent decades, these riparian areas have continued to decline as a result of ongoing agricultural conversion as well and urban development and stream channelization. As of 1989, there were over 100 dams within the Central Valley drainage basin, as well as thousands of miles of water delivery canals and streambank flood control projects for irrigation, municipal and industrial water supplies, hydroelectic power, flood control, navigation, and recreation (Frayer *et al.* 1989). Riparian forests in the Central Valley have dwindled to discontinuous strips of widths currently measurable in yards rather than miles.

Some accounts state that the Sacramento Valley supported approximately 775,000 to 800,000 acres of riparian forest as of approximately 1848, just prior to statehood (Smith 1977; Katibah 1984). No comparable estimates are available for the San Joaquin Valley. Based on early soil maps, however, more than 921,000 acres of riparian habitat are believed to have been present throughout the Central Valley under pre-settlement conditions (Huxel *et al* 2001; Katibah 1984). Another source estimates that of approximately five million acres of wetlands in the Central Valley in the 1850s, approximately 1,600,000 acres were riparian wetlands (Warner and Hendrix 1985; Frayer *et al.* 1989).

Based on a California Department of Fish and Game riparian vegetation distribution map, by 1979, there were approximately 102,000 acres of riparian vegetation remaining in the Central Valley. This represents a decline in acreage of approximately 89 percent as of 1979 (Katibah 1984). More extreme figures were given by Frayer *et al.* (1989), who reported that woody riparian forests in the Central Valley had declined to 34,600 acres by the mid-1980s (from 65,400 acres in 1939). Although these studies have differing findings in terms of the number of acres lost (most likely explained by differing methodologies), they attest to a dramatic historic loss of riparian habitat in the Central Valley. As there is no reason to believe that riparian habitat suitable to the beetle (elderberry shrubs) would be destroyed at a different rate than other riparian habitat, we can assume that the rate of loss for beetle habitat in riparian areas has been equally dramatic.

A number of studies have focused on riparian vegetation losses along the Sacramento River, which supports some of the densest known populations of the beetle. Approximately 98 percent of the middle Sacramento River's historic riparian vegetation was believed to have been extirpated by 1977 (DWR 1979). The State Department of Water Resources estimated that native riparian habitat along the Sacramento River from Redding to Colusa decreased from 27,720 acres to 18,360 acres (34 percent) between 1952 and 1972 (McGill *et al.* 1975; Conrad *et al.* 1977). The average rate of riparian loss on the middle Sacramento River was 430 acres per year from 1952 to 1972, and 410 acres per year from 1972 to 1977. In 1987, riparian areas as large as 180 acres were observed converted to orchards along this River (McCarten and Patterson 1987).

Barr (1991) examined 79 sites in the Central Valley supporting valley elderberry longhorn beetle habitat. When 72 of these sites were re-examined by researchers in 1997, seven no longer supported valley elderberry longhorn beetle habitat. This loss represents a decrease in the number of sites with valley elderberry longhorn beetle habitat by approximately nine percent in six years.

No comparable information exists on the historic loss of non-riparian valley elderberry longhorn beetle habitat such as elderberry savanna and other vegetation communities where elderberry shrubs also occur (oak or mixed chaparral-woodland, or grasslands adjacent to riparian habitat). However, all natural habitats throughout the Central Valley have been heavily adversely affected within the last 200 years (Thompson 1961), and we can therefore assume that non-riparian beetle habitat also has suffered a widespread decline. This analysis focuses on loss of riparian habitat because the beetle is primarily dependent upon riparian habitat. Adjacent upland areas are also likely to be important for the species (Huxel pers. comm. 2000), but this upland habitat typically consist of oak woodland or elderberry savanna bordering willow riparian habitat (Barr 1991). The riparian acreage figures given by Frayer *et al.* (1989) and Katibah (1984) included oak woodlands concentrated along major drainages in the Central Valley, and therefore probably included lands we would classify as upland habitat for the beetle adjacent to riparian drainages.

Between 1980 and 1995, the human population in the Central Valley grew by 50 percent, while the rest of California grew by 37 percent . The Central Valley's population was 4.7 million by 1999, and it is expected to more than double by 2040. The American Farmland Trust estimates that by 2040 more than 1 million cultivated acres will be lost and 2.5 million more put at risk (Ritter 2000). With this growing population in the Central Valley, increased development pressure is likely to result in continuing loss of riparian habitat.

While habitat loss is clearly a large factor leading to the species' decline, other factors are likely to pose significant threats to the long term survival of the beetle. Only approximately 20 percent of riparian sites with elderberry observed by Barr (1991) and Collinge *et al.* (2001) support beetle populations (Barr 1991, Collinge *et al.* 2001). Jones and Stokes (1988) found 65 percent of 4,800 riparian acres on the Sacramento River have evidence of beetle presence. The fact that a large percentage of apparently suitable habitat is unoccupied suggests that the beetle is limited by factors other than habitat availability, such as habitat quality or limited dispersal ability.

Destruction of riparian habitat in central California has resulted not only in a significant acreage loss, but also has resulted in beetle habitat fragmentation. Fahrig (1997) states that habitat fragmentation is only important for habitats that have suffered greater than 80 percent loss. Riparian habitat in the Central Valley, which has experienced greater than 90 percent loss by most estimates, would meet this criterion as habitat vulnerable to effects of fragmentation. Existing data suggests that beetle populations, specifically, are affected by habitat fragmentation. Barr (1991) found that small, isolated habitat remnants were less likely to be occupied by beetles than larger patches, indicating that valley elderberry longhorn beetle subpopulations are extirpated from small habitat fragments. Barr (1991) and Collinge *et al.* (2001) consistently found valley elderberry longhorn beetle exit holes occurring in clumps of elderberry bushes rather than isolated bushes, suggesting that isolated shrubs do not typically provide long-term viable habitat for this species. Local populations of organisms often undergo periodic colonization and extinction, while the metapopulation (set of spatially separated groups of a species) may persist (Collinge 1996).

Habitat fragmentation can be an important factor contributing to species declines because: (1) it divides a large population into two or more small populations that become more vulnerable to direct loss, inbreeding depression, genetic drift, and other problems associated with small populations; (2) it limits a species' potential for dispersal and colonization; and (3) it makes habitat more vulnerable to outside influences by increasing the edge:interior ratio (Primack 1998).

Small, isolated subpopulations are susceptible to extirpation from random demographic, environmental, and/or genetic events (Shaffer 1981; Lande 1988; Lande 1993; Primack 1998). While a large area may support a single large population, the smaller subpopulations that result from habitat fragmentation may not be large enough to persist over a long time period. As a population becomes smaller, it tends to lose genetic variability through genetic drift, leading to inbreeding depression and a lack of adaptive flexibility. Smaller populations also become more vulnerable to random fluctuations in reproductive and mortality rates, and are more likely to be extirpated by random environmental factors.

The beetle is a specialist on elderberry plants, and tends to have small population sizes and occurs in low densities (Barr 1991; Collinge *et al.* 2001). Collinge *et al.* (2001) compared resource use and density of exit holes between the beetle and a related subspecies, the California elderberry longhorn beetle (*Desmocerus californicus californicus*). The valley elderberry longhorn beetle tended to occur in areas with higher elderberry densities, but had lower exit hole densities than the California elderberry longhorn beetle. With extensive riparian habitat loss and fragmentation, these naturally-small valley elderberry longhorn beetle populations are broken into even smaller, isolated populations. Once a small valley elderberry longhorn beetle population has been extirpated from an isolated habitat patch, the species may be unable to re-colonize this patch if it is unable to disperse from nearby occupied habitat. Insects with limited dispersal and colonization abilities may persist better in large habitat patches than small patches because small fragments may be insufficient to maintain viable populations and the insects may be unable to disperse to more suitable habitat (Collinge 1996).

Studies suggest that the beetle is unable to re-colonize drainages where the species has been extirpated, because of its limited dispersal ability (Barr 1991; Collinge *et al.* 2001). Huxel and

Hastings (1999) used computer simulations of colonization and extinction patterns based on differing dispersal distances, and found that the short dispersal simulations best matched the 1997 census data in terms of site occupancy. This suggests that dispersal and colonization are limited to nearby sites. At spatial scales greater than 6.2 miles (10 km.), such as across drainages, valley elderberry longhorn beetle occupancy appears to be strongly influenced by regional extinction and colonization processes, and colonization is constrained by limited dispersal (Collinge *et al.* 2001; Huxel and Hastings 1999). Except for one occasion, drainages examined by Barr that were occupied in 1991 remained occupied in 1997 (Collinge *et al.* 2001; Huxel and Hastings 1999). The one exception was Stoney Creek, which was occupied in 1991 but not in 1997. All drainages found by Barr (1991) to be unoccupied in 1991 were also unoccupied in 1997. This data suggests that drainages unoccupied by the valley elderberry longhorn beetle remain so.

Habitat fragmentation not only isolates small populations, but also increases the interface between habitat and urban or agricultural land, increasing negative edge effects such as the invasion of non-native species (Huxel *et al.* 2001; Huxel 2000; Soule 1990) and pesticide contamination (Barr 1991). Several edge effect-related factors may be related to the decline of the beetle.

Project-Related Effects to the Valley Elderberry Longhorn Beetle

The overall effect of this project will result in long-term beneficial effects to the valley elderberry longhorn beetle. The project will restore 1,500 acres of habitat fro the imperiled animal. This addition of habitat in the area will benefit the listed beetle by increasing population numbers and improving the dispersal abilities of the species. The proposed project may result in short-term adverse effects to the valley elderberry longhorn beetle. Maintenance and operations activities and potential flood-fighting activities may remove elderberry shrubs from the proposed actions area. If flood-fighting activities occur within the proposed action area, the Corps will restore these areas with the native riparian vegetation mix used during the original restoration effort. Therefore, these direct effects are expected to be only a short-term disturbance.

Indirect effects may occur if maintenance and flood-fighting activities alter the terrain, such as driplines, which may adversely affect elderberry bushes. Vehicles and construction equipment may leak hazardous substances such as motor oil and antifreeze. Although the quantity leaked by a given vehicle or engine may be minute, these substances can accumulate on roads or in parking lots and then get washed into the adjacent environment by runoff during rain storms. A variety of substances could be introduced during accidental spills of materials.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed project are not considered in this section, because they require separate consultation pursuant to section 7 of the Act. An undetermined number of future land use conversions and routine agricultural practices are not subject to

Federal authorization or funding and may alter the habitat or increase incidental take of the beetle and are, therefore, cumulative to the proposed project. Most of these future non-Federal projects are considered indirect effects of the proposed action and effects are addressed through an interim process of project approval and habitat conservation plan development.

Many activities affecting the beetle involve effects to elderberry shrubs located within riparian ecosystems adjoining or within jurisdictional wetlands. These projects will be evaluated via formal consultation between the Service and the Corps via the Federal nexus provided by section 404 of the Clean Water Act. However, a number of projects exist for which there is no need to discharge dredged or fill material into waters of the U.S. These projects, for which no section 404 permit is required, may lack a Federal nexus and thus, move forward absent formal consultation. These projects pose a significant threat to the recovery of the valley elderberry longhorn beetle. This loss of habitat negatively affects the environmental baseline and is difficult to quantify.

Conclusion

After reviewing the current status of the beetle, the environmental baseline for the action area, the effects of the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration project, and the cumulative effects, it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the beetle. Critical habitat has been designated for the beetle. However, this action does not directly or indirectly affect these areas, and therefore, no destruction or adverse modification of critical habitat is anticipated.

Incidental Take Statement

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates incidental take of the valley elderberry longhorn beetle will be difficult to detect or quantify. The cryptic nature of these species and their relatively small body size make the finding of a dead specimen unlikely. The species occur in habitats that make them difficult to detect. Due to the difficulty in quantifying the number of beetles that will be taken as a result of the proposed action, the Service is quantifying take in terms of the number of elderberry shrubs with stems one inch or greater in diameter that will become unsuitable for beetles due to direct or indirect effects as a result of the action. The Service anticipates that all valley elderberry longhorn beetles inhabiting elderberry bushes within the 1,500 acre project site will be taken as a result of the proposed project.

Upon implementation of the following reasonable and prudent measures, incidental take associated with the project on the listed valley elderberry longhorn beetle, in the form of harm, harassment, or mortality from habitat loss or direct mortality will become exempt from the prohibitions described under section 9 of the Act for direct and indirect effects. In addition, incidental take in the form of harm, harassment, or mortality associated with the proposed project will be exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the valley elderberry longhorn beetle or result in destruction or adverse modification of critical habitat for the valley elderberry longhorn beetle.

Reasonable and Prudent Measure

The proposed action contains all of the measures needed to adequately minimize the impacts of anticipated take on the beetle. For that reason, the Service has no Reasonable and Prudent Measures.

Reporting Requirements

The Sacramento Fish and Wildlife Office is to be notified within one working day of the finding of any listed species or any unanticipated take of species addressed in this biological opinion. The Service contact persons for this are the Chief of the Endangered Species Division (Central Valley) at (916) 414-6600, and the Resident Agent-in-Charge of the Service's Law Enforcement Division at (916) 414-6660.

Any dead or severely injured beetles found (adults, pupae, or larvae) shall be deposited in the

Entomology Department of the California Academy of Sciences. The Academy's contact is the Senior Curator of Coleoptera at (415) 750-7239. All observations of valley elderberry longhorn beetles - live, injured, or dead - or fresh beetle exit holes shall be recorded on California Natural Diversity Data Base (CNDDB) field sheets and sent to California Department of Fish and Game, Wildlife Habitat Data Analysis Branch, 1807 13th Street Room 2002, Sacramento, California 95814.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1. The Corps should work with the Service to address significant, unavoidable environmental impacts approved by local agencies.

2. The Corps should continue to assist the Service in the implementation of recovery efforts for the valley elderberry longhorn beetle.

3. It is recommended that the Corps continue to protect and restore riparian and wetland habitats in the Sacramento River basin, to increase habitat for the valley elderberry longhorn beetle.

4. It is recommended that the Corps ensure that monitoring of the proposed restoration project continue for 10 years in accordance with the Service's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle.* The Corps could approach private non-profit organizations, government agencies, or universities with the possibility of continuing these monitoring efforts.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting federally-listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Reinitiation – Closing Statement

This concludes formal consultation on the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Please contact Rick Kuyper or Adam Zerrenner, Sacramento Valley Branch Chief, at (916) 414-6645 if you have any questions or comments regarding the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project.

Sincerely,

fr Kenneth D. Sanchez
Acting Field Supervisor

cc:

FWS, Regional Office, Portland, Oregon (Attn: L. Salata)
U.S. Army Corps of Engineers, Sacramento, California (Attn: Erin Taylor)
Sacramento National Wildlife Refuge Complex, Willows, California (Attn: Kevin Foerster)
California Department of Fish and Game, Rancho Cordova, California (Attn: Terry Roscoe)
The Reclamation Board, Sacramento, California (Attn: Peter Rabbon and Stephen Bradley)
California Department of Water Resources, Sacramento, California (Attn: Annalena Bronson)

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DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

AUG 03 2004

Mr. Wayne White, Field Supervisor
U.S. Fish and Wildlife Service
2800 Cottage Way, Suite W2605
Sacramento, California 95825-1846

Dear Mr. White:

This letter transmits revised conservation measures (enclosure) to replace the "Proposed Conservation Measures" in the Service's June 30, 2004, biological opinion (BO) on the effects of the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration Project in Hamilton City, California. These revised conservation measures were developed in coordination with the Service, the State Reclamation Board, and our Emergency Management Division.

In a phone conversation on August 3, 2004, Mr. Chris Nagano of your staff requested that we transmit these revised conservation measures to the Service and indicated that your agency would then provide the Corps with a letter to supplement the BO. If you have any questions, please contact Mr. Scott Clark at (916) 557-7211 or email: E.Scott.Clark@usace.army.mil. We appreciate your cooperation in expediting the resolution of this issue.

Sincerely,

E. Scott Clark

for Mark C. Charlton
Chief, Planning Division

Enclosure

Conservation Measures

The following conservation measures will be implemented to provide protection for elderberry shrubs planted during restoration activities in the project area:

1. For the purposes of flood-fighting (i.e., placement of flood-fighting material, such as rock), it is permissible to remove any elderberry shrub within the proposed project area. The proposed management for the project includes maintaining the levee and a 300-foot buffer adjacent to the waterside of the levee in a grassland vegetation that is free of elderberry shrubs. Access to this area during flood-fighting would necessarily be via the landside of the levee, which would not include any elderberry plantings. Therefore, any flood-fighting activities on the levee or within the 300-foot buffer that would affect elderberry shrubs that may voluntarily establish within these areas would not require implementation of measures to protect elderberry shrubs. However, for any Corps flood-fighting activities affecting areas on the waterside of the buffer area, a Service-approved biologist familiar with elderberry shrubs shall join the flood-fighting efforts to provide assistance. Access routes, staging areas, and all project activities should be chosen in a manner that will cause the least amount of damage to beetle habitat without adversely affecting the flood-fighting efforts. Removal of elderberry shrubs should be limited to the minimum necessary to achieve the project goal. The biologist will have the authority to coordinate with the onsite engineer to ensure that appropriate consideration is given to avoiding effects to elderberry shrubs. State and local agencies should make similar efforts when flood-fighting without Corps assistance.

2. During Corps emergency flood-fighting activities in the project area on the waterside of the buffer area, a reasonable effort will be made to clearly demarcate access routes and work boundaries. As soon as possible after the initiation of flood-fighting, a Service-approved biologist shall identify sensitive habitat that could be avoided without affecting flood-fighting activities and place adequate high visibility flagging around the avoidance areas to prevent unnecessary encroachment of construction equipment and personnel into beetle habitat during project work activities. Such flagging shall be inspected and maintained daily by a Service-approved biologist until completion of the project, at which time the flagging shall be removed. The Service-approved biologist shall have the authority to recommend alternatives to any action that might result in effects to the avoidance areas. If the Service-approved biologist exercises this authority, the Service shall be notified within one calendar day. State and local agencies should make similar efforts when flood-fighting without Corps assistance.

3. For the purposes of routine maintenance activities, which will be described in an O&M Manual (e.g., levee inspections, vegetation removal from the levee and a 300-foot buffer zone adjacent to the levee, or clearing vegetation within the restoration area to maintain hydraulic capacity of the floodplain), it is permissible to remove any elderberry shrub. If the routine maintenance activity will include vegetation removal, a Service-approved biologist familiar with elderberry shrubs shall be onsite during the activities to ensure that elderberry plants outside of the maintenance area are not disturbed.

4. During routine maintenance activities, elderberry shrubs within the maintenance activity project area that are not required to be removed will be clearly demarcated with adequate high visibility flagging by the Service-approved biologist. Such flagging shall be inspected and maintained daily by a Service-approved biologist until completion of the project, at which time the flagging shall be removed. The Service-approved biologist shall have the authority to recommend alternatives to any action that might result in effects to the avoidance areas. If the Service-approved biologist exercises this authority, the Service shall be notified within one calendar day.

5. Prior to maintenance activities and during Corps flood-fighting activities, all workers shall be informed of the importance of avoiding effects to elderberry shrubs. Workers shall be provided with information on their responsibilities with regard to listed-species and an overview of the life-history of the species and description of the restoration area.

6. After Corps flood-fighting activities take place in areas on the waterside of the buffer area, a report prepared by the monitoring biologist(s) shall be forwarded to the Chief of the Endangered Species Division (Central Valley) at the Sacramento Fish and Wildlife Office within 60 calendar days of the completion of the project. This report shall detail: (1) dates that flood-fighting activities occurred; (2) known project effects on federally-listed species, if any; (3) occurrences of incidental take of federally-listed species, if any; and (4) other pertinent information. State and local agencies should make similar efforts when flood-fighting without Corps assistance.

7. After Corps flood-fighting activities take place on the waterside of the buffer area, the Corps shall revegetate all areas where VELB habitat was removed or similarly affected within the proposed project area with the native riparian species used in the original restoration. Replacement will be at a ratio of 1:1 for effects to VELB habitat in the project area. State and local agencies should make similar efforts when flood-fighting without Corps assistance.

8. During maintenance activities, all fueling and maintenance of vehicles and other equipment, stockpiling of construction materials, and storage of portable equipment, vehicles and supplies, including chemicals, shall be restricted to designated staging areas, which shall be located at least 250 feet from any riparian habitat. The agency responsible for O&M shall ensure that all reasonable measures are taken to avoid contamination of habitat during such operations. All workers shall be informed of the importance of preventing spills and appropriate measures to take should a spill occur. Any spills of hazardous materials shall be cleaned up immediately. Such spills shall be reported in O&M activities reports.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
1-1-04-F-0257

AUG 03 2004

Mark C. Charlton
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Amendment to the Biological Opinion for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project (Service File Number 1-1-04-F-0145), Glenn County, California

Dear Mr. Charlton:

This letter is an amendment to the biological opinion for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project (Service file number 1-1-04-F-0145) that was issued on June 30, 2004, by the U.S. Fish and Wildlife Service (Service). Your letter was received on August 3, 2004. It is our understanding that the U.S. Army Corps of Engineers (Corps) is proposing to modify the project description. At issue are the adverse effects of the project on the threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*). Our comments are made under the authority of the Endangered Species Act of 1973, as amended (Act).

The Service has reviewed your August 3, 2004, letter which outlines modifications to the proposed conservation measures for the proposed project. The documentation describes the proposed project's effects on listed species. Based on our analysis, the Service has determined that the proposed project, including the modifications to the conservation measures in the Biological Opinion, will result in the establishment of a significant amount of habitat for the valley elderberry longhorn beetle that will be of long-term benefit to this listed animal, and any adverse effects will be temporary and relatively minor in nature. Therefore, the proposed conservation measures, as outlined on page 4 of the Biological Opinion (Service file number 1-1-04-F-0145) are superceded by the proposed conservation measures as described in your August 3, 2004, letter.

The Status of the Species, Environmental Baseline, Effects of the Proposed Action, Cumulative Effects, Conclusion, Incidental Take, Conservation Measures, and the remainder of the Terms and Conditions and the project description remain the same as in the June 30, 2004, Biological Opinion.

If you have questions regarding this amendment to the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project Biological Opinion, please contact Rick Kuyper or Chris Nagano, of my staff at (916) 414-6630.

Sincerely,

Ch Nagano

fn Kenneth D. Sanchez
Acting Field Supervisor

cc:
FWS, Regional Office, Portland, Oregon (Attn: L. Salata)
Sacramento National Wildlife Refuge Complex, Willows, California (Attn: Kevin Foerster)
California Department of Fish and Game, Rancho Cordova, California (Attn: Terry Roscoe)
The Reclamation Board, Sacramento, California (Attn: Peter Rabbon and Stephen Bradley)
California Department of Water Resources, Sacramento, California (Attn: Annalena Bronson)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

June 23, 2004

In Response Refer To:
151422SWR04SA9096:HLB

Mark Charlton
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street, Room 1560
Sacramento, CA 95814

Dear Mr. Charlton:

This letter responds to your April 1, 2004 letter requesting formal consultation with the National Marine Fisheries Service (NOAA Fisheries) on the effects of the Hamilton City Ecosystem Restoration project on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), candidate Central Valley fall/late fall-run Chinook salmon (*O. tshawytscha*), and the designated critical habitat of winter-run Chinook salmon or the essential fish habitat (EFH) of Pacific Salmon.

The Hamilton City Ecosystem Restorationp project is located along the Sacramento River near Hamilton City, in Glenn County, California. The Army Corps of Engineers (Corps) proposes to integrate ecosystem restoration and flood control by constructing a 6.8 mile long setback levee, and restoring up to 1,480 acres of native, riparian, and upland vegetation between the levee and the river. Once the setback levee is constructed, the existing levee will be removed and natural connectivity between the Sacramento River and its floodplain will be re-established.

The new setback levee will begin approximately two miles north of Hamilton City by tying into high ground and continue south to the State Route 32 Bridge (Gianella Bridge). Rock riprap will be placed along the levee embankment where it parallels and ties into the approach of the Gianella Bridge. Approximately one hundred feet of rock riprap will be placed in the Sacramento River along the bridge abutments to prevent project-related hydraulic changes from scouring structural components of the bridge. South of State Route 32, the levee alignment generally will follow an existing "J" levee around Dunning Slough before heading south and west of the primary floodplain restoration area. As the levee continues south, it gradually tapers into a training dike in floodable agricultural land.

Native vegetation will be restored on all project lands on the water side of the new setback levee and within Dunning Slough. Existing orchards within the restoration area would be removed and replaced with native vegetation. Approximately 1,000 acres will be restored to riparian conditions, 260 acres will be restored to scrub vegetation, 150 acres will be restored to savannah, and 70 acres will be restored to grassland.

The Sacramento River, in the vicinity of the project area, is a migration corridor and rearing habitat for anadromous salmonids. The action area does not provide adult holding, spawning, or early rearing habitat for salmonids. Federally listed juvenile salmonids may be within the action area from mid-July to early May, and adults may be present from October to June. Potential project-related impacts that may affect Federally listed anadromous salmonids include temporary increases in sediment delivery to the Sacramento River during high flow events, the short-term loss of riparian vegetation related to the removal of the existing levee, and impacts related to the placement of riprap at the Gianella Bridge. Direct effects to salmonids are possible if riprap placement occurs when juvenile salmonids are present within the action area. Indirect effects to juvenile salmonids are possible if riprap actions destroy important constituent elements of anadromous habitat such as shaded riverine aquatic habitat (SRA), shallow-water rearing habitat, or other features that provide cover and food.

The increased input of sediment to the Sacramento River within the action area is not expected to result in any adverse effects that result in the take of anadromous fish because this portion of the river is naturally turbid and the Corps does not expect turbidity levels to increase above regional standards established by the Central Valley Regional Water Quality Control Board (Regional Board). Turbidity levels that are within Regional Board standards generally are accepted to be within levels that do not injure or kill salmonids. Adverse effects to anadromous salmonids from loss of riparian and SRA during levee removal actions will be avoided by keeping equipment out of the water and by flagging and protecting areas that contain large woody debris or riparian vegetation. Additionally, the restoration of 1,000 acres of riparian habitat is expected to improve baseline conditions for SRA elements. Short-term impacts to anadromous fish habitat related to loss of riparian vegetation during new levee construction are expected to be minimal, and not result in take of listed species or adverse modification to critical habitat because the extensive riparian planting in recovered floodplain habitat will result in a greater extent of riparian vegetation throughout the project area and offset any short-term loss. Direct effects to anadromous fish from the placement of in-water riprap can be avoided by constructing during the summer months when juvenile anadromous fish are not present. The Corps proposes to schedule all inwater construction activities for the period of June 1 to July 15, to avoid peak migration periods of anadromous fish.

The Corps initially requested formal consultation based on their determination that the placement of rock riprap would be an adverse effect to anadromous salmonids; however, based on the avoidance, minimization, and restoration measures proposed by the Corps, NOAA Fisheries anticipates that the likelihood of the proposed action causing adverse effects that result in the incidental take of Federally listed anadromous fish is negligible. Therefore, formal consultation is not required.

Provided that the above measures, and the protective measures identified in the biological assessment, and draft Environmental Impact Statement/Environmental Impact Report are adhered to, NOAA Fisheries believes that the Hamilton City Ecosystem Restorationp project is not likely to adversely affect Federally listed anadromous or the designated critical habitat of Sacramento River winter-run Chinook salmon. The proposed project is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon Fishery Management Plan, pursuant to the Magnuson-Stevens Conservation and Management Act (MSA). NOAA Fisheries has determined that the measures proposed to avoid adverse effects to Federally listed species and designated critical habitat will minimize adverse effects to EFH for Pacific salmon and that additional EFH Conservation Measures are not necessary. This concludes section 7 and EFH consultation for the proposed project; however, should new information indicate that the project may effect these species in an unforseen manner, further consultation may be necessary.

If you have any questions regarding this correspondence or if NOAA Fisheries can provide further assistance to the Comprehensive Study, please contact Mr. Howard Brown in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Brown may be reached by telephone at (916) 930-3608, or by Fax at (916) 930-3629.

Sincerely,

f. Rodney R. McInnis
Acting Regional Administrator

cc: NMFS-PRD, Long Beach, CA

B.2: Cultural Resources Appendix

Appendix B.2: Cultural Resources

Regulatory Setting

"Cultural resource" is a term that refers to the imprint of human occupation left on the landscape. This imprint is manifested in the form of prehistoric and historic archeological sites, and historic buildings, structures, and objects. Archeological sites consist of artifacts, plant and faunal remains, trash deposits, and many types of features. Artifacts reflect anything that was manufactured or modified by human hands. Features can include structural remains, fire pits, and storage areas. Prehistoric archeological sites are loci of human activity occurring before European contact, which was first made in the southwest with the Spanish entrada in A.D. 1540. Prehistoric artifacts include: flaked stone tools such as projectile points, knives, scrapers, and chopping tools; ground stone implements like manos and metates; plain and decorated ceramics; and features or facilities that include subterranean and above ground architectural units, hearths, granaries, storage cysts, and trash deposits known as middens.

Historic archeological sites reflect occupation after the advent of written records. Material remaining on historic archeological sites includes refuse dumps, structure foundations, roads, privies, and any other physical evidence of historic occupation. Refuse consists of food waste, bottles, ceramic dinnerware, and cans. In a number of historic archeological situations, privies are important because they often served as secondary trash deposits. There is usually a strong interplay between historic archeological sites and written records. The archeological data is frequently used to verify or supplement historic records. Historic structures minimally include industrial facilities, roadways, bridges, and water transport or detention systems such as canals, ditches, aqueducts, pumps, and dams. Historic buildings include commercial, residential, agricultural, and ecclesiastical buildings.

There are two principal methods of locating cultural resources. Before a project is started, a records and literature search is conducted at any number of repositories of archeological site records. The search may show that an archeological or historical survey may have been conducted and some cultural resources were identified. That information may be enough to proceed with the significance evaluation stage of the project. If a conclusion were reached that (1) no previous survey had been done or (2) a previous survey were either out of date or inadequate, the project cultural resources expert, either a historian or archeologist, will conduct a survey to determine if any cultural resources are within the proposed study area boundaries.

After a cultural resource(s) has been identified during a survey or record and literature search, the appropriate Federal agency oversees a process to determine whether the cultural resource is eligible for listing in the National Register of Historic Places (National Register). Section 106 of the National Historic Preservation Act mandates this process. The Federal regulation that guides the process is 36 C.F.R. 800. For a cultural resource to be determined eligible for listing in the National Register, it must meet certain criteria. The resource has to be at least 50 years old or exhibit exceptional importance.

After meeting the age requirement, cultural resources are evaluated according to the four criteria defined below. The National Register criteria for evaluation as defined in 36 C.F.R. 60.4 are as follows:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:
> (1) that are associated with events that have made a significant contribution to the broad patterns of our history; or
> (2) that are associated with the lives of persons significant in our past; or
> (3) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> (4) that have yielded, or may be likely to yield, information important in prehistory or history.

After a cultural resource has been determined eligible for listing in the National Register, it is accorded the same level of protection as any other property that is listed and becomes formally known as a "historic property," regardless of age. The term historic property refers exclusively to National Register eligible or listed properties.

Prehistory, Ethnography, and History References

The study area lies within an archeological sub-region of the Central Valley Region referred to as the Sacramento Valley (Moratto 1984). The potential area of potential effects (APE) for this project crosses the prehistoric territory of the Konkow. Konkow was spoken in a number of dialects along the lower reaches of the Feather River Canyon and in the adjacent parts of the Sacramento Valley. The term Konkow refers only to the Northwestern Maidu whose regional boundaries would have included the lower reaches of the Feather River and adjacent parts of the Sacramento Valley. (Sturtevant 1978). The Konkow territory included part of the Sacramento Valley floor as well as a section of the Sierra foothills east of Chico and Oroville.

Due to dam building in the last fifty years, salvage archeology has come to play a significant role in shaping the known prehistory of several Indian groups. The Maidu, and the Konkow by extension, have been best examined through excavations performed in the 1960s in the Lake Oroville area along the Feather River in the foothills of Butte County. The findings of multiple investigations revealed the development of the Mesilla, Bidwell, Sweetwater, and Oroville complexes through nearly 3,000 years. Choppers, scrapers, hammerstones, and Spire-lopped Olivella beads do not seem to have been greatly altered over time, though other artifacts did vary, and those distinguish the complexes.

The Mesilla Complex is distinguished by Haliotis and Olivella beads, charmstones, bone pins, and spatulae that indicate contact with Sacramento Valley cultures. There is evidence of sporadic or seasonal occupation of the foothills between circa 1000 B.C.

and A.D. 1 by people who hunted, as well as processed their food in bowl mortars and on millingstones.

People of the Bidwell Complex, between A.D. 1 and 800, were more stationary, living in relatively permanent villages and traveling away from permanent village locations for tasks such as hunting, fishing, and acorn and seed gathering.

Olivella bead and Haliotis ornament forms, steatite cups, platters, bowls, and tubular smoking pipes distinguish the Sweetwater Complex, dating from A.D. 800 to 1500. Other artifacts include small, lightweight projectile points of the Eastgate, Rose Spring, and Gunther Barbed types that reveal that the bow and arrow were in use by A.D. 800.

The Oroville Complex dates from A.D. 1500 until the epidemic of 1833, which decidedly marks the invasion of whites and the historic period. Characteristics of this complex include bedrock mortars and other seed-grinding implements and artifacts include bird bone tubes, gorge hooks, gaming bones, and clamshell disk beads. Evidence of several different structures, including dance houses, have been found around Lake Oroville (Moratto 1984).

The Konkow people derive their name from a native term meaning "meadowland" and their diversity to other Maidu groups, such as the Nisenan, is marked by changes in dialect and location of villages and territory. As a kind of division of the Maidu people, the Konkow share many similarities as well as differences. Precontact villages have been estimated at approximately 35 persons, with a gathering of seven houses per village and five persons per house. Several villages may have made up a village-community that probably did not exceed a population of 200. Each village-community owned and defended a known territory and was led by a headman who was the primary spokesman and lived in the central village. Each village was self-sufficient and was not bound under strict political control by the headman, who serves in an advisory capacity. The headman was selected by a shaman who conveyed the wishes of the spirits to the people.

The Konkow and Maidu religion and cosmogony is similar to creation mythology. In mythology, a creator persona, as well as a turtle, helped to create the world, with help from the sun and moon, which took on personalities and acted directly as entities. The devil took on the persona of a coyote, a mythological troublemaker, and was thought to have brought death to the people. Other mythological figures were represented as hummingbirds, lizards, dogs, and rattlesnakes. Spirits and shamans played important roles in Konkow life as advisors. Shamans often served as mediums to the spirits and communicated between spirits and the people. They had important roles in hunting and gathering traditions and served as spiritual advisors to the people.

The climate of the Konkow region was mild, with wet winters and dry summers. The winters had occasional freezing temperatures and fog and rain occurred in varying degrees through the seasons. The Feather, Yuba, Sacramento, and American rivers carved deep, narrow canyons through Konkow territory and created settlement sites situated on ridges, generally high above the rivers. Sites were also located on small flats on the crest of ridges, part way down canyon sides and on top of elevated knolls, sites that were better situated for defensive and attack positions.

During the summer the Konkow journeyed up into the mountains for hunting and down into the valleys for gathering grass seeds. Summer camps were established with structures for housing and ceremonies. The plants and animals that were gathered and hunted had multiple uses. The Konkow utilized flora and fauna to the fullest for specific purposes like food, shelter, clothing, tools, and medicines.

Common plants eaten included nuts from the digger pine, wild mint tea, cider made from manzanita, roots, and berries. Insects were also popular, with yellow jacket larvae, angleworms, locusts, grasshoppers and crickets making up part of the Konkow diet. Fishing with nets or fish traps was common. The first salmon had to be caught by a shaman. It was then cooked, and each man ate a piece before the fishing season could begin. Hunting tools included knives, spears, bows and arrows in order to catch prey. Of the many animals hunted or captured, the Konkow did not eat coyote, dog, wolf, bear or mountain lion.

Clothing during all seasons was scant and nose piercing helped to identify affiliation to secret societies, while tattoos were often worn by most village members. Willow, redbud, and hazelnut shoots were twined together to make baskets that served as both art and for purposes such as seed gathering. The Konkow basket weaving designs are distinctly different from other Maidu groups in terms of both materials used and patterns on the baskets.

Warfare between villages within a village community was more common than that between various native groups. Conflicts between villages were often due to blood revenge. This revenge could often be settled through payment of a sum of money to the offended party. The Konkow fought the Yana, while the Maidu had numerous foreign enemies, including the Washo, Yana, Achumawi and Paiute. Raiding and ambush were common warfare tactics, and the Konkow were known for capturing and torturing prisoners to death. Conflicts between the Konkow and whites began to occur after gold was discovered at Coloma in 1848. Before 1848, there had been little white intrusion into Konkow territory. Previous expeditions led by Gabriel Moraga in 1808, Captain Luis A. Arguello in 1821, and Jedediah Smith in 1828 were either far enough away from Konkow villages or not perceived as threatening by villagers.

In 1844, land grants within Konkow territory were issued and immigrants began to settle in the area. The malaria epidemic of 1833 decimated the Konkow population, along with many native groups, and the continuous discovery of gold hedged the Konkow in. The arrival of livestock and farms led to changes in the ecology that the Konkow could not battle. Their usual food sources became extinct or scarce, and natives countered the loss of their natural environment by killing and eating the settlers' livestock. Retaliation on both sides resulted until 1850 when Congress authorized treaties to place Indians on reservations. The Konkow signed one such treaty and by 1855, Konkow were removed to a reservation called Nome Lackee.

The status of the Konkow after their removal to reservations continued to decline. Like most California Indians, they suffer from high unemployment rates, poor housing and sanitation, and low educational achievement. There has been a renewed interest by Maidu and Konkow descendents in their traditional values and cultural expressions. The annual Maidu Bear Dance in Janesville is an attempt to preserve language, ceremonies, and the art of basket making among the Maidu groups. The pride of native ancestry indicates a continued interest in their cultural and history (Riddell 1978: 370-386).

At the time of Gabriel Moraga's 1808 expedition, there had been little contact between whites and Indians. Moraga set out from the Mission de San Jose with the intention of exploring California's interior for a suitable mission site. A dozen explorers traveled north and explored the San Joaquin, Cosumnes, Mokelumne and American rivers. The expedition was not considered a success since the party could not identify a suitable site and eventually the expansion of the mission system into the central valley was abandoned. In late 1821, Captain Luis Antonio Arguello, Commandant of the Presidio de San Francisco was ordered to conduct a military expedition into northern California to investigate reports of unlawful white settlement. His journal was heavily documented and recorded. Spanish law did not allow foreign settlers and Arguello and his heavily armed troop explored northern California, discovering Patwin tribes and confirming that the rumored white settlers were in fact known Russian settlers on the Pacific coast. Arguello's journal provided information on native groups in the area, and communicated the Spanish goals of securing land. When he and his troop encountered Indian villages, Arguello was clear in his intent to secure territory.

The movement of whites into the area that would become Glenn County began with those Spanish expeditions in 1808 and continued with trappers in the late 1820s before immigrants and farmers began to settle in the gold rush era. Glenn County and Hamilton City were far enough removed from the area occupied by missions to avoid European influences. Earlier Spanish expeditions confirmed that the central valley was not a suitable area for the mission system expansion. As a result, the native groups in the area did not suffer from the forced occupation and religious conversion that the missions brought to coastal and central valley native groups. Starting in 1828, fur trappers began to hunt through the Konkow territory, including Jedediah Smith and trappers from the Rocky Mountain Fur Company and Hudson's Bay Company. Trappers traveled all along the major waterways and smaller streams, introducing the malaria epidemic that decimated native populations in 1833. At least 20,000 Indians in the Central Valley were killed in the epidemic, including Nomlaki, Mechoopda, Konkow and Patwin tribes. The vast number of fur trappers along the rivers exhausted the natural environment and by the mid 1830s the rivers had been almost completely stripped. In addition to the malaria epidemic trappers and incoming settlers killed and enslaved Indians. Indians fought back with battles that were often bloody.

Glenn County was not formed until 1891, when it was separated from Colusa County. Both John Bidwell and Lieutenant John C. Fremont were early settlers to the early Glenn County area. Bidwell was employed by American Consul, Thomas O. Larkin, to scout for land grants in the Sacramento Valley. Bidwell was also employed by John Sutter to oversee commercial activity in Sutter's business concerns. Both Bidwell and Fremont owned land in the vicinity of Glenn County and had a strong interest in the economic development of the area. By 1844, Bidwell was actively searching for gold along the Bear River. His quest was interrupted by commitments as an administrator and manager to John Sutter and a 2-year stint as a Major in the U.S. Army during the Mexican War. After the Bear Flag Revolt and acquisition of the Oregon Territory, settlers began to settle both legally with Mexican land grants and illegally as squatters. In 1848, Bidwell wrote the contract between Sutter and James W. Marshall for construction of the mill on the American River where gold was discovered. Marshall's discovery served as the catalyst for the gold rush. Another early settler, Peter Lassen, worked with Fremont in 1848 to encourage out-of-state immigrants to northern California. Not much encouragement to settle in California was needed after gold was discovered in 1848.

Transportation to the area and within the territory became a priority to incoming immigrants. The rivers became major thoroughfares to move both people and freight via ferries and all manner of steam-powered boats. Other means of transportation included horseback, wagon, and travel by coach and foot. After 1849, trails and routes to California became more developed and easier to use. Stage lines were established in the 1850s. One of the main northern stage roads went from Sacramento through Hamilton City with thirteen roadhouses and hotels along the way. Stages made daily trips and helped bring settlers and visitors further north (The Nature Conservancy 2003: 39-51).

The railroad reached northern California in the 1860s, bringing an end to major river travel. Railroads were mostly built far away from rivers and waterways to avoid the floodplain and therefore changed the economic systems developed through river travel. River communities diminished and towns began to sprout up along the railroads. Hamilton City was established along a Southern Pacific line, though the railroad was not the original catalyst for the establishment of the city. In 1905, Hamilton City was founded as the site for a large sugar beet factory. Now operated by Holly Sugar Company, the city was originally named for J.G. Hamilton, president of the original sugar company (Hoover, et al 1990: 96).

References

Hoover, et al. 1990. Historic Spots in California: Fourth Edition. Stanford: Stanford University Press.

Moratto, Michael J. 1984. California Archaeology. Orlando: Academic Press, Inc.

Nature Conservancy, The. 2003. *Cultural Resource Overview and Management Plan: Sacramento River Conservation Area, Tehama, Butte, Glenn and Colusa Counties, California*. California State University, Chico, Archaeological Research Program Reports, No. 50.

Riddell, Francis A. 1978. Handbook of North American Indians. Volume 8. Washington: Smithsonian Institution.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

Environmental Resources Branch

AUG 11 2003

Dr. Knox Mellon
State Historic Preservation Officer
Office of Historic Preservation
P.O. Box 942896
Sacramento, California 94296-0001

Dear Dr. Mellon:

The U.S. Army Corps of Engineers, Sacramento District (Corps), is writing pursuant to 36 CFR 800.3(c)(3) to inform you of the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration feasibility study near Hamilton City and adjacent to the Sacramento River in Glenn County (enclosure 1). The area of potential effects (APE) is located on the Hamilton City, Foster Island, and Ord Ferry, California, 7.5-minute U.S.G.S. topographic maps, T22N R1W, on non-sectioned land (enclosure 2). In accordance with 36 CFR 800.4(a)(1), we are also requesting that you comment on the APE.

The Corps and The Reclamation Board of the State of California are conducting a feasibility study to develop and evaluate potential alternative plans to reduce flood damages and restore the ecosystem along the Sacramento River near Hamilton City. The feasibility study will be submitted to Congress in 2004 for consideration for Federal authorization to implement the project. State and/or local interests would be responsible for operation and maintenance of any project that is implemented.

The APE of the study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the east and the Glenn Colusa Canal to the west, and extends about 2 miles north and 6 miles south of Hamilton City. In accordance with 36 CFR 800.4(2), we are using a phased identification and evaluation process for the feasibility study. The proposed project is in the preliminary stage, and the APE may be adjusted as alternatives are considered and identified.

We have completed a records and literature search at the Northwest Information Center at California State University, Chico. We will also check the National Register of Historic Places and the California Historic Bridge Inventory, conduct a field survey, and obtain a list of potentially interested Native Americans from the Native American Heritage Commission.

Comments on the APE may be sent to Ms. Melissa Montag (CESPK-PD-R), U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922. If you have any questions, please contact either Ms. Montag, Historian/Social Scientist, at (916) 557-7907 or email: melissa.l.montag@usace.army.mil, or Mr. Richard Perry, Archeologist, at (916) 557-5218 or email: richard.m.perry@usace.army.mil. Please contact Mr. Jerry Gianelli, Project Manager, at (916) 557-7828 with any specific project questions.

Sincerely,

Tanis J. Toland

Tanis J. Toland
Chief, Environmental Analysis Section

Enclosures

STATE OF CALIFORNIA – THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, *Governor*

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 942896
SACRAMENTO, CA 94296-0001
(916) 653-6624 Fax: (916) 653-9824
calshpo@ohp.parks.ca.gov
www.ohp.parks.ca.gov

January 22, 2004

REPLY TO: COE030812A

Tanis J. Toland
Chief, Environmental Analysis Section
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

Re: Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study, Hamilton City, Glenn County

Dear Ms. Toland:

Thank you for your August 11, 2003 submittal that initiates consultation with me regarding the undertaking referenced above. You are consulting with me in accordance with 36 CFR Part 800, regulations implementing Section 106 of the National Historic Preservation Act. Specifically, you are requesting my concurrence with the Corps' determination of the Area of Potential Effects (APE) for this undertaking.

Your letter explains the Corps is conducting a feasibility study to develop and evaluate potential alternative plans to reduce flood damages and restore the ecosystem along the Sacramento River near Hamilton City. Your letter explains that the project is in the preliminary stage and the APE may be adjusted as alternatives are considered and identified. As long as all alternatives are contained within the red line depicting the APE you have enclosed with your letter, I do not object to the Corps' APE for this undertaking. I stress that should alternatives be implemented that are outside this area, the Corps should submit a revised APE for my review.

Your letter continues, explaining some of the efforts the Corps will put forth in the identification of historic properties. I look forward to reviewing the Corps compliance efforts pursuant to 36 CFR §800.4(a)-(d). If you have any questions about my comments, please contact staff archaeologist Anmarie Medin at (916) 653-8920 or at amedi@ohp.parks.ca.gov.

Sincerely,

for

Dr. Knox Mellon
State Historic Preservation Officer

DRAFT
January 27, 2004

Socioeconomic Profile of Hamilton City CDP (1)

2000 Population (2)	
Hispanic/Latino	1,533
White	330
American Indian	10
Asian	6
Black/African American	5
Other	19
Total	1,903
1999 Per Capita Income	
Hamilton City (2)	$9,050
Glenn County (3)	$18,015
California (3)	$29,910

(1) CDP = census designated place, which is a densely settled concentration of population that is not within an incorporated place but is locally identified by a name
(2) US Census; CDP data
(3) CA Department of Finance

B.3: Air Quality

GLENN COUNTY

AG COMMISSIONER
P.O. Box 351
Willows, CA 95988
Phone: 530.934.6501/Fax: 530.934.6503
E-mail: Agcommr@countyofglenn.net

AIR POLLUTION OFFICE
P.O. Box 351
Willows, CA 95988
Phone: 530.934.6500/Fax: 530.934.6503
E-mail: Airpollution@countyofglenn.net

Date: 7/9/03

To: JOSH GARCIA

Fax#: 916-557-7856

From: R. STEWARD

Number of pages (including this one): 3

Message:

JOSH,

2 PAGES TO FOLLOW

REGARDING MITIGATION MEASURES FOR SMALL PROJECTS.

SERVER/AG/FORMS
02.08.03

MITIGATION MEASURES
SMALL PROJECTS

CONSTRUCTION PHASE

1. Grading and excavation activities shall be suspended when wind conditions exceed 20 miles per hour.
2. Trucks hauling dirt, sand, gravel, soil, or other loose material shall be covered or shall maintain at least two feet of freeboard in accordance with the requirements of California Vehicle Code §23114. This provision shall be enforced by local law enforcement agencies.
3. Construction sites shall be watered to keep dust movement at a minimum. Dust which is tracked off the construction site onto public roadways or is wind-blown off-site may be deemed a nuisance by the local air district and subject to enforcement action.
4. Incorporate the use of soil stabilizers or palliatives to minimize dust from construction activities.
5. Reestablish ground cover on the construction site through seeding and watering prior to final occupancy.
6. Provide temporary traffic control as appropriate during all phases of construction to improve traffic flow (e.g. flag person).
7. Schedule construction activities that affect traffic flow to off-peak hours.
8. Sweep streets at the end of the day if visible soil materials are carried onto adjacent public paved roads (recommend water sweeper with reclaimed water).
9. Reduce traffic speeds on all unpaved roads surfaces to 15 miles per hour or less.

LAND USE MEASURES

1. Use low-VOC (less than 3.5 pounds of VOC per gallon) architectural coatings.
2. Landscape to provide passive solar benefits.
3. Introduce energy efficient window glazing, wall insulation, and ventilation methods.

4. Incorporate sidewalks, walkways, and bike paths into the development design so that more direct and convenient access for those modes of travel which will encourage their use.

5. Orient buildings for passive solar design.

6. Tree planting in excess of that already required.

7. Landscape with native drought-resistant species to reduce water consumption and to provide passive solar benefits.

TECHNOLOGICAL MEASURES

1. Improve the thermal integrity of building(s) and reduce the thermal load with automated time clocks or occupant sensors.

2. Provide adequate high efficiency lighting for those who walk or ride at night to increase actual and perceived personal safety.

3. Incorporate appropriate high efficiency passive solar design and solar heaters.

4. Provide energy-efficient process systems, such as water heaters, furnaces, and boiler units.

5. All new wood burning devices shall be EPA Phase II certified.

6. Install an electrical outlet at the front and back of all residential units for electrical yard equipment.

TRANSPORTATION/CIRCULATION MEASURES

1. Provide adequate ingress and egress at entrances to project to minimize vehicle idling at curbsides.

2. Provide dedicated turn lanes as appropriate (in cooperation with Public Works and/or Cal Trans),

3. Site design to maximize bicycle and pedestrian access to and within the project.

B.4: Notices

BILLING CODE: 3710-EZ

DEPARTMENT OF DEFENSE

Department of the Army; Corps of Engineers

Intent to Prepare a Joint Environmental Impact Statement and Environmental Impact Report for the Sacramento and San Joaquin River Basins Comprehensive Study, Hamilton City Flood Damage Reduction and Ecosystem Restoration, Glenn County, CA

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DOD.

ACTION: Notice of intent.

SUMMARY: A combined Feasibility Report and joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) will be prepared to satisfy the requirements of the National Environmental Policy Act and the California Environmental Quality Act. The U.S. Army Corps of Engineers (Corps), Sacramento District, will serve as the Federal lead agency for the EIS with The Reclamation Board of the State of California (the Board), the non-federal sponsor, serving as the State lead agency for the EIR. The combined Feasibility Report and joint EIS/EIR will evaluate the environmental effects of a potential flood damage reduction and ecosystem restoration project at Hamilton City. The Hamilton City Flood Damage Reduction and Ecosystem Restoration is the first site-specific evaluation to be initiated as a result of the Sacramento and San

Joaquin River Basins Comprehensive Study conducted by the Corps and the Board. Concurrently with the release of this notice of intent (NOI), the Board is issuing a notice of preparation (NOP) to initiate the CEQA process.

Scoping and public involvement activities were conducted under the original NOI issued for the Comprehensive Study. A series of scoping and outreach meetings were held in February through May 1998, November through December 1998, February 1999, June 1999, October through November 2001, and August through September 2002. Development of the EIS/EIR for the Comprehensive Study was at a programmatic level with the preliminary site-specific evaluation for Hamilton City Flood Damage Reduction and Ecosystem Restoration packaged as an attachment to the main programmatic document. The Comprehensive Study has since discontinued the environmental documentation effort and therefore this NOI is being submitted to establish that the Feasibility Report and EIS/EIR for Hamilton City Flood Damage Reduction and Ecosystem Restoration will continue as a separate and complete document.

FOR FURTHER INFORMATION CONTACT: Questions about the combined Feasibility Report and joint EIS/EIR can be answered by Erin Taylor at (916) 557-6862 or by mail at U.S. Army Corps of Engineers, Planning Division, ATTN: Erin Taylor, 1325 J Street, Sacramento, CA 95814-2922, or e-mail: Erin.A.Taylor@usace.army.mil

SUPPLEMENTARY INFORMATION:

1. Proposed Action.

The combined Feasibility Report and joint EIS/EIR will evaluate ways to reduce the risk of flooding and restore the Sacramento River's connection with its flood plain, natural flood plain processes, and riparian and associated flood plain habitat.

2. Alternatives.

Alternatives include the no-action, reinforcing the existing levee, several setback levee alignments at some distance from the river, and flood-proofing or relocating structures at risk of flooding, with different habitat configurations and methods of establishment. Maximum area of potential affect is estimated to be 2,600 acres currently held by a combination of private, State, and Federal agencies. Fee title and/or conservation and flood easements would likely be required to implement any project. The Corps will conduct site-specific hydrologic, hydraulic and geotechnical analyses, to determine the most suitable potential levee alignments and the feasibility of repairing the existing levee in place. The Feasibility Study will focus on the economic feasibility and will run a risk analysis of the alternatives. Ecosystem restoration would consist of either planting native habitat or allowing native habitats to establish naturally in the area between any new levee and the river. Selection of a preferred alternative will depend on the result of these studies and the desires of the local community.

3. Scoping Process.

a. This notice re-initiates the scoping process whereby the Corps and the Board will identify the scope of issues to be addressed in the EIS/EIR and identify the significant environmental issues related to the flood damage reduction and ecosystem restoration at Hamilton City. The Corps and the Board have initiated a process of involving Federal, State, and local agencies, and concerned individuals under the Comprehensive Study.

b. Significant issues to be analyzed in depth include; agricultural resources, air quality, biological resources, cultural resources, geology and soils, hazardous, toxic, and radioactive materials, hydrology and water quality, and land use.

4. Public Meeting Scoping.

Community meetings will be held during scoping, after the release of the draft EIS/EIR, and after release of the final EIS/EIR. A public scoping meeting will be held the week of January 6, 2003. The purpose of the meeting is to explain the NOI/NOP, and to solicit suggestions, recommendations, and comments to help refine the issues, measures, and alternatives to be addressed in the EIS/EIR. The public is asked to submit any issues (points of concern, dispute or disagreement) regarding potential effects of the proposed action or alternatives by mail to Corps (see FOR FURTHER INFORMATION CONTACT above for address).

5. Availability.

The draft EIS/EIR is scheduled to be available for public review and comment in August 2003. The comment period on the draft EIS/EIR will be 45 days from the date the notice of availability is published in the Federal Register by the Environmental Protection Agency. All interested parties should respond to this notice and provide a current address if they wish to be notified of the draft EIS/EIR circulation and future scoping meeting dates.

Date:

MICHAEL J. CONRAD JR.
COL, EN
Commanding

BILLING CODE: 3710-EZ

DEPARTMENT OF DEFENSE

Department of the Army; Corps of Engineers

Availability for the Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report for the Hamilton City Flood Damage Reduction and Ecosystem Restoration, Glenn County, CA

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DoD

ACTION: Notice of availability.

SUMMARY: The U.S. Army Corps of Engineers (Corps), in coordination with The Reclamation Board of the State of California and the Hamilton City Community Services District, have prepared a Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report (DFR/DEIS-EIR) for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, Glenn County, CA.

DATES: The DFR/DEIS-EIR is being made available for a 45-day public comment period. All comments should be submitted on or before May 17, 2004.

ADDRESSES: Send written comments to U.S. Army Corps of Engineers, Sacramento District, ATTN: Ms. Erin Taylor/Environmental Analysis Section, 1325 J Street, Sacramento, CA 95814-2922.

FOR FURTHER INFORMATION CONTACT: To obtain additional information related to this report, interested persons are invited to contact the following: Ms. Erin Taylor, Environmental Manager, U.S. Army Corps of Engineers, 1325 J Street, Sacramento, CA 95814-2922, (916) 557-5140 or fax (916) 557-7202, email compstudy@usace.army.mil.

SUPPLEMENTARY INFORMATION:

1. Report Availability. Printed copies of the DFR/DEIS-EIR are available for public inspection and review at the following locations:

a. U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, CA 95814-2922.

b. Hamilton City Library, Reference Section, P.O. Box 1055, Hamilton City, CA 95951-1055.

c. Bayliss Library, Reference Section, 7830 County Road 39, Glenn, CA 95943.

d. Corning Library, Reference Section, 740 3rd Street, Corning, CA 96021.

e. Orland City Library, Reference Section, 333 Mill Street, Orland, CA 95963.

f. Willows Public Library, Reference Section, 201 North Lassen Street, Willows, CA 95988.

The entire DFR/DEIS-EIR may also be viewed on the U.S. Army Corps of Engineers, Sacramento District website at the following address: http://www.compstudy.org

2. Commenting. Comments received in response to this report, including names and addresses of those who comment, will be considered part of the public record on this proposed action. Comments submitted anonymously will be accepted and considered. Pursuant to 7 CFR 1.27(d), any person may request the agency to withhold a submission from the public record by showing how the Freedom of Information (FOIA) permits such confidentiality. Persons requesting such confidentiality should be aware that under the

FOIA, confidentiality may be granted in only very limited circumstances, such as to protect trade secrets. The Corps will inform the requester of the agency's decision regarding the request for confidentiality, and where the request is denied, the agency will return the submission and notify the requester that the comments may be resubmitted with or without the name and address.

Date	MICHAEL J. CONRAD, Jr. COL, EN Commanding

B.5: Natural Resources Conservation Service (NRCS) Coordination Letter

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

September 15, 2003

Environmental Resources Branch

HUE-DANG [illegible]

Mr. Phil Hogan
U.S. Natural Resources Conservation Service
Woodland Field Office
221 West Court Street, Suite 5
Woodland, California 95695-3012

David Rose, Willows FO

Dear Mr. Hogan:

We are requesting a Farmland Conversion Impact Rating for our Hamilton City Flood Damage Reduction and Ecosystem Restoration Project. The rating is to help us address the impacts from constructing a setback levee and restoring the ecosystem within the new setback levee alignment and the river channel. There are currently two action alternatives and one no action alternative being considered. We are requesting an assessment of the maximum extent of potential agricultural conversion. The study area has been divided into zones for ease of assessment (attached). A maximum total of 1550 acres could be converted to restoration by this project.

Enclosed are a vicinity map, a regional map, a Farmland Conversion Impact Rating form, and the potential restoration zone map. Of note on this map, there are two areas already being restored that are not a part of this project including the DFG and USFWS property. In addition, the zone B2 is currently not being proposed for restoration.

To meet our project schedule, we would appreciate receiving your impact rating for the proposed project within 30 days. If you have any questions, contact Erin Taylor of our Environmental Resources Branch at (916) 557-6862.

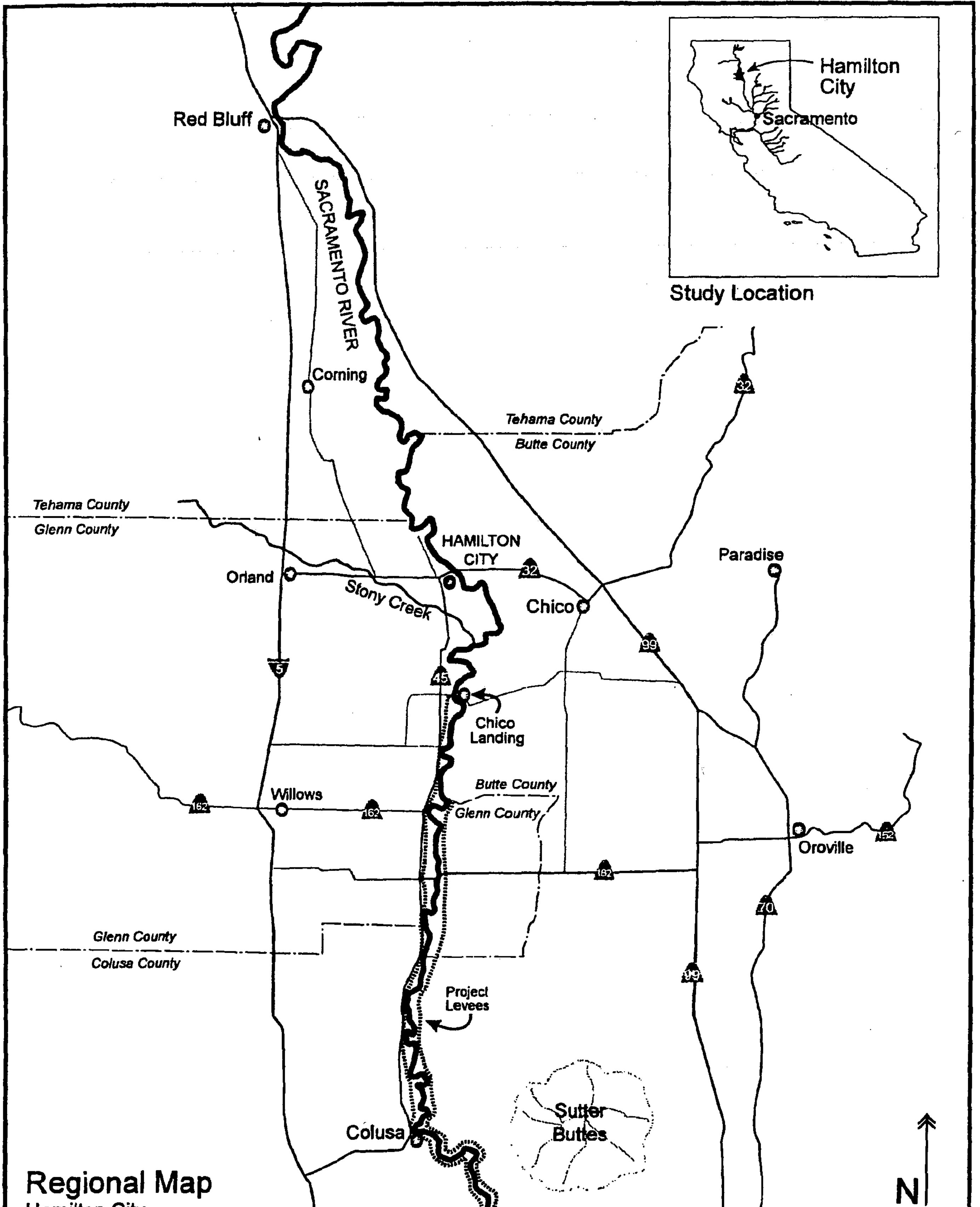
Sincerely,

Tanis J. Toland

Tanis J. Toland
Chief, Environmental Analysis Section

SEP 2003
RECEIVED

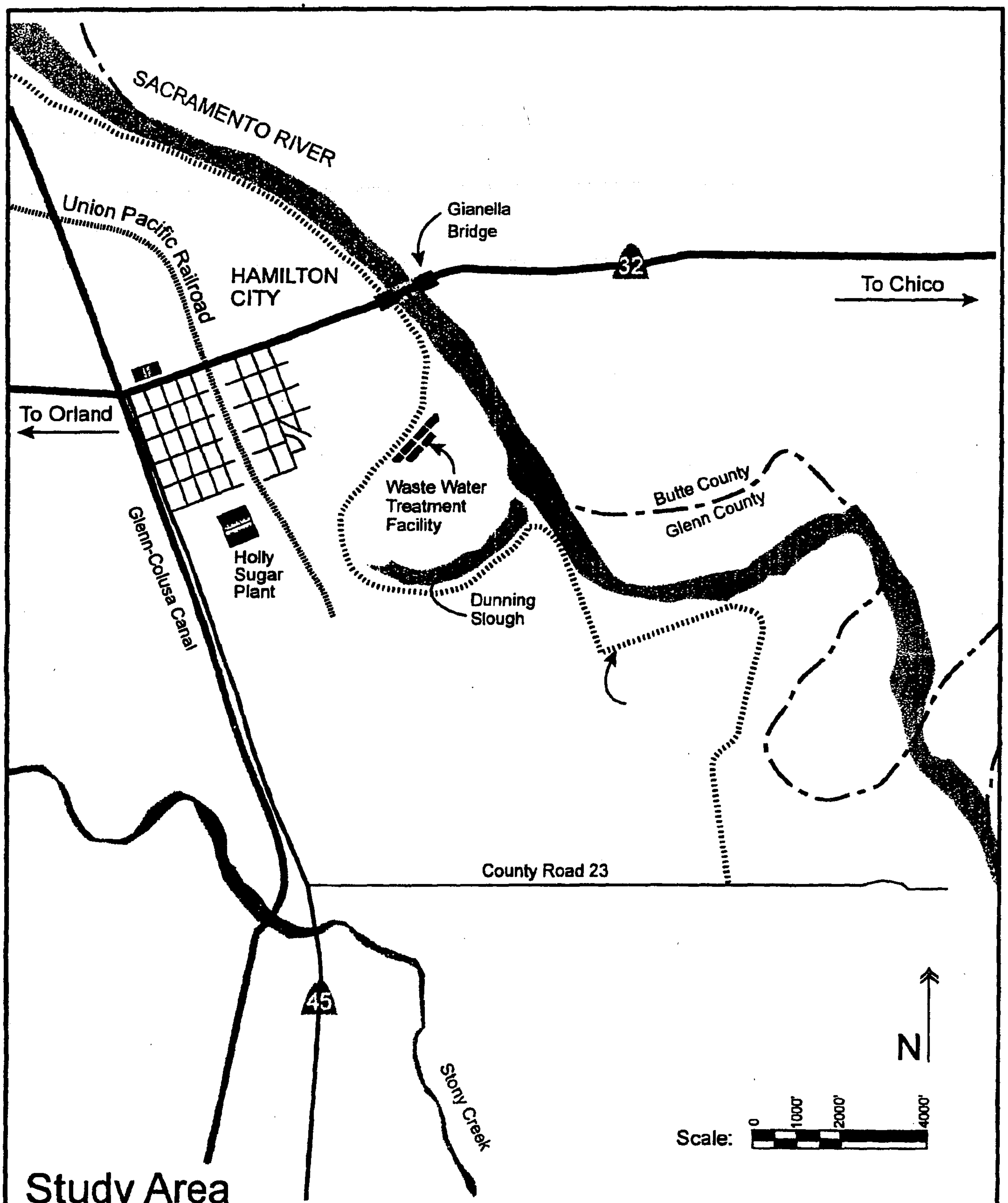
OCT 03 REC'D



Regional Map

Hamilton City

Flood Damage Reduction and Ecosystem Restoration



Study Area

Hamilton City

Flood Damage Reduction and Ecosystem Restoration

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*

Date Of Land Evaluation Request 9/5/03

Name Of Project Hamilton City Flood Damage Reduction and Ecosy

Federal Agency Involved U.S. Army Corps of Engineers

Proposed Land Use Setback levee and Restoration

County And State Glenn County, California

PART II *(To be completed by NRCS)*

Date Request Received By NRCS 9/30/03

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply – do not complete additional parts of this form).* Yes ☑ No ☐

Acres Irrigated 213,111

Average Farm Size 250

Major Crop(s) Rice, almonds, prunes

Farmable Land In Govt. Jurisdiction Acres: 451,163 % 53

Amount Of Farmland As Defined in FPPA Acres: 212,005 % 25

Name Of Land Evaluation System Used California System

Name Of Local Site Assessment System N/A

Date Land Evaluation Returned By NRCS 10/27/03

PART III *(To be completed by Federal Agency)*	Alternative Site Rating			
	Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	1,550.0			
B. Total Acres To Be Converted Indirectly	0.0			
C. Total Acres In Site	1,550.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland	1195			
B. Total Acres Statewide And Local Important Farmland	186			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted	0.34%			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value				
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*	0 75	0 (Storie INDEX)	0	0

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use					
2. Perimeter In Nonurban Use					
3. Percent Of Site Being Farmed					
4. Protection Provided By State And Local Government					
5. Distance From Urban Builtup Area					
6. Distance To Urban Support Services					
7. Size Of Present Farm Unit Compared To Average					
8. Creation Of Nonfarmable Farmland					
9. Availability Of Farm Support Services					
10. On-Farm Investments					
11. Effects Of Conversion On Farm Support Services					
12. Compatibility With Existing Agricultural Use					
TOTAL SITE ASSESSMENT POINTS	160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	0	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	0	0	0	0

Site Selected:

Date Of Selection

Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

(See Instructions on reverse side)

This form was electronically produced by National Production Services Staff

Form AD-1006 (10-83)

Erin

USDA United States Department of Agriculture

Natural Resources Conservation Service

132 No. Enright, Suite B
Willows, CA 95988
(530) 934-4601, Ext.3

October 27, 2003

Tanis Toland
US Army Engineering District, Sacramento
Corps of Engineers
1325 J St
Sacramento, CA 95814-2922

RE – Hamilton City Project

Per your request, I have enclosed the Farmland Conversion Impact Rating for the proposed site.

The soil information shows the proposed project location does contain prime, unique, statewide, or local important farmland.

Sincerely,

Vincent Obersinner
Conservationist

Enclosures: Project soils list

---

10 · 29 · 03

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 9/5/03
Name Of Project Hamilton City Flood Damage Reduction and Ecosy	Federal Agency Involved U.S. Army Corps of Engineers
Proposed Land Use Setback levee and Restoration	County And State Glenn County, California
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 9/30/03

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply – do not complete additional parts of this form).* Yes ☑ No ☐	Acres Irrigated 213,111	Average Farm Size 250
Major Crop(s) Rice, almonds, prunes	Farmable Land In Govt. Jurisdiction Acres: 451,163 % 53	Amount Of Farmland As Defined in FPPA Acres: 212,005 % 25
Name Of Land Evaluation System Used California System	Name Of Local Site Assessment System N/A	Date Land Evaluation Returned By NRCS 10/27/03

			Alternative Site Rating			
PART III *(To be completed by Federal Agency)*			Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly			1,550.0			
B. Total Acres To Be Converted Indirectly			0.0			
C. Total Acres In Site			1,550.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information						
A. Total Acres Prime And Unique Farmland			1195			
B. Total Acres Statewide And Local Important Farmland			186			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted			0.34%			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value						
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*			0 75	0 Storie INDEX	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*		Maximum Points				
1. Area In Nonurban Use	15	15	90% or more non-urban			
2. Perimeter In Nonurban Use	10	10	90% or more perimeter non-urban			
3. Percent Of Site Being Farmed	20	20	90% or more farmed for more than 5 of last 10 years			
4. Protection Provided By State And Local Government	20	7	about 1/3 of site protected. Score 1/3 of total			
5. Distance From Urban Builtup Area	15	0	Part of levee less than 750' from town			
6. Distance To Urban Support Services	15	0	part of levee less than .5 mi from town			
7. Size Of Present Farm Unit Compared To Average	10	7	210/250 = .84			
8. Creation Of Nonfarmable Farmland	10	1	does not impact neighboring farming			
9. Availability Of Farm Support Services	5	5	area farmed, so assume nearby			
10. On-Farm Investments	20	18	high quality on-farm investments - orchards, irrigation			
11. Effects Of Conversion On Farm Support Services	25	9	some reduction in demand			
12. Compatibility With Existing Agricultural Use	10	3	somewhat incompatible			
TOTAL SITE ASSESSMENT POINTS		175 160	0 95	0	0	0
PART VII *(To be completed by Federal Agency)*						
Relative Value Of Farmland *(From Part V)*		100	0 75	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*		160	0 95	0	0	0
TOTAL POINTS *(Total of above 2 lines)*		260	0 170	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

P = F/H

(See Instructions on reverse side)

This form was electronically produced by National Production Services Staff

Form AD-1006 (10-83)

GLENN COUNTY SOILS IN PROJECT SITE

				—FARMLAND—	
SYMBOL	***LCC***	***MAP UNIT***	***DEPTH***	***PRIME***	***STATE WIDE IMPORT***
AoA	IIIs4	Arbuckle gravelly loam, 0 to 2 % slopes, grvly lm	60	Y	
CeA	IIIc1	Columbia fine sandy loam, 0 to 2 % slope	60	Y	
CgA	IIIw2	Columbia loamy fine sand, coarse variant, 0-2 % slopes	60	Y	
ChA	IIIw2	Columbia silt loam, 0 to 2 % slopes	60	Y	
ChB	IIIw2	Columbia silt loam, 2 to 8 % slopes	60	Y	
Wn	IIIc1	Wyo silt loam	60	Y	
Cf	IIIw0	Columbia fine sandy loam, moderately deep over sand and gravel, 0 to 2 % slopes	60		Y
Cl	IIIs3	Columbia silt loam, moderately deep, over clay pan, 0 to 1 % slopes	60		Y
Cm	IIIs0	Columbia silt loam, moderately deep over gravel, 0 to 2 % slopes	60		Y
CpB	IIIw3	Columbia silt loam, water table, 1 to 8 % slopes	60		Y

B.6: Water Quality

CLEAN WATER ACT SECTION 404(b)(1) EVALUATION

Hamilton City Flood Damage Reduction and Ecosystem Restoration, California

I. PROJECT DESCRIPTION

A. Location.

The Hamilton City Flood Damage Reduction and Ecosystem Restoration project (Hamilton City project) is located near Hamilton City, California. The project area starts at Country Road 203, 1.5 miles north of Hamilton City, crosses Highway 32, 0.65 miles east of Hamilton City, and ends at Highway 23, 1.8 miles south of Hamilton City. Hamilton City is located 36 miles north of Colusa, California.

B. General Description.

The Hamilton City project would provide Hamilton City with flood protection with a setback levee built to the U.S. Army Corps of Engineers (Corps) requirements. The project would also help reconnect the Sacramento River to portions of the floodplain and restore some of the habitat along the river that was disconnected from the river due to past flood control protection.

C. Description of Dredge or Fill Material.

The proposed fill material would be up to 60 feet of rock riprap placed on and around the Gianella Bridge abutment to protect the bridge from erosion.

D. Alternatives

1. No Action.

Under this alternative the Corps would not construct or restore the levees around Hamilton City. There would be no restoration of the flood plans near the Sacramento River. The "J" levees would continue to be privately maintained and flood fighting would continue to be required during high flow events in the river. The levees would continue to be relatively poor geotechnical condition and erosion at the toe of the levee at the northern end of the "J" levee would continue. Other habitat restoration on DFG and USFWS property and flood control projects would continue in the Hamilton City area.

2. Alternative 1

This alternative would construct a 6.6-mile long and 6-foot tall levee roughly 500 to 7,600 feet from the river. Most of the existing "J" levee would be removed or breached to reconnect the river to the surrounding flood plan. Approximately 1,300 acres of land would be restored.

North of Highway 32, the levee alignment ties to the newly constructed Glenn County backup levee and runs roughly parallel to and approximately 500 feet to the west of the Sacramento River. At Highway 32, the levee would tie into the existing approach to the Gianella Bridge. The highway would not be raised, but approximately 60 feet of rock riprap would be placed on and around the abutment.

South of Highway 32, the alignment would cut across the easternmost section of the Irvine Finch River Access, requiring modifications of the river access entrance and parking lot. The alignment would also cut across a portion of Dunning Slough providing protection to the Hamilton City wastewater treatment ponds, abandoned holding ponds for the Holly Sugar plant, and a lime disposal pile. Approximately 1,500 feet of rock would be placed on the setback levee in Dunning Slough as erosion protection.

All the land on the waterside of the setback levee would be actively restored to riparian, scrub, oak savannah, willow scrub, and grassland habitat. The "J" levee would be breached or removed, except for the portions of the levee that would reduce flow velocities for the established restored habitats.

At the north end of the project, entrenched rock would be buried in a 1,500 foot-long trench parallel to County Road 203 and approximately 200 feet from the toe of the levee. The new levee at the southern end of the project area would be planted to a significant amount to protect the levee from erosion due to water velocities.

3. Alternative 4

This alternative would construct a 4.1-mile long and 6-foot tall levee, set back approximately 500 to 2,700 feet from the river. This alternative would remove most of the existing "J" levee and restore approximately 1,100 acres of habitat. The levee alignment between where the levee ties into the Glenn County backup levee to the southern end of Dunning Slough is the same as Alternative 1. The levee would then wrap around Holly Sugar Plant and tie into the high ground along Highway 45.

The location and amount of riprap and entrenched rock would the same as alternative 1.

4. Alternative 5

This alternative would construct a 5.3-mile long and 6-foot tall levee, remove most of the existing "J" levee to reconnect the river to the surrounding flood plain, and restore 1,600 acres of native vegetation.

The setback levee alignment would begin two miles north of Hamilton City, where the northern end of the levee ties into high ground. The levee would then run southeast along County Road 203 until turning east and run parallel to and about 1,300 feet west of the Sacramento River, following higher ground. On the eastern edge of the town, the levee would cross Highway 32 and run south along a new housing development. This alignment would require raising Highway 32, protecting the highway and bridge from erosion due to a flood event, and relocate a remnant slough that creates emergent wetland habitat and is used to detain and convey storm water runoff. At the south end of town, the levee would wrap around Dunning Slough and then follow the western edge of The Nature Conservancy property before turning east and ending at the southern end of the "J" levee at Road 23 with a training dyke continuing below that line. This alternative dose not tie into the high ground and would allow for backwater to flood adjacent agriculture land.

On the waterside of the setback levee, approximately 1,600 acres of land would be restored to natural habitat. 1050 acres of riparian, 300 acres of scrub, 150 acres of savannah, and 100 acres of grassland would be restored. The "J" levee would be removed except for the portions that would protect the restoration from water velocities. Native vegetation would restore most of the TNC lands that is in the study area. Restoration would occur on the land directly east of Hamilton City between Highway 32 and Dunning Slough, and land in Dunning Slough. Existing orchards in the project area would be removed and native vegetation would be planted.

Erosion controls would be the same as Alternative 1.

5. Alternative 6

This alternative would construct a 5.7-mile long and 6-foot levee, remove most of the existing "J" levee, and restore 1,500 acres of native vegetation.

North of Highway 32, the levee would tie into the high ground at the northern end of the "J" levee, about two miles north of Hamilton City. The levee would run south along County Road 203 until turning east and run parallel to and about 1,300 feet to the west of the Sacramento River, following higher ground. At Highway 32, the levee would turn east and run parallel to the highway until tying into the approach to Gianella Bridge. The highway would not be raised in this alternative plan, but 1,000 foot of rock riprap would be placed on and around the bridge abutment.

South of Highway 32, the levee would follow the existing "J" levee. Some modifications would be done to the river access entrance and parking lot during the levee construction. The alignment would cross a portion of Dunning Slough providing protection to the Hamilton City wastewater treatment plant, some abandoned holding ponds for the Holly Sugar plant, and a lime disposal pile.

South of Dunning Slough, the levee alignment is same as alternative 4, except that the land directly east of Hamilton City between Highway 32 and Dunning Slough would be restored and the area south of Road 23 would be restored. The levee would continue south of Road 23 in the form of a training dyke.

The re-vegetation would be restored to riparian forest, scrub, oak savannah, willow scrub, and grasslands. The land in the middle of Dunning Slough would be restored to an oak savannah due to the higher elevation. Most of the "J" levee would be removed, except for the portions that would be used to reduce the water velocities of the Sacramento River.

The erosion controls would be the same as Alternative 1.

7. Preferred Alternative.

The preferred alternative has been identified as Alternative 6.

II. FACTUAL DETERMINATIONS.

A. Physical/chemical Characteristics and Anticipated Changes.

1. Suspended Particulates; Turbidity.

Turbidity could affect the water quality of the Sacramento River in the project area during the placement of the rock riprap on and around the Gianella Bridge abutment and during any construction work that may occur near the riverbank. The construction work that would be near the river or the construction that may affect water quality includes restoration work, orchard removal, levee breaching, and placing rock riprap in the river under the Gianella Bridge.

2. Current Patterns and Circulation.

There would be no change to the flow patterns of the Sacramento River.

3. Normal Water Level Fluctuations.

There would be no change to the river's water levels.

4. Water Quality (temperature, salinity patterns, and other parameters).

Temperature and salinity would not be affected by this project. Construction could have a temporary adverse effect on water quality due to heavy equipment operation, exposure of bare soil areas during storm events, breaching of the existing levees. These activities could result in erosion during a storm or flood event, increase turbidity, or sedimentation released into the Sacramento River. The setback levee would be constructed away from the river and would not affect the water quality of the Sacramento River. These effects would be a temporary adverse affect on water quality during the construction of the project. After construction is complete the water quality of the Sacramento River would return to preexisting conditions.

Alternative 5 would place fill material into a drainage ditch utilized by Hamilton City to contain runoff and would not be subject to the 404(b)(1) evaluation for the construction of the setback levee. A total of 45 acres of wetlands would be restored in the restoration area waterside of the setback levee at 3:1 ratio to off set the adverse effects to the ditch/wetland.

5. Flood Control Functions.

The removal of most of the "J" levee and the construction of the setback levee would reconnect the river to the surrounding floodplain. The reconnection to the floodplain would increase the flood capacity of the river near Hamilton City. The setback levee would provide the Hamilton City area with the required flood damage protection.

6. Storm, Wave, and Erosion Buffers.

There are no storm or wave buffers associated with this project.

The restored areas of land on the waterside of the setback levee would help stabilize the banks of the river in the project area. To protect the Gianella Bridge from bank erosion 1,000 feet of rock riprap would be placed on and around the bridge abutment. This would protect the riverbanks under the bridge from erosion due to water velocities during a flood event. Entrenched Rock would be Buried in a 1,500 foot-long trench at the north end of the levee. The trenched rock would be placed parallel to County Road 203 and approximately 200 feet from the toe of the levee. At Dunning Slough 500 feet of rock riprap would be placed along the levee at the bend that would be exposed to overland water flows. At the southern most end of the levee would be planted with significant amounts of vegetation to reduce the water velocities at the levee.

7. Erosion and Accretion Patters.

The erosion of the levee toe at the northern end of the existing "J" levee would be repaired and protected. The construction of the setback levee and the restoration sites would be protected from erosion with plantings. Erosion at the Gianella Bridge would be protected by rock riprap.

8. Actions to Minimize Effects.

Silt fences, wattles, straw mulch, detention ponds and other best management practices as needed would be used to keep sediment and storm water runoff from entering the Sacramento River. Rock riprap would be washed before being placed in the river for erosion protections. Avoid destroying existing vegetation when possible, seed and stabilize all disturbed soils after construction is complete, and the development of an erosion and sediment control plan incorporating a site drainage plan consistent with the Regional Water Quality Control Board would be developed by the contractor to minimize the adverse effects to water quality.

There would be short-term adverse affects on recreational fisheries in the project area. Access to the recreational facilities could be adversely affected during the construction of the setback levee. Modifications to the access would be conducted as needed to allow the public access to the facility during construction. The project would have long term benefits for recreational fishing by creating addition habitat for fisheries, which would increase the population of fish in the project area. The effects to commercial fisheries would be similar to recreational fisheries.

3. Water Related Recreation.

The adverse affects and long-term benefits would be the same as the recreational and commercial fisheries.

4. Parks, National, Historical Monuments, National Seashores, Wild and Scenic Rivers, Wilderness Areas, and Research Sites.

This project would have no effect on parks, national, historical monuments, national seashore, wild and scenic rivers, wilderness area, and research sites. Historical and cultural sensitive sites would be avoided during construction.

E. Determination of Cumulative Effects on the Aquatic Ecosystem.

This project would have cumulative long-term benefits with other restoration projects near the project area. This project could have an adverse significant affect on agriculture land due to the loss of agriculture land in other parts of Central Valley. The long-term productivity of the agriculture in the project area has been decreasing due to flooding and erosion in the project area. The improved flood protection would contribute to higher long-term productivity on agricultural lands on the landside of the setback levee.

F. Determination of Secondary Effects on Aquatic Ecosystem.

There would be no adverse secondary effects to the water quality and aquatic habitat anticipated from the project construction. There would be some minor, short-term adverse construction effects. Best management practices would be implemented to minimize these adverse effects.

III. FINDINGS OF COMPLIANCE

A. Adaptation of the Section 404(b)(1) Guidelines to this Evaluation.

No significant adoption of the guidelines was made for this evaluation.

B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site, Which Would Have Less Adverse Effect on Aquatic Ecosystem.

There are no other practicable alternatives to the proposed action.

C. Compliance with Applicable State Water Quality Standards.

The proposed fill would not violate any applicable State water quality standards.

D. Compliance with Applicable Toxic Effluent Standard or Prohibition Under Section 307 of the Clean Water Act.

The proposed fill would not violate the toxic effluent standards of Section 307 of the Clean Water Act.

E. Compliance with Endangered Species Act of 1973.

The proposed fill would not have a significant adverse effect on any endangered species or critical habitat.

F. Compliance with Special Protection Measures for Marine Sanctuaries Designated by the Marine Protect, Research, and Sanctuaries Act of 1972.

The project is not located in an area that would affect marine resources.

G. Evaluation of Extent of Degradation of the Waters of the United States.

The proposed fill activities would have minor, short-term adverse effects on sedimentation and turbidity. This project should have some long-term beneficial effect on sedimentation and turbidity.

H. Appropriate and Practicable Steps to Minimize Potential Adverse Effects of the Discharge on the Aquatic Ecosystem.

The project would develop vest management practices and mitigation measures to avoid significant adverse effects on water quality.

I. On the basis of the Guideline, the proposed disposal site for the discharge of fill material is specified as complying with the requirements of these Guidelines.

B.7: Land Evaluation and Site Assessment/Farmland Conversion

SUPPLEMENTAL INFORMATION ON CONVERSION OF AGRICULTURAL LANDS

ASSESSMENT OF EFFECTS OF CONVERSION OF AGRICULTURAL LANDS

The Hamilton City Feasibility Study is an integrated document combining a Feasibility Study with an Environmental Impact Statement/Environmental Impact Report (EIS/EIR). The EIS/EIR is written to comply with the National Environmental Policy Act and the California Environmental Quality Act (NEPA/CEQA). In particular, to comply with CEQA an impacts assessment of resources is required and the significance of any impacts disclosed and minimized to less than significant levels with suitable mitigation measures, if possible.

One resource that is assessed in the EIS/EIR is farmland. In an effort to assess the effect on the environment from the conversion of farmland to other uses, both qualitative and quantitative assessment tools are available. The California Department of Conservation recommended that the Land Evaluation and Site Assessment (LESA) be used for this project. The LESA model is an optional methodology that can be utilized in a CEQA assessment to ensure that significant effects on the environment of agricultural land conversions are quantitatively and consistently considered in the environmental review process. (Section 21095, Public Resource Code). This model was applied experimentally for this restoration project. **The model was found to be an inadequate application for assessing the potential effects of restoration projects for many reasons.** Problems of the model include that it does not allow weighing of the relative benefits and effects of each alternative plan, nor does it consider the future without-project condition. Rather, the model assumes that any action that would change the use of important farmlands away from agricultural use will have an adverse physical effect on soils. The model then quantifies the degree of the effect based on limited factors such as the inherent quality and location of the soils. A soils assessment tool is not a complete assessment of the conversion of agriculture to restoration and should not be considered as such. Many factors should be taken into consideration when assessing impacts of conversion of agriculture to restoration. The fundamental premise of the LESA model is that a change in the use of important farmland may be a significant effect on the soils. A number of factors that the LESA model does not take into consideration are:

- Flood damage reduction benefits to neighboring agricultural land from construction of the levee provided in the tentatively recommended plan (which are benefits the agricultural land owners specifically desire).

- Land was purchased from willing sellers. Local agriculture landowners sold lands near the river that were problematic to farming due to erosion, seepage and scouring flood flows and retained ownership of lands that they anticipated would ultimately be landside of a setback levee which would benefit from the project as a whole which includes the multi-purposes of flood damage reduction and ecosystem restoration.

- The effect on farmland will vary depending upon the use to which it is converted. Conversion of lands to native habitat would actually improve soils.

project damages in the area is related to the flooding of agricultural lands. Therefore, part of the intent of the project is to reduce damages to agricultural lands, which includes removal of elements vulnerable to damage from the flooding.

- **Implement features that are consistent with local and regional land use plans.**

  Although this project is designed to stand alone, it complements a set of other projects The Nature Conservancy (TNC) and the Sacramento River Conservation Area Forum (SRCAF) members are developing. Collectively, these projects accomplish habitat protection, habitat restoration, improved ecosystem processes, coordinated floodplain management, and habitat restoration monitoring, thereby addressing many of CALFED Bay Delta Authority Implementation Plan goals, Ecosystem Restoration Program (ERP) Goals 1, 2, 4, 5, and 6, Key CALFED Science Program goals, Sacramento Region Priorities 1, 3, 4, 7 and Central Valley Project Improvement Act (CVPIA) goals and priorities.

- **Involve all affected parties, especially landowners and local communities, in developing appropriate configurations to achieve the optimal balance between resource effects and benefits.**

  Landowners and the local community have been extensively involved in this project and have helped develop the alternative alignments that were analyzed. The project has regularly been discussed at the Hamilton City Community Service District meetings and at the Sacramento River Conservation Area Forum meetings. A public scoping meeting was held in Hamilton City on January 9, 2003, and an additional public workshop, which focused on the development of alternative plans, was held in Hamilton City on June 12, 2003. In addition to the public workshops, a series of plan formulation meetings were held from December 2002 through January 2003 to discuss the problems, opportunities, significant resources, and potential measures and alternatives. The meetings included study team members and representatives from the local community and interested agencies and organizations. Participants in the meetings included:

  - Local Landowners and Residents
  - Hamilton City Community Services District
  - Glenn County Public Works Department
  - Butte County Public Works Department
  - Glenn Colusa Irrigation District
  - U.S. Fish and Wildlife Service
  - NOAA Fisheries
  - The Nature Conservancy
  - California Department of Fish and Game
  - Sacramento River Partners
  - Sacramento River Conservation Area Forum
  - Sacramento River Preservation Trust
  - California Department of Transportation (Caltrans)

- California Department of Parks and Recreation

Members of the study team regularly attended Hamilton City Workgroup meetings to report on the progress of the study, solicit feedback from the workgroup, and answer questions. These meetings were held at the Hamilton City Fire Hall approximately every two months over the course of the study. The Hamilton City Community Services District led the meetings and the Sacramento River Conservation Area Forum helped with meeting facilitation. The purpose of the meetings was to provide a forum to discuss and coordinate water resources related studies, projects, and other issues affecting the Hamilton City area. Local landowners and residents, representatives of local, State, and Federal agencies, representatives from State and Federal elected officials, representatives from non-profit organizations, and others attended the meetings. Information provided by the local and regional interest groups and individuals guided the identification of resources problems and helped formulate the alternative plans to address the problems and identification of the tentatively selected plan. The Hamilton City Feasibility Study has also periodically been discussed at the Sacramento River Conservation Area Forum (SRCAF) Board meetings.

A final public meeting will be held in Hamilton City upon the release of the draft Feasibility Report/EIR/EIS to present the findings of the feasibility study and to provide the public an opportunity to express their views on the results and recommendations of the Hamilton City Feasibility Study.

- **Restore existing degraded habitat as a priority before converting agricultural land.**

  Restoration of about 181 acres of existing degraded habitat in the study area is included as part of the project. Restoration of that land alone was not considered to be a significant contribution to the goals and objectives of the study and project. TNC acquired additional lands from willing sellers using State grant funding[1] that were also included in the project in order to achieve the goals and objectives of the project. These parcels of land experience erosion, seepage, and scouring flood flow problems.

- **If public lands are not available for restoration efforts, focus restoration efforts on acquiring land that can meet ecosystem restoration goals from willing sellers where at least part of the reason to sell is an economic hardship (for example, lands that flood frequently or where levees are too expensive to maintain)**

  The tentatively recommended plan includes native habitat restoration on lands predominantly acquired by The Nature Conservancy from willing sellers. Those lands have been at a frequent risk of flooding and the tentatively recommended plan would alleviate the flood risk for remaining agricultural parcels landside of the new setback levee. The tentatively recommended plan includes a training dike; a short, levee-like structure that, while not preventing

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[1] Funding came from the River Protection Program under Proposition 13. The funds were appropriated to Department of Water Resources for allocation to TNC. The agreement goes on to say that TNC would use these funds to acquire lands near the Sacramento River in the Hamilton City Area for the protection and restoration of various riparian habitats and to provide those lands for a future flood damage reduction project.

backwater, would reduce high frequency, damaging flows that currently scour agricultural lands.

- **Use a planned or phased habitat development approach in concert with adaptive management.**

  The restoration plan includes planting the restoration area before the "J" levee is breached and as the setback levee is being built. The restoration plan is based on a vegetative predictive model developed by TNC that determines habitats to be planted based on soils, topography, frequency of flooding, and depth to groundwater. As more information regarding soils and depth to groundwater is developed, the restoration plan will be adapted.

- **Develop buffers and other tangible support for remaining agricultural lands. Vegetation planted on these buffers should be compatible with farming and habitat objectives.**

  The tentatively recommended plan includes a buffer from the landside toe of the levee to the waterside restoration plantings that will be planted with native grasses which is compatible with both farming and habitat restoration objectives. The final buffer distance will be determined during PED. These grasses would require burning or mowing as a part of the O&M manual. This buffer includes the setback levee with a gravel road for maintenance and inspection on top. The planting plan includes limiting the area of planting elderberries on areas adjacent to agricultural fields. The width of the elderberry buffer would be 300 feet, consistent with the current TNC "good neighbor" practices. It is anticipated that the restoration plan will allow the non-Federal sponsor to remove elderberries under 1-inch diameter from the buffer strip, though this is pending issuance of a take permit from the USFWS.

- **Implement erosion control measures to the extent possible during and after project construction activities.**

  Restoration will begin before the "J" levee is breached and as the new levee is being built. Best management practices will be implemented for erosion control as the levee is breached to prevent any water quality degradation. Prior to the start of construction, a National Pollution Discharge Elimination System (NPDES) general permit for construction activities will be obtained from the Central Valley Regional Water Quality Control Board, and a storm water pollution prevention plan (SWPPP) will be developed per the Guidelines of the general permit. The SWPPP will list all best management practices to be implemented during construction activities for control of erosion, siltation, and any other pollutants that could potentially enter storm water or surface waters in the project area.

  Temporary fast growing cover crops will be seeded over all restoration areas. Permanent native vegetative cover will be no till drill seeded into the temporary cover. Areas disturbed by construction of flood control measures will be seeded with an erosion control seed mix and also will receive straw mulch. Areas disturbed by construction with steeper topography that generate sheet flow will receive appropriate erosion control best management practices, such as straw mulch, bonded fiber matrix hydro mulch, and erosion control fabric. in addition to the vegetative cover. Areas disturbed by construction with topography that concentrates flow or conveys concentrated off site run-on would receive best management practices for erosion control, such straw mulch, bonded fiber matrix hydro mulch, cobble dissipaters and erosion control fabric, in addition to the vegetative cover.

Sedimentation best management practices will consist of straw rolls, silt fences and/or sedimentation ponds, which will be implemented where necessary to prevent discharge of sediment-laden runoff into receiving waters. Additionally, vegetative buffer strips 50 feet in width will be used on the downslope edges of sites bordering receiving waters. These strips may be native grass established before soil disturbing activities or may be existing vegetation left in place.

- **Protect exposed soils with mulches, geotextiles, and vegetative ground covers to the extent possible during and after project construction activities in order to minimize soil loss.**

The tentatively recommended plan includes a vegetation barrier of 20 feet waterside of the setback levee and vegetation landside of the setback levee where necessary for protection from wave action. Long-term wave wash protection will be provided by the restoration plantings. Areas that will not be protected in the long term may be protected by vegetative barriers, riprap, or by reducing levee slope and planting with suitable erosion control grasses. In addition, a SWPPP will be implemented to reduce erosion and sediment discharges listed under the previous bulleted item.

- **When it appears that land within an agricultural preserve may be acquired from a willing seller by a State CALFED agency for a public improvement as used in Government Code Section 51920, advise the Director of Conservation and the local governing body.**

There are currently lands covered by Williamson Act and the Farmland Protection Act in the project area. TNC and the non-federal sponsor own most of these lands. The Director of Conservation and the local governing body will be advised of the removal of the lands from these programs.

- **Implement seepage control measures.**

The levee will be built to Corps engineering standards and includes a training dike and rock revetment to prevent erosion and seepage. The levee would be designed to provide adequate seepage control and interior drainage. The interior drainage will be collected near the water treatment plant and pumped over to the other side.

Further Consistencies. The project also considered the programmatic commitments related to implementation of CALFED actions to ensure this project would be consistent with the ROD. The programmatic commitments are:

- **Local Leadership** - This project was initially developed by leadership within Glenn County and the Hamilton City Community Services District, working in conjunction with TNC and local landowners.
- **Stakeholder Consultation** - Locals have been involved in every step of the development of this project from its conception. The project team conducted two Public Workshops in Hamilton City as well as an information booth at the local levee festival.
- **Environmental Justice** - The primary beneficiaries of the flood damage reduction portion of the proposed project is the Hamilton City community, which is low-income.
- **Tribal Consultation** - Funding for consultation with Tribal representatives would be included in the project budget to enable outreach efforts. Up to 1 percent of the Federal portion of the project first costs would be allocated for cultural resources data recovery.
- **Land Acquisition** - Most of the land required for the project has already been purchased from willing sellers because of the flood-prone nature of the land. The project has been designed to consider third party and redirected impacts such as level of flood protection and hydraulic effects.
- **CALFED Agency Coordination** - This project has been coordinated with CALFED and has been reviewed by the CALFED Independent Review Panel (IRP).
- **Integration of Non-Signatory Agencies** - This project will continue to be coordinated with all affected agencies.
- **Environmental Documentation** -This proposed project is documented in an integrated Feasibility EIS/EIR report.
- **Permit Clearinghouse** - A permit clearinghouse has been established for the CALFED Bay-Delta Program to coordinate and facilitate permit applications and approvals and compliance with CEQA and NEPA. Since this document is not tiered off the CALFED EIR/EIS, but rather is a stand alone EIS/EIR, the Corps and non-federal sponsor will be obtaining all the necessary permits and approvals.
- **Adaptive Management/Science** - The restoration project will be managed to support the vegetative composition that occurs naturally over time.
- **Beneficiaries Pay** - The local sponsors will pay a portion of the project first costs along with ongoing O&M costs.
- **Compliance with Water Rights laws** - the project would use water rights currently associated with the parcels to be restored.
- **Project Operations** - This is not applicable to the Hamilton City project.
- **Coordinated Operation Agreement.** - This is not applicable to the Hamilton City project

Final LESA Score Sheet

	Factor Scores	Factor Weight	Weighted Factor Scores
LE Factors			
Land Capability Classification	61.45	0.25	15.36
Storie Index	81	0.25	20.37
LE Subtotal		**0.5**	**35.73**
SA Factors			
Project Size	100	0.15	15
Water Resource Availability	85	0.15	12.75
Surrounding Agricultural land	85	0.15	12.75
Protected Resource land	0	0.05	0
SA Subtotal		**0.5**	40.5

76.23
Final Score

Surrounding Agricultural Land Use Score

A	B	C	D	E	F	G
Zone of Influence						
Total Acres	**Acres in Agriculture**	**Acres of Protected Resource Land**	**Percent in Agriculture (A/B)**	**Percent Protected resource land (A/C)**	**Surrounding Agricultural Land Score (from Table)**	**Surrounding Protected resource Land Score (From Table)**
13120.06	8552.80	1396.59	65.19%	10.64%	85	0

Surrounding Agricultural Land Scoring Table

Percent of ZOI in Agriculture	Surrounding Agricultural Land Score
90-100	100
80-89	95
70-79	90
65-69	85
60-64	80
55-59	70
50-54	60
45-49	50
40-44	40
35-39	30
30-34	20
20-29	10
<19	0

Surrounding Protected Resource Land Scoring Table

Percent of ZOI in Agriculture	Surrounding Agricultural Land Score
90-100	100
80-89	95
70-79	90
65-69	85
60-64	80
55-59	70
50-54	60
45-49	50
40-44	40
35-39	30
30-34	20
20-29	10
<19	0

Land Evaluation Worksheet

Land Capability Classification (LCC) and Storie Index Scores

A	B	C	D	E	F	G	H
Soil Map Unit (Soil Types)	**Project Acres (total acres of each soil type)**	**Proportion of Project Area (divide each soil type by total acres)**	**LCC (for each soil type)**	**LCC Rating LCC Score (use scoring table below)**	**LCC Score (multiply CxE)**	**Storie Index**	**Storie Index Score(CxG)**
CeA	25.157	1.54%	IIIc1	70	1.08	85	1
ChA	1183.294	72.32%	IIIw2	60	43.39	85	61
ChB	49.173	3.01%	IIIw2	60	1.80	77	2
Ck	32.335	1.98%		70	1.38	95	2
Cm	38.192	2.33%	IIIs0	60	1.40	72	2
CpB	22.41	1.37%	IIIw3	60	0.82	46	1
CrB	48.797	2.98%		60	1.79	55	2
HgA	0.35	0.02%		60	0.01	54	0
Rh	49.409	3.02%		60	1.81	21	1
Wg	0.701	0.04%		60	0.03	77	0
Wn	179.514	10.97%	IIIc1	70	7.68	90	10
no label	6.911	0.42%		60	0.25	0	0
Totals	**1636.243**	**100.00%**			**61.45**		**81**
					link to final score sheet		link to final score sheet

Note: Numbers in blue indicate input.
Number in brown are formulas

*Note: numbers in red are based on professional judgement

LCC Scoring table

LCC Class	**I**	**IIe**	**IIs,w**	**IIIe**	**IIIs,w**	**IVe**	**IVs,w**	**V**	**VIe,s,w**	**VIIe,s,w**	**VIII**
	100	90	80	70	60	50	40	30	20	10	0

Water Resource Availability

A	B	C	D	E
Project Portion	**Water Source**	**Proportion of Project Area**	**Water Availability Score**	**Weighted Availability Score (CxD)**
1	Well Water	1	85	85
2				
3				

Water Resource Availability Scoring Table

	Non-Drought Years			**Drought Years**			
	RESTRICTIONS			RESTRICTIONS			
Options	Irrigated Production Feasible	Physical Restrictions ?	Economic Restrictions ?	Irrigated Production Feasible	Physical Restrictions ?	Economic Restrictions ?	Water Resource Score
1	YES	NO	NO	YES	NO	NO	100
2	YES	NO	NO	YES	NO	YES	95
3	YES	NO	YES	YES	NO	YES	90
4	YES	NO	NO	YES	YES	NO	85
5	YES	NO	NO	YES	YES	YES	80
6	YES	YES	NO	YES	YES	NO	75
7	YES	YES	YES	YES	YES	YES	65
8	YES	NO	NO	NO	~	~	50
9	YES	NO	YES	NO	~	~	45
10	YES	YES	NO	NO	~	~	35
11	YES	YES	YES	NO	~	~	30
12	Irrigated production not feasible, but rainfall adequate for dryland production in both drought and non-drought years						25
13	Irrigated production not feasible, but rainfall adequate for dryland production in non-drought years (but not in drought years).						20
14	Neither irrigated nor dryland production feasible						0

Site Assessment Worksheet 1

Project Size Score

	I	J	K	
Soil Map Unit	**LCC Class I-II**	**LCC Class III**	**LCC Class IV-VIII**	
CeA		25.157		
ChA		1183.294		
ChB		49.173		
Ck		32.335		
Cm		38.192		
CpB		22.41		
CrB		48.797		
HgA		0.35		
Rh		49.409		
Wg		0.701		
Wn		179.514		
no label		6.911		
Totals		**1636.243**	**0**	**Total Acres**
		100		**Project Size Scores**
		100		**Highest Project Size Score**

Project Size Scoring Table

Class I or II		**Class III**		**Class IV or Lower**	
Acreage	Points	Acreage	Points	Acreage	Points
>80	100	>160	100	>320	100
60-79	90	120-159	90	240-319	80
40-59	80	80-119	80	160-239	60
20-39	50	60-79	70	100-159	40
10,19	30	40-59	60	40-99	20
10<	0	20-39	30	40<	0
		10,19	10		
		10<	0		

B.8: Coordination Act Report (CAR)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
CRC-Flood & Waterway Planning Branch

JUL 9 2004

Colonel Michael J. Conrad
District Engineer
Corps of Engineers, Sacramento District
ATTN: Chief, Planning Division
1325 J Street
Sacramento, California 95814-2922

Dear Colonel Conrad:

Enclosed is the U.S. Fish and Wildlife Service's Fish and Wildlife Coordination Act (FWCA) report for the Corps of Engineer's Hamilton City Flood Reduction and Ecosystem Restoration Project, in Glenn County, California. This report has been prepared under the authority of, and in accordance with, the provisions of section 2(b) of the FWCA (48 stat.401, as amended; 16 U.S.C. 661 et seq.).

If you have any questions or comments regarding this report please contact Jennifer Hobbs at (916) 414-6541.

Sincerely,

Michael G. Hoover

David L. Harlow
Acting Field Supervisor

Enclosure
cc:
CNO, Sacramento, CA
CDFG, Region 1, Redding, CA
~~USCOE, Sacramento, CA (Attn: Erin Taylor)~~
NMFS, Sacramento, CA

TAKE PRIDE
IN AMERICA

EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service (Service) is assisting the U.S. Army Corps of Engineers (Corps) in the preparation of a Feasibility Study and Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, Glenn County, California. The California Department of Water Resources (DWR) is the project's non-Federal sponsor and Hamilton City is the local sponsor. The objectives of the project include reducing flood damages and reconnecting the Sacramento River to its floodplain and restoring floodplain habitats.

The study area is located along the Sacramento River from just north of Hamilton City to the confluence of Stony Creek and the Sacramento River (about 5 miles south of town). This document evaluates five alternatives including a no-action alternative. The three action alternatives involve setting back the west levee and increasing the floodplain. All of the alternatives would protect Hamilton City from flooding and increase the amount of native cover-types (riparian, grassland, oak savannah, and scrub shrub) on that stretch of the Sacramento River. In addition, all alternatives would allow for some of the river's natural functions to occur such as deposition and erosion along the banks.

A Habitat Evaluation Procedures (HEP) was completed in order to compare the affects of each alternative. The HEP report can be found in Appendix A. All three alternatives provide an increase in Average Annual Habitat Units (AAHUs). The greatest wildlife benefits would result from Alternative 5, with an increase in 937.04 AAHUs. The least number of AAHUs is Alternative 1 with 643.58. Alternative 6 falls in between these numbers. Because of both the high amount of benefits from the HEP and because it also restores the largest amount of land (1,825.1 acres) the Service recommends Alternative 5. Alternatives 2, 3, and 7 were dropped from consideration prior to applying the HEP and Alternative 4 was dropped by the Corps between the draft and the final EIS/EIR.

A biological opinion was issued to the Corps on June 30, 2004 by the Service. The opinion is not for the take of valley elderberry longhorn beetle due to the restoration project, but for potential future take resulting from emergency flood fighting activities in the restoration area.

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Appendix A	Hamilton City Fish and Wildlife Habitat Restoration Project Habitat Evaluation Procedures
Appendix B	Federal Agencies' Responsibilities Under Sections 7(a) and (c) of the Endangered Species Act/State Listed Species in Glenn County

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This is the U.S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act (FWCA) report for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, Glenn County, California. This report is prepared under the authority of, and in accordance with the FWCA, as amended. Funding to initiate this study was provided by the State of California through Assembly Bill 1X-11 and by Congress in the 1998 Energy and Water Development Act. The California Department of Water Resources is the project's non-Federal sponsor and Hamilton City is the project's local sponsor.

The information presented is based primarily upon project planning information made available by the Corps, various reports pertinent to the project area, and application of Habitat Evaluation Procedures (HEP) methodology (Appendix A). Coordination with the National Oceanic and Atmospheric Administration (NOAA) Fisheries and California Department of Fish and Game (CDFG) was accomplished by providing a draft copy of this report for review and comment.

Hamilton City has a history of flooding due to high flows from the Sacramento River. However, completion of Shasta Dam resulted in regulation of peak flows in the Sacramento River. Since completion of Shasta Dam, flooding in the Hamilton City area occurred in 1970 and 1974, when the existing private levee failed, and in 1986 and 1997, when levee overtopping and ultimately failure were prevented only due to flood fighting efforts.

Riparian habitat has decreased drastically along the Sacramento River due to flood control structures, bank protection, and clearing of land for agricultural and urban uses. In addition to direct loss of riparian habitat, the little that remains is highly fragmented, with little connectivity along the Sacramento River system or to other native cover-types.

This report presents the current views of the Service on this project. Our analysis is based on engineering and other project information provided by the Corps. Our appraisal of resources is based on literature reviews; personal communications with other recognized experts; field investigations and surveys; best professional judgment of Service biologists; and a projection of future conditions using current land-use information and analyses provided by the Corps. Our analyses will not remain valid if the project, the resource base, or anticipated future conditions change significantly.

AREA DESCRIPTION

The Sacramento River hydrology has been altered by dams, diversions, and levees. Shasta and Keswick Dams are the two main dams on the system upstream of the project area. The project area is about 100 miles north of Sacramento and 10 miles west of Chico. Hamilton City lies less than 1 mile to the west of the Sacramento River. The project area is bounded on the west by the Glenn-Colusa Irrigation Canal (GCID) and includes the eastern bank of the Sacramento River.

The existing private levee, known as the "J" levee, runs along the west bank of the Sacramento River from the top of the study area to just south of Dunning Slough.

PROJECT DESCRIPTION

A no-action alternative and three restoration alternatives are being evaluated. A description of each alternative is provided below.

No Action

Under the no-action alternative, no action would be taken by the Corps to help reduce the chance of flooding in Hamilton City or to restore native habitat along the Sacramento River. The existing "J" levee would remain in place.

Alternative 1, Locally Developed Setback Levee

This alternative consists of constructing a levee about 6.6 miles long and 6 feet high, set back roughly 500 to 7,600 feet from the river, and removal of most of the existing "J" levee. It includes actively restoring about 1,300 acres of native habitat in Zones A1, A2 and A4, E, G, and B2, waterside of the setback levee. This alternative is shown in Figure 1.

In order to achieve ecosystem restoration, most of the "J" levee would be removed to reconnect the river to the floodplain. While this action would enable ecosystem restoration, it would lower the community's existing flood protection. The Federal and State governments would be obligated to mitigate the effect of removing the private levee that currently protects Hamilton City. To ensure that the replacement levee would have the same possibility of passing a flood as the "J" levee can with flood-fighting, the replacement levee would be the same height as the "J" levee. Entrenched rock would be buried in a 1,500-foot-long trench in Zone G, parallel to County Road 203 and about 200 feet from the toe of the levee. When the river erodes away the bank at the location of the trench, the rock would fall and armor the bank preventing erosion beyond that point.

North of Highway 32, the levee alignment ties into the newly constructed Glenn County backup levee and runs roughly parallel to and about 500 feet west of the Sacramento River. At Highway 32, the levee ties into the existing approach to the Gianella Bridge. The highway would not need to be raised, but measures to protect the highway embankment and bridge from floodwaters would be necessary. Because a replacement levee would be set back from the "J" levee, the northern bridge abutment would be exposed to direct flows, which could scour the abutment. To ensure the bridge is not compromised by the project, 1,000 feet of rock riprap would be placed on and around the abutment.

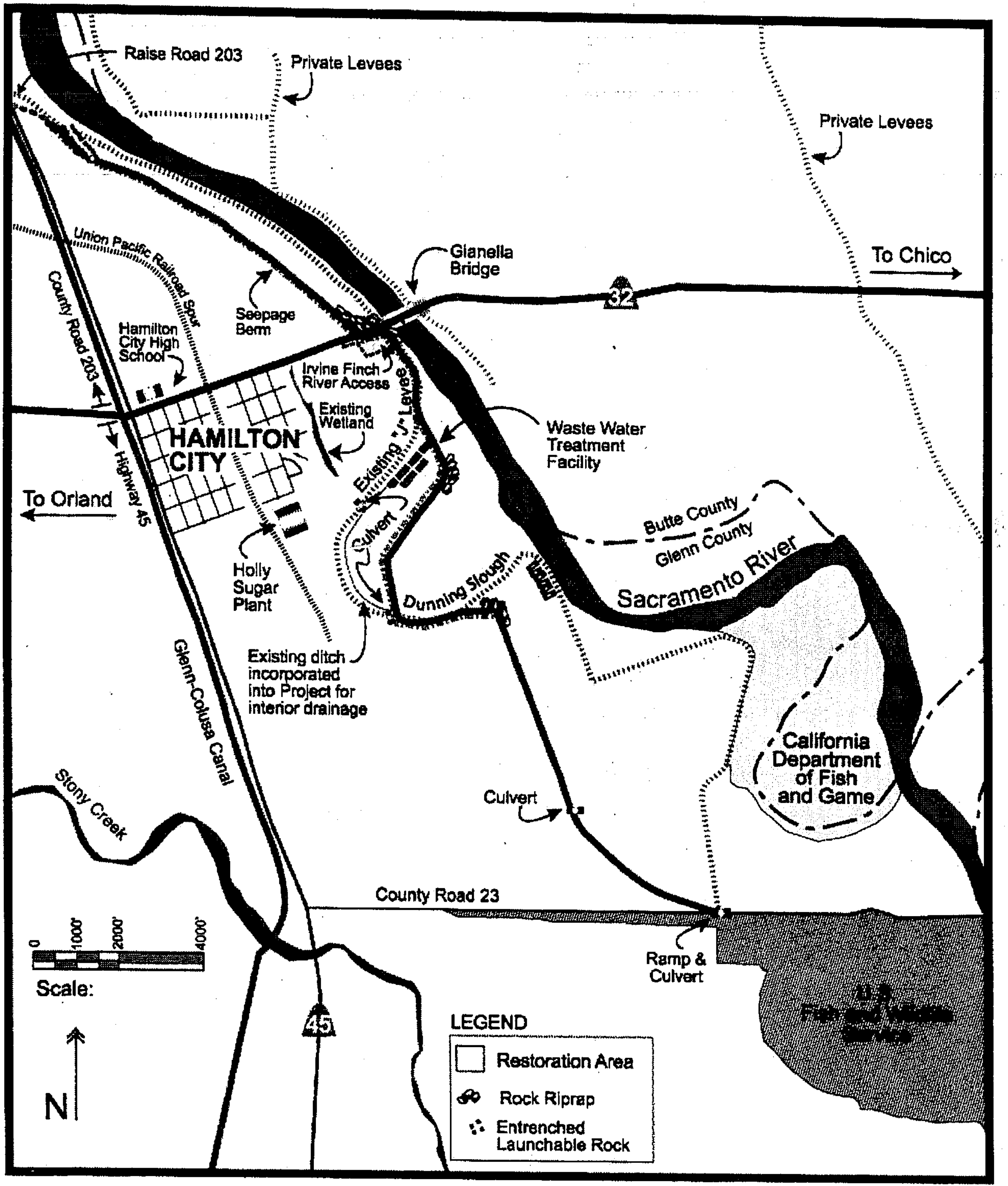

Figure 1. Alternative 1 - Locally Developed Setback Levee

South of Highway 32, the alignment cuts across the easternmost section of the Irvine Finch River Access (just south of the highway), requiring modification of the River Access entrance and parking lot. The alignment also cuts across a portion of Dunning Slough providing protection to the Hamilton City wastewater treatment ponds, some abandoned holding ponds for the old Holly Sugar plant (in which the community would like to expand the treatment plant in the future), and a lime disposal pile. About 1,500 feet of rock would be placed on the setback levee in Dunning Slough as erosion protection. Because a replacement levee would be set back from the "J" levee, a bend in the replacement levee would be exposed to overland flows from multiple angles, which could erode the new levee. In order to ensure that the new levee is not subject to this erosion, 500 feet of rock riprap would be placed along the levee at the bend.

South of Dunning Slough, the alignment roughly follows along the western edge of The Nature Conservancy (TNC) property before turning east toward the southern end of the "J" levee at Road 23. The alignment ends at Road 23, not tying into high ground.

A replacement levee would not affect the existing erosion conditions south of Dunning Slough. It is assumed that the Chico Landing to Red Bluff Project (local site constructed in 1975-1976) would remain authorized and continue to be maintained. For the new levee to perform to the same level as the "J" levee, erosion control at the end of the levee would consist of planting significant amounts of vegetation (about 20 feet or so from the levee toe) to reduce velocities at the levee.

All lands to the waterside of the setback levee would be actively restored with a mixture of riparian, scrub, oak savannah, and grassland habitat (except the CDFG and Service lands, which are assumed to be restored under the without-project condition). The "J" levee would be removed, except for portions where it would serve to reduce velocities of the Sacramento River for establishment of newly planted habitat. Established riparian vegetation waterside of the "J" levee would be avoided wherever possible.

Alternative 5, Intermediate Upstream of Dunning Slough, Locally Developed Downstream of Dunning Slough

This alternative plan consists of actively restoring about 1,600 acres of native vegetation, constructing a setback levee about 5.3 miles long, and 6 feet high, and removing most of the "J" levee. The alternative plan is shown in Figure 2 and includes restoration of Zones A1, A2, and A4, B2, E, F, G, and H, waterside of the setback levee.

The setback levee alignment begins about 2 miles north of Hamilton City, at the point where the northern end of the "J" levee ties into high ground. Entrenched rock would be buried in a 1,500 foot-long trench in Zone G, parallel to County Road 203 and about 200 feet from the toe of the levee. When the river erodes away the bank at the location of the trench, the rock would fall and armor the bank preventing erosion beyond that point. From there, the levee alignment runs

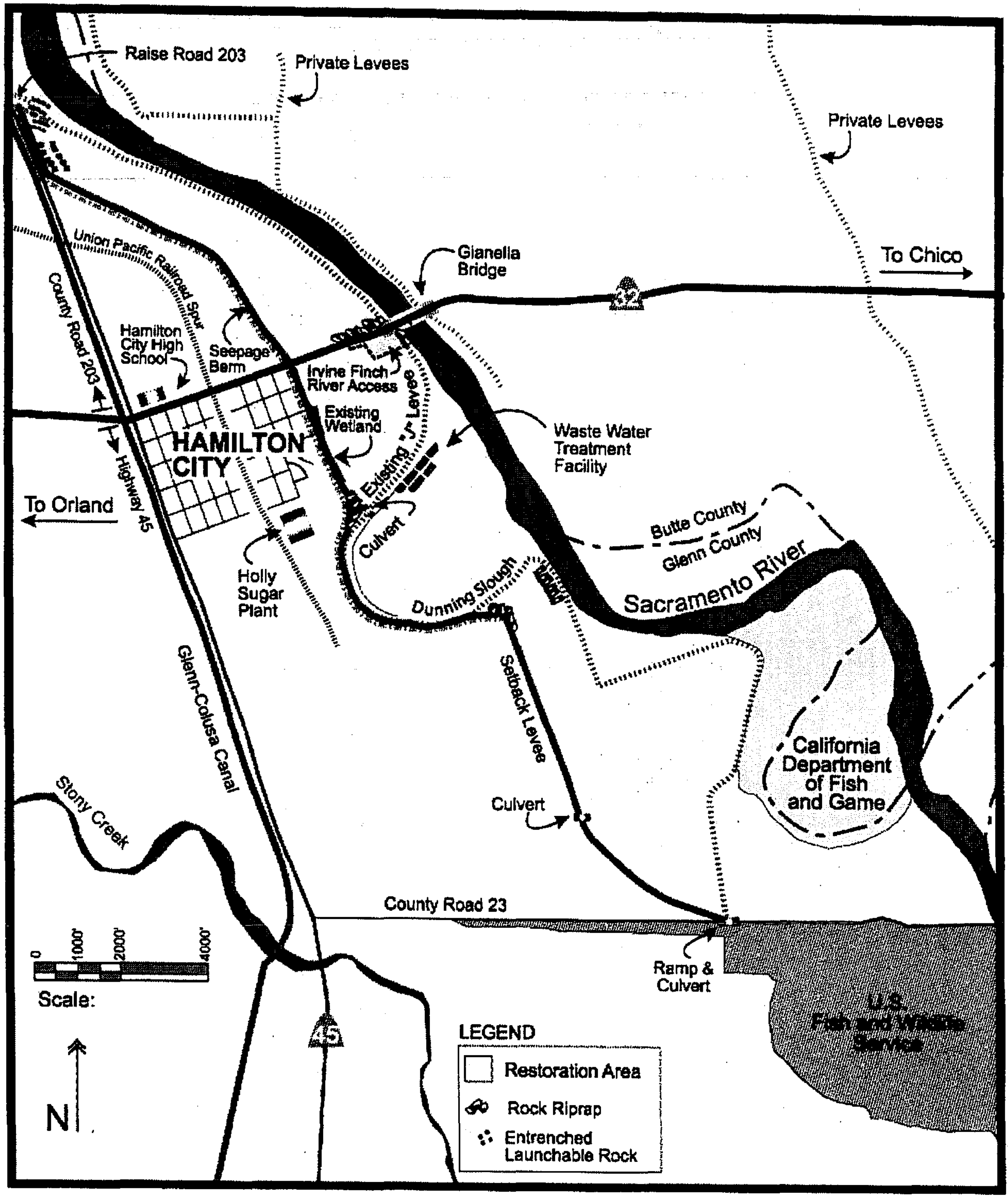

Figure 2. Alternative 5 - Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough

southeast along County Road 203 until turning easterly and running roughly parallel to and about 1,300 feet west of the Sacramento River, following higher ground.

At the eastern edge of town, the levee alignment crosses Highway 32 and runs south alongside a new housing development (Palisades subdivision). This alignment requires raising Highway 32 (with soil embankment), protecting the highway and bridge (and possibly the water treatment plant) from erosion caused by floodwaters, and relocating a remnant slough that provides a small, but significant, emergent wetland habitat and is also used to detain and convey storm water runoff. The northern abutment of the Gianella Bridge would be exposed to direct flows and could scour the abutment. In order to ensure that bridge is not compromised by the project, 1,000 feet of rock riprap would be placed on and around the abutment. At the south end of town, the alignment wraps around Dunning Slough and then roughly follows along the western edge of TNC property before turning east and ending at the southern end of the "J" levee at Road 23. This alignment does not tie into high ground and therefore allows some backwater flooding of agricultural lands, as does the "J" levee.

About 1,500 feet of rock would be placed on the setback levee in Dunning Slough as erosion protection. Because a replacement levee would be set back from the "J" levee, a bend in the setback levee would be exposed to overland flows from multiple angles, which could erode the levee. In order to ensure that the new levee is not subject to this erosion, 500 feet of rock riprap would be placed along the levee at the bend.

Lands waterside of the new levee would be restored to native habitat. About 1,600 acres of native habitat would be restored including: 1,050 acres of riparian, 300 acres of scrub, 150 acres of savannah, and 100 acres of grassland. The "J" levee would be removed, except for portions where it would serve to reduce velocities of the Sacramento River for establishment of newly planted habitat. Established riparian vegetation waterside of the existing "J" levee would be avoided wherever possible. The removal of most of the "J" levee would allow periodic overbank flooding, increasing the ecosystem value of riparian and scrub habitat in the floodplain (periodic flooding was assumed not to affect the value of grassland and oak savannah habitat).

Native vegetation would be restored on most of the TNC lands within the study area. Restoration would also occur on the land directly east of Hamilton City between Highway 32 and Dunning Slough (Zone F) and land within Dunning Slough (Zone A1). Existing orchards in the proposed restoration areas would be removed and native vegetation planted. Some orchard trees may be left to provide interim cover and structure for wildlife species while the planted vegetation matures. The native vegetation would predominantly be riparian species, but some scrub, oak savannah and grassland species would also be included, based on hydrologic, topographic, and soil conditions. The land in the middle of Dunning Slough (Zone A1), is relatively higher elevation than the rest of the restored area, and oak savannah vegetation is anticipated to be more appropriate for these lands.

Alternative 6, Intermediate Upstream of Hwy 32, Locally Developed Downstream of Hwy 32

This alternative plan consists of actively restoring about 1,500 acres of native vegetation, constructing a setback levee about 5.7 miles long, and 6 feet high, and removal of most of the "J" levee. The alternative plan is shown in Figure 3 and includes Zones A1, A2, A4, B2 E, G, and H waterside of the setback levee.

North of Highway 32, the levee alignment ties into high ground at the northern end of the "J" levee, about 2 miles north of Hamilton City. Entrenched rock would be buried in a 1,500-foot long trench in Zone G, parallel to County Road 203 and about 200 feet from the toe of the levee. When the river erodes away the bank at the location of the trench, the rock would fall and armor the bank preventing erosion beyond that point. The levee runs southeast along County Road 203 until turning easterly and running roughly parallel to and about 1,300 feet west of the Sacramento River, following higher ground.

At Highway 32, the levee turns east and runs parallel to the highway until tying into the approach to Gianella Bridge. The highway would not need to be raised in this alternative plan. Because the northern bridge abutment would be exposed to direct flows, the bridge abutment would be exposed to scour. In order to ensure that bridge is not compromised by the potential project, 1,000 feet of rock riprap would be placed on and around the abutment. South of Highway 32, the alignment follows the "J" Levee in order to minimize negative effects to the Irvine Finch River Access (just south of the highway). Some minor modifications to the River Access entrance and parking lot during levee construction may be required. The alignment also cuts across a portion of Dunning Slough providing protection to the Hamilton City wastewater treatment plant, the abandoned holding ponds for the old Holly Sugar plant (in which the community would like to expand the treatment plant in the future), and a lime disposal pile.

Because a replacement levee would be set back from the "J" levee, a bend in the replacement levee would be exposed to overland flows from multiple angles, which could erode a replacement levee. In order to ensure that the replacement levee is not subject to this erosion, 500 feet of rock riprap would be placed along the levee at the bend.

South of Dunning Slough, the alignment would roughly follow along the western edge of TNC property before turning east and merging with the southern end of the "J" levee at Road 23. As the levee turns east, the levee height would gradually decrease from 7 feet to about 2 feet. At this point the new levee would become a "training dike" meant to direct flows rather than control them. This height reduction is to avoid negative hydraulic effects to downstream property owners. The training dike would continue for about a mile south of Road 23, running just west of the Service property boundary. A small ramp with culverts on either side would be constructed over the training dike at Road 23 to maintain the river access. This alignment does not tie into high ground and therefore allows some backwater flooding of agricultural lands, as currently happens with the "J" levee. In fact, the training dike is designed to allow flood waters

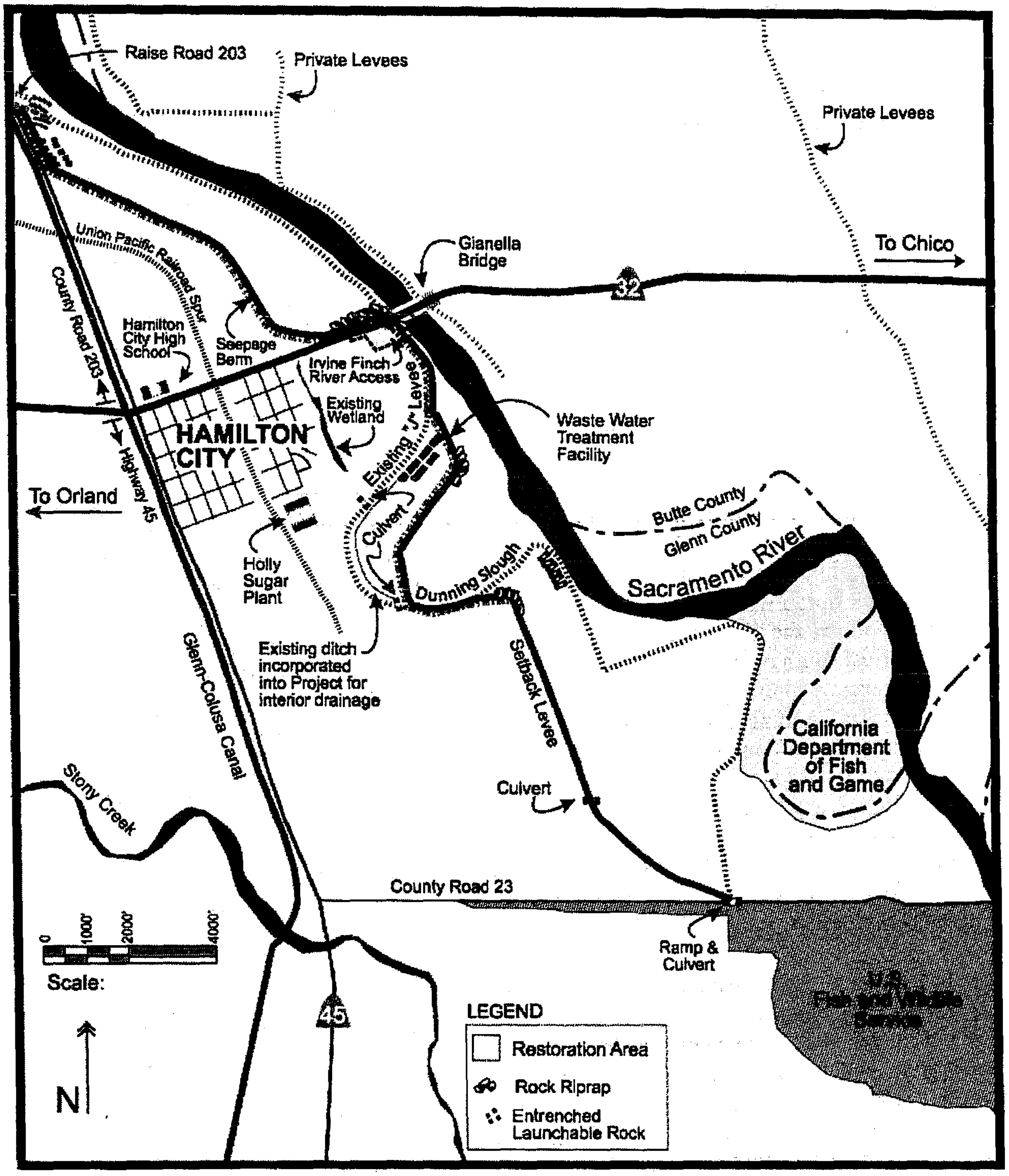

Figure 3. Alternative 6 - Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32

to overtop it and spread out into the agricultural areas without the high velocities that cause extensive damage to the orchards.

A setback levee would not affect the existing erosion conditions south of Dunning Slough. It is assumed that the Chico Landing to Red Bluff Project (local site constructed in 1975-1976) would remain authorized and continue to be maintained. For the new levee to perform to the same level as the "J" levee, erosion control at the end of the levee would consist of planting significant amounts of vegetation (about 20 feet or so from the levee toe) to reduce velocities at the levee.

The restored area under this alternative is the same as the previous alternative, except that the land directly east of Hamilton City between Highway 32 and Dunning Slough (Zone F) would not be restored and the area south of Road 23 (Zone B2) would be restored. Existing orchards in the proposed restoration areas would be removed and native vegetation planted. The native vegetation would predominantly be riparian species, but some scrub, oak savannah and grassland species would also be included, based on hydrologic, topographic, and soil conditions. The land in the middle of Dunning Slough (Zone A1), which is relatively higher in elevation than the rest of the restored area, is anticipated to be more appropriate for oak savannah vegetation.

EXISTING BIOLOGICAL RESOURCES

Vegetation

Four cover types can currently be found in the project area: riparian, orchard, grain crop, and grassland.

Riparian forest habitat occurs in the active floodplain along the Sacramento River. Generally, relatively narrow bands of forest grow along channels, but more extensive stands exist in oxbows and back waters that are only periodically connected to the river. The riparian forest is dominated by black willow, with only occasional occurrence of Fremont cottonwood and a few valley oak. Understory species include narrow-leaved willow, red willow, and Oregon ash. Common herbaceous species include mugwort and western goldenrod.

Grassland habitat is found primarily in the Dunning Slough area in the south part of the project area. In addition, small areas of grassland can be found on the private levee and along irrigation canals. Common plant species include annual grasses and forbs.

Orchards are a predominant habitat in the project area. Orchards in the area consist of plum almond, and walnut trees. Herbaceous ground cover under the tree rows typically consists of annual grasses, forbs, or bare soil.

Grain crop habitat consists of hay. This crop is found in the Dunning Slough area. Vegetative growth is highest in the summer and the over-winter management consists of plowing under the hay stubble and leaving the field fallow.

Wildlife

Riparian habitat is especially valuable for wildlife. Riparian trees provide nesting habitat for many birds, notably cavity-nesting species and a large assemblage of raptors, including the State-listed Swainson's hawk. Birds which glean insects off of bark, leaves, and leaf tangles such as bushtits, woodpeckers, and nuthatches, also use riparian habitats. Typical mammal species that can be found in riparian areas include deer, raccoons, beavers, coyotes, and red foxes. The multilayered vegetation provides an abundance of insect prey that feed on fresh foliage and stems during the growing season.

Grassland areas located on the levees and margins of agricultural fields provide habitat for granivorous birds such as western meadowlarks, California quail, sparrows, and finches, and for mammals such as voles, mice, and pocket gophers. These areas also provide foraging habitat for hawks.

Fallow agricultural fields support high rodent populations which in turn provide prey for many raptor species in the area. Orchards provide limited value for various bird species for nesting and foraging. In addition, orchards located along rivers where riparian habitat has been reduced and fragmented, can provide cover and act as a migration corridor for some mammal species.

Fisheries

The Sacramento River supports many different fish species, most of which can be found in the project area at some time of the year. Common anadromous species in the area include chinook salmon, steelhead trout, striped bass, and American shad. Common resident species include largemouth bass and other sunfish, catfish, Sacramento sucker, tule perch, and Sacramento pikeminnow.

Many fish populations are declining in the Sacramento River system, in large part because of the long-term degradation of the Sacramento River ecosystem. Riparian and shaded riverine aquatic (SRA) habitat has decreased significantly with the building of dams, levees, and water diversions.

Endangered Species

Appendix B provides a list of Federally listed threatened and endangered species, dated February, 3, 2004, and a summary of a Federal agency's responsibilities under section 7(a) and (c) of the Endangered Species Act (Act) of 1973, as amended. According to this list there are

15 threatened and endangered species or critical habitats that may occur in the project area. Endangered species are the Conservancy fairy shrimp, vernal pool tadpole shrimp, hairy Orcutt grass, and Greene's tuctoria. Threatened species are the bald eagle, northern spotted owl, giant garter snake, California red-legged frog, delta smelt, Central Valley steelhead, Central Valley spring-run chinook salmon, Southern Oregon/Northern California coho salmon, vernal pool fairy shrimp, valley elderberry longhorn beetle, and Hoover's spurge. Also listed is the critical habitat for the winter-run chinook salmon, Central Valley fall/late fall-run chinook, vernal pool invertebrates, and vernal pool plants.

There are also 3 candidate species and 26 species of concern. Although candidate species are not protected under the Act, the 1988 amendments require the Service or NOAA Fisheries to monitor their status. If any of these species decline precipitously during the planning of this project, they could be listed on an emergency basis. NOAA Fisheries has responsibility for most marine fish and wildlife, including anadromous salmonids, and should be consulted on activities which may affect any such listed or proposed species in the project area. The Service has consultation responsibility for the remaining species.

The CDFG has responsibility for State listed species and species of concern. A summary report from the CDFG's RareFind DataBase (February 2004) was retrieved for the project area, specifically for Glenn County (Appendix B). State listed endangered species are Colusa grass, Indian Valley brodiaea, bald eagle, great gray owl, hairy Orcutt grass, palmate-bracted bird's-beak, and western yellow-billed cuckoo. Threatened species are the giant garter snake, bank swallow, and Swainson's hawk. In addition, Tracy's eriasturm is listed as rare by CDFG. The CDFG should be contacted regarding any State listed species or species of concern that may be impacted by project activities.

The Service's biological opinion on the project was completed on June 30, 2004. Conservation measures proposed by the Corps can be found in the opinion in Appendix B.

FUTURE CONDITIONS WITHOUT THE PROJECT

Vegetation

No change in land use or management is assumed under the no action alternative. Vegetation removal and spread of exotic species may lead to some minor changes in the existing vegetation.

Wildlife

Since little change is expected to occur to the vegetation with the project area, present trends of use by wildlife species would continue. Normal year-to-year population fluctuations of individual species would continue to occur as now.

Fisheries

The aquatic resources of the project area are not expected to change significantly from existing conditions. Resident and migratory fishes would continue to use the area as they do today.

FUTURE CONDITIONS WITH THE PROJECT

Alternative 1, Locally Developed Setback Levee

Vegetation

Table 1 summarizes the acres with and without the project, average annual habitat units (AAHUs) with and without the project, and net change in AAHUs. Vegetation and cover-types would benefit by reconnecting some of the area to the river's floodplain and native vegetation planting. Projected cover-types were determined through evaluation of water table depths, soils, and site elevation in relation to the river. Periodic floodflows on portions of the project area helps restore part of the area the river historically meandered through. It also provides benefits to the new and existing vegetation in the project area by: increasing soil moisture, adding nutrients and organic matter, bringing in seeds and plant material for natural revegetation, and facilitating deposition and removal of sediment. Subjecting more land to the river's erosional and depositional forces would allow native habitats to experience successional change in vegetation composition, instead of artificially keeping the vegetation at one age class. It is fully expected that some of the existing and planted vegetation would erode away and fall into the river creating large woody debris for aquatic species over the life of the project.

Table 1. Summary of cover-types acreages, and AAHUs that would be impacted and created under Alternative 1.

Cover-type	Alternative 1 Without Project	Alternative 1 With Project	AAHUs without Project	AAHUs with project	Net Change in AAHUs
Riparian	97.1	955.7	44.44	889.81	845.37
Grassland	83.7	145.6	85.28	148.56	63.28
Orchard	1198.1	0.0	436.1	16.77	-419.33
Grain crop	89.9	0.0	62.64	2.41	-60.23
Oak savannah	0.0	140.4	0.00	136.86	136.86
Scrub shrub	0.0	227.1	0.00	219.07	219.07
Totals	1468.8	1468.8	628.46	1413.48	785.02

There would be some short-term temporary effects to vegetation in the project area during construction. Effort would be made to avoid removing existing vegetation when breaching or removing the "J" levee. Any loss of vegetation would be made up for by the planting and restoration of the site.

Wildlife

Effects of construction on wildlife in the area include disturbance from construction activity and noise. Wildlife such as birds and mammals, typically respond to this type of activity by leaving the construction area. Construction related effects are planned to be short-term and timed to avoid disrupting wildlife to the greatest extent possible. With the project, wildlife in the area would benefit from an increase in native cover-types, better ecological values, and greater connectivity especially of the riparian areas. The replacement of orchard and grain cover-types with native cover-types would supply higher value to wildlife through higher vegetative and animal diversity, reduction of disturbance due to farming operations, and increased structural diversity.

Fisheries

Fish in the Sacramento River would be adversely affected by the placement of rock around the abutments of Gianella Bridge on Highway 32. Riprap has been shown to halt erosion, arrest meander migration, create a relatively smooth surface, limit lateral mobility of the channel, decrease near-shore roughness, reduce habitat complexity, and impede plant growth at the waterline. While entrenched rock and rock riprap are also proposed along other sections of the new levee, they would have less of an effect than the rock along the bridge because they are setback from the river and would only interface with the water on large events. While the rock placed around the abutments of Gianella Bridge would adversely affect fisheries in the Sacramento River, the overall effect of the project to fisheries is beneficial due to the large amount of bank that would be exposed to erosion (about 18,000 linear feet) and the removal of 11,250 square feet of rock currently located on the "J" levee.

Alternative 5, Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough

Vegetation

Alternative 5 would have similar effects to vegetation as Alternative 1. More area would be restored with this alternative (Table 2) than with Alternative 1.

Table 2. Summary of cover-types, acreages, and AAHUs that would be impacted and created under Alternative 5.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Riparian	109.8	1162.1	44.44	1073.68	1029.24
Grassland	84.8	163.1	86.40	166.09	79.69
Orchard	1540.6	0.0	561.00	21.57	-539.43
Grain crop	89.9	0.0	62.64	2.41	-60.23
Oak savannal	0.0	153.9	0.00	150.20	150.20
Scrub shrub	0.0	281.2	0.00	277.56	277.56
Totals	1825.1[1]	1767.4[1]	754.48	1691.51	937.03

1. The Corps chose to subtract some of the riparian habitat that would be created in this alternative because the construction of the levee would have affected a wetland area. During the HEP this area was measured using a riparian model because of the woody vegetation growing along one side. The Corps felt that mitigating this loss with riparian habitat would not adequately replace the wetland values and decided to remove 45 acres of riparian habitat from the with project condition.

Grassland habitat would reach the pre-project condition about 5 years after completion of construction and riparian habitat would be of a higher value than pre-project condition after 20 years.

Wildlife

Effects to wildlife under Alternative 5 would be similar to those described in Alternative 1.

Fisheries

Effects to fisheries under Alternative 5 would be similar to those discussed in Alternative 1.

Alternative 6, Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32

Vegetation

The acreages of each habitat type that would be available under each alternative are shown in Table 3.

Wildlife

Effects to wildlife under Alternative 6 would be similar to those described in Alternative 1.

Table 3. Summary of cover-types acreages, and AAHUs that would be affected and created under Alternative 6.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Riparian	97.1	1093.7	44.44	1011.27	966.83
Grassland	84.6	155.1	86.30	158.09	71.79
Orchard	1386.3	0.0	504.82	19.41	-485.41
Grain crop	89.9	0.0	62.64	2.41	-60.23
Oak savannah	0.0	147.9	0.00	144.28	144.28
Scrub shrub	0.0	261.2	0.00	252.05	252.05
Totals	1657.9	1657.9	698.2	1587.51	889.31

Fisheries

Effects to fisheries under Alternative 6 would be similar to those discussed in Alternative 1.

DISCUSSION

Fish and Wildlife Service's Mitigation Policy

The recommendations provided herein for the protection of fish and wildlife resources are in accordance with the Fish and Wildlife Service's Mitigation Policy as published in the Federal Register (46:15 January 23, 1981).

The Mitigation Policy provides Service personnel with guidance in making recommendations to protect or conserve fish and wildlife resources. The policy helps ensure consistent and effective Service recommendations, while allowing agencies and developers to anticipate Service recommendations and plan early for mitigation needs. The intent of the policy is to ensure protection and conservation of the most important and valuable fish and wildlife resources, while allowing reasonable and balanced use of the Nation's national resources.

Under the Mitigation Policy, resources are assigned to one of four distinct Resource Categories, each having a mitigation planning goal which is consistent with the fish and wildlife values involved. The Resource Categories cover a range of habitat values from those considered to be unique and irreplaceable to those believed to be much more common and of relatively lesser value to fish and wildlife. The Mitigation Policy does not apply to threatened and endangered species, Service recommendations for completed Federal projects or projects permitted or licensed prior to enactment of Service authorities, or Service recommendations related to the enhancement of fish and wildlife resources, however.

In applying the Mitigation policy during an impact assessment, the Service first identifies each specific habitat or cover-type that may be impacted by the project. Evaluation species which utilize each habitat or cover-type are then selected for Resource Category analysis. Selection of evaluation species can be based on several rationale, as follows: (1) species known to be sensitive to specific land- and water-use actions; (2) species that play a key role in nutrient cycling or energy flow; (3) species that utilize a common environmental resource; or (4) species that are associated with Important Resource Problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Fish and Wildlife Service. (Note: Evaluation species used for Resource Category determinations may or may not be the same evaluation species used in a HEP application, if one is conducted. Based on the relative importance of each specific habitat to its selected evaluation species, and the habitat's relative

abundance, the appropriate Resource Category and associated mitigation planning goal are determined.

Mitigation planning goals range from "no loss of existing habitat value" (i.e., Resource Category 1) to "minimize loss of habitat value" (i.e., Resource Category 4). The planning goal of Resource Category 2 is "no net loss of in-kind habitat value"; to achieve this goal, any unavoidable losses would need to be replaced in-kind. "In-kind replacement" means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate those lost.

In addition to mitigation planning goals based on habitat values, Region 1 of the Service, which includes California, has a mitigation goal of no net loss of acreage for wetland habitat. This goal is applied in all impact analyses.

In recommending mitigation for adverse impacts to any of these habitats, the Service uses the same sequential mitigation steps recommended in the Council on Environmental Quality's regulations. These mitigation steps (in order of preference) are: avoidance, minimizing, rectification measures, measures to reduce or eliminate impacts over time, and compensation measures.

Resource Categories

Riparian

The **riparian** cover-type occurs along the Sacramento River in a narrow band of deciduous trees and shrubs between the river and the levee slope. It can also be found in lesser quality along a drainage canal from Hamilton City and on the southern end of Dunning Slough. The evaluation species selected for riparian habitat are woodpecker guild and raptor guild. Woody riparian vegetation of the project area provides valuable foraging substrate for woodpeckers, as well as for many passerine bird species. Red-shouldered, Swainson's and red-tailed hawks may nest in the project area or vicinity, building stick-nests in large riparian trees. Riparian forest and scrub-shrub are of generally high value to the evaluation species, and are today very scarce habitat types in the project area. Therefore, the Service finds that any riparian forest and riparian scrub-shrub habitats that would be effected by the project should have a mitigation goal of "no net loss of in-kind habitat value or acreage," Resource Category 2.

Grassland

Grassland cover-type is found along levee slopes and in patches in the Dunning Slough area. Evaluation species selected for this cover-type is the red-tailed hawk and the western meadowlark. The red-tailed hawk feeds and nests in this habitat, and has high consumptive and, to a lesser degree, non-consumptive human uses (*e.g.*, bird-watching). The meadowlark represents passerine birds that breed within this habitat. Generally, this habitat has medium habitat values. The Service designates the upland habitat in the project area as Resource Category 3. Our associated mitigation planning goal is to "no net loss of habitat value while minimizing loss of in-kind habitat value."

Orchards

Orchard cover-type consists of highly managed areas of plum, walnut, and almond orchards. The evaluation species for this cover-type include raptors and mourning doves. Orchards provide raptors and mourning doves perching sites and cover. This cover-type in the project area is of low to moderate quality and value. The Service designates the orchard habitat as Resource Category 4. Our associated mitigation planning goal of "minimize loss of habitat value."

Grain crop

Grain crop cover-type is limited to the area inside of Dunning Slough. Evaluation species selected for these cover-types the raptor guild (including Swainson's hawks, red-tailed hawks, ferruginous hawks, American kestrel, white-tailed kite, and great horned owl) and passerine ground-foraging birds (including western meadowlark and white-crowned sparrow). The values of these habitats vary according with season and crop, much of the agricultural in the Hamilton City project area provide medium-to-high value foraging habitat for diverse assemblages of birds of prey. Therefore, the Service finds that agricultural lands to be affected by the project, should have a mitigation planning goal of "no net loss of habitat value while minimizing loss of in-kind habitat value," Resource Category 4.

Habitat Evaluation Procedures (HEP)

The wildlife values resulting from the various action alternatives were determined using HEP. This methodology was developed by the Service and other resource and water development agencies for documenting the quality of available habitat for selected fish and wildlife. HEP facilitates two types of habitat comparisons: (1) the relative values of different locations at the same point in time; and (2) the relative values of the same locations at different points in time. Combining these two analyses allows the impacts of proposed habitat changes to be quantified. Descriptions of assumptions, procedures, and calculations are presented in Appendix B. Results are summarized in the text. HEP analysis was not applied to aquatic species because expected impacts would likely be immeasurable or nonexistent.

General Methodology

Acreage associated with each alternative was generated from a GIS layer by the Corps. The HSI models were chosen because they were readily available, their variables included characteristics of the cover-types that would change with the project, and their relative simplicity facilitated completing the HEP in a timely manner.

For consistency with HEP, we used the standard 0.0 to 1.0 range for each Suitability Index (SI). The impact areas and SIs were estimated using our best professional biological judgment of the physical changes and resource responses anticipated due to the project. These were based on our review of available information about the site and its characteristics. More detailed descriptions of methodologies are given in the HEP (Appendix A).

RESULTS

All alternatives provide benefit to fish and wildlife in the project area by restoring some of the historic floodplain. Benefits to restoring floodplain habitat include habitat complexity, high invertebrate production, and introduction of sediment and nutrients. For fish, floodplain habitat provides a mosaic of habitat structure and low velocity habitat, which have been lost along the Sacramento River due to flood control and water diversion projects. Amphibian and reptile species would benefit from increased wetted areas for breeding and better value upland habitat. The cover-types created with this project would benefit the western pond turtle by providing a mosaic of breeding, basking, and refugia areas. Migratory songbirds and raptors would be able to use the riparian forest and scrub habitat for breeding.

Any of the proposed alternatives would be acceptable to the Service. Alternative 5 would create the greatest amount of restored habitat. The other three alternatives provide less acreage and slightly less habitat value, but still benefit fish and wildlife resources. Based on current project information all alternatives would provide net benefits and therefore, no compensatory mitigation would be needed.

RECOMMENDATIONS

If the project is constructed, the Service recommends that the Corps implement the following:

1) Due to both the high amount of benefits from the HEP and the large amount of acres restored the Service recommends the Corps choose Alternative 5.

2) Use native grasses when planting grass species.

3) Develop and implement a vegetation monitoring program as part of the project. Monitoring the riparian restoration effort should focus on recording tree survival rates, the quantification of improved habitat values for wildlife (primarily bird species) by measuring percent tree and shrub cover, average height of overstory trees, canopy layering, and total woody riparian vegetation, and developing recommendations for alternative methods of riparian restoration should initial efforts fail. A vegetation monitoring report should be submitted annually for the first 5 years after planting activities, and on the 10th, 15th, and 20th year after planting. The monitoring reports should also identify any shortcomings in the restoration effort and include remedial actions on how to improve restoration efforts. All phases of the revegetation, and monitoring programs should be coordinated with, and approved by, the Service, CDFG, and NOAA Fisheries.

4) Comply with the Conservation Measures in the Service's biological opinion (Appendix B).

5) Complete the appropriate consultation with the CDFG regarding impacts to State listed species, and NOAA Fisheries, as required under section 7 of the Federal Endangered Species Act, for potential impacts to anadromous fish and marine species under NOAA Fishery's jurisdiction.

APPENDIX A
HABITAT EVALUATION PROCEDURES

HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION PROJECT

MAY 2004

INTRODUCTION

This application of Habitat Evaluation Procedures (HEP) is intended to quantify the affects to fish and wildlife resources that would occur with the construction of the project for the Hamilton City Levee Modification Initial Project. The proposed project is fully described in the "Project Description" section of the accompanying Fish and Wildlife Coordination Act (FWCA) Report. HEP is used to quantify anticipated affects to fish and wildlife and their habitats, and to determine mitigation needs. This particular HEP study addresses the potential benefits of different alignments of set back levees along the Sacramento River adjacent to Hamilton City.

A detailed description of the four ecosystem restoration alternatives can be found in the proceeding report. In general each alternative provides a setback levee which would both protect Hamilton City from flooding and provide an increased amount of area to the floodplain of the Sacramento River and restoring native cover-types (riparian, grassland, oak savannah, and scrub shrub) within the floodplain.

GOALS AND OBJECTIVES OF THIS HEP

A fundamental and critical step in designing any HEP application is the setting of overall goals and objectives. In this HEP application, such goals and objectives were developed based on the overall, long-term resource management goals of the Fish and Wildlife Service (Service). The mitigation policies of the Service (see description within the body of the FWCA Report) were also carefully considered.

1. The primary goal was to evaluate the impacts on fish and wildlife from the two proposed plans so that relative comparisons of benefits could be made.

2. Quantify habitat conditions before project construction.

3. Quantify habitat condition after project construction.

METHODOLOGY

HEP Description

HEP is an impact assessment methodology developed by the Fish and Wildlife Service (Service) and other State and Federal resources agencies which can be used to document the quality and quantity of available habitat for selected wildlife species. HEP provides information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time, and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed or anticipated land and water-use changes on wildlife habitat can be quantified. In a similar manner, any compensation needs (in terms of acreage) for the project can also be quantified.

A HEP application is based on the assumption that habitat for selected wildlife species or communities can be described by a model which produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, is assumed to relate directly to the carrying capacity of the habitat being evaluated. The HSI is multiplied by the area of available habitat to obtain Habitat Units

(HUs). The Average Annual Habitat Units (AAHUs) over the life of the project are then used in the comparisons described above. Species, guild, or community-based models can be used, depending on mitigation objectives.

HSI values are quantified at several points in time over the life of the project. These points in time are known as Target Years (TYs) and are selected for years in which habitat conditions are expected to change and can be reasonably defined. In every HEP analysis, there must be a Target Year 0 (TY0) which represents the baseline conditions, Target Year 1 (TY1) which is the first year habitat conditions are expected to deviate from baseline conditions, and an ending Target Year, which defines the period of analysis. The period of analysis consists of the life of the project, plus the period of construction.

When using HEP, it is necessary to determine HSIs for each evaluation element at selected target years for both with-project and without-project scenarios. Proposed mitigation areas must be treated similarly (with-management is substituted for with-project conditions). Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values are projected. This is accomplished by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it is necessary to make assumptions regarding baseline and future values within project impact and compensation areas.

The reliability of a HEP application, including the significance of HUs and AAHUs, is directly dependent on the ability of the HEP user to assign a well-defined and accurate HSI to the selected evaluation species or communities. Also, the HEP user must be able to identify and measure (or predict) the area of each distinct cover-type that is utilized by fish and wildlife within the project area. Both the HSIs and cover-type acreages must also be reasonably estimable at various future points in time. The Service has determined that these HEP criteria can be met, or at least reasonably approximated, for the Hamilton City Levee Modification Initial Project; thus HEP was considered to be an appropriate analytical tool.

HEP applications often rely on a team approach to sampling and projecting future values. In this application, HEP team members were: Jennifer Hobbs (Service) and Erin Taylor (Corps of Engineers (Corps)).

The six cover-types identified for evaluation of baseline conditions are: 1) riparian forest; 2) annual grassland; 3) orchard; and 4) grain crop; 5) oak savannah; and 6) scrub shrub. The HSI models and habitat variables measured to generate each HSI are summarized in Table 1.

Table 1. HSI models, cover-types, HSI model variables, and methods used for data collection.

HSI MODEL AND COVER-TYPE	HSI MODEL VARIABLES	DATA COLLECTION METHOD
Riparian forest Riparian forest	V1- average tree height V2- average canopy width of stand V3- tree canopy closure V4- # of tree/shrub species V5- understory vegetative density V6- frequency of floodplain inundation	visual estimation along transect line intercept densiometer line intercept line intercept local data
Grassland Red-tailed hawk	V1- % herbaceous cover V2- % herbaceous cover between 3 - 18 inches tall V3- number of suitable perch sites for hunting per 10 acres V7- number of suitable nest sites per 10 acres	line intercept line intercept line intercept belt transect
Orchard Red-tailed hawk	V4- % tree cover V7- number of suitable nest sites per 10 acres	line intercept belt transect
Grain crop Red-tailed hawk	V3- number of suitable perch sites for hunting per 10 acres V5- over-winter management practices in grain crops V7- number of suitable nest sites per 10 acres	line intercept observation belt transect
Oak savannah Red-tailed hawk	V1- % herbaceous cover V2- % herbaceous cover between 3 - 18 inches tall V4- % tree cover V7- number of suitable nest sites per 10 acres	line intercept line intercept line intercept belt transect
Scrub shrub Scrub shrub	V1- number of tree or shrub species V2- % canopy cover V3- average width of stand V4 - frequency of floodplain inundation	N/A N/A N/A N/A

Prior to field data collection, HSI models were selected to evaluate the cover-types in the project area. The HSI models used in this study are mechanistic models. The term "mechanistic" means that the models define a specific mathematical relationship between measured habitat parameters and their value to the evaluation species. The HSI models define both the habitat variables important in determining the value of the habitat to the species, and the relationships between these variables.

The models selected for use in this HEP application represent an ecological perspective of the area and show a sensitivity to habitat changes: 1) a **riparian forest model** (USFWS 1989) was used to evaluate affects to the native riparian forest; 2) a **red-tailed hawk model** (USFWS 1985) was used to evaluate affects to grassland, orchard, grain crop, and oak savannah cover-types; and 3) a **scrub shrub model** (USFWS 1989) was used to estimate scrub shrub cover-type with the project. All models are in Appendix B-3 of this report.

A variable was added to the riparian and scrub shrub models to account for the additional benefit of enlarging the floodplain. Currently the majority of the riparian habitat is not connected to the river and so does not receive the benefits of the changing hydrograph. With the project all of the riparian and scrub shrub would be in the floodplain and would be expected to flood at a 5 year flood event.

DATA COLLECTION

Cover-types were mapped on aerial photos provided by the Corps to the Service. Acreage of each cover-type was quantified by the Corps using Arc View. Field data were collected in early September 2001. Using primarily a stratified random sampling scheme, 100-foot-long transects were placed and data was collected every 10 feet. The data collection methods presented in each model were followed. The number of sample sites needed to adequately represent the value of each cover-type for the evaluation species was determined by the HEP team, and based on the acreage and the degree of hetergeneity for the cover-type being sampled.

HEP ANALYSIS PROCEDURES

HSI calculations for each evaluation species were undertaken at the completion of data collection. All SI and HSI values were calculated with the use of a computer spreadsheet using the equations contained in each model. The assumptions used in predicting habitat changes in future Target Years and the predicted future scenarios are contained in Appendix B-1. Baseline and future scenario SI values were developed for each cover-type. A HSI value was then calculated for each evaluation species and used in the HEP accounting software to determine compensation needs. Baseline and future HSI values for each evaluation species are shown in Appendix A-2. The HEP Version 2.2 Accounting Software package was used on an IBM-compatible personal computer to calculate HUs, and AAHUs.

RESULTS

The four restoration alternatives would retain existing native cover-types, riparian and grassland, as well as convert grain and orchard cover-types to riparian, grassland, oak savannah, and scrub shrub The alternatives vary in the amount of acres that would be restored, the following list is ordered by the most acres restored to the least: Alternative 5, 1,767.4 acres; Alternative 6, 1,657.9 acres; and Alternative 1, 1,468.8 acres. Increases in AAHUs correlates to the amount of acres restored. Alternative 5 has the largest net change with 937.03 AAHUs. Under all alternatives native cover-types would benefit from the project by an increase in acreage and habitat quality due to vegetation plantings and maintenance practices.

For more specific information on the individual alternatives refer to Tables 2 through 7 on the following pages.

Table 2. Summary of cover-types acreages, and AAHUs that would be affected and created under Alternative 1.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Riparian	97.1	955.7	44.44	889.81	845.37
Grassland	83.7	145.6	85.28	148.56	63.28
Orchard	1198.1	0.0	436.1	16.77	-419.33
Grain crop	89.9	0.0	62.64	2.41	-60.23
Oak savannah	0.0	140.4	0.00	136.86	136.86
Scrub shrub	0.0	227.1	0.00	219.07	219.07
Totals	1468.8	1468.8	628.46	1413.48	785.02

Table 3. Summary of cover-types, acreages, and AAHUs that would be impacted and created under Alternative 5.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Riparian	109.8	1162.1	44.44	1073.68	1029.24
Grassland	84.8	163.1	86.40	166.09	79.69
Orchard	1540.6	0.0	561.00	21.57	-539.43
Grain crop	89.9	0.0	62.64	2.41	-60.23
Oak savannah	0.0	153.9	0.00	150.20	150.20
Scrub shrub	0.0	281.2	0.00	277.56	277.56
Total	1825.1	1767.4	754.48	1691.51	937.03

Table 4. Summary of cover-types acreages, and AAHUs that would be affected and created under Alternative 6.

Cover-Type	Alternative 6 Without Project	Alternative 6 With Project	AAHUs without project	AAHUs with project	Net Change in AAHUs
Riparian	97.1	1093.7	44.44	1011.27	966.83
Grassland	84.6	155.1	86.30	158.09	71.79
Orchard	1386.3	0.0	504.82	19.41	-485.41
Grain crop	89.9	0.0	62.64	2.41	-60.23
Oak savannah	0.0	147.9	0.00	144.28	144.28
Scrub shrub	0.0	261.2	0.00	252.05	252.05
Totals	1657.9	1657.9	698.2	1587.51	889.31

Table 5. HSIs and acreage for the cover-types for all years for future conditions without the project (TY 0) and future conditions with the project for Alternative 1 for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Riparian forest	97.1	0.47	97.1	0.47	955.7	0.67	955.7	0.88	955.7	0.88	955.7	0.94	955.7	0.95
Grassland	83.7	0.98	83.7	0.98	145.6	0.98	145.6	1.00	145.6	1.00	145.6	1.00	145.6	1.00
Orchard	1198.1	0.35	0	0.35	0	0.35	0	0.35	0	0.35	0	0.35	0	0.35
Grain crop	89.9	0.67	0	0.67	0	0.67	0	0.67	0	0.67	0	0.67	0	0.67
Oak savanna	0	0.00	0	0.00	140.4	0.83	140.4	0.83	140.4	1.00	140.4	1.00	140.4	1.00
Scrub shrub	0	0.00	0	0.00	227.1	0.72	227.1	0.72	227.1	1.00	227.1	1.00	227.1	1.00

Table 6. HSIs and acreage for the cover-types for all years for future conditions without the project (TY 0) and future conditions with the project for Alternative 5 for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Riparian forest	109.8	0.47	109.8	0.47	1162.1	0.67	1162.1	0.88	1162.1	0.88	1162.1	0.94	1162.1	0.95
Grassland	84.8	0.98	84.8	0.98	163.1	0.98	163.1	1.00	163.1	1.00	163.1	1.00	163.1	1.00
Orchard	1540.6	0.35	0	0.35	0	0.35	0	0.35	0	0.35	0	0.35	0	0.35
Grain crop	89.9	0.67	0	0.67	0	0.67	0	0.67	0	0.67	0	0.67	0	0.67
Oak savanna	0	0.00	0	0.00	153.9	0.83	153.9	0.83	153.9	1.00	153.9	1.00	153.9	1.00
Scrub shrub	0	0.00	0	0.00	288.2	0.72	288.2	0.72	288.2	1.00	288.2	1.00	288.2	1.00

Table 7. HSIs and acreage for the cover-types for all years for future conditions without the project (TY 0) and future conditions with the project for Alternative 6 for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project.

SPECIES MODEL COVER TYPE	TY 0		TY 1		TY 5		TY [illegible]		TY 10		TY 20		TY 52	
	AREA	HSI	AREA	HSI	AREA	HSI	AREA	HSI	AREA	HSI	AREA	HSI	AREA	HSI
Riparian forest	97.1	0.47	97.1	0.47	1093.7	0.67	1093.7	0.88	1093.7	0.88	1093.7	0.94	1093.7	0.95
Grassland	84.6	0.98	84.6	0.98	155.1	0.98	155.1	1.00	155.1	1.00	155.1	1.00	155.1	1.00
Orchard	1386.3	0.35	0	0.35	0	0.35	0	0.35	0	0.35	0	0.35	0	0.35
Grain crop	89.9	0.67	0	0.67	0	0.67	0	0.67	0	0.67	0	0.67	0	0.67
Oak savanna	0	0.00	0	0.00	147.9	0.83	147.9	0.83	147.9	1.00	147.9	1.00	147.9	1.00
Scrub shrub	0	0.00	0	0.00	261.2	0.72	261.2	0.72	261.2	1.00	261.2	1.00	261.2	1.00

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HEP APPENDIX A-1
ASSUMPTIONS USED IN PREDICTING FUTURE SCENARIOS

HEP APPENDIX A-1
ASSUMPTIONS USED IN PREDICTING FUTURE SCENARIOS FOR THE HAMILTON CITY INITIAL PROJECT HEP

General

1. HEP is a suitable methodology for quantifying project impacts to fish and wildlife.
2. Project life is 50 years.
3. Construction time will only take one year to complete restoration actions, and levee would be breeched or removed at low water.
4. TY (Target Year) 0 is baseline conditions.
5. The data collection methods used to select sample sites were sufficiently random for the purposes of this study.
6. Planted tree species were not considered trees ($\geq$ 16 ft.) in the HSI models until TY 10.
7. Management of existing habitat would remain unchanged in the future.
8. Acreages for each alternative were provided by the Corps in consultation with the Nature Conservancy.
9. The evaluation species selected are good representatives of the habitat quality per each habitat, and the changes in habitat quality relate to each evaluation species.
10. The species selected are sufficient to gauge the extent of impacts from the project.
11. Random stratification for restoration plantings.
12. Vegetation would be planted at maximum densities to ensure greatest habitat value.

Future without the Project (Impact Area)

1. Future land management would not change from current use.

Future with the Project (Impact Area)

GRASSLAND HABITAT

1. Native grass species would be used for grassland.
2. Vegetation would reach maximum density by TY 5.

RIPARIAN

1. At TY 0, 1 there would be trees still existing.
2. Newly planted riparian/upland tree species would have a 70% survival rate.
3. A diverse number of species would be planted (more than four).

OAK SAVANNAH

1. Some orchard trees would be left in place to provide some habitat while native tree plantings become established.
2. Equilibrium would be reached at TY 20.

SCRUB SHRUB

1. A diverse number of species would be planted (more than four).
2. Canopy cover would become maximally beneficial at TY 10.

VARIABLES FOR EACH HSI MODEL AND HSI EQUATIONS

(1) RIPARIAN FOREST, RIPARIAN FOREST MODEL

V1 - average tree height
V2 - average canopy width of the stand
V3 - % tree canopy closure
V4 - # of tree and shrub species
V5 - understory vegetative density
V6 – floodplain inundation

HSI equation: $$\frac{(V1 * V3 * V4)^{1/3} + (V2 * V5)^{1/2} + V6}{3}$$

(2) GRASSLAND, RED-TAILED HAWK

V1 - % herbaceous cover
V2 - % herbaceous cover between 3 – 18 inches tall
V3 - number of suitable perch sites for hunting per 10 acres
V7 – number of suitable nest sites per 10 acres

Food HSI: $$\frac{(V1^2 * V2)^{.3} + V3)}{2}$$

Reproductive HSI: V7

HSI equation: $$\frac{2 * \text{Food HSI} + \text{Reproductive HSI}}{3}$$

(3) ORCHARD, RED-TAILED HAWK

V4 - % tree cover
V7 - number of suitable nest sites per 10 acres

HSI equation: $$\frac{2 * (V4 * 0.6) + V7}{3}$$

(4) GRAIN, RED-TAILED HAWK

V3 - number of suitable perch sites for hunting per 10 acres
V5 - over-winter management practices in grain crop
V7 - number of suitable nest sites per 10 acres

HSI equation: $$\frac{V7 + 2*(\frac{V3 + V5}{2})}{3}$$

HEP APPENDIX A-2
DATA ANALYSIS ASSUMPTIONS FOR THE HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION PROJECT HEP

Weighted HSI = (12.7*0.35+34.5*0.50)/47.2 = 0.46

TY1, TY52 - same as TY0, HSI = 0.46

(2) GRASSLAND, RED-TAILED HAWK

TY0 - baseline habitat conditions
V1 = 94%; SI = 1.0
V2 = 45%; SI = 0.84
V3 = 1 perch site; SI = 1.0
V7 = 1 nest site; SI = 1.0

$$\text{Food HSI: } \frac{(1.0^2 * 0.84)^{.3} + 1.0)}{2} = 0.96$$

Reproductive HSI: 1.0

$$\text{HIS} = \frac{2 * 0.97 + 1.0}{3} = 0.98$$

TY1, TY52 - same as TY0, HSI = 0.98

(3) ORCHARD, RED-TAILED HAWK

TY0 - baseline habitat conditions
V4 = 76%; SI = 0.51
V7 = 0.2 nest sites; SI = 0.03

$$\text{HSI} = \frac{2*(0.51 * 0.6) + 0.03}{3} = 0.35$$

TY1, TY52 - same as TY0, HSI = 0.35

(4) GRAIN, RED-TAILED HAWK

TY0 - baseline habitat conditions
V3 = 1 perch site; SI = 1.0
V5 = A fall plowing; no residual food or cover available; SI = 0.0
V7 = 2 nest sites; SI = 1.0

$$\text{HSI} = \frac{1.0 + 2*\frac{(1.0 + 0)}{2}}{3} = 0.67$$

TY1, TY52 - same as TY0, HSI = 0.67

(5) OAK SAVANNAH, RED-TAILED HAWK

(5) OAK SAVANNAH, RED-TAILED HAWK

V1 - % herbaceous cover
V2 - % herbaceous cover between 3 - 18 inches tall
V4 - % tree cover
V7 - number of suitable nest sites per 10 acres

HSI equation: $\dfrac{2 * (V1^{2} * V2 * V4)^{1/3} + V7}{3}$

(6) SCRUB SHRUB, SCRUB SHRUB

V1 - number of % herbaceous cover
V2 - % canopy cover
V3 - average width of stand
V4 - frequency of floodplain inundation

HSI equation: $(V1 * V2 * V3 * V4)^{1/4}$

HSI CALCULATIONS FOR THE HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION PROJECT HEP

WITHOUT PROJECT CONDITIONS

(1) RIPARIAN FOREST, RIPARIAN FOREST

Dunning Slough Area
TY0 (34.5 acres) - baseline habitat conditions
V1 = 50 feet; SI = 0.84
V2 = 100 feet; SI = 1.00
V3 = 44%; SI = 0.86
V4 = 3 species; SI = 0.90
V5 = 8%; SI = 0.40
V6 = out of floodplain; SI = 0.0

$HSI = ((0.84*0.86*0.90)^{1/3}+(1.0*0.40^{1/2}+0.0)/3 = 0.50$

Drainage ditch
TY0 (12.7 acres) - baseline habitat conditions
V1 = 26 feet; SI = 0.42
V2 = 30 feet; SI = 0.20
V3 = 41%; SI = 0.70
V4 = 4 species; SI = 1.00
V5 = 23%; SI = 0.70
V6 = out of floodplain; SI = 0.0

$HSI = ((0.42*0.70*1.0)^{1/3}+(0.20*0.70)^{1/2}+0.0)/3 = 0.35$

TY0 - baseline habitat conditions, cover-type does not currently exist HSI = 0.0

TY1, TY52 - same as TY0, HSI = 0.0

(6) SCRUB SHRUB, SCRUB SHRUB

TY0 - baseline habitat conditions, cover-type does not currently exist HSI = 0.0

TY1, TY52 - same as TY0, HSI = 0.0

WITH PROJECT CONDITIONS - ALTERNATIVE 1

(1) RIPARIAN FOREST, RIPARIAN FOREST

TY0 (97.1 acres) - baseline habitat conditions
Same as TY0, without the project, HSI = 0.47

TY1 (97.1 acres) – baseline habitat conditions for existing riparian, planting begins on new riparian, HSI = 0.47

TY3 (955.7 acres) – riparian restoration completed
V1 = 40 feet; SI = 0.63
V2 = 70 feet; SI = 1.0
V3 = 15%; SI = 0.28
V4 = 4 species; SI = 1.0
V5 = 10%; SI = 0.2
V6 = floodplain restored; SI = 1.0

$$HSI = ((0.63*0.28*1.0)^{1/3}+(1.0*0.2)^{1/2}+1.0)/3 = 0.67$$

TY5 (955.7 acres) – vegetation becomes established

V1 = 40 feet; SI = 0.63
V2 = 70 feet; SI = 1.0
V3 = 30% ; SI = 0.64
V4 = 4 species; SI = 1.0
V5 = 20%; SI = 0.75
V6 = floodplain restored; SI = 1.0

$$HSI = ((0.63*0.64*1.0)^{1/3}+(1.0*0.75)^{1/2}+1.0)/3 = 0.88$$

TY20 (955.7 acres) – values improve

V1 = 45 feet; SI = 0.75
V2 = 75 feet; SI = 1.0

V3 = 70%; SI = 1.0
V4 = 4 species; SI = 1.0
V5 = 25%; SI = 0.82
V6 = floodplain restored; SI = 1.0

HSI = $((0.75*1.0*1.0)^{1/3}+(1.0*0.82)^{1/2}+1.0)/3 = 0.94$

TY52 (955.7 acres) – end of period of analysis

V1 = 50 feet; SI = 0.84
V2 = 70 feet; SI = 1.0
V3 = 70%; SI = 1.0
V4 = 4 species; SI = 1.0
V5 = 25%; SI = 0.82
V6 = floodplain restored; SI = 1.0

HSI = $((0.84*1.0*1.0)^{1/3}+(1.0*0.82)^{1/2}+1.0)/3 = 0.95$

(2) GRASSLAND, RED-TAILED HAWK

TY0 (83.7 acres) - baseline habitat conditions
Same as TY0, without the project, HSI = 0.98

TY1 (83.7 acres) - baseline habitat conditions for existing grassland, planting begins on new grassland, HSI = 0.98

TY3 - TY52 (145.6 acres) - restoration complete grassland established

V1 = 95%; SI = 1
V2 = 75%; SI = 1
V3 = 1 perch site; SI = 1
V4 = 2 nest sites; SI = 1

Food HSI: $\frac{(1.0^2 * 1.0)^{1/3} + 1.0)}{2} = 1.0$

Reproductive HSI: 1.0

HSI = $\frac{2 * 1.0 + 1.0}{3} = 1.0$

(3) ORCHARD, RED-TAILED HAWK

TY0 (1198.1 acres) - baseline habitat conditions
Same as TY0, without the project, HSI = 0.35

TY1 – TY52 (0.0 acres) - first year of construction, orchards converted to native cover-types
HSI = 0

(4) **GRAIN, RED-TAILED HAWK**

TY0 - (89.9 acres) - baseline habitat conditions
Same at without project conditions for TY0, HSI = 0.67

TY1 – TY52 (0.0 acres) - first year of construction, grain not planted.
HSI = 0

(5) **OAK SAVANNAH, RED-TAILED HAWK**

TY0 (0 acres) – baseline habitat conditions
Same as without project conditions for TY0, HSI = 0.0

TY1 - (0 acres) - restoration begins.

TY3 (140.4 acres) - restoration complete

V1 = 50%; SI = 1.0
V2 = 50%; SI = 1.0
V4 = 15% ; SI = 1.0
V7 = 1 nest site; SI = 0.5

HSI =$2*(1.0^2*1.0*1.0)^{1/4}+0.5/3 = 0.83$

TY10 - TY 52 - (140.4 acres) - values have established.
V1 = 50%; SI = 1.0
V2 = 50%; SI = 1.0
V4 = 15%; SI = 1.0
V7 = 1 nest site; SI = 1.0

HSI =$2*(1.0^2*1.0*1.0)^{1/4}+1.0/3 = 1.0$

(6) **SCRUB SHRUB, SCRUB SHRUB**

TY0 (0 acres) - baseline habitat conditions
Same as without project conditions for TY0, HSI = 0.0

TY1 - (0.0 acres) - restoration begins.

TY3 - (291.3 acres) - restoration complete
V1 = 4 species; SI = 1.0
V2 = 10%; SI = 0.2
V3 = 25 feet; SI = 0.4
V4 = in the floodplain; SI = 1.0

HSI = $(1.0*0.2*0.4*1.0)^{1/4}$

TY10 - TY52 (291.3 acres) - values have established
V1 = 4 species; SI = 1.0

(5) <u>OAK SAVANNAH, RED-TAILED HAWK</u>
TY0 (0 acres) – baseline habitat conditions
Same as without project conditions for TY0, HSI = 0.0

TY1 - (0 acres) - restoration begins.

TY3 (154.6 acres) - restoration complete

V1 = 50%; SI = 1.0
V2 = 50%; SI = 1.0
V4 = 15% ; SI = 1.0
V7 = 1 nest site; SI = 0.5

HSI $=2*(1.0^2*1.0*1.0)^{1/4}+0.5/3 = 0.83$

TY10 - TY 52 - (154.6 acres) - values have established.
V1 = 50%; SI = 1.0
V2 = 50%; SI = 1.0
V4 = 15%; SI = 1.0
V7 = 1 nest site; SI = 1.0

HSI $=2*(1.0^2*1.0*1.0)^{1/4}+1.0/3 = 1.0$

(6) <u>SCRUB SHRUB, SCRUB SHRUB</u>
TY0 (0 acres) - baseline habitat conditions
Same as without project conditions for TY0, HSI = 0.0

TY1 - (0.0 acres) - restoration begins.

TY3 - (291.3 acres) - restoration complete
V1 = 4 species; SI = 1.0
V2 = 10%; SI = 0.2
V3 = 25 feet; SI = 0.4
V4 = in the floodplain; SI = 1.0

HSI $= (1.0*0.2*0.4*1.0)^{1/4}$

TY10 - TY52 (291.3 acres) - values have established
V1 = 4 species; SI = 1.0
V2 = 40%; SI = 1.0
V3 = 50 feet; SI = 1.0
V4 = in the floodplain; SI = 1.0

HSI $= (1.0*1.0*1.0*1.0)^{1/4}$

WITH PROJECT CONDITION - ALTERNATIVE 6

(1) RIPARIAN FOREST, RIPARIAN FOREST

TY0 (97.1 acres) - baseline habitat conditions
Same as TY0, without the project, HSI = 0.47

TY1 (97.1 acres) – baseline habitat conditions for existing riparian, planting begins on new riparian, HSI = 0.47

TY3 (1093.7 acres) – riparian restoration completed
V1 = 40 feet; SI = 0.63
V2 = 70 feet; SI = 1.0
V3 = 15%; SI = 0.28
V4 = 4 species; SI = 1.0
V5 = 10%; SI = 0.2
V6 = floodplain restored; SI = 1.0

$HSI = ((0.63*0.28*1.0)^{1/3}+(1.0*0.2)^{1/2}+1.0)/3 = 0.67$

TY5 (1093.7 acres) – vegetation becomes established

V1 = 40 feet; SI = 0.63
V2 = 70 feet; SI = 1.0
V3 = 30% ; SI = 0.64
V4 = 4 species; SI = 1.0
V5 = 20%; SI = 0.75
V6 = floodplain restored; SI = 1.0

$HSI = ((0.63*0.64*1.0)^{1/3}+(1.0*0.75)^{1/2}+1.0)/3 = 0.88$

TY20 (1093.7 acres) – values improve

V1 = 45 feet; SI = 0.75
V2 = 75 feet; SI = 1.0
V3 = 70% ; SI = 1.0
V4 = 4 species; SI = 1.0
V5 = 25%; SI = 0.82
V6 = floodplain restored; SI = 1.0

$HSI = ((0.75*1.0*1.0)^{1/3}+(1.0*0.82)^{1/2}+1.0)/3 = 0.94$

TY52 (1093.7 acres) – end of period of analysis

V1 = 50 feet; SI = 0.84

HEP APPENDIX A-3
HABITAT SUITABILITY INDEX MODELS

COMMUNITY-BASED
HABITAT SUITABILITY INDEX MODEL
FOR RIPARIAN FOREST COVER-TYPE

Adapted from a model used by the HEP team evaluating impacts of proposed riprap bank protection along the lower Sacramento River

As Revised
June 2003

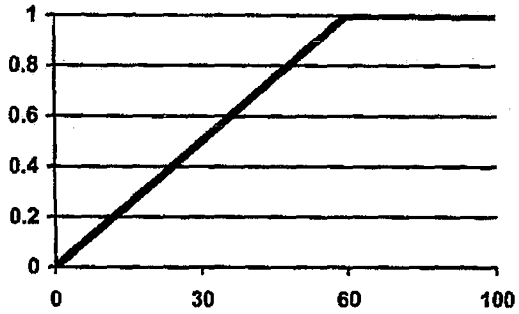
BACKGROUND: The cover-type model described here is for Riparian Forest Cover. This cover-type is defined as a stand of woody vegetation composed of primarily trees greater than 20-feet-tall. The Riparian Forest cover-type model identifies and quantifies characteristics of this cover type which are important to a wide array of wildlife. The model does not attempt to portray exactly the needs of any one species, but rather it broadly portrays the needs of many species or species groups of riparian zones.

For example, many birds, including nesting raptors such as red-tailed hawks and re-shouldered hawks require tall trees, and thus tree height, with taller trees being more favorable, has been included as a key model variable. Also, many songbirds, such as the northern oriole and least Bell's vireo, require relatively dense canopies, thus canopy closure, with greater closure providing greater value, is included as a model variable. Similarly, riparian water birds such as herons an egrets have specific needs relating to canopy closure, width of stand, and density of vegetative understory, so these needs have been met as much as possible with the appropriate model variables.

The single Habitat Suitability Index (HSI) value which is derived using the Riparian Forest cover-type model is therefore, not an exact measure of the habitat value of any single wildlife species. Instead, the HSI indicates the overall, broad quality of the cover-type to a broad array of the most important species which inhabit the creek's riparian zone. As such, the use of this single HSI value in the HEP process is assumed to provide the same results (i.e., estimates of relative impacts and compensation needs) as if the HEP were completed using a number of individual wildlife species models. Past comparisons using actual HSI data collected from Riparian Forest Cover along the Sacramento River suggest the validity of this assumption.

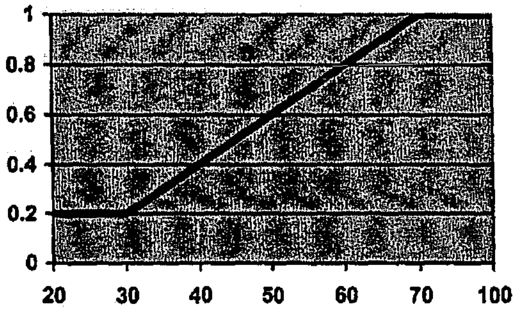
VARIABLE

V_1 – Average tree height.
V_2 – Average canopy width of the stand.
V_3 – Tree canopy closure.
V_4 – Number of tree or shrub species.
V_5 – Understory vegetative density.
V_6 – Area inundated by floodplain.
V_1 – Average tree height. Assumptions: For most wildlife species of concern, the taller the trees, the better the habitat value. Nesting raptors in particular require relatively tall trees. A tree height, on average, of about 60 feet or greater is optimum.



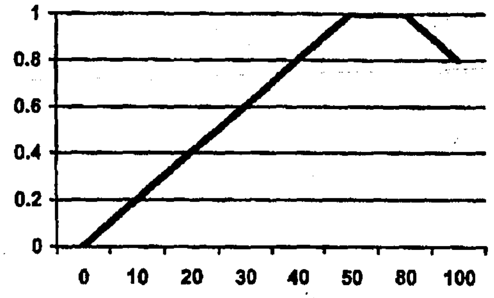
V_1 – Average Tree Height (Ft.)

V_2 – Average canopy width of the stand. Assumptions: Generally, the wider the stand, the better the values for most key fish and wildlife. Stands less than 30-feet-wide have relatively low values; stands over 70 feet in width are best.



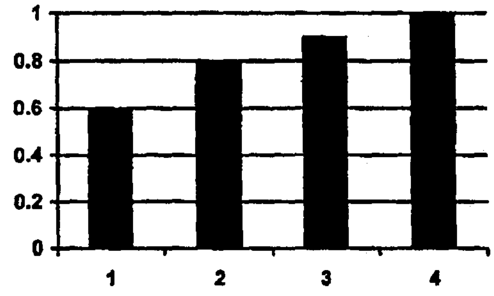
V_2 – Average Canopy Width of the Stand (Ft.)

V_3 – Tree canopy closure. Assumptions: In general, the greater the forest density, as determined by percent of canopy closure, the greater the values of the forest. However, if the stand becomes too dense, habitat values frequently decline. The optimal condition is with percent canopy closure of 50 to 80 percent.



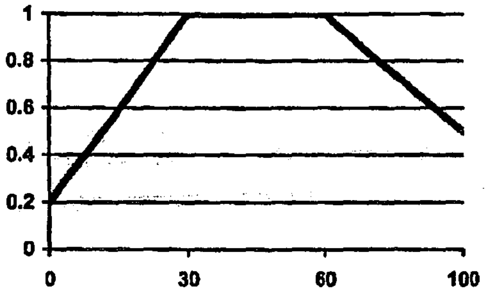
V$_3$ – Tree Canopy Closure (Percent)

V$_4$ – Number of tree or shrub species. Assumptions: The greater the habitat diversity, as indicated by the number of tree or shrub species making up the stand(s), the greater the values to fish and wildlife. Four or more species of trees or shrubs are considered the optimal condition.



V$_4$ – Number of Tree or Shrub Species

V_5 – Understory vegetative density. Suitability Index (SI) determination. Assumptions: The best Riparian Forest habitat occurs when both overstory and understory canopies are relatively dense. The understory should generally have a moderate density of vegetation at various elevations. By estimating the understory of the forest for the horizontal planes at 2, 6, and 14 feet above ground, and then averaging these three figures (i.e., the three estimates of percent vegetative cover), a good index of overall understory density can be derived.



V_5 – Average Understory Vegetative Density (%)
(At 2. 6. and 14 Feet Above Ground)

V_6 – Floodplain inundation. Assumptions: Riparian habitat that experiences flooding provides additional structure and food for wildlife and fish.

Area in floodplain	1.0
Area outside of floodplain	0.0

HABITAT SUITABILITY INDEX (HSI): Average canopy width and understory density are believed to be slightly more important variables than the other three variables. The five variables are thus combined as follows:

$$HSI = \frac{(V_1 \times V_3 \times V_4)^{1/3} + (V_2 \times V_5)^{1/2} + V_6}{3}$$

COMMUNITY-BASED
HABITAT SUITABILITY INDEX MODEL
FOR THE SCRUB-SHRUB COVER-TYPE

Adapted from a model used by the HEP team evaluating impacts of proposed riprap bank protection along the lower Sacramento River

As Revised
June 2003

BACKGROUND: The cover-type model described here is for Scrub Shrub Cover. This cover-type is defined as a stand of woody trees or shrubs averaging less than 20-feet-tall. The Scrub-Shrub community model identifies and quantifies characteristics of this cover type which are important to a wide array of wildlife. Thus, the model may not portray exactly the needs of any one species, but rather it broadly portrays the needs of many species or species groups of riparian zones.

Among the species whose needs were considered in developing this model were the following; songbirds, such as the yellow warbler, and least Bell's vireo; gamebirds, such as the pheasant and California quail; the heron and egret family; and furbearing aquatic mammals.

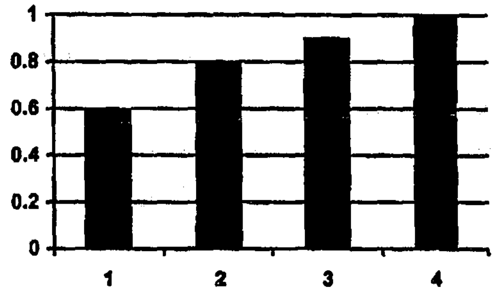
The single Habitat Suitability Index (HSI) value which is derived using the Scrub-Shrub cover-type model is therefore, not an exact measure of the habitat value of any single wildlife species. Instead, the HSI indicates the overall, broad quality of the cover-type to a broad array of the most important species which inhabit the creek's riparian zone. As such, the use of this single HSI value in the HEP process is assumed to provide the same results (i.e., estimates of relative impacts and compensation needs) as if the HEP were completed using a number of individual wildlife species models. Past comparisons using actual HSI data collected from Riparian Forest Cover along the Sacramento River suggest the validity of this assumption.

AREA OF APPLICABILITY: Riparian Scrub-Shrub Cover along the Sacramento River.

VARIABLE

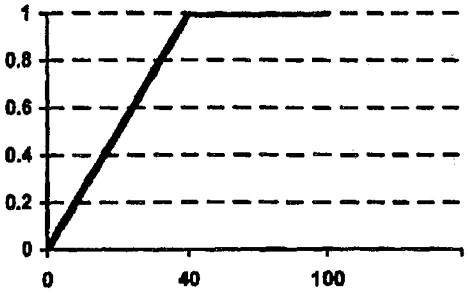
V_1 – Number of tree or shrub species.
V_2 – Percent of canopy closure.
V_3 – Average width of stand(s).
V_4 – Area inundated by floodplain.

V_1 – Number of tree or shrub species. Suitability Index (SI) determination. Assumptions: The greater the habitat diversity, as indicated by the number of tree or shrub species making up the stand(s), the greater the values to fish and wildlife. Four or more species of trees or shrubs are considered the optimal condition.



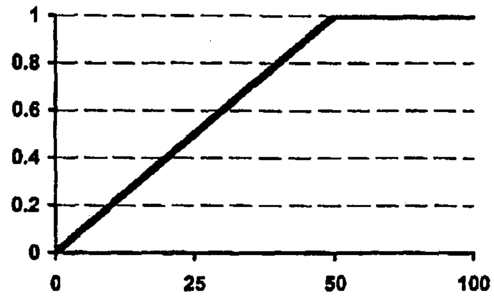
V_1 – Number of Tree or Shrub Species

V_2 – Percent of canopy closure. Suitability Index (SI) determination. Assumptions: In general, the greater the Scrub-Shrub density, as measured by percentage of canopy closure of the trees or shrubs, the greater the values for fish and wildlife. For relatively narrow stands, optimal canopy closure is 40-100 percent; for wider stands, optimal closures is 40-75 percent.



V_2 – Canopy Closure (Percent)

V_3 – Average width of stand(s). Suitability Index (SI) determination. Assumptions: The wider the stand, the greater the values for fish and wildlife. Stands at least 50-feet-wide are considered optimal.



V_3 – Average Width of Stand (Feet)

V_4 – Floodplain inundation. Assumptions: Riparian scrub shrub habitat that experiences flooding provides additional structure and food for wildlife and fish.

Area in floodplain	1.0
Area outside of floodplain	0.0

<u>HABITAT SUITABILITY INDEX (HSI)</u>: The four variable are closely related and about equally important in determining the HSI. Variables are generally measured or estimated during periods of maximum vegetative leaf-out.

$$HSI = (V_1 \times V_2 \times V_3 \times V_4)^{1/4}$$

APPENDIX B
FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT
SECTION 7 CONSULTATION

APPENDIX B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT AND FEDERAL AND STATE LISTED SPECIES

SECTION 7(a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment–Major Construction Activity[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species would be affected. Upon completion, the BA should be forwarded to our office.

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[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2] "Effects of the action" refers to the direct and indirect effects on an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

U.S. DEPARTMENT OF THE INTERIOR · MARCH 3, 1849

United States Department of the Interior

U.S. FISH & WILDLIFE SERVICE

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
1-1-04-F-0145

JUN 30 2004

Mr. Mark C. Charlton
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Formal Endangered Species Consultation on the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, Glenn County, California

Dear Mr. Charlton:

This document has been prepared in response to your April 1, 2004, request to initiate formal consultation with the U.S. Fish and Wildlife Service (Service) on the effects of the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, in Glenn County, California, on the threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (beetle). Your request was received by the Service on April 2, 2004. This document represents the Service's biological opinion on the effects of the proposed project on the threatened beetle, in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act).

The Service has reviewed the biological information submitted by the U.S. Army Corps of Engineers (Corps). The documentation describes the proposed project's effects on listed species. This biological opinion is in accordance with the standards established in the Service's July 9, 1999, *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (Conservation Guidelines). Based on our analysis, the Service has determined the proposed project will result in the establishment of a significant amount of habitat for the valley elderberry longhorn beetle that will be of long-term benefit to this listed animal, and any adverse effects will be temporary and relatively minor in nature.

The findings and requirements in this consultation are based on: (1) a site visit by Justin Ly of the Service and Annalena Bronson of the California Department of Water Resources on April 1, 2003; (2) the *Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle- Hamilton City Flood Damage Reduction and Ecosystem Restoration*, dated March, 2004;

(3) the *Hamilton City Flood Damage Reduction and Ecosystem Restoration, California, Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report*, dated March, 2004; (4) the *Hamilton City Flood Damage Reduction and Ecosystem Restoration, California, Habitat Revegetation Report*, dated December, 2003; and, (5) numerous telephone conversations between the Corps and the Service.

Consultation History

April 1, 2003. A visit to the site by Justin Ly, of the Service and Annalena Bronson, of the California Department of Water Resources.

March 10, 2004. Erin Taylor of the Corps provided the draft Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle-Hamilton City Flood Damage Reduction and Ecosystem Restoration, dated January, 2004, to the Service.

March 19, 2004. Erin Taylor provided the final Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle- Hamilton City Flood Damage Reduction and Ecosystem Restoration, dated March, 2004, to the Service.

April 1, 2004. The Service received the request for formal section 7 consultation from the Corps.

Project Description

Hamilton City is located in Glenn County, California, along the west bank of the Sacramento River, approximately 85 miles north of the City of Sacramento. The proposed project area includes Hamilton City and the surrounding rural area, which comprises approximately 1,500 acres. The proposed action area is bounded by the Sacramento River to the East and the Glenn Colusa Canal to the west and extends approximately two miles north and six miles south of Hamilton City. Surrounding land use is primarily orchards. The objectives of the project are to reduce flood risk and flood damages and to restore the riverine ecosystem along the west bank of the Sacramento River in and around Hamilton City.

Flood protection to Hamilton City and the surrounding area is provided by the "J" levee, which is an existing private levee. Currently, the Sacramento River is actively eroding into the toe of the levee at the northern end of the proposed project area. Glenn County has built a backup levee, approximately 1,000 feet in length, to protect the community in the event the toe erosion causes failure at the northern end of the "J" levee.

Currently, there are approximately 107 elderberry shrubs (*Sambucus* species), with stems one inch or greater at ground level in the proposed action area. Of these 107 elderberry shrubs, 21 shrubs with stems one inch or greater at ground level have beetle exit holes. These elderberry shrubs can be avoided with the potential setback levee alignments currently being considered. However, there is potential for the 107 existing elderberry shrubs to be removed during future flood-fighting activities.

The Reclamation Board has identified the proposed project area as having a high level of potential for restoration. The Reclamation Board is seeking to plant a mix of native riparian vegetation, including a minimum of one elderberry shrub per 1,800 feet (2,747 elderberry shrubs) in order to benefit the listed beetle. The approximate 2,747 or more elderberry shrubs that are proposed for planting are not for mitigation purposes and are only proposed for the benefit of the beetle, and other threatened and endangered species. The Reclamation Board has stated that the addition of elderberry shrubs to the restoration project is dependent on the authorization for incidental take of all elderberry shrubs planted within the 1,500 acre proposed action area. This would include the loss of all elderberry shrub habitat that occurs in the action area in the future. The Reclamation Board is seeking incidental take of all elderberry shrubs that would result from future maintenance and operations activities and potential flood-fighting activities that may be required for the setback levee in the future. Flood-fighting activities have occurred in the project area in 1983, 1986, 1995, 1997, and 1998.

The Corps has indicated in the *Elderberry Planting and Monitoring Plan for the Valley Elderberry Longhorn Beetle- Hamilton City Flood Damage Reduction and Ecosystem Restoration*, dated March, 2004, that the following maintenance and flood-fighting activities may occur within the proposed action area:

1. Maintain ability to access the entire length of levee (approximately 6 miles) for maintenance and flood-fighting;

2. Maintain ability to access the entire length of the levee for large equipment to deliver and place flood-fighting material, including rock;

3. Maintain ability to maintain hydraulic capacity by selective clearing of vegetation;

4. Maintain ability to remove vegetation from the levee and within 15 feet of levee toe;

5. Maintain ability to access the levee to clear bank and berm of vegetation in order to place rock riprap bank protection when erosion is encroaching into the projected levee slope.

The Corps would be involved in the restoration, planting, and establishment for the first three years of restoration. Land ownership would then be turned over to a non-Federal sponsor. The Corps would require that the non-Federal sponsor supply the lands, easements, and rights-of-way for the proposed project. The Reclamation Board is the Corp's non-Federal sponsor for only the flood control component of the project. The Reclamation Board has yet to identify a non-Federal sponsor for the restoration component of the project. Possible non-Federal sponsors include The Nature Conservancy, the California Department of Fish and Game, or CalFed. Maintenance of the restoration area would then become the non-Federal sponsor's responsibility. The Corps will not be able to implement the proposed project without a non-Federal restoration sponsor.

Proposed Conservation Measures

The following measures have been proposed by the Corps:

1. A minimum of one elderberry shrub would be planted per 1,800 square feet (2,747 elderberry shrubs);

2. The Corps would be involved in the restoration, planting, and establishment for the first three years of restoration. Land ownership would be turned over to The Nature Conservancy, the California Department of Fish and Game, CalFed, or another non-Federal sponsor after the first three years. The Corps will attempt to ensure that monitoring will be continued by the non-Federal sponsor after three years in accordance with the Service's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle.*

3. Flood-fighting activities are expected to occur in the future. If flood-fighting activities occur within the proposed action area, the Corps will restore the areas disturbed during flood-fighting activities with the original vegetation species mix. Flood fighting by the Corps is considered emergency work and falls under PL-84 99, which includes consultation with the Service. This future consultation would require that the previous vegetation be restored.

4. A Service-approved biologist familiar with elderberry shrubs shall be onsite during flood-fighting activities and have the authority to choose access routes. Access routes, staging areas, and all project activities should be chosen in a manner that will cause the least amount of damage to beetle habitat. Removal of elderberry shrubs should be limited to the minimum necessary to achieve the project goal.

Status of the Species

The beetle was listed as a threatened species under the Act on August 8, 1980 (45 FR 52803). Critical habitat for the species was designated and published at 50 CFR §17.95. Two areas along the American River in the Sacramento metropolitan area have been designated as critical habitat for the beetle. Critical habitat for this species has been designated along the lower American River at Goethe and Ancil Hoffman parks (American River Parkway Zone) and at the Sacramento Zone, an area about a half mile from the American River downstream from the American River Parkway Zone. In addition, an area along Putah Creek, Solano County, and the area west of Nimbus Dam along the American River Parkway, Sacramento County, are considered essential habitat, according to the Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984). These critical habitat and essential habitat areas within the American River parkway and Putah Creek support large numbers of mature elderberry shrubs with extensive evidence of use by the beetle.

The beetle is dependent on the elderberry, its host plant, which is a locally common component of the remaining riparian forests and savannah areas and, to a lesser extent, the mixed chaparralfoothill woodlands of the Central Valley. Use of the elderberry shrubs by the animal, a wood borer, is rarely apparent. Frequently but not exclusively, the only exterior evidence of the shrub's use by the beetle is an exit hole created by the larva just prior to the pupal stage. Observations made within elderberry shrubs along the Cosumnes River, in the Folsom Lake area, and near Blue Ravine in Folsom indicate that larval galleries can be found in elderberry stems with no evidence of exit holes; the larvae either succumb prior to constructing an exit hole or are not far enough along in the developmental process to construct an exit hole. Beetle larvae appear to be distributed in stems which are 1.0 inch or greater in diameter at ground level. The Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984) and Barr (1991) contain further details on the valley elderberry longhorn beetle's life history.

Population densities of the beetle are probably naturally low (Service 1984); and it has been suggested, based on the spatial distribution of occupied shrubs (Barr 1991), that the beetle is a poor disperser (Collinger *et al.* 2001). Low density and limited dispersal capability cause the beetle to be vulnerable to the negative effects of the isolation of small subpopulations due to habitat fragmentation.

When the beetle was listed as threatened in 1980, the species was known from less than 10 localities along the American River, the Merced River, and Putah Creek. By the time the Valley Elderberry Longhorn Beetle Recovery Plan was prepared in 1984, additional occupied localities had been found along the American River and Putah Creek. As of 2004, the California Natural Diversity Database (CNDDB) contained 190 occurrences for this species in 44 drainages throughout the Central Valley, from a location along the Sacramento River in Shasta County, southward to an area along Caliente Creek in Kern County (CNDDB 2004). Glenn County has 12 occurrences of the beetle (CNDDB 2004). The beetle continues to be threatened by habitat loss and fragmentation, predation by the non-native Argentine ants (*Linepithema humile*) (Holway 1995; Huxel 2000; Huxel and Hastings 1999; Huxel *et al.* 2001; Ward 1987), and possibly other factors such as pesticide drift, non-native plant invasion, improper burning regimes, off-road vehicle use, rip-rap bank protection projects, wood cutting, and over grazing by livestock (CNDDB 2004).

Environmental Baseline

Riparian forests, the primary habitat for the beetle, have been severely depleted throughout the Central Valley over the last two centuries as a result of expansive agricultural and urban development (Huxel *et al.* 2001; Katibah 1984; Roberts *et al.* 1977; Thompson 1961). Since colonization, these forests have been "...modified with a rapidity and completeness matched in few parts of the United States" (Thompson 1961). As of 1849, the rivers and larger streams of the Central Valley were largely undisturbed. They supported continuous bands of riparian woodland four to five miles in width along some major drainages such as the lower Sacramento River, and generally about two miles wide along the lesser streams (Thompson 1961). Most of the riverine floodplains supported riparian vegetation to about the 100-year flood line (Katibah 1984). A large human population influx occurred after 1849, however, and much of the Central Valley riparian habitat was rapidly converted to agriculture and used as a source of wood for fuel and construction to serve a wide area (Thompson 1961). By as early as 1868, riparian woodland had been severely affected in the Central Valley, as evidenced by the following excerpt:

> "This fine growth of timber which once graced our river [Sacramento], tempered the atmosphere, and gave protection to the adjoining plains from the sweeping winds, has entirely disappeared - the woodchopper's axe has stripped the river farms of nearly all the hard wood timber, and the owners are now obliged to rely upon the growth of willows for firewood." (Cronise 1868, in Thompson 1961).

The clearing of riparian forests for fuel and construction made this land available for agriculture (Thompson 1977). Natural levees bordering the rivers, once supporting vast tracts of riparian habitat, became prime agricultural land (Thompson 1961). As agriculture expanded in the Central Valley, needs for increased water supply and flood protection spurred water development and reclamation projects. Artificial levees, river channelization, dam building, water diversion, and heavy groundwater pumping further reduced riparian habitat to small, isolated fragments (Katibah 1984). In recent decades, these riparian areas have continued to decline as a result of ongoing agricultural conversion as well and urban development and stream channelization. As of 1989, there were over 100 dams within the Central Valley drainage basin, as well as thousands of miles of water delivery canals and streambank flood control projects for irrigation, municipal and industrial water supplies, hydroelectic power, flood control, navigation, and recreation (Frayer *et al.* 1989). Riparian forests in the Central Valley have dwindled to discontinuous strips of widths currently measurable in yards rather than miles.

Some accounts state that the Sacramento Valley supported approximately 775,000 to 800,000 acres of riparian forest as of approximately 1848, just prior to statehood (Smith 1977; Katibah 1984). No comparable estimates are available for the San Joaquin Valley. Based on early soil maps, however, more than 921,000 acres of riparian habitat are believed to have been present throughout the Central Valley under pre-settlement conditions (Huxel *et al* 2001; Katibah 1984). Another source estimates that of approximately five million acres of wetlands in the Central Valley in the 1850s, approximately 1,600,000 acres were riparian wetlands (Warner and Hendrix 1985; Frayer *et al.* 1989).

Based on a California Department of Fish and Game riparian vegetation distribution map, by 1979, there were approximately 102,000 acres of riparian vegetation remaining in the Central Valley. This represents a decline in acreage of approximately 89 percent as of 1979 (Katibah 1984). More extreme figures were given by Frayer *et al.* (1989), who reported that woody riparian forests in the Central Valley had declined to 34,600 acres by the mid-1980s (from 65,400 acres in 1939). Although these studies have differing findings in terms of the number of acres lost (most likely explained by differing methodologies), they attest to a dramatic historic loss of riparian habitat in the Central Valley. As there is no reason to believe that riparian habitat suitable to the beetle (elderberry shrubs) would be destroyed at a different rate than other riparian habitat, we can assume that the rate of loss for beetle habitat in riparian areas has been equally dramatic.

A number of studies have focused on riparian vegetation losses along the Sacramento River, which supports some of the densest known populations of the beetle. Approximately 98 percent of the middle Sacramento River's historic riparian vegetation was believed to have been extirpated by 1977 (DWR 1979). The State Department of Water Resources estimated that native riparian habitat along the Sacramento River from Redding to Colusa decreased from 27,720 acres to 18,360 acres (34 percent) between 1952 and 1972 (McGill *et al.* 1975; Conrad *et al.* 1977). The average rate of riparian loss on the middle Sacramento River was 430 acres per year from 1952 to 1972, and 410 acres per year from 1972 to 1977. In 1987, riparian areas as large as 180 acres were observed converted to orchards along this River (McCarten and Patterson 1987).

Barr (1991) examined 79 sites in the Central Valley supporting valley elderberry longhorn beetle habitat. When 72 of these sites were re-examined by researchers in 1997, seven no longer supported valley elderberry longhorn beetle habitat. This loss represents a decrease in the number of sites with valley elderberry longhorn beetle habitat by approximately nine percent in six years.

No comparable information exists on the historic loss of non-riparian valley elderberry longhorn beetle habitat such as elderberry savanna and other vegetation communities where elderberry shrubs also occur (oak or mixed chaparral-woodland, or grasslands adjacent to riparian habitat). However, all natural habitats throughout the Central Valley have been heavily adversely affected within the last 200 years (Thompson 1961), and we can therefore assume that non-riparian beetle habitat also has suffered a widespread decline. This analysis focuses on loss of riparian habitat because the beetle is primarily dependent upon riparian habitat. Adjacent upland areas are also likely to be important for the species (Huxel pers. comm. 2000), but this upland habitat typically consist of oak woodland or elderberry savanna bordering willow riparian habitat (Barr 1991). The riparian acreage figures given by Frayer *et al.* (1989) and Katibah (1984) included oak woodlands concentrated along major drainages in the Central Valley, and therefore probably included lands we would classify as upland habitat for the beetle adjacent to riparian drainages.

Between 1980 and 1995, the human population in the Central Valley grew by 50 percent, while the rest of California grew by 37 percent . The Central Valley's population was 4.7 million by 1999, and it is expected to more than double by 2040. The American Farmland Trust estimates that by 2040 more than 1 million cultivated acres will be lost and 2.5 million more put at risk (Ritter 2000). With this growing population in the Central Valley, increased development pressure is likely to result in continuing loss of riparian habitat.

While habitat loss is clearly a large factor leading to the species' decline, other factors are likely to pose significant threats to the long term survival of the beetle. Only approximately 20 percent of riparian sites with elderberry observed by Barr (1991) and Collinge *et al.* (2001) support beetle populations (Barr 1991, Collinge *et al.* 2001). Jones and Stokes (1988) found 65 percent of 4,800 riparian acres on the Sacramento River have evidence of beetle presence. The fact that a large percentage of apparently suitable habitat is unoccupied suggests that the beetle is limited by factors other than habitat availability, such as habitat quality or limited dispersal ability.

Destruction of riparian habitat in central California has resulted not only in a significant acreage loss, but also has resulted in beetle habitat fragmentation. Fahrig (1997) states that habitat fragmentation is only important for habitats that have suffered greater than 80 percent loss. Riparian habitat in the Central Valley, which has experienced greater than 90 percent loss by most estimates, would meet this criterion as habitat vulnerable to effects of fragmentation. Existing data suggests that beetle populations, specifically, are affected by habitat fragmentation. Barr (1991) found that small, isolated habitat remnants were less likely to be occupied by beetles than larger patches, indicating that valley elderberry longhorn beetle subpopulations are extirpated from small habitat fragments. Barr (1991) and Collinge *et al.* (2001) consistently found valley elderberry longhorn beetle exit holes occurring in clumps of elderberry bushes rather than isolated bushes, suggesting that isolated shrubs do not typically provide long-term viable habitat for this species. Local populations of organisms often undergo periodic colonization and extinction, while the metapopulation (set of spatially separated groups of a species) may persist (Collinge 1996).

Habitat fragmentation can be an important factor contributing to species declines because: (1) it divides a large population into two or more small populations that become more vulnerable to direct loss, inbreeding depression, genetic drift, and other problems associated with small populations; (2) it limits a species' potential for dispersal and colonization; and (3) it makes habitat more vulnerable to outside influences by increasing the edge:interior ratio (Primack 1998).

Small, isolated subpopulations are susceptible to extirpation from random demographic, environmental, and/or genetic events (Shaffer 1981; Lande 1988; Lande 1993; Primack 1998). While a large area may support a single large population, the smaller subpopulations that result from habitat fragmentation may not be large enough to persist over a long time period. As a population becomes smaller, it tends to lose genetic variability through genetic drift, leading to inbreeding depression and a lack of adaptive flexibility. Smaller populations also become more vulnerable to random fluctuations in reproductive and mortality rates, and are more likely to be extirpated by random environmental factors.

The beetle is a specialist on elderberry plants, and tends to have small population sizes and occurs in low densities (Barr 1991; Collinge *et al.* 2001). Collinge *et al.* (2001) compared resource use and density of exit holes between the beetle and a related subspecies, the California elderberry longhorn beetle (*Desmocerus californicus californicus*). The valley elderberry longhorn beetle tended to occur in areas with higher elderberry densities, but had lower exit hole densities than the California elderberry longhorn beetle. With extensive riparian habitat loss and fragmentation, these naturally-small valley elderberry longhorn beetle populations are broken into even smaller, isolated populations. Once a small valley elderberry longhorn beetle population has been extirpated from an isolated habitat patch, the species may be unable to re-colonize this patch if it is unable to disperse from nearby occupied habitat. Insects with limited dispersal and colonization abilities may persist better in large habitat patches than small patches because small fragments may be insufficient to maintain viable populations and the insects may be unable to disperse to more suitable habitat (Collinge 1996).

Studies suggest that the beetle is unable to re-colonize drainages where the species has been extirpated, because of its limited dispersal ability (Barr 1991; Collinge *et al.* 2001). Huxel and

Hastings (1999) used computer simulations of colonization and extinction patterns based on differing dispersal distances, and found that the short dispersal simulations best matched the 1997 census data in terms of site occupancy. This suggests that dispersal and colonization are limited to nearby sites. At spatial scales greater than 6.2 miles (10 km.), such as across drainages, valley elderberry longhorn beetle occupancy appears to be strongly influenced by regional extinction and colonization processes, and colonization is constrained by limited dispersal (Collinge *et al.* 2001; Huxel and Hastings 1999). Except for one occasion, drainages examined by Barr that were occupied in 1991 remained occupied in 1997 (Collinge *et al.* 2001; Huxel and Hastings 1999). The one exception was Stoney Creek, which was occupied in 1991 but not in 1997. All drainages found by Barr (1991) to be unoccupied in 1991 were also unoccupied in 1997. This data suggests that drainages unoccupied by the valley elderberry longhorn beetle remain so.

Habitat fragmentation not only isolates small populations, but also increases the interface between habitat and urban or agricultural land, increasing negative edge effects such as the invasion of non-native species (Huxel *et al.* 2001; Huxel 2000; Soule 1990) and pesticide contamination (Barr 1991). Several edge effect-related factors may be related to the decline of the beetle.

Project-Related Effects to the Valley Elderberry Longhorn Beetle

The overall effect of this project will result in long-term beneficial effects to the valley elderberry longhorn beetle. The project will restore 1,500 acres of habitat fro the imperiled animal. This addition of habitat in the area will benefit the listed beetle by increasing population numbers and improving the dispersal abilities of the species. The proposed project may result in short-term adverse effects to the valley elderberry longhorn beetle. Maintenance and operations activities and potential flood-fighting activities may remove elderberry shrubs from the proposed actions area. If flood-fighting activities occur within the proposed action area, the Corps will restore these areas with the native riparian vegetation mix used during the original restoration effort. Therefore, these direct effects are expected to be only a short-term disturbance.

Indirect effects may occur if maintenance and flood-fighting activities alter the terrain, such as driplines, which may adversely affect elderberry bushes. Vehicles and construction equipment may leak hazardous substances such as motor oil and antifreeze. Although the quantity leaked by a given vehicle or engine may be minute, these substances can accumulate on roads or in parking lots and then get washed into the adjacent environment by runoff during rain storms. A variety of substances could be introduced during accidental spills of materials.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed project are not considered in this section, because they require separate consultation pursuant to section 7 of the Act. An undetermined number of future land use conversions and routine agricultural practices are not subject to

Federal authorization or funding and may alter the habitat or increase incidental take of the beetle and are, therefore, cumulative to the proposed project. Most of these future non-Federal projects are considered indirect effects of the proposed action and effects are addressed through an interim process of project approval and habitat conservation plan development.

Many activities affecting the beetle involve effects to elderberry shrubs located within riparian ecosystems adjoining or within jurisdictional wetlands. These projects will be evaluated via formal consultation between the Service and the Corps via the Federal nexus provided by section 404 of the Clean Water Act. However, a number of projects exist for which there is no need to discharge dredged or fill material into waters of the U.S. These projects, for which no section 404 permit is required, may lack a Federal nexus and thus, move forward absent formal consultation. These projects pose a significant threat to the recovery of the valley elderberry longhorn beetle. This loss of habitat negatively affects the environmental baseline and is difficult to quantify.

Conclusion

After reviewing the current status of the beetle, the environmental baseline for the action area, the effects of the proposed Hamilton City Flood Damage Reduction and Ecosystem Restoration project, and the cumulative effects, it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the beetle. Critical habitat has been designated for the beetle. However, this action does not directly or indirectly affect these areas, and therefore, no destruction or adverse modification of critical habitat is anticipated.

Incidental Take Statement

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates incidental take of the valley elderberry longhorn beetle will be difficult to detect or quantify. The cryptic nature of these species and their relatively small body size make the finding of a dead specimen unlikely. The species occur in habitats that make them difficult to detect. Due to the difficulty in quantifying the number of beetles that will be taken as a result of the proposed action, the Service is quantifying take in terms of the number of elderberry shrubs with stems one inch or greater in diameter that will become unsuitable for beetles due to direct or indirect effects as a result of the action. The Service anticipates that all valley elderberry longhorn beetles inhabiting elderberry bushes within the 1,500 acre project site will be taken as a result of the proposed project.

Upon implementation of the following reasonable and prudent measures, incidental take associated with the project on the listed valley elderberry longhorn beetle, in the form of harm, harassment, or mortality from habitat loss or direct mortality will become exempt from the prohibitions described under section 9 of the Act for direct and indirect effects. In addition, incidental take in the form of harm, harassment, or mortality associated with the proposed project will be exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the valley elderberry longhorn beetle or result in destruction or adverse modification of critical habitat for the valley elderberry longhorn beetle.

Reasonable and Prudent Measure

The proposed action contains all of the measures needed to adequately minimize the impacts of anticipated take on the beetle. For that reason, the Service has no Reasonable and Prudent Measures.

Reporting Requirements

The Sacramento Fish and Wildlife Office is to be notified within one working day of the finding of any listed species or any unanticipated take of species addressed in this biological opinion. The Service contact persons for this are the Chief of the Endangered Species Division (Central Valley) at (916) 414-6600, and the Resident Agent-in-Charge of the Service's Law Enforcement Division at (916) 414-6660.

Any dead or severely injured beetles found (adults, pupae, or larvae) shall be deposited in the

Entomology Department of the California Academy of Sciences. The Academy's contact is the Senior Curator of Coleoptera at (415) 750-7239. All observations of valley elderberry longhorn beetles - live, injured, or dead - or fresh beetle exit holes shall be recorded on California Natural Diversity Data Base (CNDDB) field sheets and sent to California Department of Fish and Game, Wildlife Habitat Data Analysis Branch, 1807 13th Street Room 2002, Sacramento, California 95814.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1. The Corps should work with the Service to address significant, unavoidable environmental impacts approved by local agencies.

2. The Corps should continue to assist the Service in the implementation of recovery efforts for the valley elderberry longhorn beetle.

3. It is recommended that the Corps continue to protect and restore riparian and wetland habitats in the Sacramento River basin, to increase habitat for the valley elderberry longhorn beetle.

4. It is recommended that the Corps ensure that monitoring of the proposed restoration project continue for 10 years in accordance with the Service's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle.* The Corps could approach private non-profit organizations, government agencies, or universities with the possibility of continuing these monitoring efforts.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting federally-listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Reinitiation – Closing Statement

This concludes formal consultation on the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Please contact Rick Kuyper or Adam Zerrenner, Sacramento Valley Branch Chief, at (916) 414-6645 if you have any questions or comments regarding the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project.

Sincerely,

Cliff Wagner

for Kenneth D. Sanchez
Acting Field Supervisor

cc:

FWS, Regional Office, Portland, Oregon (Attn: L. Salata)
U.S. Army Corps of Engineers, Sacramento, California (Attn: Erin Taylor)
Sacramento National Wildlife Refuge Complex, Willows, California (Attn: Kevin Foerster)
California Department of Fish and Game, Rancho Cordova, California (Attn: Terry Roscoe)
The Reclamation Board, Sacramento, California (Attn: Peter Rabbon and Stephen Bradley)
California Department of Water Resources, Sacramento, California (Attn: Annalena Bronson)

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Hamilton City Flood Damage Reduction
And
Ecosystem Restoration Feasibility Study

Appendix C

Engineering

July 2004

Sacramento District
Sacramento, California

ENGINEERING APPENDICES

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Appendix C1.

BASIS OF DESIGN AND COST ESTIMATE

Hamilton City Flood Damage Reduction And Ecosystem Restoration Feasibility Study

Basis of Design and Cost Estimate
Table of Contents

Hamilton City Flood Damage Reduction
And Ecosystem Restoration Feasibility Study
Appendix C1 - Basis of Design and Cost Estimate

I. Introduction

A. Purpose and Scope

The purpose of this appendix is to present preliminary level design and costs of six alternatives proposed in the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study, which includes the identification of a recommended plan. The basis for the costs are a compilation of preliminary measures that were unique in providing specific goals or objectives such as reducing flood risk in the study area and provide a more ecosystem friendly river system. Setback levees at varying distances were included within each alternative except Alternative 3, which looked at a ring levee encompassing Hamilton City. Each alternative was also to ensure that there were no hydraulic impacts downstream of the study area. The individual alternatives are discussed in detail in the main report. All alternatives were evaluated at an equal level of detail. Preliminary cost estimates were developed for each of the alternatives with prepared template costs for basic features using typical M-CACES standards.

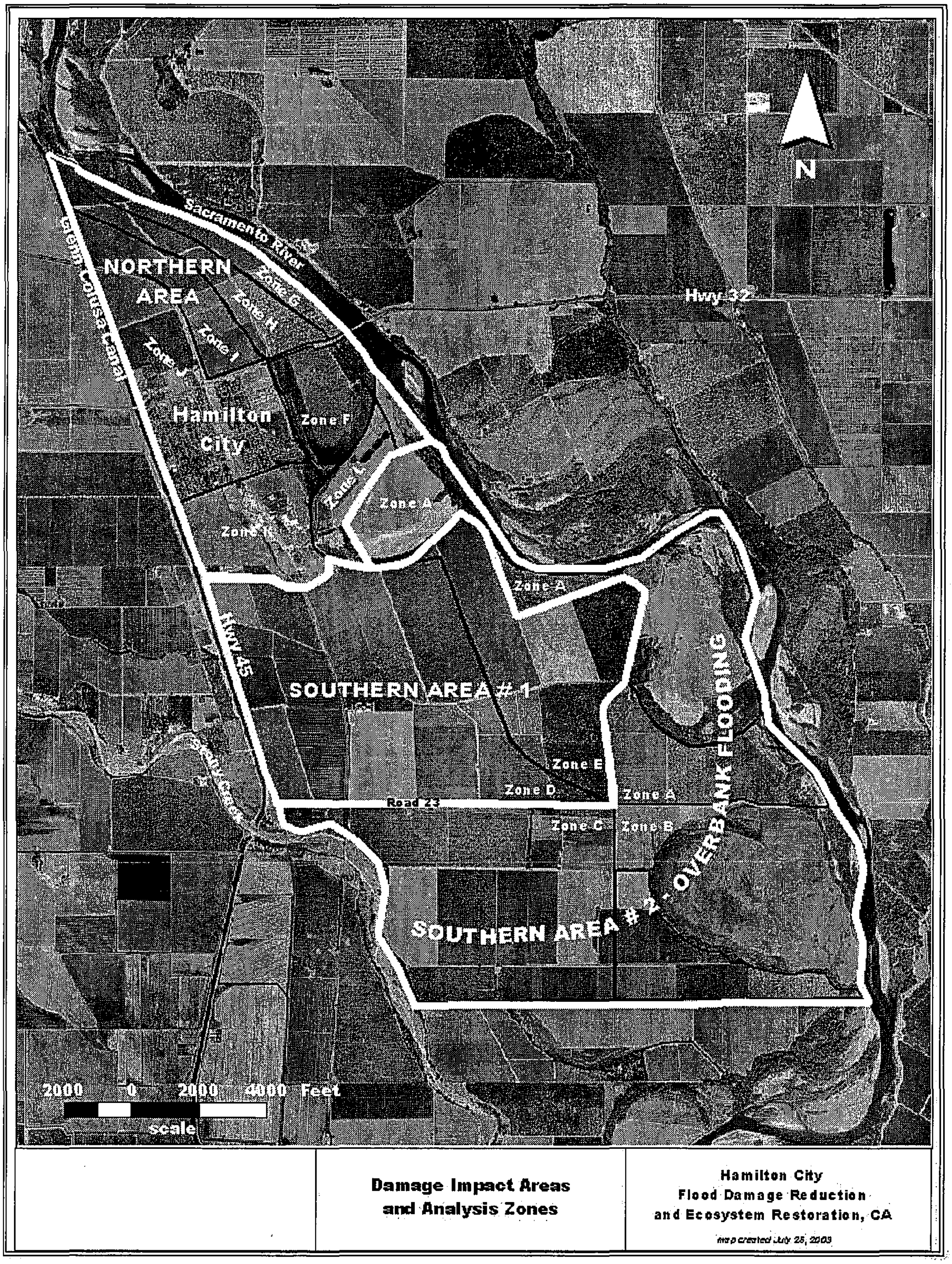
B Project Performance

Design alternatives included different levels of project performance within each alternative. Each ***intra***-design (Design Impact Area) would provide varying reliability of passing a particular event at 90-percent confidence relative to a specific *n*-year design. Figure C1-1 shows the boundaries of these proposed damage impact areas and include the following reliability criteria:

Table C1-1: Design Reliability

Damage Impact Area	*n*-Year Design	Frequency of Exceedance (90% Confidence)	Conditional Non-Exceedance					
			10 year flood	25 year flood	50 year flood	100 year flood	250 year flood	500 year flood
Northern Area	320	1 in 75	100	100	96	84	49	17
Southern Area #1	100	1 in 35	100	96	81	53	20	6
Southern Area #2	20	1 in 11	93	46	20	6	1	0

Figure C1-1
Damage Impact Areas and Analysis Zones



C. Project Description

The regional and study area locations of the project are referenced in Figure C1-2 and Figure C1-3, respectively, and described in Chapter 2 of the main report.

Figure C1-2 Regional map of the Hamilton City area.

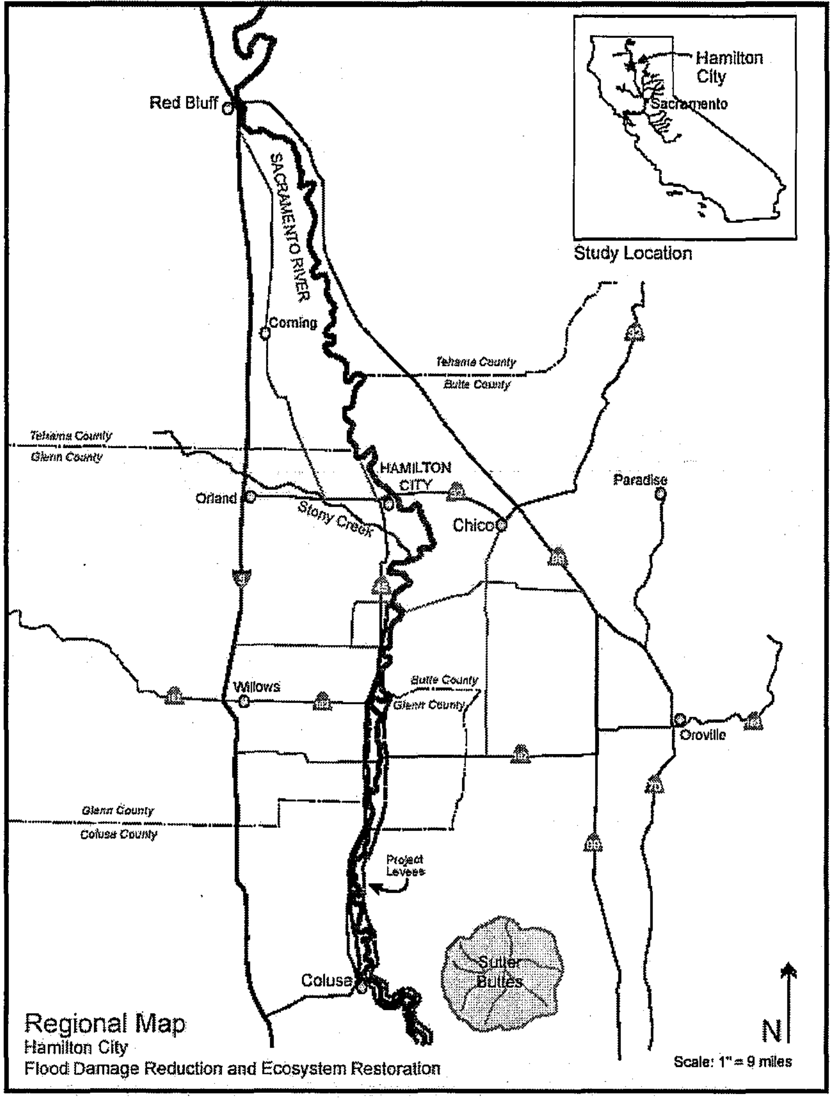
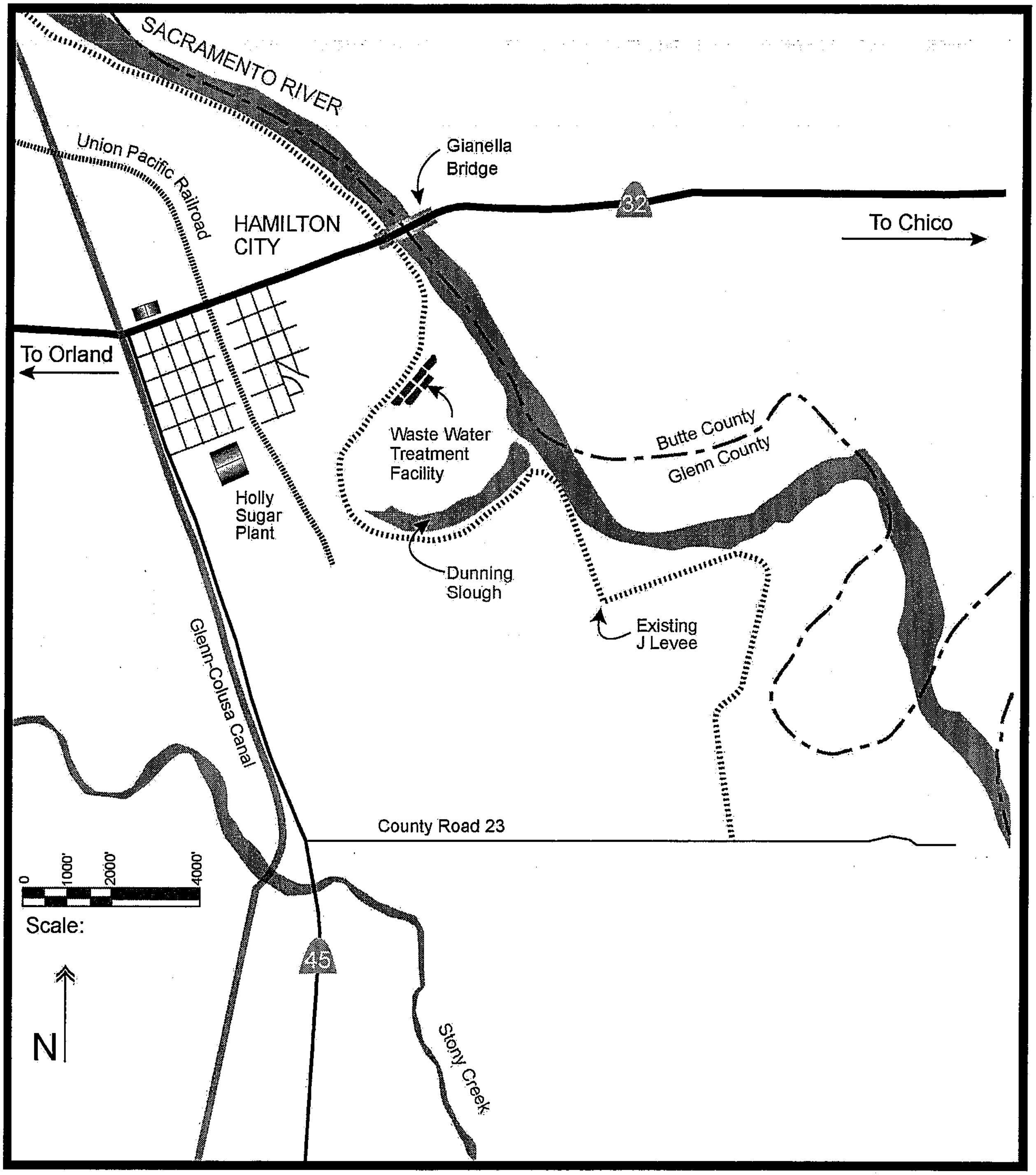


Figure C1-3 Study Area Map (Existing)



D. Description of Alternative Plans

The individual alternatives with Ecosystem Restoration (ER) and Flood Damage Reduction (FDR) benefits are briefly summarized below in Table C1-2 and are described in more detail in the main report.

Table C1-2 Alternatives and Major Features with Relative Benefits

Preliminary Combined Alternatives[2]	**Increase in Habitat Units (AAHU)**	**Flood Damage Reduction Benefits**[3] **($1,000)**
1-Locally Developed Setback Levee with 500-yr FDR	783	676
2-Intermediate Setback Levee with 500-yr FDR	795	483
3-Ring Levee with 500-yr FDR	895	470
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough with 500-yr FDR	642	493
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough with 500-yr FDR	937	666
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32 with 500-yr FDR	888	676

E. Recommended Plan

An M-CACES cost estimate current for the final report has been developed only for the recommended plan.

II. Design Considerations

A. Hydrology and Hydraulic Design

The hydrology report was completed and approved for use and is included as Appendix C2. That appendix provides a more detailed description of the work in developing the study hydrology and was influential in determining the necessary information used in this report.

The hydraulic modeling is used to describe how the flood flows developed by the hydrology and reservoir operations modeling move through the river system. This includes flow within the defined system of channels, weirs, and bypasses and flooding of the overbank areas due to potential levee breaks. The models compute flooding extent, stage, how the flood changes as it moves downstream. These models are used to identify current, baseline conditions and analyze the effects of various alternatives and measures. Appendix C3 provides a detailed description of the hydraulic models. Included with Appendix 3 are the sediment, scour, and geomorphic analyses.

B. Surveying and Mapping

Topography Data

Topography (above waterline) was developed using standard photogrammetric mapping techniques. For 2-foot contour mapping, aerial photos were taken at 5,000 feet above mean terrain (all new mapping and some existing Sacramento River mapping) and for 5-foot contour mapping (existing Sacramento River mapping only), aerial photos were taken at 12,000 feet above mean terrain. The survey techniques are similar to those described for the 1995 surveys.

Datum

The North American Datum of 1983 (NAD 83 1991.35), California Coordinate System of 1983 Zone 2 was used for horizontal control. The National Geodetic Vertical Datum of 1929 (NGVD29) was used to establish elevations. The NAD83 were obtained from the California Department of Transportation, North Region Surveys and are a part of the California Spatial Reference System - Horizontal (CSRS-H). The NGVD29 values were obtained in part from the National Geodetic Survey Control Database dated 1995, The California Department of Transportation and the County of Sacramento.

Bathymetric Data

Bathymetric (below waterline) data was collected with boats equipped with a dual frequency GPS receiver, Fathometer, and sonar transducer. Bathymetric survey data was collected along river cross-sections oriented generally perpendicular to the channel banks to detail the form of the river bottom. These cross-sections were spaced roughly at a distance equal to the channel top width.

C. *Geotechnical*

Introduction and Purpose

This report discusses the analysis and design of a new setback levee, risk-based evaluations of the existing J-levee, existing explorations and conclusions/recommendations. Upon completion of the feasibility report, additional subsurface explorations and engineering will be conducted during the Pre-construction Engineering and Design Phase (PED).

Because the alignments are relatively close to each other, foundation conditions are not expected to change significantly among the alternative alignments. For this reason, this initial geotechnical analysis is based upon a single cross section from river mile 199.5, which is several hundred feet upstream of Highway 32. This cross-section of the locally developed setback levee was chosen as the representative profile because of the levee's close proximity to the Sacramento River. For conservatism, the soil parameters chosen to use in the model were chosen such that they represent a worst-case scenario (i.e. high permeability and low shear strength). Appendix C4 provides a more detailed description of the geotechnical analysis.

D. *Relocations*

For discussion purposes, a portion of Highway 32 would need to be raised in alternative 1. Levee alignments in these two alternatives combined with the degrading of the existing J Levee would expose the current highway configuration to increased flooding.

The sewer treatment facility could be relocated in alternatives 1 and 2 from its current location inside of Dunning Slough. This would allow for the reconnection of Dunning Slough with the Sacramento River.

It is assumed that any of the alternatives may require the relocation or protection of various utilities such as power lines, gas lines, and possibly fiber optic cables. Some irrigation pumps may also need to be relocated.

The alternative carried forward for design and cost estimating purposes is the recommended plan (combination 6). This alternative offers an opportunity to provide dual-performance levees for urban and agriculture development, respectively. The alternative is also provides a high level of acceptance by the stakeholders and sponsors.

E. Minimize Impacts to Traffic Flows, Recreation, and Environment

Construction work will be designed and scheduled to allow public traffic to continue to use roads with minimum interruptions, especially during peak commuter times.

F. Operations and Maintenance

Creating a project levee system will typically increase annual costs for operation and maintenance. Specifically, any setback levee or realignment of existing levee structures will require the degrading, breaching or total removal of any existing private levee. Operation and maintenance of realigned or setback levees will require maintenance for wind and wave erosion during flood events. In addition, the recommended plan will include maintaining facilities such as roads and culverts, or water delivery systems associated with the realigned or setback levees.

III. Real Estate Requirements

The real estate work will include the evaluation, cost estimation and identification of relocation, land and acquisition requirements necessary to support development and assessment of the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study.

Lands acquired for environmental mitigation, enhancement, and restoration purposes will, by regulation, be fee acquisitions. Lands acquired in support of levees, floodways or flowage areas will be easements, and lands acquired for temporary work areas in support of levee construction or improvement will be temporary work area easements. Additionally, there will be requirements for borrow sites and disposal areas. These acquisitions may be fee, easement or leasehold depending on the specific circumstances of the requirement. Real Estate relocations involving the replacement of existing public utilities or facilities (such as the boat ramp located immediately downstream of the Highway 32 bridge) may also be a real estate component cost.

At each study phase, the real estate requirements will be addressed in greater detail and refined. For this phase of the study measures and alternatives are general in nature, therefore, so are the real estate requirements. These requirements and land costs are identified by a range of values for types of land use by county. Based on an assessment of predominant land usage a reasonable mean land value can be identified through the use of price ranges as identified in the California Agricultural Property Information Exchange Guide and available records for recent comparable sales of properties. Temporary construction easements are more in the nature of a land rental and value is frequently established on such a basis. Acquisition for borrow and disposal is not addressed at this level, but should be recognized as a potential cost where material will be needed to build new levees raise existing levees and/or strengthen existing levees either by the use of berms or slurry walls. Currently, borrow will be select fill purchased from the Glenn County Irrigation District (GCID).

The recommended plan would require the acquisition of about 1,500 acres in fee title along with about 145 acres of permanent easements and about 28 acres of temporary work easements are required for the recommended plan. This consists of lands under and waterside of the proposed setback levee. The non-Federal sponsor would acquire these lands as part of the project.

Real estate acquisition for the recommended plan is split among 13 landowners. Relocations are estimated to be about $653,000 which would consist of raising County Road 203 about 1.5 feet to tie into the new levee, ramping County Road 23 over the new levee, as well as relocating affected utilities and irrigation ditches. Detail on relocations and costs can be found in Table C5-3, Appendix C5 Civil Design.

IV. Value Engineering

A value engineering (VE) study of the feasibility study was completed in late fall of 2003. A thorough VE study will be required at the 35 % design level (PED). The M-CACES estimate includes a cost for the VE study during PED. Design documents will be delivered to the Value Engineering Office (VEO) and shall include comprehensive estimates. Upon completion of the study, copies of the study will be provided to all interested parties. The Project Manager will make the final determination whether the VE is approved or disapproved.

V. Basis of Cost Estimate

A. First Costs

The detailed estimate of the first costs for the alternatives is based on October 2003 price levels for comparative purposes. For the recommended plan, a M-CACES cost estimate has been developed. The Real Estate Division furnished the estimated cost of lands. The unit prices used for construction items were based on adjustments of average bid prices received for comparable work in the same study area. An average 25 percent contingency allowance has been included in the estimates. Suitable allowances have been included for Engineering and Design and Supervision and Administration, based on costs experienced on similar construction work in the Sacramento District.

B. Annual Costs

The detailed estimate of annual costs for the recommended plan is calculated on the first cost. Costs for the alternative is based on October 2003 price levels at 5.628 %

interest rate and 50-year amortization period. Annual costs were determined in accordance with EM 1120-2-104. The costs for maintenance, operation, and major replacement were computed from a Sacramento District compilation of cost factors. Such costs were compiled from prior costs in the Sacramento District and elsewhere.

C. *Summary of First and Annual Costs*

The summary of first and annual costs for the recommended plan is shown in Tables C1-3.

Table C1-3
First and Annual Costs Of Recommended Plan[1] ($1,000)

Item	Cost
Investment Cost	
First Cost[2]	43,650
Interest During Construction	3,258
Total	46,908
Annual Cost	
Interest and Amortization	2,819
OMRR&R[3]	55
Subtotal	2,874
Annual Benefits	
Monetary (Flood Damage Reduction)	584
Non-monetary (Ecosystem Restoration)	888 AAHUs
Net Annual FDR Benefits	253
FDR Benefit-Cost Ratio	1.8 to 1

[1] Based on October 2003 price levels, 5 5/8 percent rate of interest, and a 50-year period of analysis.
[2] Excludes Cultural Resource Preservation.
[3] Operation, Maintenance, Repair, Replacement and Rehabilitation.

VI. Implementation

A. *Features and Costs*

Successful implementation of the recommended plan would include construction of the above-mentioned physical features and replacement, and any mitigation required.

The M-CACES costs for this alternative are summarized in Table C1-4 below.

Table C1-4
ESTIMATED COSTS OF RECOMMENDED PLAN[1] ($1,000)

MCACES Account[2]	Description	Total First Cost
01	Lands and Damages[3]	12,825
02	Relocations[4]	563
06	Fish and Wildlife[5]	24,097
11	Levees[6]	921
18	Cultural Resources[7]	170
30	Planning, Engineering, Design[8]	3,070
31	Construction Management[9]	2,174
	Total First Cost	43,820

[1] Based on October 2003 price levels, 5 5/8 percent rate of interest, and a 50-year period of analysis.

[2] MCACES (Micro Computer-Aided Cost Engineering System) is the software program and associated format used by the Corps in developing cost estimates. Costs are divided into various categories, identified as "accounts." Detailed costs estimates are presented in Appendix C, part 8, Cost Engineering.

[3] Real Estate land costs. Includes no Damages.

[4] Relocations include raising County Road 203, ramping County Road 23, and relocating affected utilities and irrigation ditches.

[5] Includes habitat restoration, removal of "J" levee, levee costs allocated to restoration, plus 25 percent contingency.

[6] Includes levee costs allocated to flood damage reduction and training dike, plus 25 percent contingency.

[7] Assumes approximately 0.4 percent of project first cost.

[8] 12 percent of 02, 06, 08, 11, and 18 accounts. PED is cost shared 75 percent Federal and 25 percent non-Federal during PED, then adjusted as part of the total project cost sharing to 65 percent Federal and 35 percent non-Federal during construction.

[9] 8.5 percent of 02, 06, 08,11 and 18 accounts.

Appendix C2.

HYDROLOGIC

US ARMY CORPS
OF ENGINEERS
Sacramento District

Hamilton City Feasibility Study
Hamilton City, California

HYDROLOGY OFFICE REPORT
February 2004

HAMILTON CITY FEASIBILITY STUDY
HAMILTON CITY, CALIFORNIA

HYDROLOGY OFFICE REPORT
FEBRUARY 2004

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HAMILTON CITY FEASIBILITY STUDY
HAMILTON CITY, CALIFORNIA

HYDROLOGY OFFICE REPORT
FEBRUARY 2004

1. Purpose and Scope

This office report presents hydrologic data needed to develop floodplains for the Sacramento River near Hamilton City, Glenn County, California. The hydrologic analysis is part of a feasibility study conducted by the U.S. Army Corps of Engineers and the Reclamation Board of the State of California to develop and evaluate potential alternative plans to reduce flood damages and restore the ecosystem in this area.

The area covered by the hydrologic analysis includes the Sacramento River Valley from the headwaters upstream of Lake Shasta down to the Sacramento River at Hamilton City. The drainage area encompasses over 11,000 square miles, and includes contributions from Sacramento Valley "westside tributaries" (Clear, Cottonwood, Thomes, and Elder creeks) and "eastside tributaries" (Cow, Battle, Mill, and Deer creeks). The area evaluated includes headwater reservoirs and the Sacramento River tributaries north of Glenn County (Plate 1). This report includes newly-generated synthetic hydrology using headwater reservoir models for the study area.

Two sets of Sacramento River flow frequency curves for unregulated conditions were developed: one for the total Sacramento River flow at the Latitude of Hamilton City index point and the second for local flow at Hamilton City (minus any contribution upstream of Shasta Dam). The local flow frequency curves for Hamilton City included a peak flow curve. A Sacramento River flood centering series above Hamilton City, with concurrent floods above Shasta Dam, was developed, based on the two sets of frequency curves. The tributary hydrographs constructed for each frequency event were input into the reservoir system models to simulate regulated flows downstream. The hydrologic methods and reservoir system models used were created as part of the Sacramento and San Joaquin River Basins Comprehensive Study. Documentation of the methods and models are presented in References 2a and 2b, listed below.

2. References

Information from the references listed below was used in this study. References c, d, e, and f are previous flood studies in the vicinity of Hamilton City.

a. Sacramento and San Joaquin River Basins Comprehensive Study: Technical Studies Documentation, Appendix B, Synthetic Hydrology Technical Documentation. U.S. Army Corps of Engineers, Sacramento District, December 2002.

b. Sacramento and San Joaquin River Basins Comprehensive Study: Reservoir Simulation Model User's Guide. U.S. Army Corps of Engineers, Sacramento District, December 2002.

c. Hamilton City, California, Feasibility Investigation Office Report. U.S. Army Corps of Engineers, Sacramento District, July 1997.

d. Section 205 Reconnaissance Investigation, Sacramento River near Hamilton City, California. U.S. Army Corps of Engineers, Sacramento District, January 1991.

e. Design Memorandum No. 1, Cottonwood Creek, California, Hydrology Report. U.S. Army Corps of Engineers, Sacramento District, July 1977.

f. Reconnaissance Report on Flood Control on Sacramento River at Hamilton City, Glenn County, California. U.S. Army Corps of Engineers, Sacramento District, March 1975.

g. United States Average Annual Precipitation, 1961-1990, George Taylor, the Oregon Climate Service at Oregon State University, Corvallis, Oregon, September 2000. http://nationalatlas.gov/atlasftp.html.

h. Guidelines for Determining Flood Flow Frequency, Bulletin #17B of the Hydrology Subcommittee, Interagency Advisory Committee on Water Data, U.S. Department of the Interior, Geological Survey, Office of Water Data Coordination, Reston, Virginia, revised September 1981, editorial corrections March 1982.

i. Flood Frequency Analysis, HEC-FFA, User's Manual. U.S. Army Corps of Engineers, Hydrologic Engineering Center, May 1992.

j. Regional Frequency Computation, REGFQ, User's Manual. U.S. Army Corps of Engineers, Hydrologic Engineering Center, July 1972.

k. HEC-5, Simulations of Flood Control and Conservation Systems, User's Manual, Version 8.0. U.S. Army Corps of Engineers, Hydrologic Engineering Center, October 1998.

l. HEC-RAS River Analysis System, User's Manual, Version 3.0. U.S. Army Corps of Engineers, Hydrologic Engineering Center, January 2001.

3. Descriptive Information

The Sacramento River originates in the northern part of California and flows southward through Lake Shasta to the Sacramento Valley. It enters the Sacramento Valley about 5 miles northeast of Red Bluff, then flows southward about 240 river miles to the Sacramento-San Joaquin Delta east of San Francisco.

Hamilton City is located about 60 miles south of Redding and 85 miles north of the City of Sacramento in the central part of northern California (see Plate 2). Hamilton City is located about 6,000 feet west of the Sacramento River, in Glenn County. The study area includes Hamilton City and the surrounding rural area. The area around Hamilton City is primarily agricultural with a variety of crops, including several types of orchards.

The Hamilton City climate is characterized by hot, dry summers and mild winters. Normal annual precipitation varies considerably throughout the basin, ranging from a low of 21 inches around Hamilton City to over 100 inches at Mount Lassen, to the northeast in the Sierra Nevada Mountains (Reference 2g). Precipitation occurs primarily during the period from November to April. During the late summer and early fall, precipitation is confined to occasional local thunderstorm activity, usually light in rainfall amounts.

Soils on the Sacramento Valley floor around Hamilton City are alluvial, composed of sediments derived from the surrounding mountains. Topography of the basin varies from flat valley areas and low rolling foothills, to steep mountainous terrain to the west (Coast Ranges), north (Cascade Range), and east (Sierra Nevada Mountains). The elevation is around 170 feet near Hamilton City, but rises to above 10,000 feet at Mount Lassen.

4. Flood Problems

4a. Storm Characteristics. Major flood-producing storms over central and northern California are generally associated with storm systems that originate about 30° to 50° north latitude and develop a moist air trajectory from about the latitude of the Hawaiian Islands. As the system approaches the coast, the trajectory is over cooler water, thus retarding release of the moisture until the air mass is borne inland, where the north-south coast ranges lift the air mass and cause condensation and release of moisture. This general flow pattern produces strong southwesterly or southerly winds up the Sacramento Valley that are lifted as they flow over the mountains at the north end of the valley. This lifting effect, combined with some convergence, accounts for the major portion of storm precipitation around Hamilton City.

Intense thunderstorms have occurred in the area around Hamilton City, but they do not cause high flows on the mainstem Sacramento River. Local storms may cause interior drainage flooding, which will become less of a problem due to alternatives being considered for the Hamilton City feasibility study. Also, interior drainage problems are not major, since Hamilton City is not an urban center and has existing drainage facilities and low lying areas to handle these flows as well as flows off the orchards and other agricultural areas north of the city. Areas south of the City drain south and eventually enter the Sacramento River downstream of Hamilton City. This hydrology report does not address interior drainage flooding. Hydraulic Design Section will cover that aspect of the study.

4b. Historic Flooding. Flooding along the Sacramento River occurs from midwinter to early spring and is usually due to a combination of rain and snowmelt conditions. Some of the more significant peak flows on the Sacramento River at the Latitude of Hamilton City occurred in February 1940 (350,000 cfs, before Shasta Dam was built), February 1958, December 1964, January 1969, January 1970, January 1974, February 1986, January 1995 (155,000 cfs), and January 1997 (155,000 cfs). The magnitudes of most of these peak flows are difficult to determine, since much of the flow occurs out-of-channel. Hamilton City was flooded during February 1940, prior to the completion of Shasta Dam. In January 1974 floodwaters inundated orchards and the lower eastern portion of Hamilton City, due to failure of the levee along Dunning Slough, southeast of Hamilton City. During the February 1986 event, sandbagging on the top of the levee prevented flooding in Hamilton City. Additionally, because a levee broke east of the river, pressure on the Hamilton City levee was reduced. During the storm of January 1997 the city was evacuated, but crews working on the levee were able to prevent flooding in the city. Flood fighting efforts also prevented Hamilton City from being flooded in 1983, 1995, and 1998.

5. Hydrologic Analysis Procedure

The hydrologic analysis was performed to generate 30-day flood hydrographs for the Sacramento River at Hamilton City index point for several synthetic exceedence frequency events, using Comprehensive Study methodology. Generating the hydrographs is a three-step process consisting of: (1) development of unregulated rain flood flow frequency curves, (2) creation of synthetic flood patterns and subsequent development of tributary and downstream mainstem flood hydrographs based on those patterns, and (3) input of the synthetic tributary hydrographs into the reservoir system models to produce regulated hydrographs at Hamilton City. A schematic diagram of the process is illustrated on Plate 3 (taken from the Reservoir Simulation Model User's Guide, Reference 2b).

6. Analysis for Unregulated Flow Frequency Curves

Unregulated flow frequency curves were created using procedures defined in Bulletin 17B, Guidelines for Determining Flood Flow Frequency, Reference 2h, for key index locations where a systematic record of natural flow data exists or could be computed. Bulletin 17B requires the use of a Pearson Type III distribution with log transformation of the data as the method to analyze flood flow frequency. The mean, standard deviation, and skew of the log-transformed data are computed for the flows at the stream gage or index point. The data are screened for high and low outliers and, if found, adjustments to the statistics are computed as outlined in Bulletin 17B. The statistics may be further adjusted or smoothed to account for sampling error differences among the various durations, or after comparison with similar gages in the area. Sets of unregulated frequency curves of primary significance to this analysis are those for Sacramento River at Shasta Dam, at Bend Bridge, and at the Latitude of Ord Ferry index points. These existing frequency curves (in Reference 2a), developed as part of the Comprehensive Study, cover durations from 1 day to 30 days and are presented here on Plates 4 through 6.

Two new sets of unregulated flow frequency curves were developed specifically for the mainstem of the Sacramento River at Hamilton City: one for the total Sacramento River flow at the Latitude of Hamilton City, and the other for the Sacramento River local flows between Shasta Dam and Hamilton City, for the 1-, 3-, 7-, 15- and 30-day durations. Also, a peak flow frequency curve was developed for the Sacramento River local flow at Hamilton City. The sets of flow frequency curves for Hamilton City are presented in Plates 7 and 8 and their development is discussed below.

6a. <u>Frequency Curves for Sacramento River at the Latitude of Hamilton City</u>. Comprehensive Study methodology, described in Reference 2a, Chapter III, pages 3 - 4, was used to develop the unregulated rain flood frequency curves for the total Sacramento River flow at Latitude of Hamilton City index point. "Latitude of Hamilton City" includes any and all diverted or channelized flows that pass Hamilton City's geographic latitude. The flow frequency curves reflect this assumption. The procedures described below were used to route the upstream hydrographs down the Sacramento River to combine them at Hamilton City for a "Latitude of Hamilton City" hydrograph. When the hydrographs are routed through the floodplain using a dynamic routing model, such as the HEC-RAS River Analysis System (Reference 2l), the peaks and volumes will be different. The HEC-RAS model will likely skew the mainstem flow frequency curves more negatively.

River routings were simulated assuming infinite channel capacity with no flow lost to overbank areas. The daily natural flow data for 1922 to 1997 for the mainstem Sacramento River at Bend Bridge were routed downstream to Hamilton City using the Muskingum routing method. The adjustments made to develop unregulated flows at Shasta Dam and Bend Bridge and for downstream Valley tributaries are listed in Reference 2a, Attachment B.1, Table 1. The observed or adjusted daily flows at the four tributary streamflow gaging stations, for Elder Creek near Paskenta, Mill Creek near Los Molinos, Thomes Creek at Paskenta, and Deer Creek near Vina, were routed, using Muskingum routing parameters, to Hamilton City and then added to the Sacramento River mainstem flows plus an estimate for local flow contribution from smaller, ungaged tributaries. The estimate used for local flow contribution was 55 percent of the combined gaged daily flows for the tributaries, Elder, Mill, Thomes, and Deer creeks, plus 48 percent of the gaged flow for Big Chico Creek near Chico. The estimate for local flow, developed for the Comprehensive Study, is based on historic flow records at Bend Bridge, at Ord Ferry, and for the 5 gaged unregulated tributaries between Bend Bridge and Ord Ferry, Elder, Thomes, Mill, Deer, and Big Chico creeks. The data sets for the unregulated Sacramento River flows at Bend Bridge and for the tributary gaging stations were developed for the Comprehensive Study. The annual historic routed and combined flows at Hamilton City were plotted using moving averages of the daily time series for 1-, 3-, 7-, 15-, and 30-day duration natural flow data. Statistics were computed for the samples of annual flows, using statistical analysis tools (FFA and REGFQ computer programs, References 2i and 2j). As with the unregulated frequency curves for Bend Bridge and Latitude of Ord Ferry, water year 1977 was excluded as a low outlier for Hamilton City. The sample skews were adjusted to match those at the downstream Latitude of Ord Ferry frequency curves. The unregulated flow frequency curves for total Sacramento River flow at the Latitude of Hamilton City, with their statistics, are presented in Plate 7. Table 1 lists the Muskingum routing parameters.

TABLE 1
MUSKINGUM ROUTING PARAMETERS FOR SACRAMENTO RIVER BASIN INDEX POINTS

Source	From	To	Travel Time (Hours)	Muskingum Coefficient
Sacramento River	Shasta Dam	Keswick	2	0.4
Sacramento River	Keswick	Clear Creek	3	0.4
Clear Creek	Whiskeytown Dam	Mouth	2	0.4
Sacramento River	Clear Creek	Cow Creek	2	0.1
Cow Creek	Gage near Millville	Mouth	1	0.2
Battle Creek	Gage below Coleman F.H.	Mouth	1	0.2
Sacramento River	Battle Creek	Bend-Bridge	3	0.1
Sacramento River	Bend-Bridge	Hamilton City	17	0.2
Mill Creek	Gage near Los Molinos	Hamilton City	14	0.2
Elder Creek	Gage near Paskenta	Hamilton City	19	0.2
Deer Creek	Gage near Vina	Hamilton City	13	0.2
Thomes Creek	Gage at Paskenta	Hamilton City	19	0.2

Note: Cottonwood Creek contributions were included, but the gage is so close to the Sacramento River, that no Muskingum routing of Cottonwood Creek flows was performed. (Source: Reference 2a.)

6b. Unregulated Frequency Curves for Local Flow at Hamilton City. The local flow at Hamilton City is the streamflow from the Sacramento River tributaries between Shasta Dam and

Hamilton City, excluding any contribution upstream of Shasta Dam. Frequency curves for unregulated local flow between Shasta Dam and Hamilton City were needed for the development of a Sacramento River flood centering series above Hamilton City, with concurrent floods above Shasta Dam. Such a Hamilton City flood centering series is needed to test the potential for flooding at Hamilton City when Shasta Dam controls flood flows on the upper Sacramento River basin. Development of the flow frequency curves was similar to that of the frequency curves at the Latitude of Hamilton City, except that the daily flows for Sacramento River upstream of Shasta Dam were removed from the routed and combined Sacramento River flows. The unregulated daily flow record for Sacramento River at Shasta Dam (prior to 1943, Sacramento River at Kennett) was developed for the Comprehensive Study for water years 1932 to 1997. The unregulated daily flows at Shasta Dam were routed downstream to Bend Bridge using Muskingum routing parameters (Table 1), and were then subtracted from the unregulated daily flows for Sacramento River at Bend Bridge for the period 1932 to 1997. The remaining flows were the Bend Bridge local flows, unregulated runoff from the local drainage area between Shasta Dam and Bend Bridge. The Bend Bridge daily local flows were routed down to Hamilton City and added to the routed flows from the four gaged tributaries plus an estimate for local ungaged drainage.

The annual flows for the 1-, 3-, 7-, 15-, and 30-day durations for 1932-1997 were plotted and statistics computed using the FFA and REGFQ computer programs. Water year 1977 was excluded as a low outlier. The unregulated flow frequency curves for Sacramento River Local Flow at Hamilton City, with their statistics, are presented in Plate 8.

6c. Unregulated Peak Flow Frequency Curve for Local Flow at Hamilton City. Comprehensive Study methodology did not include a procedure to develop peak flow frequency curves for the mainstem Sacramento River index points (at the Latitudes of Ord Ferry, Verona and Sacramento). For that reason, peak flow frequency curves are not shown on Plates 4 through 7. A peak flow frequency curve was needed at Hamilton City, because the peak flow overtops the levee and causes the flood damage. A record of unregulated peak flows is not available for the Sacramento River downstream of Bend Bridge. The development of the unregulated peak flow curve was based upon the relationship of regulated peak and one-day flows for the Sacramento River at Hamilton City, using streamflow records from the California Department of

Water Resources gage at that location. Records for the Hamilton City gage (regulated conditions) began in 1945. The mean logarithms for the regulated peak and one-day annual flows at Hamilton City were computed. The difference between the peak flow mean log and the one-day flow mean log (for regulated conditions) was added to the mean log of the one-day flow frequency curve for unregulated conditions for Hamilton City Local Flow (Plate 8), to estimate the mean log of the unregulated peak flow frequency curve. The peak flow frequency curve also has the same standard deviation and skew as the one day curve. The relationship between regulated peak and one-day flows on the Sacramento River was verified by a check of the records at Bend Bridge for regulated conditions. Since it was built, Shasta Dam has controlled all inflows from the drainage area above it. All the differences between the peak and 1-day flows along the Sacramento River from Shasta Dam to Hamilton City are due to tributary flow below Shasta Dam. It is assumed that, for the period of record, 1945 to present, the contribution from above Shasta Dam to the peak flow at Hamilton City is the same as the one-day flow. The unregulated peak flow frequency curve for Hamilton City local flow was added to the set of flow frequency curves on Plate 8.

6d. Regulated Peak Flow Frequency Curve for Bend Bridge and Hamilton City.

Graphical curves of regulated peak and one-day flows were drawn for Bend Bridge and Hamilton City (shown on Plates 12 and 13, respectively) for the purpose of comparison with hypothetical results. The regulated flows at Bend Bridge represent the regulated releases from both Shasta and Whiskeytown reservoirs and the total uncontrolled local flow below Shasta Dam. Peak and 1-day values out of the reservoirs are typically the same. Therefore, the separation between the peak and 1-day curves at Bend Bridge reflects the peak off of the uncontrolled local area. The regulated frequency curves reflect a best-fit curve through the points and can be translated to log normal space. Shasta Dam loses control for floods less frequent than the 1% chance event, so the flow frequency curves on Plates 12 and 13 for regulated conditions do not extend beyond the 1% flood event.

Since high flows at Hamilton City bypass the gage, recorded flows at the gage do not reflect total flows at the Latitude of Hamilton City. At Bend Bridge all flows remain in-channel and are recorded at the gage. The relationship of the central tendency of the flows at Hamilton City is similar to that shown at Bend Bridge. Therefore, the relationship between peak and one-day flows at Bend Bridge was applied in construction of the graphical curves for Hamilton City to better estimate the total flows at the Latitude of Hamilton City.

7. Development of Flood Centering Series Patterns above Hamilton City

Comprehensive Study methodology was used to develop the combination of patterns for seven synthetic flood events (the 50-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedence events) with 30-day hydrographs, to generate the synthetic flood hydrographs for simulated regulated conditions at Hamilton City. The development of the flood centering series for mainstem Sacramento River index points is described in Reference 2a, Chapter III, pages 11 to 13.

7a. Ord Ferry Flood Centering Series. The patterns for the flood centering series for the Sacramento River at Latitude of Ord Ferry are tabulated in Table 2 (from Reference 2a). The unregulated flow frequency curves (for 1-, 3-, 7-, 15-, and 30-day durations) for the Latitude of Ord Ferry index point are displayed on Plate 6. The tributary hydrographs constructed from the Ord Ferry flood centering series, when routed and combined at the Ord Ferry index point, were roughly equal to the hypothetical volumes specified by the Latitude of Ord Ferry flow frequency curves. As a test of the frequency curves for the Latitude of Hamilton City index point, the tributary hydrographs for the Ord Ferry flood centering series were routed and combined at the Hamilton City index point. Tributary hydrographs for Stony and Big Chico Creeks were not included, as they enter the Sacramento River downstream of Hamilton City. The flood volumes of the seven synthetic hydrographs at the Hamilton City index point were roughly equal to the hypothetical volumes from the Hamilton City mainstem frequency curves. Table 3 presents a comparison of the volumes routed to Hamilton City (Ord Ferry centering series) with the hypothetical volumes from the Hamilton City mainstem frequency curves, for the seven floods, for the 1-, 3-, 7-, 15-, and 30-day durations. The flood volumes in Table 3 were developed using the Muskingum routing procedure. Actual in-channel flows may differ due to limited channel capacities and overbank flows. The Latitude of Ord Ferry flood centering series meets the guidelines for a mainstem centering series at Hamilton City as well. The Latitude of Ord Ferry flood centering patterns are tabulated on Table 2.

TABLE 2
Synthetic Flood Centerings for Sacramento River Total Flow at Latitude of Ord Ferry

Index Point	Percent Chance Exceedence						
	50%	10%	4%	2%	1%	0.50%	0.20%
Sacramento River at Shasta	82.08	16.91	5.71	2.41	1.25	0.65	0.28
Clear Creek at Whiskeytown	61.56	15.04	9.03	5.61	2.92	1.52	0.65
Cow Creek nr Millville	61.56	13.53	8.02	3.89	2.02	1.05	0.45
Cottonwood Creek nr Cottonwood	61.56	15.04	9.03	5.61	2.92	1.52	0.65
Battle Creek below Coleman FH	61.56	13.53	8.02	3.89	2.02	1.05	0.45
Mill Creek near Los Molinos	87.94	15.03	7.22	5.94	3.10	1.61	0.69
Elder Creek near Paskenta	87.94	19.33	12.50	10.10	5.26	2.74	1.17
Thomes Creek at Paskenta	87.94	19.33	12.50	10.10	5.26	2.74	1.17
Deer Creek near Vina	87.94	15.03	7.22	5.94	3.01	1.61	0.69
Big Chico Creek near Chico	87.94	15.03	7.22	5.94	3.01	1.61	0.69
Stony Creek at Black Butte	87.94	19.33	12.50	10.10	5.26	2.74	1.17
Butte Creek near Chico	87.94	15.03	10.20	8.42	4.39	2.28	0.97
Feather River at Oroville	87.94	19.33	9.62	8.42	4.39	2.28	0.97
Yuba River at New Bullards Bar	87.94	19.33	11.76	9.18	4.78	2.49	1.06
Yuba River at Englebright	87.94	19.33	11.76	9.18	4.78	2.49	1.06
Deer Creek near Smartsville	87.94	19.33	11.76	9.18	4.78	2.49	1.06
Bear River near Wheatland	87.94	19.33	12.03	10.10	5.26	2.74	1.17
Cache Creek at Clear Lake	87.94	19.33	18.05	12.63	6.58	3.42	1.46
North Fork Cache Creek at Indian Valley	87.94	19.33	18.05	12.63	6.58	3.42	1.46
American River at Folsom	87.94	19.33	14.29	12.63	6.58	3.42	1.46
Putah Creek at Berryessa	87.94	19.33	18.05	12.63	6.58	3.42	1.46

Note: The numbers in Table 2 are percent chance exceedence floods. The (x) percent chance exceedence flood is defined as having one chance in 100/x of being exceeded in any future 1-year period.

TABLE 3
Unregulated Volume Comparison
Hamilton City Flow Frequency Curves
Versus Routed Flows at Hamilton City

	Frequency Curves	Hamilton City	Ord Ferry
	Hamilton City	Flood Series	Flood Series
	Target Volumes	at Hamilton City	at Hamilton City
	Average flow in	Average flow in	Average flow in
	Day cfs	Day cfs	Day cfs
Duration	**50% Flood**	**50% Flood**	**50% Flood**
1-day	97,500	105,000	100,000
3-day	81,300	89,600	85,600
7-day	60,300	61,500	59,300
15-day	45,800	46,000	44,600
30-day	34,900	35,800	34,800
Duration	**10% Flood**	**10% Flood**	**10% Flood**
1-day	214,000	227,000	223,000
3-day	181,000	192,000	190,000
7-day	132,000	128,000	128,000
15-day	94,000	91,600	92,300
30-day	69,800	68,400	69,000
Duration	**4% Flood**	**4% Flood**	**4% Flood**
1-day	286,000	306,000	295,000
3-day	242,000	259,000	252,000
7-day	174,000	171,000	168,000
15-day	119,000	121,000	120,000
30-day	87,900	88,900	88,400
Duration	**2% Flood**	**2% Flood**	**2% Flood**
1-day	345,000	366,000	349,000
3-day	293,000	310,000	298,000
7-day	208,000	204,000	198,000
15-day	139,000	143,000	141,000
30-day	102,000	104,000	103,000
Duration	**1% Flood**	**1% Flood**	**1% Flood**
1-day	408,000	430,000	411,000
3-day	347,000	365,000	350,000
7-day	244,000	238,000	231,000
15-day	158,000	166,000	163,000
30-day	115,000	120,000	118,000
Duration	**0.5% Flood**	**0.5% Flood**	**0.5% Flood**
1-day	475,000	494,000	474,000
3-day	406,000	419,000	404,000
7-day	281,000	273,000	265,000
15-day	177,000	189,000	186,000
30-day	128,000	135,000	133,000
Duration	**0.2% Flood**	**0.2% Flood**	**0.2% Flood**
1-day	572,000	592,000	560,000
3-day	490,000	501,000	476,000
7-day	334,000	325,000	310,000
15-day	202,000	224,000	215,000
30-day	146,000	158,000	153,000

Notes: (1) Volumes in day cfs represent flows routed using the Muskingum method, not a dynamic routing into or through the floodplains. (2) The routed volumes for the Hamilton City flood series had to match within 10 percent the target volumes from the frequency curves for the Latitude of Hamilton City.

7b. Strategy for a Hamilton City Flood Centering Series. While the Ord Ferry flood centering series meets the criteria for the Hamilton City flood centering series, a centering series was needed that would test the potential for flooding at Hamilton City when Shasta Dam is controlling high flows on the upper Sacramento River, and determine at what point Shasta Dam loses control. Such a flood centering series was developed using both sets of Hamilton City flow frequency curves, the mainstem frequency curves and the local frequency curves. A flood centering series was developed specifically for the local drainage area between Shasta Dam and Hamilton City, with concurrent flood above Shasta. The tributary hydrographs constructed from the centering patterns were routed and combined at Hamilton City, and the synthetic flood volumes of the Hamilton City hydrographs were compared with the hypothetical volumes from the Hamilton City local flow frequency curves. The local flood patterns were adjusted until the routed hydrographs at Hamilton City roughly matched the hypothetical volumes from the Hamilton City local flow frequency curves. A series of concurrent flood centerings was then developed for Sacramento River above Shasta Dam and adjusted until the following condition was met: when the unregulated concurrent flood hydrographs above Shasta Dam were routed to Hamilton City and combined with the local flows, the combined hydrograph volumes roughly matched the hypothetical volumes from the Latitude of Hamilton City flow frequency curves.

7c. Flood Centering Series for Shasta Dam to Hamilton City. The seven Hamilton City flood centering patterns for the Sacramento tributaries between Shasta Dam and Hamilton City follow the general trends for the tributaries in the historic flood centering matrices for the Sacramento Basin, Reference 2a, Attachment B.3, Table B.3, Historic Flood Event Matrices. For the larger, less frequent mainstem floods, the flows from the eastside tributaries are usually more rare than those on the westside, with the least frequent flows on the eastside tributaries south of Bend Bridge: Mill Creek, Deer Creek, Big Chico Creek (south of Deer Creek). For the more frequent flood events, orographic effects are more pronounced and the flow frequencies are usually more evenly distributed between eastside and westside tributaries. The Hamilton City flood centering series patterns, tabulated on Table 4, are based on historic trends. For each hypothetical centering flood pattern, hydrographs were constructed for the major tributaries between Shasta Dam and Hamilton City: Clear Creek (for unregulated conditions), Cottonwood, Elder and Thomes creeks on the west side; Cow, Battle, Mill and Deer creeks on the east side. The tributary hydrographs were routed down to Hamilton City using the Muskingum routing parameters listed in Table 1. An estimate for local flow downstream of the gaged tributaries was not added during the routing procedure for the synthetic floods; the local flow estimate was added in the process of constructing the tributary hydrographs themselves, a procedure developed for the Comprehensive Study.

TABLE 4
Synthetic Flood Centerings for
Sacramento River Total Flow at Latitude of Hamilton City

Index Point	Percent Chance Exceedence						
	50%	10%	4%	2%	1%	0.50%	0.20%
Sacramento River at Shasta	117.65	26.14	11.76	5.88	2.61	1.11	0.33
Clear Creek at Whiskeytown	51.28	11.76	5.83	3.56	2.06	1.23	0.56
Cow Creek nr Millville	51.28	10.53	4.50	2.34	1.32	0.79	0.36
Cottonwood Creek nr Cottonwood	51.28	11.76	5.83	3.56	2.06	1.23	0.56
Battle Creek below Coleman FH	51.28	10.53	4.50	2.34	1.32	0.79	0.36
Mill Creek near Los Molinos	50.51	10.10	4.08	2.11	1.16	0.69	0.31
Elder Creek near Paskenta	50.51	10.31	4.89	3.12	1.85	1.11	0.50
Thomes Creek at Paskenta	50.51	10.31	4.89	3.12	1.85	1.11	0.50
Deer Creek near Vina	50.51	10.10	4.08	2.11	1.16	0.69	0.31
Big Chico Creek near Chico	50.51	10.10	4.08	2.11	1.16	0.69	0.31
Stony Creek at Black Butte	50.51	10.31	4.89	3.12	1.85	1.11	0.50
Butte Creek near Chico	71.94	18.35	7.55	3.82	2.07	1.22	0.54
Feather River at Oroville	125.00	100.00	50.00	20.00	10.00	5.00	2.00
Yuba River at New Bullards Bar	125.00	100.00	50.00	20.00	10.00	5.00	2.00
Yuba River at Englebright	125.00	100.00	50.00	20.00	10.00	5.00	2.00
Deer Creek near Smartsville	125.00	100.00	50.00	20.00	10.00	5.00	2.00
Bear River near Wheatland	125.00	100.00	50.00	20.00	10.00	5.00	2.00
Cache Creek at Clear Lake	125.00	100.00	50.00	20.00	10.00	5.00	2.00
North Fork Cache Creek at Indian Valley	125.00	100.00	50.00	20.00	10.00	5.00	2.00
American River at Folsom	125.00	100.00	50.00	20.00	10.00	5.00	2.00
Putah Creek at Berryessa	125.00	100.00	50.00	20.00	10.00	5.00	2.00

Note: The numbers in Table 4 are percent chance exceedence floods. The (x) percent chance exceedence flood is defined as having one chance in 100/x of being exceeded in any future 1-year period.

7d. Concurrent Flood Patterns above Shasta Dam. A flood series concurrent to the specific centering series above Hamilton City (7c above) was developed for the drainage basin upstream of Shasta Dam. The patterns for the concurrent floods above Shasta Dam are listed on Table 4. For the Hamilton City flood centering patterns, concurrent Shasta flows are more frequent than the westside and eastside tributary flows (except for the 0.5% and 0.2% floods). This pattern has been observed historically: the floods of February 1958, January-February

1983, and January-February 1998 were centered on the westside tributaries; the flood of January 1974 targeted Cow and Battle creeks; the floods of December 1964 and February 1986 were centered south of Bend Bridge. The 0.2% flood pattern is similar to that of January 1997, with the Shasta percent exceedence flood almost the same as that for the eastside tributaries south of Bend Bridge.

7e. Hamilton City Synthetic Flood Volumes. The unregulated flow hydrographs at Shasta Dam and on the westside and eastside tributaries constructed from the flood centering series (Table 4) were routed and combined at Hamilton City. Table 3 presents a comparison of the volumes from the routed hydrographs at Hamilton City for the Hamilton City flood series, the Ord Ferry flood series (at Hamilton City), and the hypothetical volumes from the Hamilton City mainstem frequency curves, for the seven floods, for the 1-, 3-, 7-, 15- and 30-day durations. The flood volumes for the Hamilton City flood series are, in general, slightly higher than those for the Ord Ferry flood series routed to Hamilton City.

8. Reservoir Simulation Model (HEC-5) Routing

The Hydrologic Engineering Center's HEC-5 software (Simulation of Flood Control and Conservation Systems), Version 8.0 (October 1998, Reference 2k), was used to route the synthetic tributary flood hydrographs through the reservoir system on the Sacramento River Basin for analysis of floodplain and channel hydraulics. The Reservoir Simulation Model User's Guide, Reference 2b, documents the reservoir model assumptions and methodology for routing the flood hydrographs through two reservoir system models, the headwater reservoirs model, and the lower basin reservoirs model. The reservoir system models routed tributary flows for the entire Sacramento basin; however, the only hydrographs needed for this study are those upstream of and at Hamilton City. The synthetic unregulated hydrographs constructed for Shasta Dam and Valley tributary locations from the Hamilton City flood centering series were input to the reservoir system models to simulate regulated hydrographs at mainstem points on the Sacramento River, including Hamilton City. The Shasta Dam hydrographs were routed through the HEC-5 headwater reservoirs model, to simulate results from regulation by reservoirs upstream of Shasta Dam for the synthetic flood series. The headwater reservoirs are listed on Table 5, and their relative locations shown in the schematic on Plate 9. The simulated regulated inflow hydrographs to Lake Shasta and the downstream tributary hydrographs were then input to the lower basins reservoir model. The only reservoirs upstream of Hamilton City that are in the lower basins reservoir model are Shasta and Whiskeytown. The schematic on Plate 10 shows the relationship of the reservoirs and the east- and westside tributaries downstream on the Sacramento River. Ord Ferry is "JUNC-SAC+STO." Hamilton City is not shown as an index point on Plate 10; it is neither a junction of the Sacramento River with any tributaries nor a hydrograph input point to the HEC-RAS routing model. Plates 9 and 10 are from Reference 2b.

TABLE 5
LIST OF RESERVOIRS IN THE
SACRAMENTO RIVER BASIN ABOVE ORD FERRY

Reservoir	Drainage	Owner	Gross Pool Storage (ac-ft)	Drainage Area (sq.mi.)	Began Operation	Purpose
Britton (Pit No. 3)	Pit River	Pac Gas & Electric Co	34,600	4700	1925	Water Supply Hydropower
Pit No. 6	Pit River	Pac Gas & Electric Co	15,700	5020	1965	Water Supply Hydropower
Pit No. 7	Pit River	Pac Gas & Electric Co	34,000	5170	1965	Water Supply Hydropower
McCloud	McCloud River	Pac Gas & Electric Co	35,300	380	1965	Hydropower
Shasta	Sacramento, McCloud & Pit	US Bureau of Reclamation	4,552,000	6665	1945	Flood Management
Whiskeytown	Clear Creek	US Bureau of Reclamation	241,100	201	1963	Water Supply
East Park	Little Stony Creek	US Bureau of Reclamation	51,000	102	1910	Water Supply
Stony Gorge	Stony Creek	US Bureau of Reclamation	50,350	735	1928	Water Supply
Black Butte	Stony Creek	USACE	143,700	741	1963	Flood Management

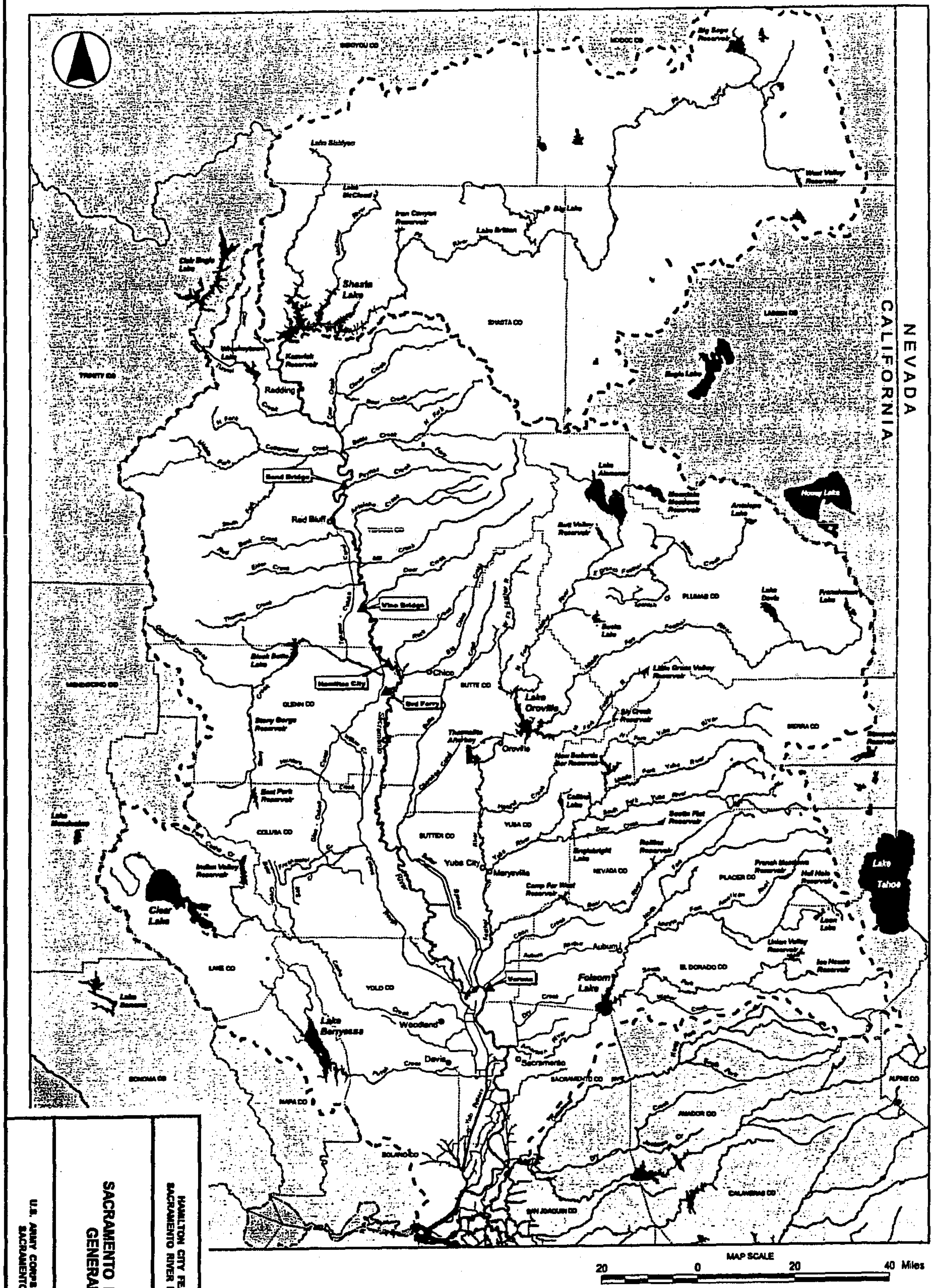
9. Results

Output from the lower basins reservoir model includes simulated regulated flood hydrographs at the "UNET-VINA BR" (Sacramento River at Vina Bridge downstream of Deer Creek) location for the 50-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedence events. These hydrographs are presented on Plate 11. Hydraulic Design Section uses a dynamic routing model, HEC-RAS, to route the regulated flow hydrographs from Vina Bridge downstream, for use in developing floodplains at Hamilton City. The flows and volumes at Hamilton City used to develop the Hamilton City floodplains are slightly different from the flows and volumes at Hamilton City listed on Table 4 for the Hamilton City flood series, due to the differences in routing methods.

Peak flow output from the HEC-RAS model (representing total regulated flow at the Latitude of Hamilton City) was plotted against the regulated peak flow frequency curve at Hamilton City (Plate 13). The model results matched well with the graphical peak flow curve.

10. Conclusions

The hydrology for Hamilton City and vicinity has been reanalyzed: new methodologies were used to develop a set of natural flow records for Sacramento River at Hamilton City; a regional flow frequency analysis was made, using observed streamflow records on nearby tributaries south of Shasta Dam; and unregulated flow frequency curves were developed for both Latitude of Hamilton City and local flows above Hamilton City. A methodology was developed to compute peak flow frequency curves for unregulated conditions on the Sacramento River downstream of Bend Bridge. As a result, synthetic flood hydrographs were developed for Sacramento River at the Latitude of Hamilton City. As a validation check, the synthetic regulated peak flows at Hamilton City were compared to the graphical peak flow curve presented on Plate 13. Good agreement between the synthetic peak flows and graphical peak flow curve further supports the methodology used in the development of the regulated flood hydrographs at Hamilton City for the 50, 10, 4, 2, 1, 0.5, and 0.2 percent chance exceedence events. It is believed that the hydrology presented in this office report is acceptable for a feasibility level analysis of flood protection alternatives.



Map Legend:

▭ Sacramento Basin

■ Lake or Reservoir

╱╲╱ River or Stream

╱╲╱ County Boundary

▲ Gaging Stations

o City

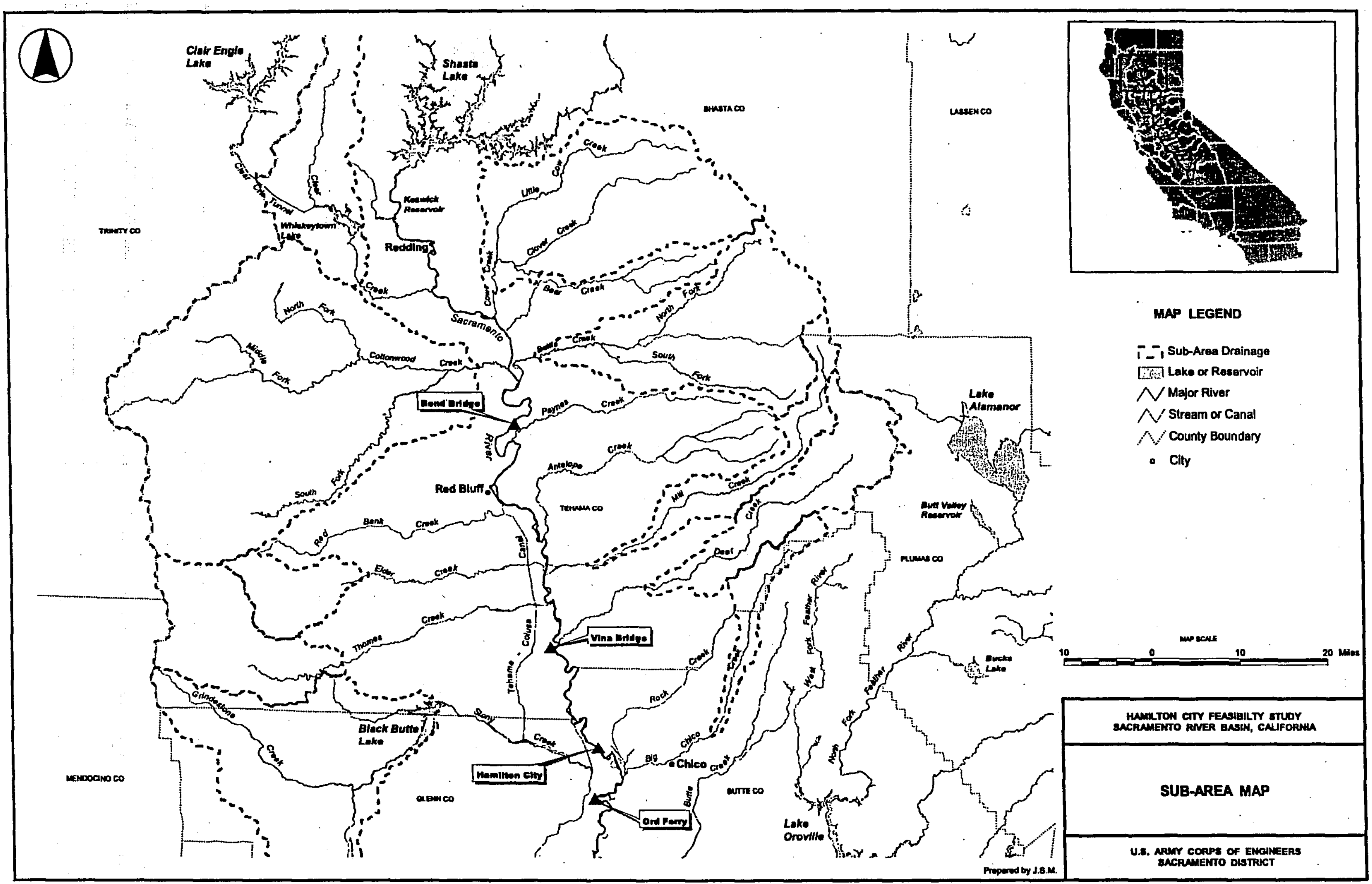
HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

SACRAMENTO RIVER BASIN
GENERAL MAP

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003

PLATE 1



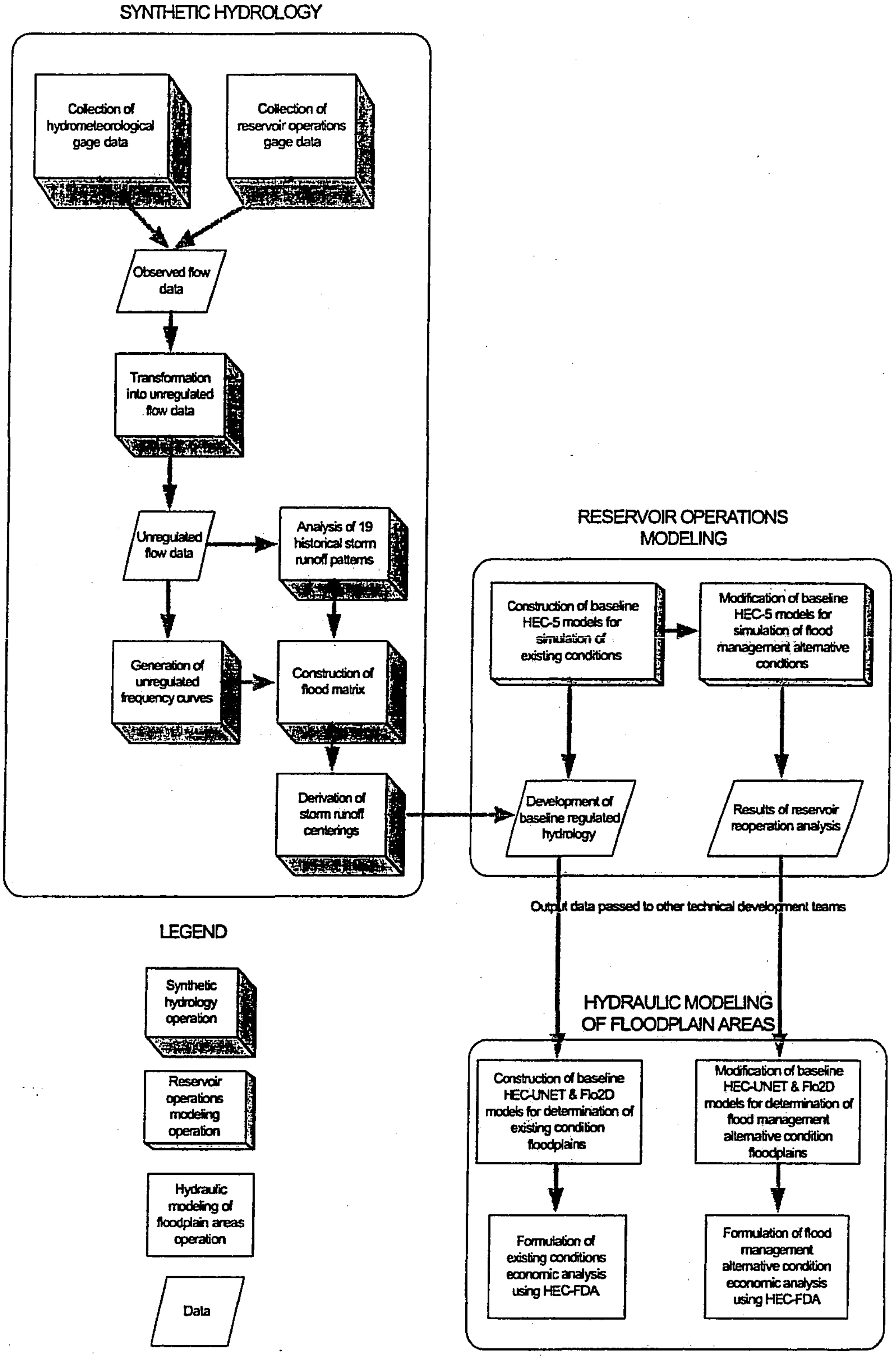
HAMILTON CITY FEASIBILTY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

SUB-AREA MAP

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003

PLATE 2



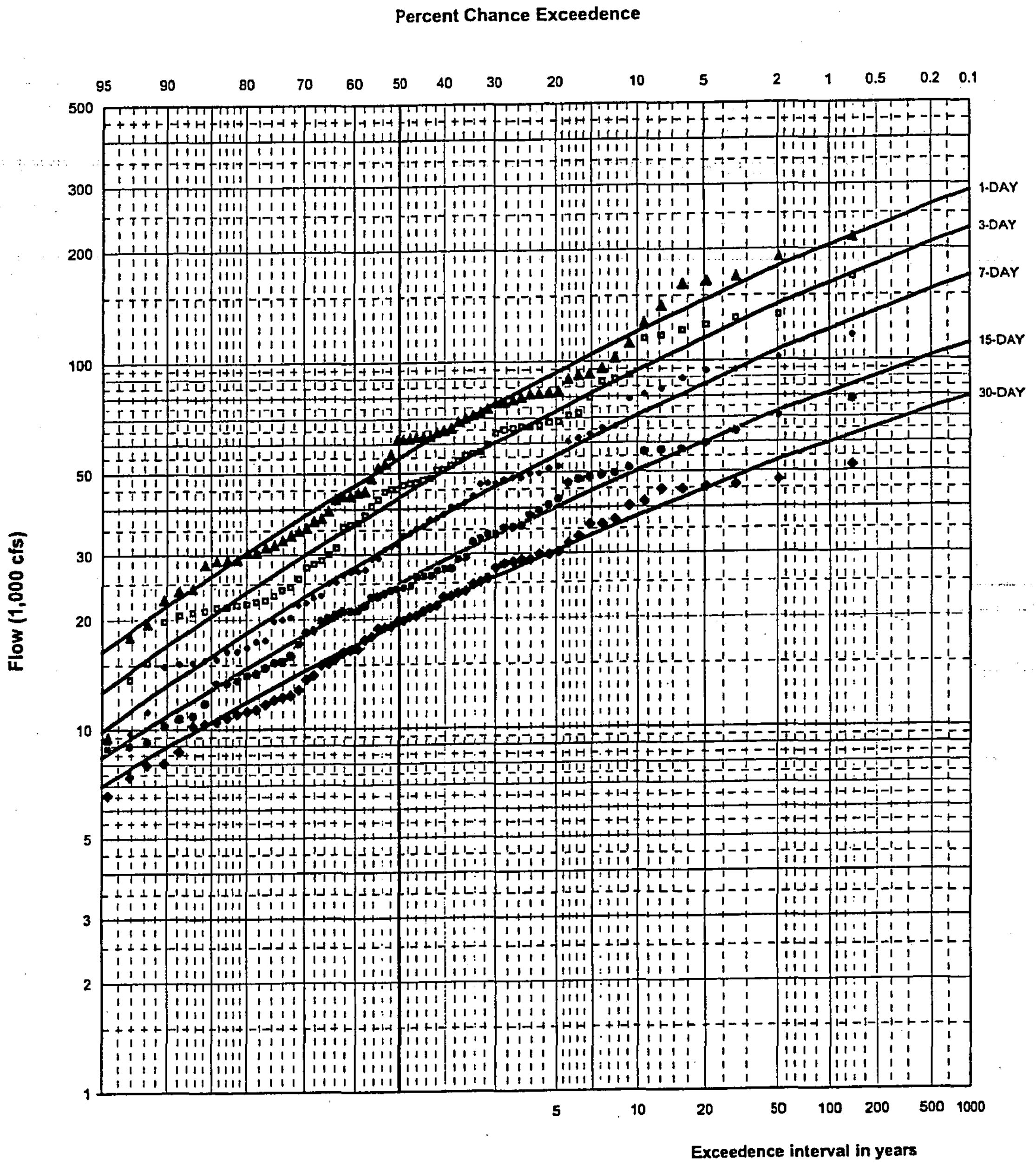
HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

HYDROLOGY AND MODELING DEVELOPMENT PROCESS SCHEMATIC

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003

PLATE 3



ADOPTED STATISTICS:

	Mean	Std.Dev.	Skew
1-day	4.721	0.290	-0.4
3-day	4.614	0.292	-0.4
7-day	4.498	0.287	-0.4
15-day	4.380	0.261	-0.4
30-day	4.275	0.246	-0.4

NOTES:

1. Equivalent years of record after correlation with Bend Bridge (1892-1998) is 98 years.
2. Adjusted USGS gage 11370000 to account for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
3. Median plotting positions.
4. Drainage area: 6,421 sq. mi.
5. Period of record: 1932-1998.

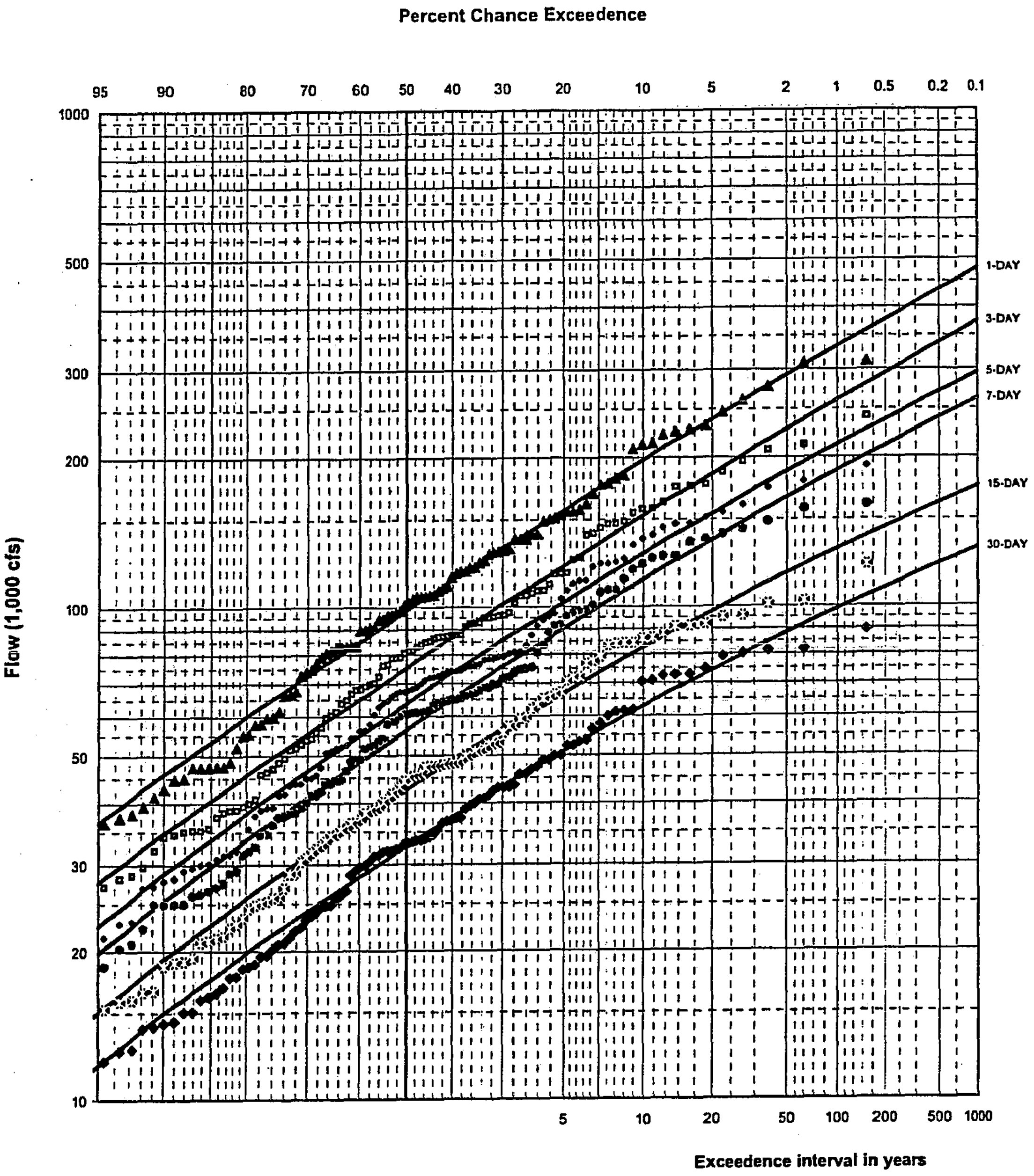
HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
SACRAMENTO RIVER AT SHASTA DAM
UNREGULATED CONDITIONS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003

PLATE 4



ADOPTED STATISTICS:

	Mean	Std.Dev.	Skew
1-day	4.984	0.247	-0.2
3-day	4.868	0.251	-0.2
5-day	4.791	0.254	-0.3
7-day	4.738	0.255	-0.3
15-day	4.612	0.248	-0.4
30-day	4.498	0.244	-0.4

NOTES:

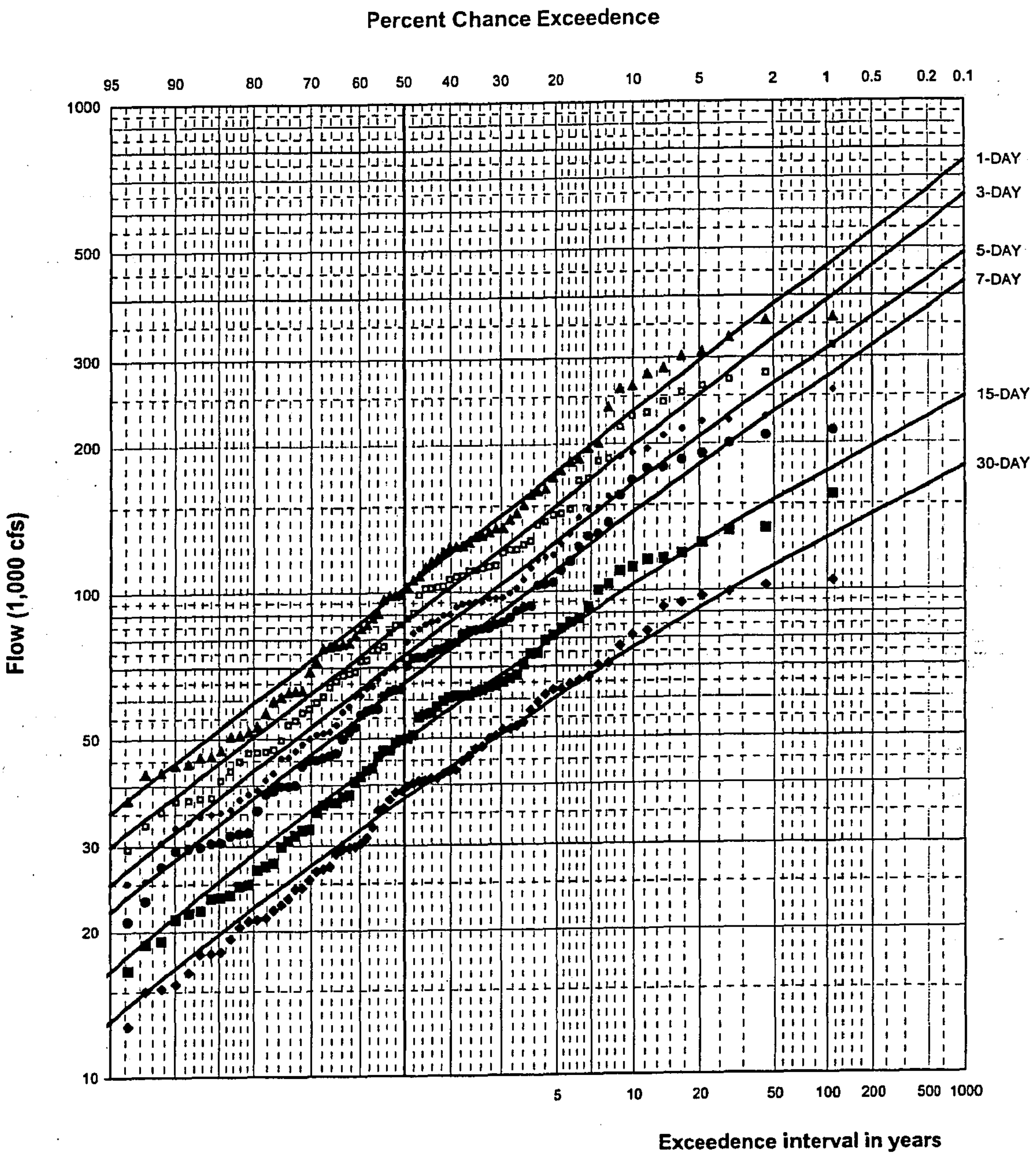
1. Adjusted USGS gage 11377100 to account for daily change in storage at Shasta Lake and Whiskeytown Reservoir (potential channel, out-of-channel, or storage losses neglected).
2. WY 1977 censored as low outlier.
3. Median plotting positions.
4. Drainage area: 8,900 sq. mi.
5. Period of record: 1893-1998.

HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
SACRAMENTO RIVER AT BEND BRIDGE
UNREGULATED CONDITIONS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003



ADOPTED STATISTICS:

	Mean	Std.Dev.	Skew
1-day	5.009	0.281	0.0
3-day	4.939	0.281	0.0
5-day	4.866	0.279	-0.1
7-day	4.809	0.278	-0.1
15-day	4.680	0.267	-0.3
30-day	4.562	0.258	-0.3

NOTES:

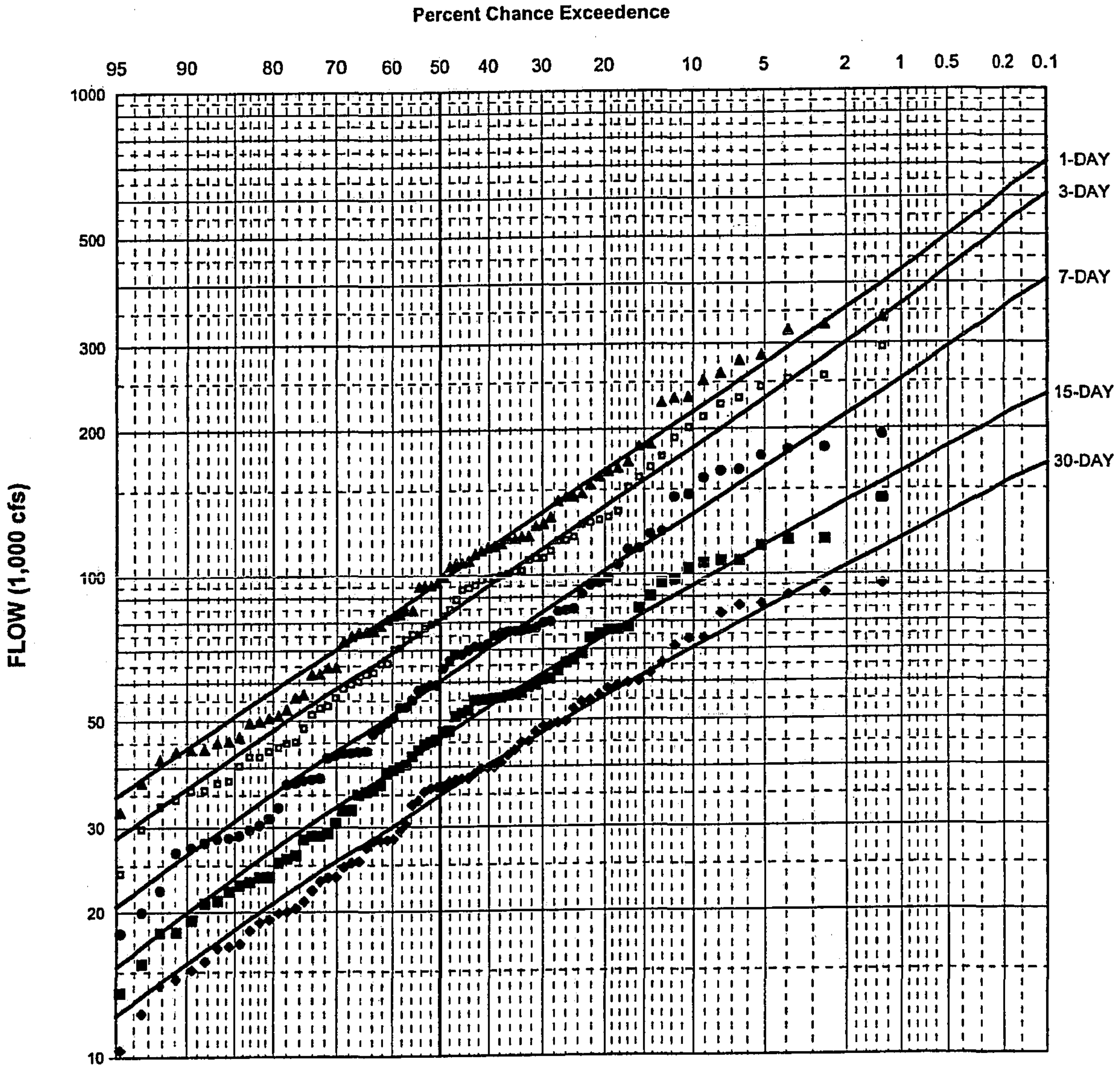
1. Adjusted USGS gage 11388700 to account for daily change in storage at upstream reservoirs (potential channel, out-of-channel, or storage losses neglected).
2. WY 1977 censored as low outlier.
3. Median plotting positions.
4. Drainage area: approx. 12,050 sq. mi.
5. Period of record: 1922-1997.

HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
SACRAMENTO RIVER AT ORD FERRY (LATITUDE)
UNREGULATED CONDITIONS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003



ADOPTED STATISTICS:

	Mean	Std.Dev.	Skew
1-day	4.989	0.267	0.0
3-day	4.910	0.271	0.0
7-day	4.776	0.271	-0.1
15-day	4.648	0.261	-0.3
30-day	4.530	0.252	-0.3

NOTES:

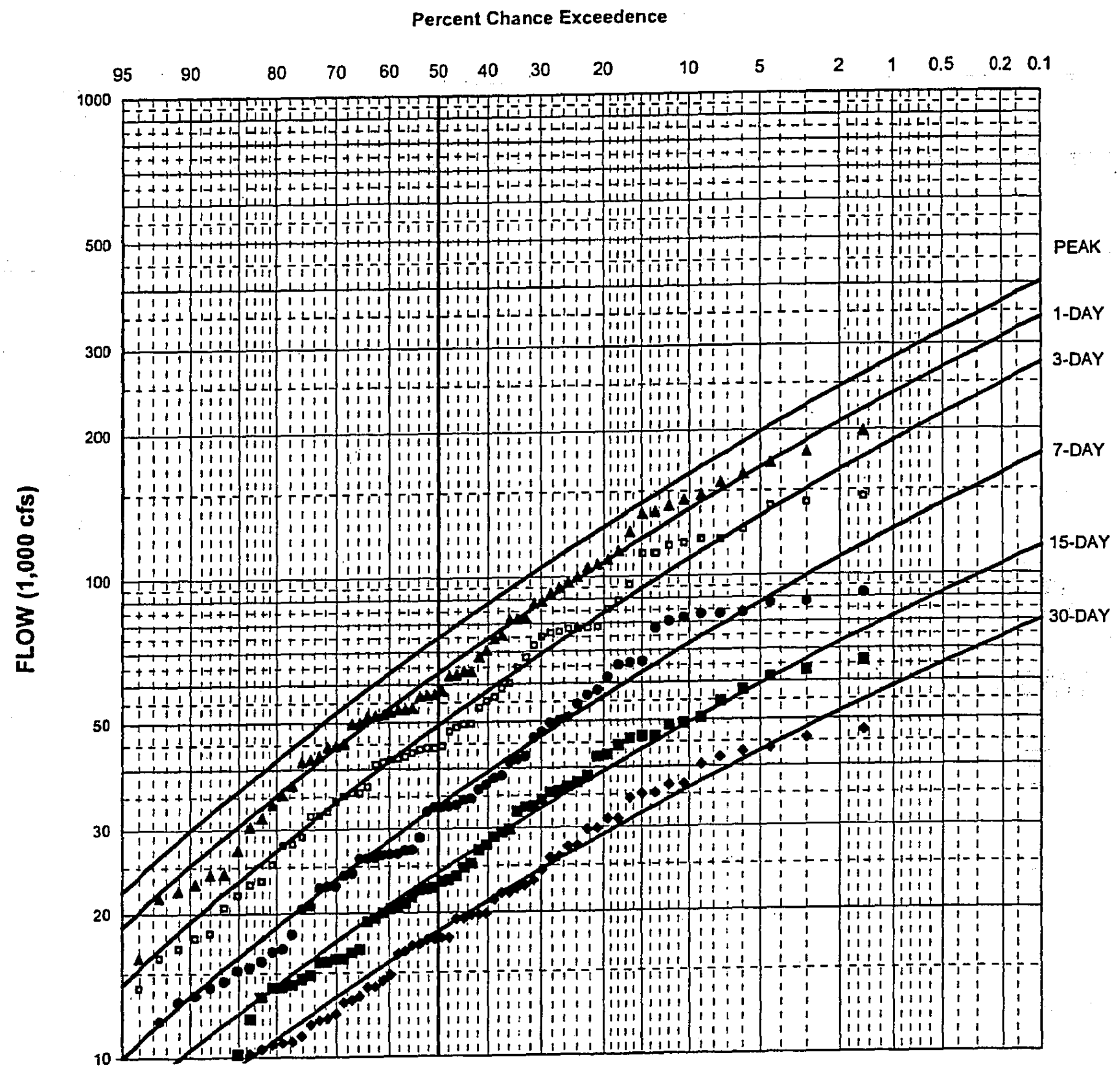
1. Median plotting positions
2. Change in storage from upstream reservoirs routed and combined at Hamilton City without regard for chanel, out of channel, or storage losses.
3. Period of record 1922-1997
4. Drainage area: approx. 11,040 sq. mi.
5. 1977 censored a low outlier

HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
SACRAMENTO RIVER AT HAMILTON CITY (LATITUDE)
UNREGULATED CONDITIONS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003



ADOPTED STATISTICS:

	Mean	Std.Dev.	Skew
Peak	4.857	0.284	-0.4
1-day	4.784	0.284	-0.4
3-day	4.673	0.290	-0.4
7-day	4.506	0.282	-0.4
15-day	4.367	0.262	-0.4
30-day	4.245	0.250	-0.4

NOTES:

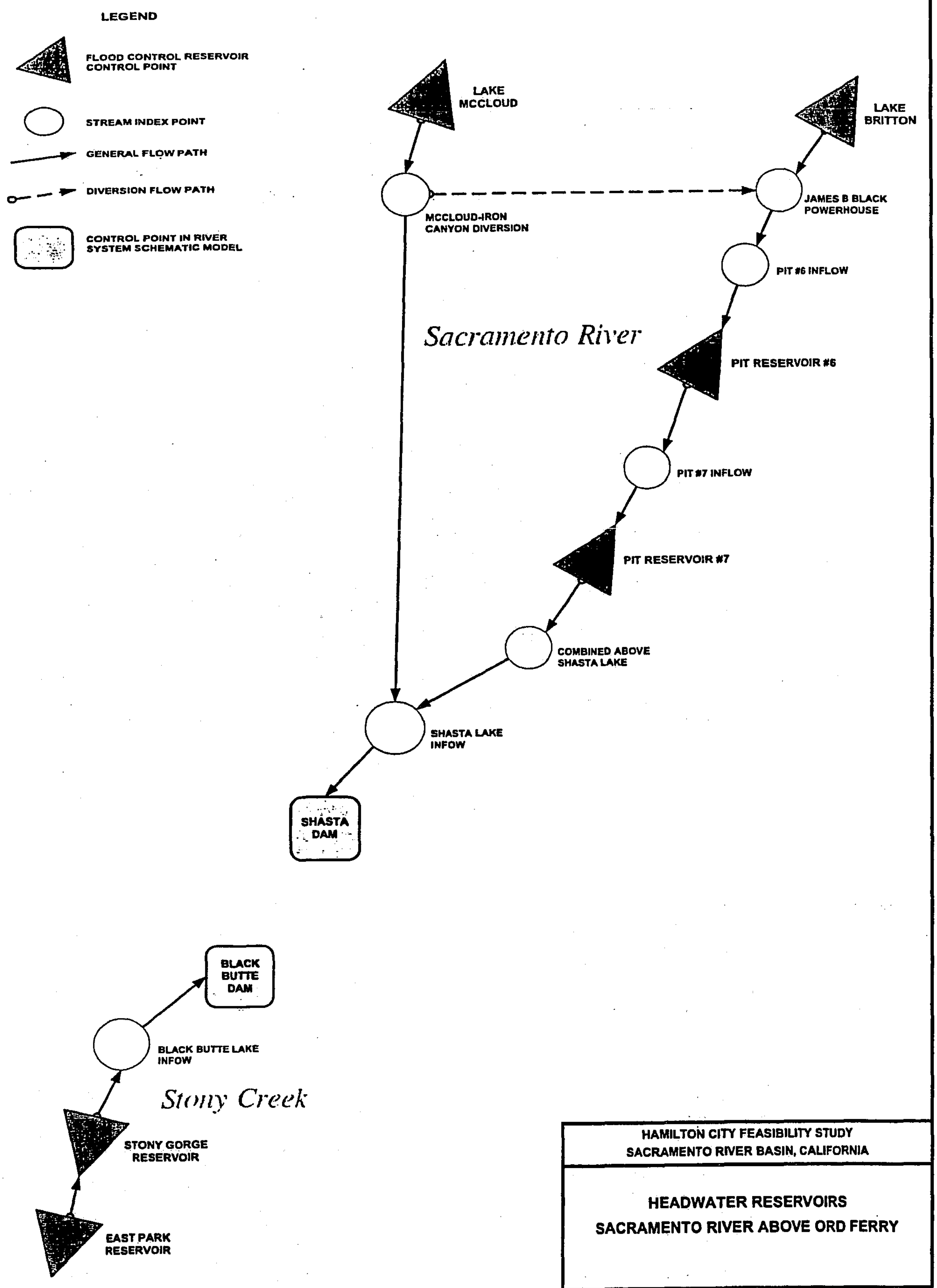
1. Median plotting positions
2. Change in storage from upstream reservoirs routed and combined at Ord Ferry without regard for channel, out of channel, or storage losses.
3. Peak flow frequency curve reflects the relationships of the peak to 1-day from recorded flows at Bend Bridge and Vina Bridge.
4. Period of record 1932-1997
5. Drainage area: approx. 4,620 sq. mi.
6. 1977 censored as a low outlier

HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RAINFLOOD FREQUENCY CURVES
LOCAL FLOW ABOVE HAMILTON CITY
UNREGULATED CONDITIONS

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

February 2004



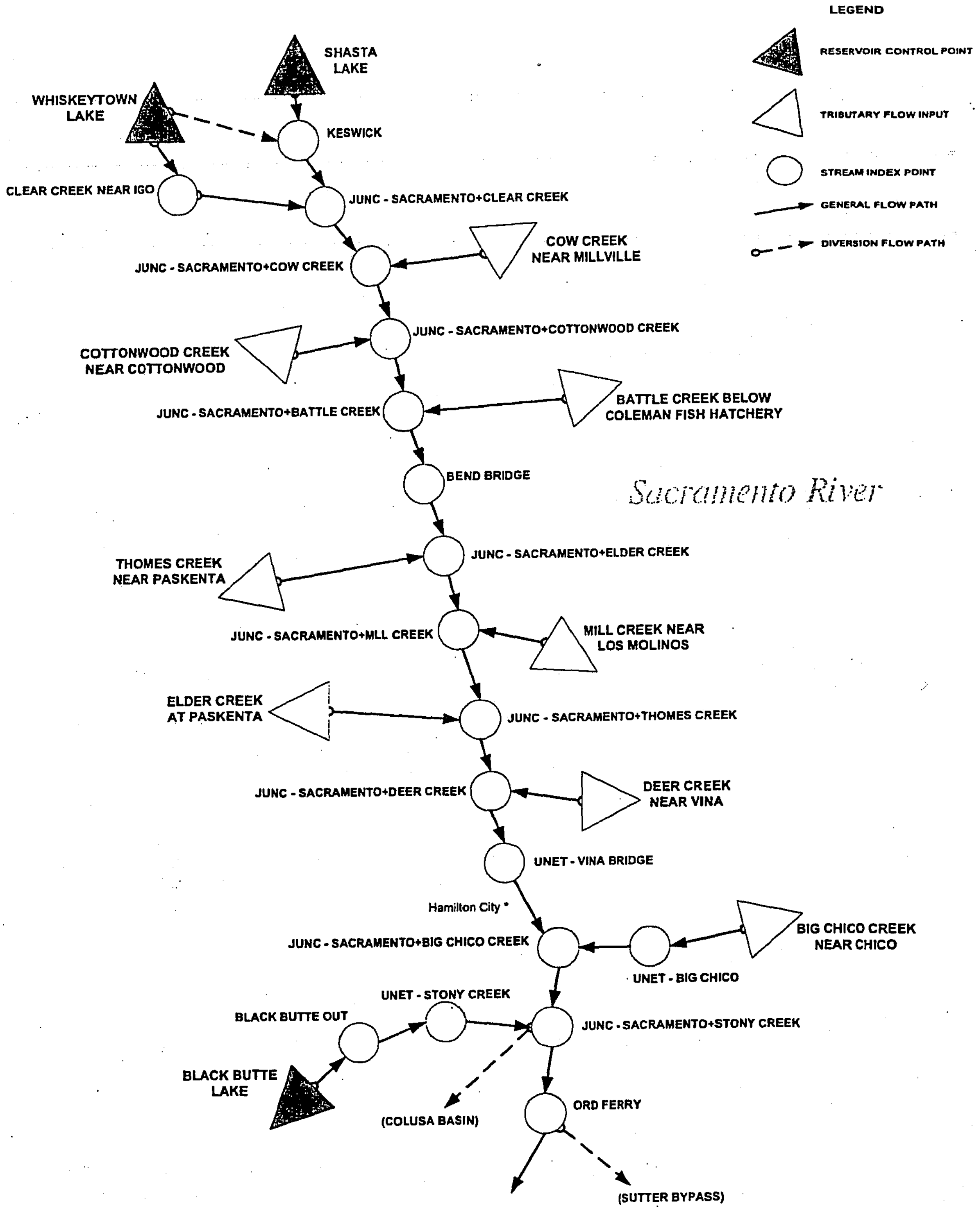
HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

HEADWATER RESERVOIRS
SACRAMENTO RIVER ABOVE ORD FERRY

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003

PLATE 9



Note:

*Hydrographs at Vina Bridge were used as input into the hydraulic model to assess conditions at Hamilton City

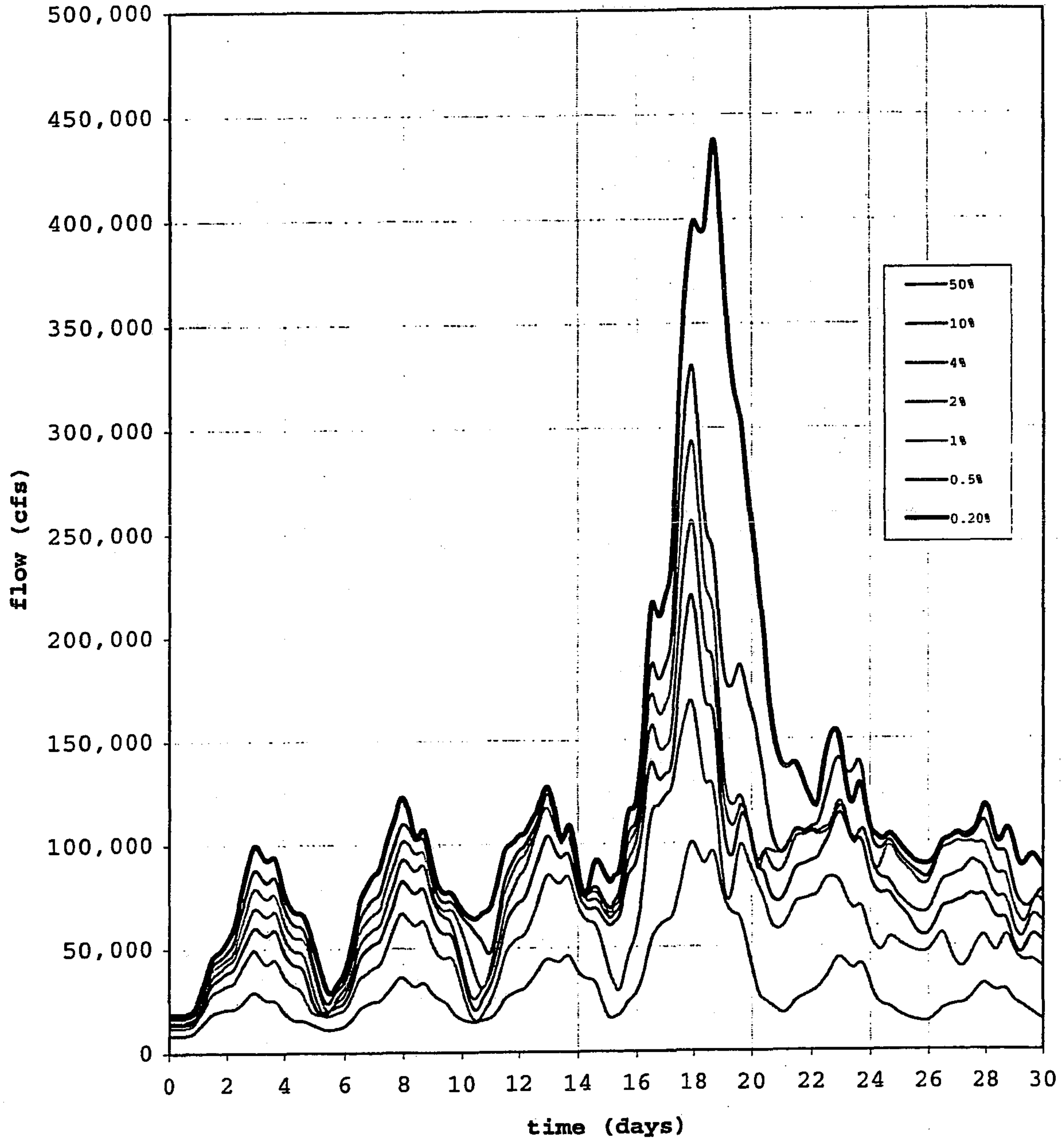
HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RIVER SYSTEM SCHEMATIC
FOR LOWER BASIN HEC-5 ROUTING
SACRAMENTO RIVER AT ORD FERRY

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

February 2004

PLATE 10

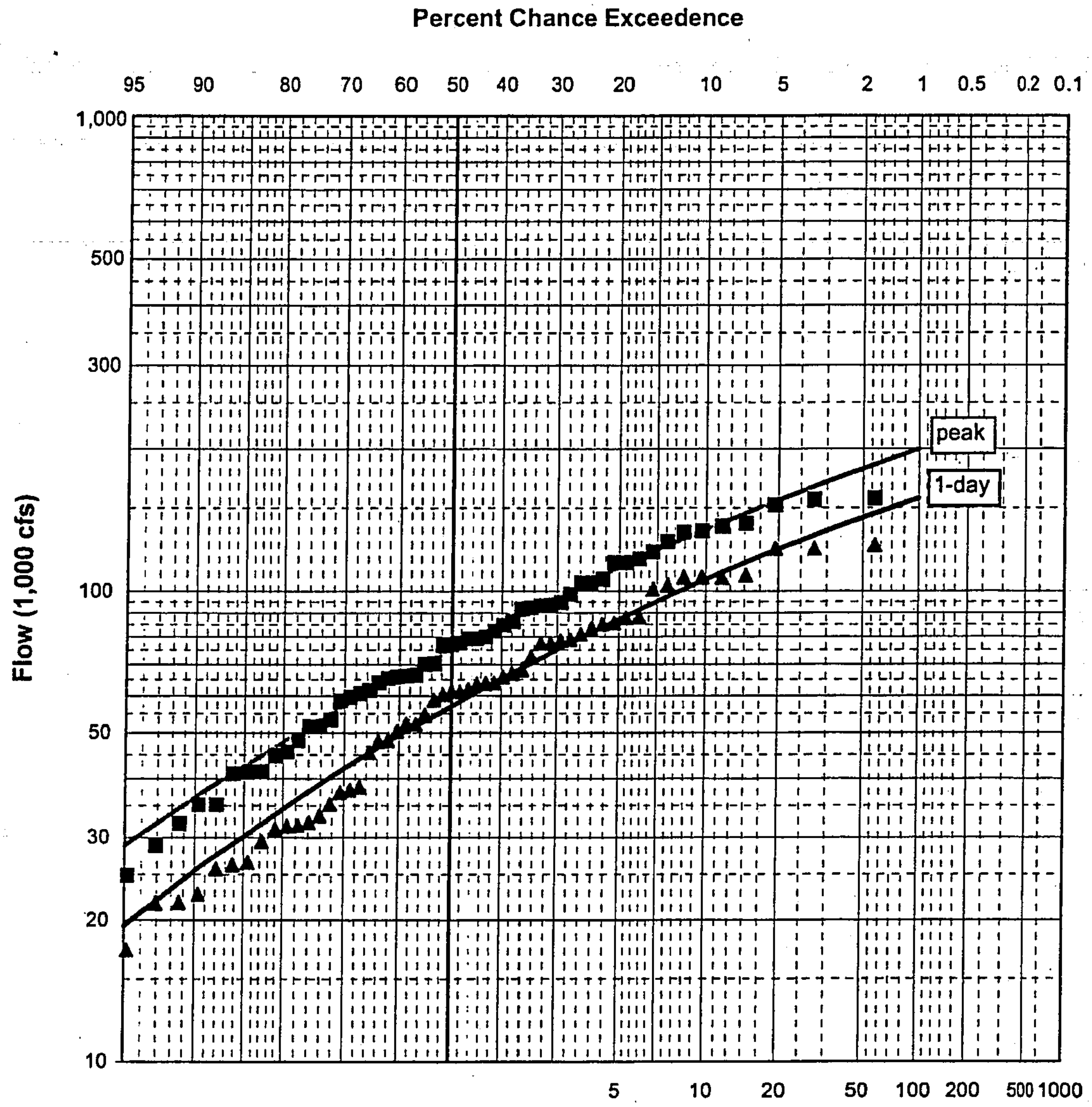


HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

HAMILTON CITY FLOOD CENTERING
REGULATED HYDROGRAPHS
SACRAMENTO RIVER AT VINA BRIDGE
LATITUDE OF VINA

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

June 2003



NOTES:

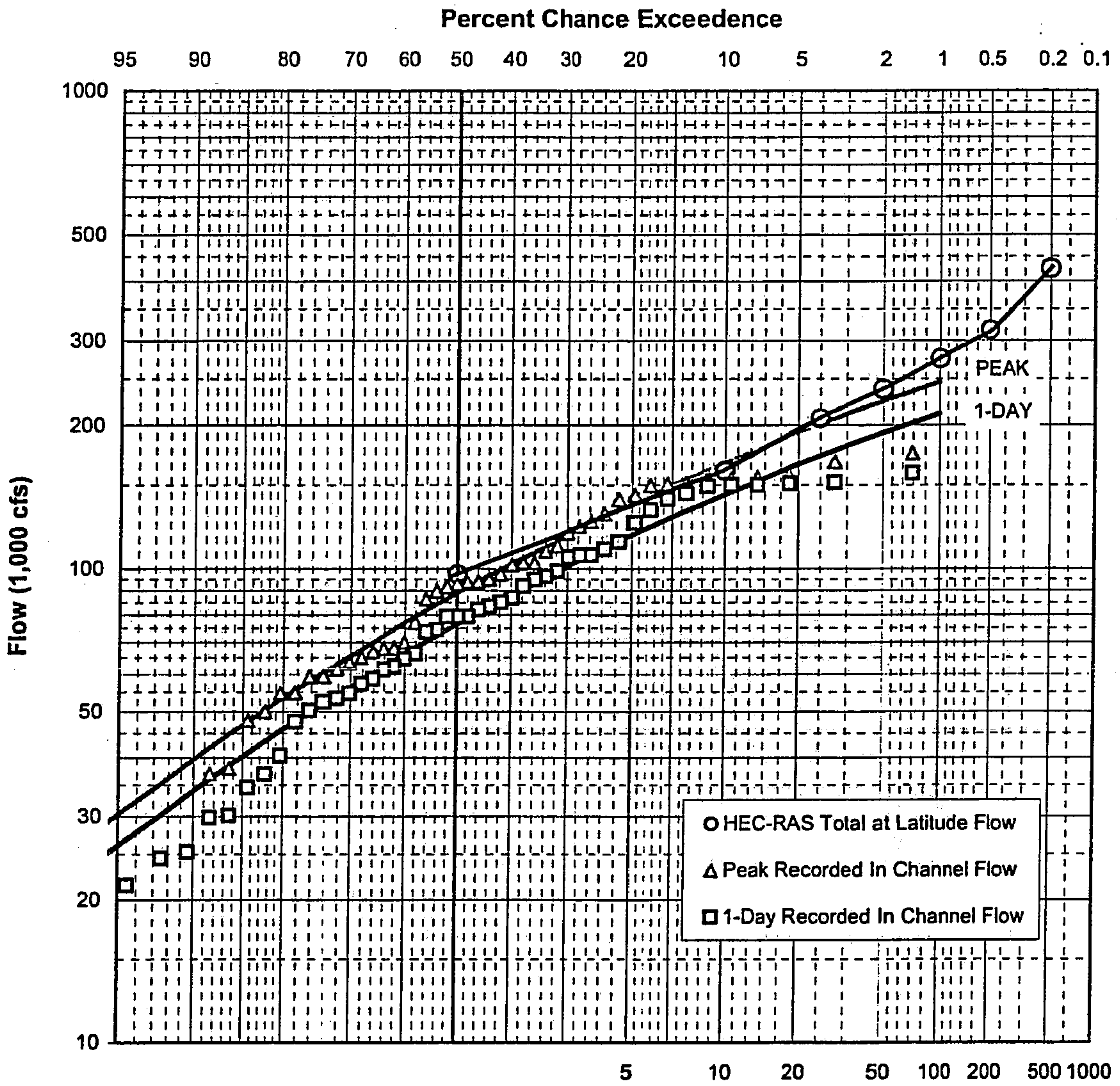
1. Period of Record 1945-2001
2. All flows in referenced period of record have remained in channel; no flows have bypassed the gage.
3. Uncontrolled releases from Shasta have not occurred during referenced period of record.
4. Peak and 1-day flow reflect controlled releases from Shasta & Whiskeytown reservoirs and uncontrolled local below Shasta.
5. Median plotting positions
6. Drainage Area 8,900 sq. mi.

HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CA

REGULATED PEAK & 1-DAY RAIN FLOOD FREQUENCY CURVES SACRAMENTO RIVER AT BEND BRIDGE

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

February 2004



NOTES:

1. Circles represent hypothetical values from HEC-RAS model
2. Hypothetical values represent total regulated flow in the main channel and out of bank at the latitude of Hamilton City.
3. During large floods, flows outside the main channel are not recorded by the Hamilton City gage (DWR station # AO-2630)
4. Peak & 1-day curves estimate total flow, not flow recorded at the gage
5. Recorded flows use median plotting positions
6. Drainage area: approx 11,040 sq. mi.
7. Period of record: 49 years between 1945-1998.

HAMILTON CITY FEASIBILITY STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

REGULATED PEAK & 1-DAY RAINFLOOD FREQUENCY CURVES SACRAMENTO RIVER AT HAMILTON CITY

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Sacramento & San Joaquin River Basins Comprehensive Study
Initial Project, Hamilton City

Flood Damage Reduction and Ecosystem Restoration Feasibility Study, California

Appendix C3
Hydraulic Design Document Report

June 2004

U.S. Army Corps of Engineers, Sacramento, California

Table of Contents

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Appendix C3. Hydraulics

C3.1. Project Description

C3.1.1. Background

The U.S. Army Corps of Engineers and The Reclamation Board of the State of California conducted a feasibility study to develop and evaluate potential alternative plans to reduce flood damages and restore the ecosystem along the Sacramento River near Hamilton City. The goal of the study is to identify a cost effective, technically feasible, and locally acceptable project that best meets the dual objectives of reducing flood damages and restoring the ecosystem and is in compliance with all Federal, State, and local laws and regulations. The study will culminate in an integrated feasibility report and environmental impact statement/environmental impact report (EIS/EIR) documenting the study findings. The intent is to submit the report to Congress for consideration for Federal authorization to implement the project. The costs to conduct the study and implement a project are shared between Federal, State, and local interests. State and/or local interests would be responsible for operation and maintenance of a project if implemented.

C3.1.2. Study Area Description

Hamilton City is located in Glenn County, California, along the right bank of the Sacramento River, about 85 miles north of the City of Sacramento. The study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the east and the Glenn Colusa Canal to the west and extends about two miles north and six miles south of Hamilton City. Hamilton City has a population of about 2,000 people. Surrounding land use is agricultural with fruit and nut orchards being the primary crops.

An existing private levee, constructed by landowners in about 1904 and known as the "J" levee, provides some flood protection to the town and surrounding area. The "J" levee, however, is not constructed to any formal engineering standards and is largely made of silty sand soil. It is extremely susceptible to erosion and flood fighting is necessary to prevent levee failure and flooding when river levels rise. Since the construction of Shasta Dam in 1945, flooding in Hamilton City due to failure of the "J" levee has occurred once (1974). In addition, extensive flood fighting has been necessary to avoid flooding in 1983, 1986, 1995, 1997, and 1998. Currently, the Sacramento River is actively eroding into the toe of the levee at the northern end of the study area. Glenn County has built a backup levee, about 1,000 feet in length, to protect the community in the event the toe erosion causes failure at the northern end of the "J" levee.

Native habitat and natural river function in the study area have been altered by construction of the "J" levee and conversion of the floodplain to agriculture and rural development. Construction of the "J" levee and hardening of the river bank and levee in several locations through the years (typically with rock) have constrained the ability of the river to meander and overflow its banks and promote propagation and succession of native vegetation. Conversion of the floodplain to agriculture and rural development has reduced the extent of native habitat to remnant patches along the river and in historic oxbows. These alterations to the ecosystem have greatly diminished the abundance, richness, and complexity of riparian, wetland, and floodplain habitat in the study area and the species dependent upon that habitat.

River miles as noted in this report are U.S. Geological Survey river miles, unless noted otherwise.

C3.1.3. Authority

In response to concerns primarily raised by the 1997 flood, the Governor of California formed the Flood Emergency Action Team (FEAT). In its May 1997 report, the FEAT recommended developing a "new master plan for improved flood control in the Central Valley" of California. The California State Legislature (September 1997) and U.S. Congress (1998) subsequently authorized the Sacramento and San Joaquin River Basins Comprehensive Study. The House Report 105-190, accompanying the 1998 Energy and Water Development Appropriations Act, Public Law (PL) 105-62 called for "development and formulation of comprehensive plans **for flood control and environmental restoration** purposes."

The U.S. House Report 108-357, which is the conference report accompanying the Energy and Water Development Appropriations Act, 2004, P.L. 108-137, urged the Secretary of the Army to include in the study an area extending from 2 miles due north to four miles due south of State Highway 32, and extending at least 1.2 miles due south of County Road 23.

C3.2. Surveys

C3.2.1. Source of Data

Survey data used to develop the hydraulic model geometry for this study was developed from two surveys, one in 1995 for the Sacramento River Bank Protection Project, Sacramento River and Tributaries, Breach at Road 29 near RM 188, Glenn County, California and one in 1998 as part of the Sacramento and San Joaquin River Basins Comprehensive Study (Comp Study). **Figure 1**, page 4, shows the 2-foot contour mapping area in the darker shading and the 5-foot contour mapping in the lighter shading. The upper line of the 2-foot contour mapping separates the two sources of survey data. The 1998 survey area is the 5-foot contour area above the 2-foot contour mapping.

C3.2.2. Surveys in 1995

Horizontal and vertical ground control for photogrammetric mapping was established using Global Positioning System (GPS) survey techniques. Aerial photographs were taken at scales of 1:10,000 for 2-foot contour mapping and 1:24,000 for 5-foot contour mapping on July 31, 1995. Northings and Eastings were defined in California State Plane Coordinates (NAD 83). Above the waterline, topography was developed using standard photogrammetric mapping techniques. For 2-foot contour mapping, aerial photos were taken at 5,000 feet in elevation (all new mapping and some existing Sacramento River mapping) and for 5-foot contour mapping (existing Sacramento River mapping only), aerial photos were taken at 12,000 feet. All photos are in black and white, and some are digital. Mapping is complete for the riverine corridor (300 feet landward of banks and levees.) Under the waterline, hydrosurvey data was collected with boats equipped with a dual frequency GPS receiver, fathometer, and sonar transducer. Hydrographic survey data was collected along river cross-sections oriented generally perpendicular to the channel banks to detail the form of the river bottom. These cross-sections were spaced roughly at a distance equal to the channel topwidth. These surveys were originally developed in metric and were later converted to feet for the Comprehensive Study.

C3.2.3. Surveys in 1998

Surveys in 1998 are part of the Sacramento and San Joaquin River Basins Comprehensive Study. The area surveyed is the 5-foot contour area above the upper limit of the 2-foot contours as described above and shown in **Figure 1**, page 4. The survey techniques are similar to those described for the 1995 surveys.

C3.2.4. Datum

The North American Datum of 1983 (NAD 83 1991.35), California Coordinate System of 1983 Zone 2 was used for horizontal control. The National Geodetic Vertical Datum of 1929 (NGVD29) was used to establish elevations. The NAD83 were obtained from the California Department of Transportation, North Region Surveys and are a part of the California Spatial Reference System - Horizontal (CSRS-H). The NGVD29 values were obtained in part from the National Geodetic Survey Control Database dated 1995, The California Department of Transportation and the County of Sacramento.

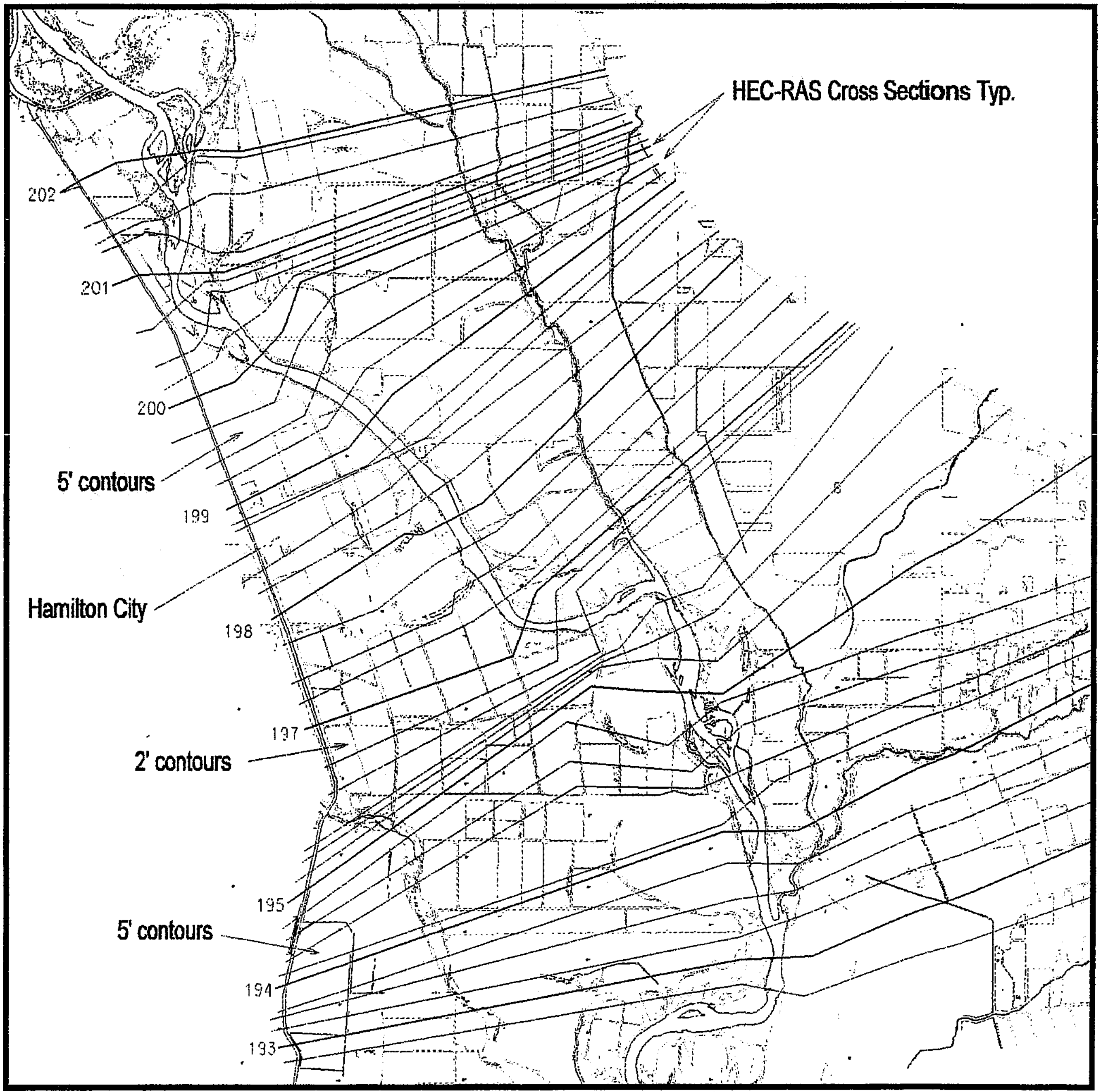


Figure 1. Survey Area and Cross Section Layout for Hydraulic Model.

C3.3. Design Tools

C3.3.1. Drafting

The Bentley software MicroStation was used as the primary drafting package for vector and raster file viewing and editing.

C3.3.2. Civil Design

The Intergraph software InRoads SelectCAD was used to produce hydraulic model cross sections and levee designs. A set of alignments, plans, profiles, and cross sections are developed for the proposed levee alignments, see Appendix C5, Civil Design.

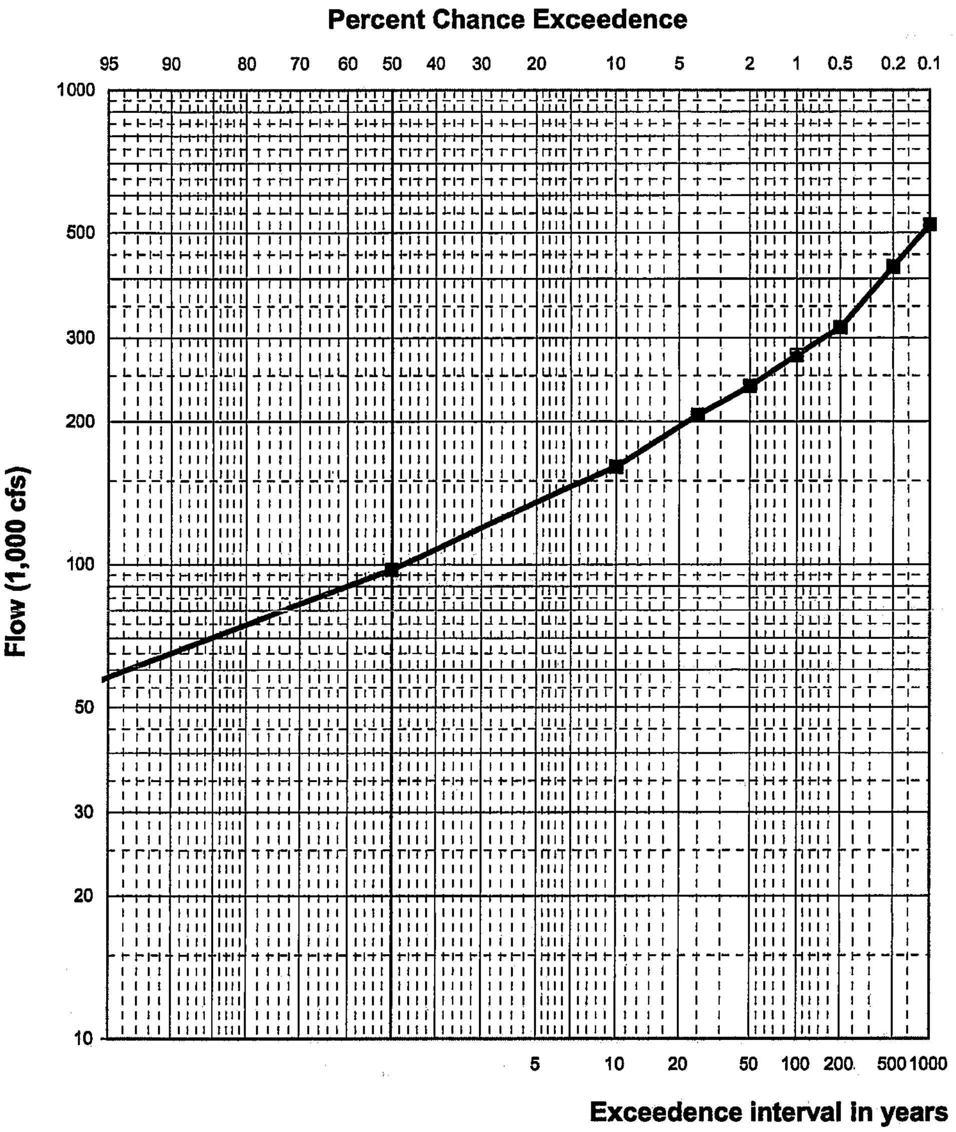
C3.3.3. Hydraulic Design

HEC-RAS Version 3.0.1, March 2001, was used for the hydraulic analysis. Hydraulic analysis used steady state, one-dimensional, standard step backwater techniques based on the following:

- The peak flow has a long duration.
- Storage area for flood flow is very small compared to the flood hydrographs
- The Sacramento River along Hamilton City is contained by high ground on each side of the floodplains.

C3.4. Hydrology

Hydrographs for the 2-year through 500-year flood events were obtained from a refinement of the Comprehensive Study Hydrology. See the hydrology documentation for this study (see Appendix C2, Hydrologic Engineering). The HEC-RAS hydraulic model for this study was extended upstream to the Comprehensive Study handoff point at Vina Bridge. The DSS file hamcity.dss was used for the 2-year event through the 500-year event. To develop the floodplains and analyze alternatives, HEC-RAS was run in the steady state mode. The peak flows for Hamilton City used for all three index points can be seen in **Table 1**, page 7. The flow values were taken from the unsteady HEC-RAS runs at RM 198.61. This study area is near the handoff point at Vina Bridge; changes in peak flows based on the channel routings have been insignificant. Peak flows used for this study are the same throughout the study reach of the river.



Pecent Exceed.	Exceed. Years	Discharge c.f.s.
0.10	1,000	520,000
0.20	500	424,511
0.50	200	315,965
1.00	100	275,910
2.00	50	237,829
4.00	25	206,575
10.00	10	160,634
50.00	2	97,524
99.99	1	30,000

SACRAMENTO-SAN JOAQUIN COMPREHENSIVE STUDY
SACRAMENTO RIVER BASIN, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
HAMILTON CITY
2003 HEC-RAS Model Results

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

1-Sep-00

Figure 2. Peak Flow Frequency Curve.

Table 1. Index Points at Hamilton City.

			Peak Stage (feet NGVD) @ River Mile (RM)		
Percent (Exceed.)	Exceed. (Years)	Discharge (cfs)	198.25 (feet)	197.25 (feet)	194.25 (feet)
0.10	1,000	520,000	153.89	150.45	143.83
0.20	500	424,511	152.30	149.08	142.09
0.31	320	342,580	150.75	147.80	140.42
0.50	200	315,965	150.39	147.93	139.81
1.00	100	275,910	149.53	147.06	138.86
2.00	50	237,829	148.37	145.94	137.86
4.00	25	206,575	147.85	144.87	136.98
10.00	10	160,634	145.73	143.18	135.40
50.00	2	97,524	141.22	138.99	132.34
99.99	1	30,000	131.27	128.95	121.79

C3.5. Project Description

Hamilton City is on the right bank of the Sacramento River. An existing levee known as the "J" levee, so named for its alphabetical relationships to other levees in the area, lies between the Sacramento River and Hamilton City. The floodplain along this reach of the river is bordered by the foothills of the Coast Range to the west and the Sierras to the east. Seven proposed plans were considered. A description of each preliminary alternative plan can be found in Chapter 3 (paragraph 3.5) of the main report.

C3.6. Hydraulic Analysis

C3.6.1. Model Description

A one-dimensional steady state HEC-RAS hydraulic model was used for this study. It was made using the original cross sections defined for the Comp Study Sac River Basin UNET one-dimensional unsteady model. A UNET model and a FLO-2D model had been used for the Comprehensive Study for the Hamilton City Reach. The cross sections from the UNET model were extended across the floodplain so one hydraulic model could be used for this study. This study was able to use a single model because the flow split into the Butte Basin was not considered.

The cross sections are shown in plan view on **Figure 1**, page 4. The cross sections extend across the valley floor to essentially contain the 500-year flood event. Cross sections are spaced about one-quarter mile apart.

Existing levees present along the east bank of the Sacramento River and Pine Creek in Butte County were included in the hydraulic model. Based on historical accounts and experience in the area the levees were allowed to fail between the water surface profiles of the January 1997 event and the 50-year peak flood event water surface profile, where the larger event is the 50-year event.

C3.6.2. Boundary Conditions

Peak flood flows entering the upstream boundary RM 202 are described above in section 4. Hydrology. **Table 1**, page 7, shows the discharges in cubic feet per second that were run in the model.

At the downstream end of the model (RM 192.75) a normal depth-rating curve was developed. The rating curve development considered stage discharge information from the Comprehensive Study UNET results and from a RMA-2V two-dimensional hydrodynamic model developed by Ayres Associates to model the Butte Basin flow splits based on the 1995 survey data described above. **Figure 3**, page 9, shows a comparison of the three stage discharge relationships. To compute normal depth a slope of 0.0006 was used. The Manning's roughness coefficients used were 0.025 for the channel and 0.10 for the overbanks.

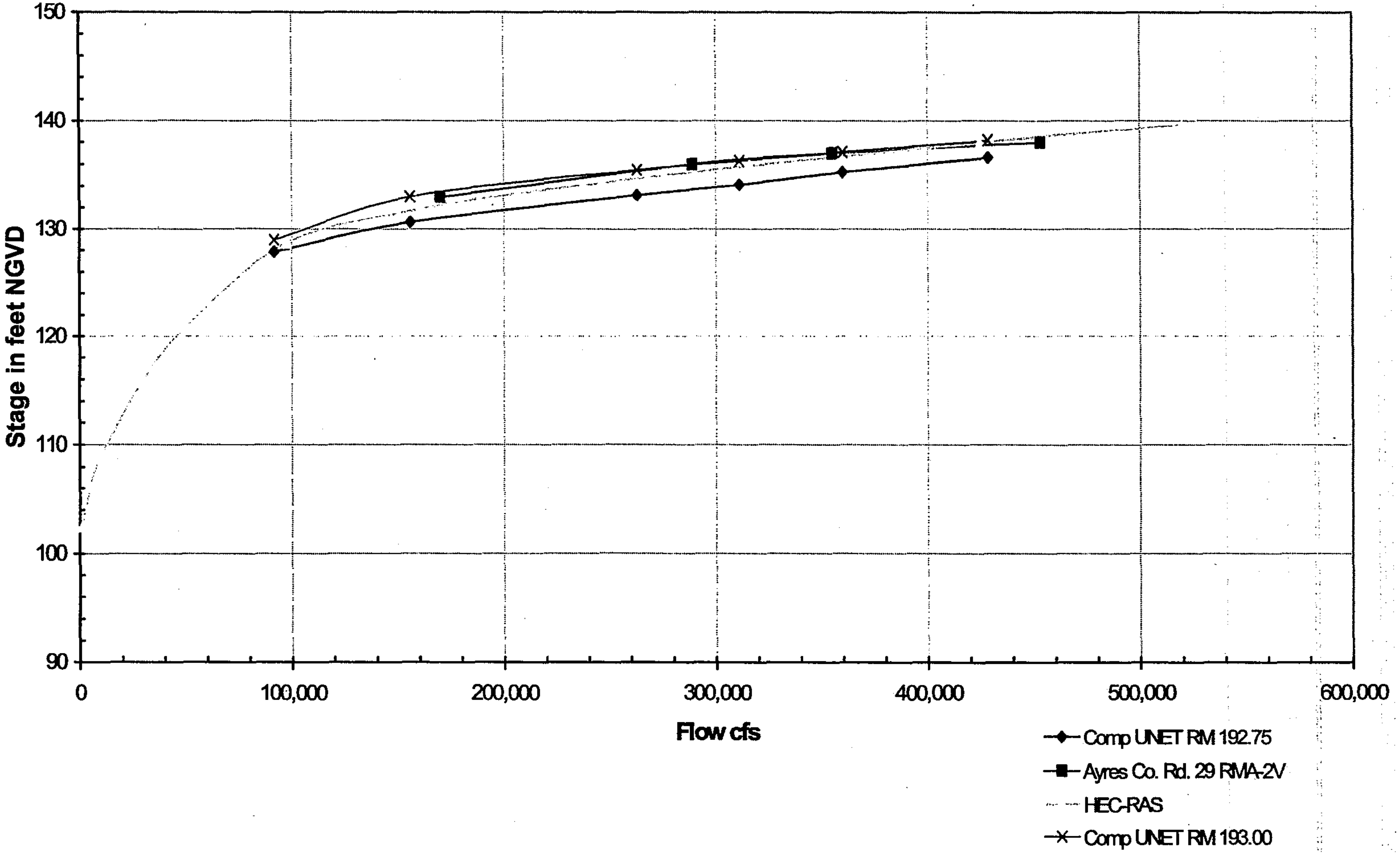


Figure 3. Rating Curve Sacramento River, RM 192.75.

C3.6.3. Manning's Roughness Coefficients

Manning's roughness coefficients were estimated considering values used in the Comprehensive Study, previous multi-dimensional studies by Ayres Associates, and matching the water surface elevations from the USGS gage rating at Gianella Bridge River Mile ~198.67 (1997 UNET river miles). Manning's roughness coefficients used for this study are listed below in **Table 2**, page 10. Form Loss coefficients of 0.1 for contraction and 0.3 for expansion was used throughout the model.

Table 2. Manning's Roughness Coefficients.

	N	N	N
River	Left	Main	Right
Mile	Overbank	Channel	Overbank
220.00	0.15	0.027	0.15
198.63	0.15	0.027	0.15
198.71	0.15	0.026	0.15
193.00	0.15	0.025	0.15
192.75	0.10	0.025	0.10

C3.6.4. Bridge Analysis and Form Loss Coefficients

The Gianella Bridge crosses the Sacramento River adjacent to Hamilton City. There are no other bridges within the study reach. The low cord (elevation 158.26 feet NGVD) on the bridge is well above the water surface for all the flood events. Flood flows can go around the bridge on both ends. The standard step energy method was used to model the bridge. Pressure and weir flow do not occur for the range of flows analyzed.

C3.6.5. Junctions, Transitions, and Bifurcations

There are no junctions or bifurcations within this study reach. All transitions were modeled using form loss and roughness coefficients.

C3.6.6. Calibration/Verification

Very little data was available to calibrate the hydraulic model. The hydraulic model results were compared to one 1997 high water mark and the DWR Hamilton City Gage rating curve (HMC rating). The gage is just upstream of the Gianella Bridge. **Figure 4**, page 11, shows the comparisons.

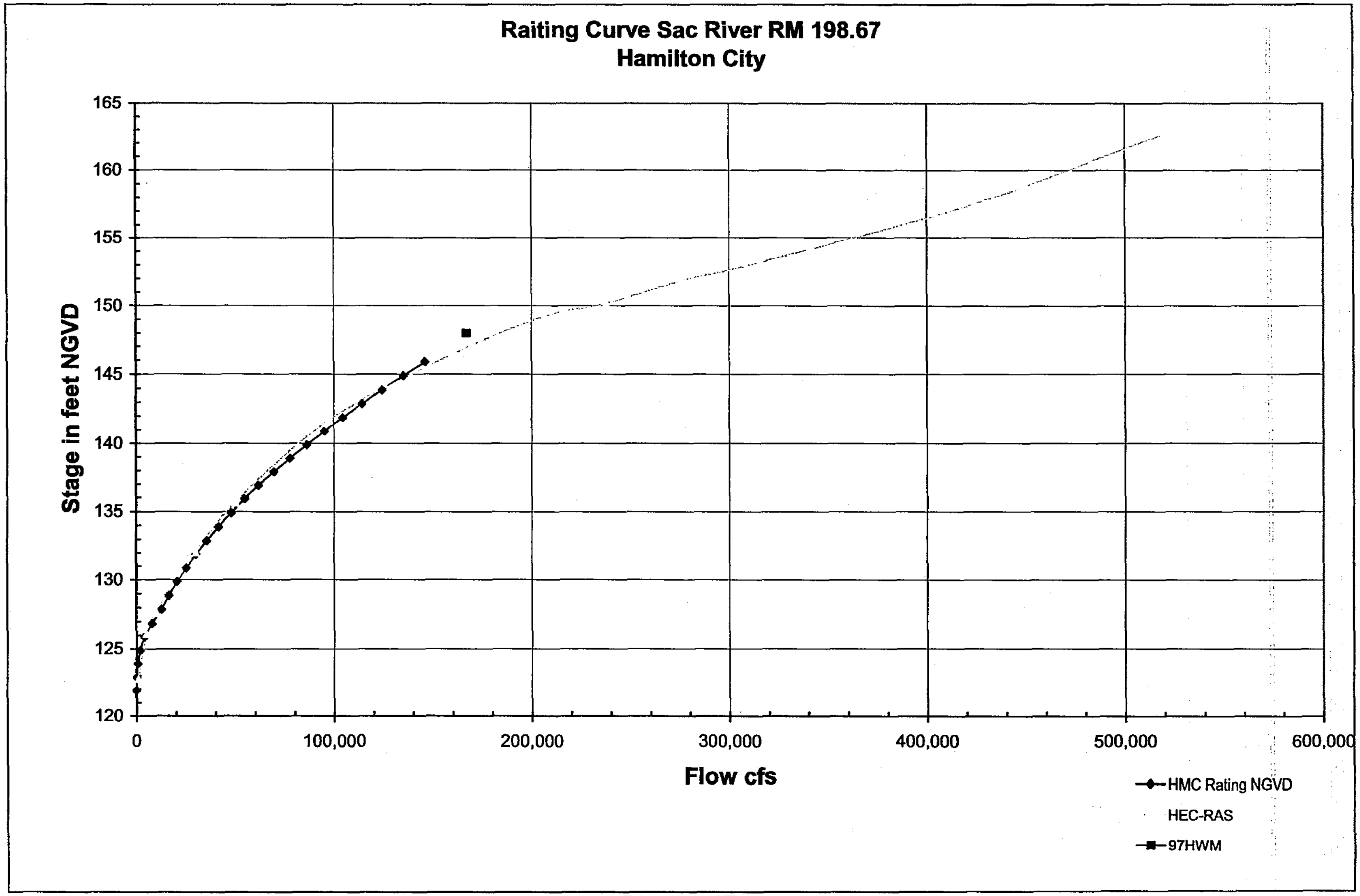


Figure 4. Hamilton City Rating Curve Sacramento River, RM 198.67.

C3.6.7. Superelevation

Superelevation of the river's water surface was not considered significant in this study because flow is in the sub-critical regime, and the river does not experience any significant bends in the study area.

C3.6.8. Wind Setup and Wave Runup

This analysis was conducted to determine the magnitude of wind-induced wave action against the proposed west-side (right bank) setback levee on the Sacramento River east of Hamilton City, California. The Stillwater Level used for the analysis is the 100-year floodplain elevation of the Sacramento River at the latitude of Hamilton City, about 152 feet.

Wind data used in the analysis are from the records at Sacramento Executive Airport, for the months of November through April, for the period of record, 1950-1986. The maximum monthly windspeeds were tabulated, in miles per hour, to find the maximum recorded 1-minute and 60-minute windspeeds for eight directions. The 60-minute windspeeds were estimated by dividing the 1-minute windspeeds by 1.24. This relationship of 1-minute to 60-minute wind speed is based on records for airport wind gages in the Central Valley. The 1- and 60-minute overland windspeeds are tabulated below, on **Table 3**, page 12.

Table 3. Sacramento Maximum Wind Speeds.

Wind Direction	1-Minute Wind (mph)	60-Minute Wind (mph)
N	48	39
NE	32	26
E	22	17
SE	62	50
S	59	47
SW	50	40
W	36	29
NW	38	31

The wind direction is the direction from which the wind is blowing. The Sacramento Valley with its southeast-northwest orientation has stronger winds coming from the north, south, and southeast. Maximum windspeeds may be somewhat less at Hamilton City, so the computed wave runup values computed for this location will be conservative.

The northeast, east, and southeast wind directions were investigated for wave action against the setback levee. The northeast wind action was evaluated against a stretch of proposed levee slightly north and west of the Gianella Bridge (Fetch #2). Wind action for the east wind was evaluated for two locations, one north (Fetch #1) and the other south (Fetch #3) of the bridge. The southeast wind-wave action was evaluated for two locations south of Gianella Bridge. One southeast wind location (Fetch #4) has a somewhat limited fetch, due to the presence at the end of the fetch of roads just below the surface of the 100-year floodplain. These roads would dissipate most of the wave energy along a longer fetch. The other, longer southeast wind fetch (Fetch #5) passes south of the sub-surface roads. A north wind fetch was not considered, due to the existence of a sub-surface levee road along the west side of the Sacramento River that would dissipate the energy of a north-facing fetch.

The **Effective Fetch Length, Fe**, is the horizontal distance in miles, in the direction of the wind, over which the wind generates waves or creates a wind setup. The effective fetch, Fe, is the average length of 9 radials, at 3-degree intervals, centered on the wind direction against the levee. For two fetch locations (Fetches #1 and #5), a single fetch, rather than an average of 9 fetch radials, was considered.

The **Average Fetch Depth, D**, is the predominant depth of water, in feet, averaged for the 9 fetch lengths (or along a single fetch) for each wind direction, and is different for each wind direction considered.

The average fetch lengths and depths for the three wind directions and five fetches were estimated using the most recent Hamilton City 100-year Floodplain Map.

The Effective Fetch Length, Average Fetch Depth, and other parameters discussed below that are associated with wave runup for the three wind directions are listed on **Table 4**, page 16.

The design windspeed over the Effective Fetch for each wind direction was developed using Figures 5.34 to 5.37 in EM 1110-2-1414, "Engineering and Design - Water Levels and Wave Heights for Coastal Engineering Design," dated 5 July 1989. The design wind is that which will generate the largest significant wave for the fetch. The following windspeed adjustments were made. The overland windspeeds were already assumed to be measured at the Standard Level of 33 feet (10 meters) above ground. The overland windspeeds were corrected to overwater windspeeds, using ratios presented in Chapter 15-2 of EM 1110-2-1420, "Hydrologic Engineering Requirements for Reservoirs," dated 31 October 1997. The boundary layer condition is assumed to be neutral.

Significant wave characteristics were developed based upon the effective fetch length (Fe), design windspeed and wind duration (the time in which the wind will generate the largest significant wave for the fetch). The significant wave characteristics are:

Significant wave height, Hs - the average height in feet of the highest one-third waves of a given wave group; height is measured as vertical distance between crest and preceding trough;

Wavelength - the horizontal distance in feet between similar points on two successive waves; **Wave period, Ts** - the time in seconds for a wave crest to travel a distance equal to one wavelength;

Deepwater wavelength, Lo - measure in feet, equals 5.12

times the wave period (Ts) squared:

$$Lo = 5.12xTs^2$$

Wavelength type - deepwater or shallow-water.

If the average water depth, D, over the fetch length, F, is less than half the deepwater wavelength, Lo, then the wave growth is affected by the bottom, and the computed design windspeed and fetch length are used to predict the significant **shallow-water wave** height and period. If the wave growth over the fetch is not affected by the bottom (deepwater conditions are in effect), the significant wave height, Hs, is predicted by the **deepwater wavelength.** The waves from the northeast, east, and southeast are all shallow-water waves, since they are less than one-half of their respective deepwater wavelengths. The shallow-water wave characteristics for each wave were computed by interpolating values from Figures 5.35 through 5.37, for constant depths of 5, 10, and 15 feet.

Theta and **cotangent Theta:** Theta is the angle of the levee embankment relative to horizontal. Cotangent theta is the slope of the levee embankment, or the ratio of horizontal distance to vertical rise. The embankment slope, cotangent theta, is 3.0 for the proposed setback levee. Other information used for computing wave runup included the **depth at toe**, ds, of the levee, estimated from the 100-year floodplain map.

Computation of Wave Runup on Sloping Embankment: The above information was used to compute the vertical height of runup, R, against a smooth, impermeable sloped embankment. Figure 7-11 in the 1984 edition of the Shore Protection Manual was used to compute the runup, R, for the Southeast wind fetches (Fetches #4 and #5), for which the ratio of the toe depth to the Significant Wave Height is greater than one and less than three. For the Northeast and East direction fetches (Fetches #1 to #3), the ratio of toe depth to Significant Wave Height is greater than three; Runup R is computed using Figure 7-12 in the 1984 Shore Protection Manual. The computed runup values were adjusted for scale effects by using Figure 7-13 in the 1984 Shore Protection Manual. The scale correction factor for all three directions is 1.12.

Slope Roughness Factor: The wave runup values above are for smooth, impermeable slopes. A roughness and porosity correction factor, r, was applied to the wave runup to account for the effects of other structure slope characteristics. Two other slope conditions were evaluated, in addition to the smooth impermeable levee slope. In one case, grass is assumed to be growing on the levee at the 100-year floodplain level. The roughness coefficient factor for grass is 85 percent of the smooth impermeable levee slope runup. The other condition is a levee with riprap placement, assuming random quarrystone, with a roughness coefficient between 60 and 66 percent of the smooth levee runup. The roughness coefficient used is dependent on the ratio of the toe depth (ds) to the Significant Wave Height (Hs), as well as the ratio of the Significant Wave Height to the product of the Wave Period, (Ts) squared and the gravitational constant.

Maximum Runup: Thirteen percent of the waves will be higher than the Significant Wave Height. For design purposes, a Maximum Runup is used that is 150 percent of the Significant Wave Runup.

Wind setup is determined by EM 1110-2-1420, formula 15-1, and is defined as the **wind tide (set-up, caused by the design wind on the water surface)**, the vertical rise in feet above the Stillwater level that would prevail with zero wind action. Formula 15-1 to determine the wind setup is:

$$S = \frac{U^2 x F}{1400 x D}$$

where:

S is setup in feet above the Stillwater level,

U is the design wind speed in miles per hour.

F is the single fetch length in miles per hour,

D is the average water depth in feet over the fetch.

F used for the southeast wind Fetch #4 is twice the effective fetch length used for computing the wave runup. For the northeast and east wind directions, Fetches #2 and #3, the averaged fetch lengths and depths were almost the same as if a single fetch were used. For those directions, the effective fetch length was used. For the two single fetches (east and southeast, Fetches #1 and #5), the single fetch length, **F**, was used in the above equation.

The Maximum Wave Runup and Wind Setup were combined for the each of the five fetches. This sum of wave runup plus wind setup was then adjusted for the wave angle (angle adjustment factor).

Angle Adjustment Factor: The wave energy is reduced when the wave hits the shoreline at an angle, instead of straight on ("shore normal"). The reduction in wave energy is considered insignificant when the wave hits the shoreline at an angle less than 30° from "shore normal". For an angle greater than 30°, a wave reduction ratio, Rh, is applied. The southeast wind (at Fetches #4 and #5) impacts against the proposed setback levee at an angle of 75°, for which a wave reduction ratio of 78 percent has been applied.

Wave Runup Plus Wind Setup: The total water level increase (wave runup plus wind setup) against the proposed setback levee, for each of the five fetches, for grassy slope and riprap, is listed on **Table 4**, page 16. North of the Gianella Bridge, the wave runup would be highest from the northeast direction. South of the Gianella Bridge, a southeast wind would produce the highest total water level increase. A barrier of trees and thick underbrush in front of the levee can deflect much of the wave energy along the fetch.

Table 4. Wind-wave runup analysis results for proposed setback levee, westside Sacramento River at Hamilton City, California.

Levee Description			Proposed Hamilton City Westside Setback Levee				
	Symbol	Units	Fetch 1	Fetch 2	Fetch 3	Fetch 4	Fetch 5
Wind Direction			East	Northeast	East	Southeast	Southeast
Embankment Description, in relation to Gianelli Bridge			north end of levee	3,000 ft WNW	3,000 ft SE	3,000 ft SE	8,000 ft SSE
Stillwater Level is 100-Yr Flood Stage Elev. (approx.)		(feet)	152	152	152	152	152
Effective Fetch Length	Fe	(mi)	4.7	3.5	3.3	1.91	3.3
Average Fetch Depth	D	(ft)	10.4	11.6	9.5	13.6	9.1
Depth at Toe (from floodplain map)	ds	(ft)	8	8	5	5	5
Overland Wind (Using Sac Exec AP)	Ul						
Elevation above ground (assumed)	s	(ft)	33	33	33	33	33
1-Minute Wind	Us	(mph)	22	32	22	62	62
60-Minute Wind	Us	(mph)	17.7	25.8	17.7	36.0	36.0
Overwater Wind Relationship to Overland Wind			=1.29*Us	=1.27*Us	=1.26*Us	=1.2*Us	=1.26*Us
1-Minute Wind	Uw	(mph)	28.4	40.6	27.8	74.4	78.1
60-Minute Wind	Uw	(mph)	22.9	32.8	22.4	60.0	63.0
Design Wind Speed (Velocity)	U	(mph)	22.0	32.5	22.0	63.7	61.0
Wind Duration	t	(min)	90	65	75	36	53
Significant Wave Height	Hs	(ft)	1.75	2.50	1.50	4.00	5.00
Wave Period	Ts	(sec)	2.80	3.00	2.50	3.20	3.75
Deepwater Wave Length: Lo = 5.12 x Ts ^2	Lo	(ft)	40.1	46.1	32.0	52.4	72.0
Half Deepwater Wave Length	0.5 * Lo	(ft)	20.1	23.0	16.0	26.2	36.0
Wave Test: D > (0.5 x Lo)?	Ratio		0.52	0.50	0.59	0.52	0.25
Ratio: D / (0.5 x Lo) > 1?	>1?		No	No	No	No	No
Wave Type: Deep or Shallow			Shallow	Shallow	Shallow	Shallow	Shallow
Computation of Shallow-Water Wave Characteristics			Fetch 1	Fetch 2	Fetch 3	Fetch 4	Fetch 5
Wind Duration	t	(min)	55	37	45	17	22
Significant Wave Height	Hs	(ft)	1.40	1.99	1.23	3.42	3.19
Wave Period	Ts	(sec)	2.40	2.63	2.19	3.00	3.25
Cotangent Theta (Slope)	cot O	(ft/ft)	3	3	3	3	3
ds/Hs	ds/Hs		5.7	4.0	4.1	1.5	1.6
Hs / (g*Ts^2)			0.0075	0.0089	0.0080	0.0118	0.0094
R/Hs for Relationship: (ds/Hs)	(ds/Hs)	Relationship	>3	>3	>3	=2	=2
R/Hs on smooth impermeable slope	interpolated		1.50	1.41	1.47	1.14	1.30
Runup (not corrected for scale effects)	R	(ft)	2.10	2.81	1.81	3.89	4.15
Scale correction factor	k		1.12	1.12	1.12	1.12	1.12
Wave Runup on smooth impermeable surface	R*k	(ft)	2.35	3.15	2.03	4.36	4.65
Roughness coefficient for Grassy Slope	Ratio r =	0.85	0.85	0.85	0.85	0.85	0.85
Significant Runup on Grassy Slope	Rs=r*R*k	(ft)	2.00	2.68	1.72	3.71	3.95
Maximum Runup on Grassy Slope	Rmax=1.5*Rs	(ft)	3.00	4.01	2.58	5.56	5.93
Roughness coefficient for riprap (random quarrystone	Ratio r	0.6 to 0.65	0.60	0.62	0.61	0.66	0.65
Significant Runup on Riprap	Rs=r*R*k	(ft)	1.41	1.95	1.24	2.88	3.02
Maximum Runup on Riprap	Rmax=1.5*Rs	(ft)	2.12	2.93	1.85	4.32	4.53
WIND SETUP:			Fetch 1	Fetch 2	Fetch 3	Fetch 4	Fetch 5
Fetch Length	F	(mi.)	4.7	3.5	3.3	3.8	3.3
Design Wind Speed	U	(mph)	22.0	32.5	22.0	63.7	61.0
Avg Fetch Depth	D	(ft)	10.4	11.6	9.5	13.6	9.1
Wind Setup S = (Fe*U^2)/(1400*D)	S	(ft)	0.16	0.23	0.12	0.81	0.96
Combined Wind+Wave for Grassy Slope	Rmax+S	(ft)	3.16	4.24	2.70	6.38	6.89
Combined Wind+Wave for Riprap	Rmax+S	(ft)	2.27	3.15	1.97	5.13	5.50
Angular Spread (from Shore Normal)		(degrees)	0	0	30	75	75
Wave Reduction Ratio	Rh	(Ratio)	1.00	1.00	1.00	0.78	0.78
Fetch Location Number			Fetch 1	Fetch 2	Fetch 3	Fetch 4	Fetch 5
Wind Direction			E	NE	E	SE	SE
Wave Runup + Wind Setup After Angular Adjustment							
Final Wave Runup & Wind Setup for Grassy Slope	Rh*Rmax+S	(ft)	3.16	4.24	2.70	4.97	5.38
Final Wave Runup & Wind Setup for Riprap	Rh*Rmax+S	(ft)	2.27	3.15	1.97	4.00	4.29

This spreadsheet for Hamilton City Project Setback Levee wave runup uses the latest criteria, EM 1110-2-1420, dated 31 Oct 1997

C3.6.9. Wind Wave Protection

The recommended minimum width suggested by the SCS in Technical Release No. 56, December 12, 1974, A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, The minimum width is 20 feet. The width is based on x / y = z where:

x = the width of the berm (vegetation zone)

y = the difference in potential water elevations against the levee

z = (from 10 to 15) depending on the fetch, in this case it would be adequate to use 10, this is a levee not a dam

Data taken from HEC-RAS along the training dike the depth of the 100-year flood is from about 5 to 8 feet. When the water is below 2 feet the waves should not be an issue. The vegetation then would protect for a variation of depth ranging from 3 to 6 feet.

Using an average variation of water stage of say 4.5 feet then the width would be 4.5 x 10 or 45 feet.

The planting density would vary depending on how wide the vegetation zone is. Using only a 20-foot width the vegetation would need to form a solid wall along the levee and would require a high level of maintenance. However, using a wider zone with the same number of plants the maintenance should be much less and the cost would be similar, especially if the plants are self seeding, rhizomatous or stoloniferous and will fill in the gaps.

If the area out from the levee will be riparian, it should offer sufficient protection without additional vegetation. If it is Oak Savannah then the levee will need additional protection.

C3.6.10. Superiority

Levee overtopping has not been fully addressed at this time. In general, the levee design is expected to provide initial overtopping at the least hazardous location for initial inundation of the interior. The least hazardous location is thought to be at the downstream end of the project, since the end of the levee is open to backwater.

C3.6.11. Breaching/Removing J-Levee

Initially it was felt that the J-Levee would be breached at appropriate locations to induce flooding in the proposed ecosystem restoration locations. After additional modeling with RMA2, a two-dimensional model, it was determined that the majority of the J-Levee would need to be removed to reduce localized water surface increases in the study area. Modeling to date for the selected alternative has taken into account the removal of the J-Levee.

C3.6.12. Project Performance

Modeling efforts by Ayres Associates with RMA2, a two-dimensional model, have identified locations of localized stage increases, see attached memorandum. Two locations exist where localized stage increases were observed within the study reach. First, upstream of Gianella Bridge (HWY 32) an increase in water surface is observed in the 2-dimensional model, east of this location a decrease in the water surface is observed in Butte County suggesting that additional flow is being conveyed through the Sacramento River. The bridge at HWY 32 acts as a control in this case, causing an increase in water surface to push flow under the bridge. Second, an increase in water surface elevation is observed in the 2-D model at the most southerly portion of the proposed setback levee at high, infrequent flows, such as the 320-year hydrologic flood frequency. By comparing the Annual Exceedance Probability (AEP) for with and without the project, the big picture can be seen. Without the project the AEP is 9%, meaning that the probability of getting flooded in any given year is twenty-four percent annually. With the project the AEP is 1%, meaning that the probability of getting flooded in any given year is five percent annually. The southern end of the project protects against the more frequent flood events, even though a localized stage increase is observed at the less frequent, more significant flows, a significant flood reduction benefit exists at the most southerly portion of the proposed setback levee.

Flows from Stony Creek were taken into account in RMA2 model runs.

C3.6.13. Results

The results of this hydraulic analysis did not reveal any unexpected results. A basic standard step backwater method was used. Water surface profiles for the full range of discharges analyzed are shown below in **Figure 5**, page 19.

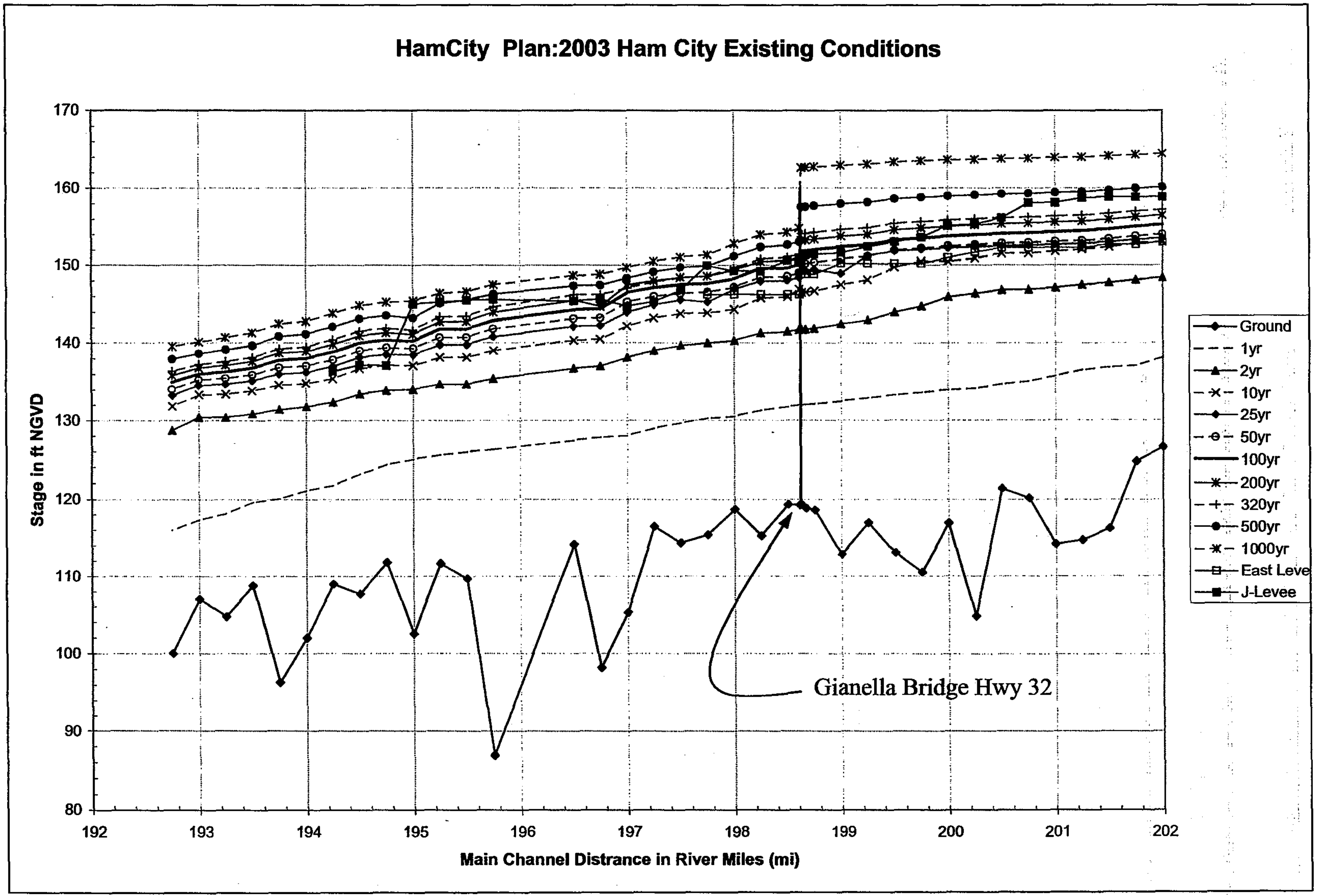


Figure 5. Water Surface Profiles in feet NGVD29.

C3.7. Floodplain Delineation (2-,10-,25-,50-,100-,200-,500-year events)

Floodplains have been developed for this study based on present and future with and without project hydrology being the same. Floodplain depths for the 2-year, 10-year, 25-year, 50-year, 100-year, 200-year, and 500-year are shown on Plates 2 through 8.

C3.8. Sedimentation and Dynamic Stability Analysis

Sedimentation and channel stability are not thought to be significant issues at this time. The preliminary results of the Sediment Analysis Model (SAM) do not indicate significant new information from the previous studies done in the area (Corps, Larson 2002). A more in-depth study may be needed during Planning, Engineering and Design (PED) phase of the project. The Modesto Formation and the Tahema Formation (an alluvial deposit that is more resistant to erosion than the more prevalent Modesto Formation) have historically limited the Sacramento River migration to some extent and would improve sedimentation and channel stability projections.

C3.8.1. Meander Migration Rates

Historic data presented by Eric Larsen (2002), see **Figure 6**, page 20, suggests that River Miles 201-198 since 1904 has been characterized by channel stability, and that there has been little to no shift in the channel since 1904. In 1978 riprap was installed between RM 201-198. **Figure 7**, page 21, shows the average historical rate of migration in the study areas of the report in meters/year; for River mile 201-198 (Zone 1) the minimum, maximum, and average rate of migration are 0.16, 41.0, and 11.5 feet/year (0.05, 12.5, and 3.5 meters/year) respectively.

The report calculates a predicted average rate of migration into the future. Two main scenarios are of interest. Scenario 1 represents existing conditions at river mile 201-198 the predicted average rate of migration is 2.3 feet/year (0.7 meters/year). Scenario 2 represents conditions where all the riprap is removed. Average rates of migration for river mile 201-198 are predicted to be 3.6 feet/year (1.1 meters/year).

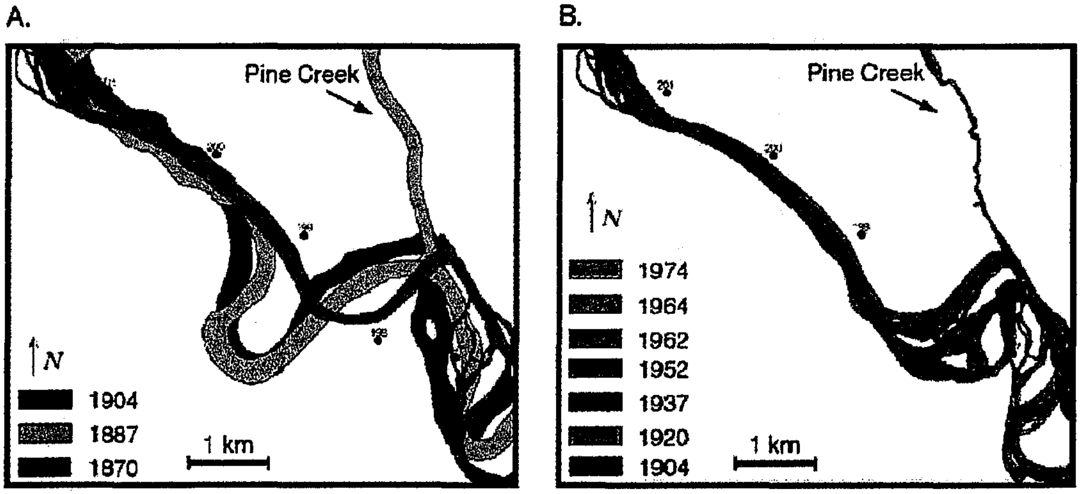


Figure 6. River miles 201-198. Historical river channel movement from (A) 1870-1904 and (B) 1904-1974 (Larsen 2002).

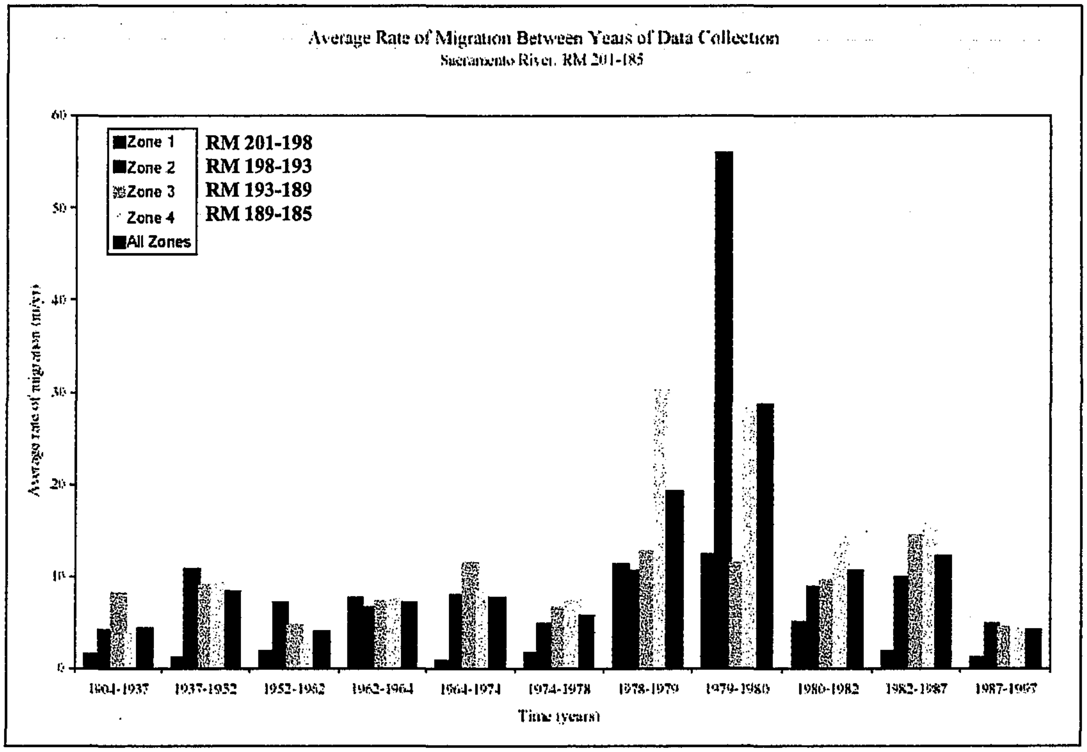


Figure 7. Average rate of migration (meters/year) (Larsen 2002).

Migration rates reported for the Sacramento River (USACE 1990) for historical period during 1908 to 1986 are summarized below. River mile 204 has a predicted 5-year migration rate of 90 feet/year; while river mile 196 has a predicted 5-year migration rate of 102 feet/year. The migration rate for river mile 201.8 for years 1981-1986 was 102 feet/year (USACE 1999).

C3.9. Channel Stabilization Features

Ayres Associates has performed an analysis on channel migration rates, sediment transport capacity and channel stabilization features. Based on this work, riprap bank protection will be placed in areas that are anticipated to have a higher risk of erosion. Entrenched rock protection will be placed at areas that are currently exhibiting high river migration rates (e.g. RM 200.7). Such locations have been noted in **Figure 8**, page 25.

C3.9.1. Current Bank Protection

In the project area on the west side of the Sacramento River, on the right bank, approximately 1,600 feet of concrete rubble and 5,000 feet of rock riprap are located south of Dunning Slough on the waterside of the existing J-Levee. The bank protection at approximately River Mile 197 to 198 was placed in 1975-76 during the Chico Landing to Red Bluff Project. In addition, south of Dunning Slough there is 500 feet of abandoned rock riprap located in the middle of the Sacramento River due to erosion and river migration that has removed part of the riprap placed in 1975-76. Near the Gianella Bridge approximately 450 feet of rock riprap was added on the bank at the J-Levee during the 1997 emergency flood fight. This emergency revetment covered about 11,250 square feet (450 feet long by about 25 feet high; greater than 20 inch diameter rock). The rock was placed in 1997 because the existing J levee is of poor quality and subject to erosion.

On the east bank of the Sacramento River, within the project study area, there is bank protection placed by the Chico to Red Bluff Project at River Mile 201 (about 1,800 feet). Also on the east bank there is privately placed revetment at River Mile 200-199.5 (2,500 feet) and privately placed rubble at River Mile 196-195.5 (about 2,200 feet) just south of Pine Creek's confluence.

C3.9.2. Rock Removal

Rock removal is not a viable option along the Sacramento River between River Mile 195 and River Mile 197.5.

The rock along the lower portion of the Hamilton City project was placed in 1976 is 26 years old. It is reaching the end of its design life. This rock was placed without scour considerations as was common during that period. As such the rock riprap bank protection usually lasts about 50-years with significant deterioration starting about 20-years from its time of placement. About 20% - 25% of the riprap cover has already eroded from the bank.

Although there is a high uncertainty in any bank erosion and/or channel migration estimate the rock riprap bank protection does not last indefinitely and will have less and less impact into the future. Removing the rock and leaving the bank (unprotected) in a bare newly disturbed condition will make the bank highly susceptible to erosion. This could easily cause a channel evolution in the area that may have undesirable hydraulic and geomorphic impacts upstream and downstream. If the rock on the channel bank is not periodically replenished; it will not stop channel migration, it will only slow it down (albeit significant initially).

C3.9.3. Project Bank Protection

Placement of rock (entrenched and revetment) is necessary at some points along the replacement levee to ensure the stability of the levee. **Figure 8**, page 25, shows the location of the proposed project bank protection.

Initially removal of the existing bank protection was considered. In consideration of public safety, risk, legal liabilities, and potential benefits it was determined that the rock riprap was to remain because of unknown hydraulic impacts both upstream and downstream that could occur. Over time, fluvial processes will remove the existing riprap and restore the river's dynamic meandering processes. If maintenance and replacement are required, then existing agreements and authorities would be used.

At Highway 32 around Gianella Bridge the replacement levee is setback from the existing J-Levee. This exposes the northern bridge abutment to direct flows, which it is not currently exposed, creating the possibility that scour could occur around the abutment. In order to ensure that bridge is not compromised by the potential project, 1,000 feet of rock riprap would be placed on and around the abutment. In addition, 100 feet of rock would be placed under the Gianella Bridge at Highway 32 specifically to protect the bridge from higher velocities as a result of passing higher flows with the tentatively selected plan. Grouted rock riprap, lining the bridge and other alternatives will be looked at in more detail in final design.

At the north and south ends of Dunning Slough a bend in the replacement levee would be exposed to overland flows, which could cause erosion on the replacement levee. In order to ensure that the replacement levee is not subject to this erosion, 1,400 feet of rock riprap would be placed along the levee at the bend.

At the southernmost extent no bank protection is anticipated assuming that the Chico Landing to Red Bluff Project (local site constructed in 1975-1976) would remain. It is felt that erosion control at the end of the levee can be controlled with vegetation (about 20 feet or so from the levee toe) to reduce velocities at the levee. No rock is anticipated in this area.

Additional rock volume may be required as the levee height increases to account for concentrated velocities and possible toe scour at the Highway 32 Bridge. Using CHANLPRO with conservative velocity estimates from HEC-RAS, **Table 5**, page 24, was developed. This shows the thickness and the percent increase based from the 100-year flood frequency flow. It was determined that an additional 29% rock by volume will be required for protecting from the 320-yr flood frequency, and a 57% increase will be required for protecting from the 500-year flood frequency based on the 100-yr flood frequency rock volume estimates. Additional analysis, including velocity change results from the 2-dimensional hydrodynamic model; RMA2 (USACE 1996) will be used for further refinement. Other alternatives to reduce costs while providing the same protection will be looked at in final design.

Table 5. Additional Rock Volume at Gianella Bridge based on 100-year Hydrologic Flood Frequency.

Hydrologic Flood Frequency	Calculated Rock Thickness		Max % Increase from 100-yr Flood
	u/s Gianella Bridge (in)	d/s Ginaella Bridge (in)	
50	24.8	42	0%
100	24	42	-
320	30	54	29%
500	36	66	57%

C3.9.4. Launchable Rock Riprap

In areas where erosion is expected or possible a launchable rock riprap will be placed to protect the levee in the event that the river starts to migrate in that general direction. Launchable rock riprap is where rock is buried in a trench below the ground, when the river erodes away the bank at the location of the trench the rock falls and armors the bank inhibiting erosion beyond that point. A detailed schematic can be seen in Plate 1.

There is potential for the river to migrate near the replacement levee at the most northern end where it ties in to County Road 45, 1,500 feet of entrenched rock would be placed from County Road 203 along the replacement levee (the portion that parallels County Road 203). An alternate approach would be to provide launchable rock riprap a between the existing setback levee and the river. This would allow the existing setback levee to act as a training dike and guide the river away from the new project levee.

South of Dunning Slough, 1,500 feet of entrenched rock would be placed to protect the new levee from erosion and river migration.

As mentioned in the previous paragraph, an additional amount of rock volume is expected to be required as protection against higher flood frequency increases. **Table 5**, page 24, has values that the rock volume is expected to increase by based on the volume of rock needed for the 100-year flood frequency.

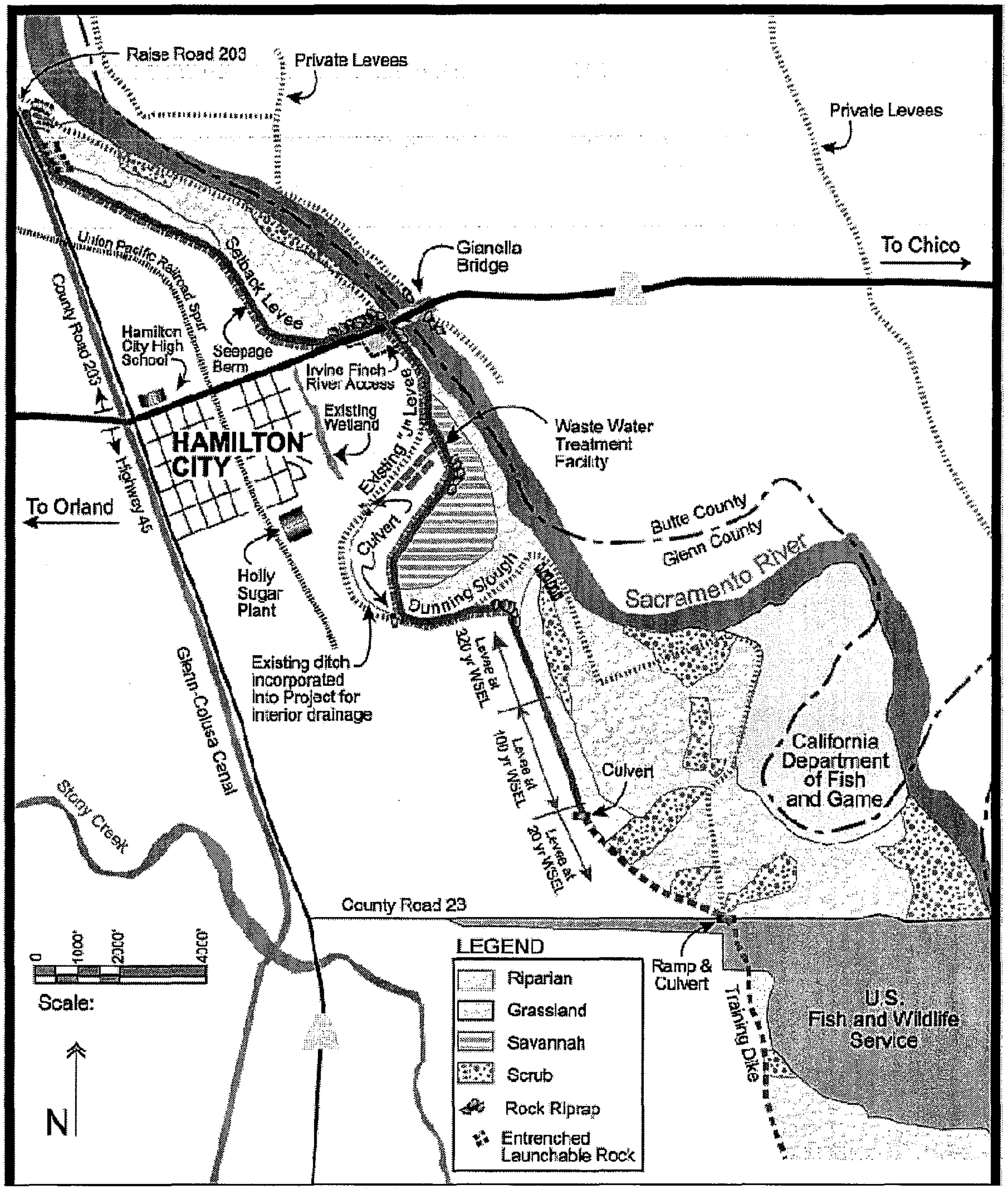


Figure 8. Tentatively Selected Plan.

C3.10. Interior Flooding Analysis

Interior flooding has not been included in this study. If levee alignment number 2, 3, or 4 is selected as the preferred alternative an interior drainage assessment will be required.

C3.11. Risk Analysis

Figure 9, page 26, shows the conditional non-exceedance probability (CNP) for various frequency flood events for top of levee of elevation 150.8 feet at index point 198.25. The CNP describes the probability of a given flood being successfully conveyed without flooding. The figure shows the flood event with the corresponding CNP. As the water surface elevation increases, the chance of flooding increases, which is to be expected. The levee height required to achieve 90% CNP of passing the 100-year event considered necessary to meet the requirements FEMA top of levee purposes is shown on **Figure 9**, page 26. The CNP for index points 197.25 and 194.25 are shown in **Figures 10 and 11**, page 27, respectively. The top of levee for each of the index points is different, which changes the CNP of passing the corresponding hydrologic flood frequency event. The height of the existing J-Levee is shown as a reference at each of the index points.

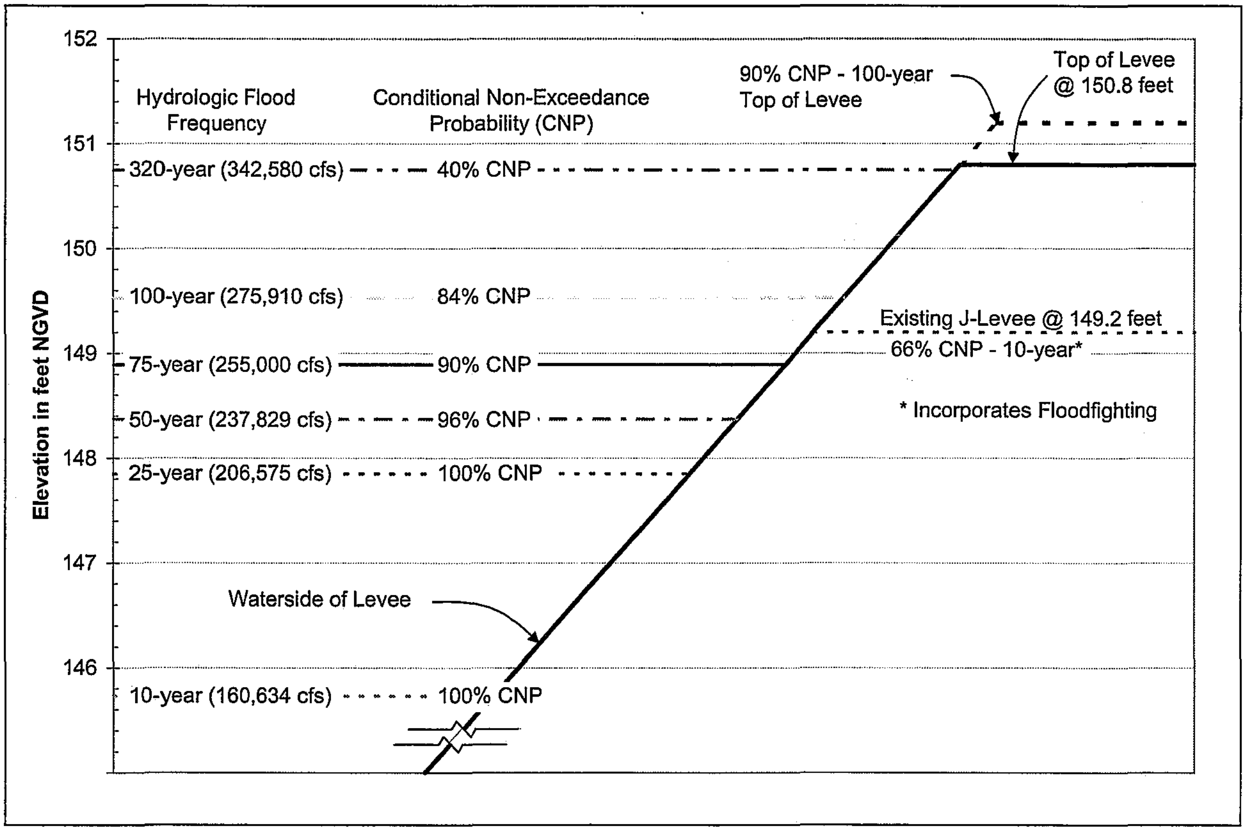


Figure 9. Project Performance for TOL of Elevation 105.8 at Index Pt. 198.25.

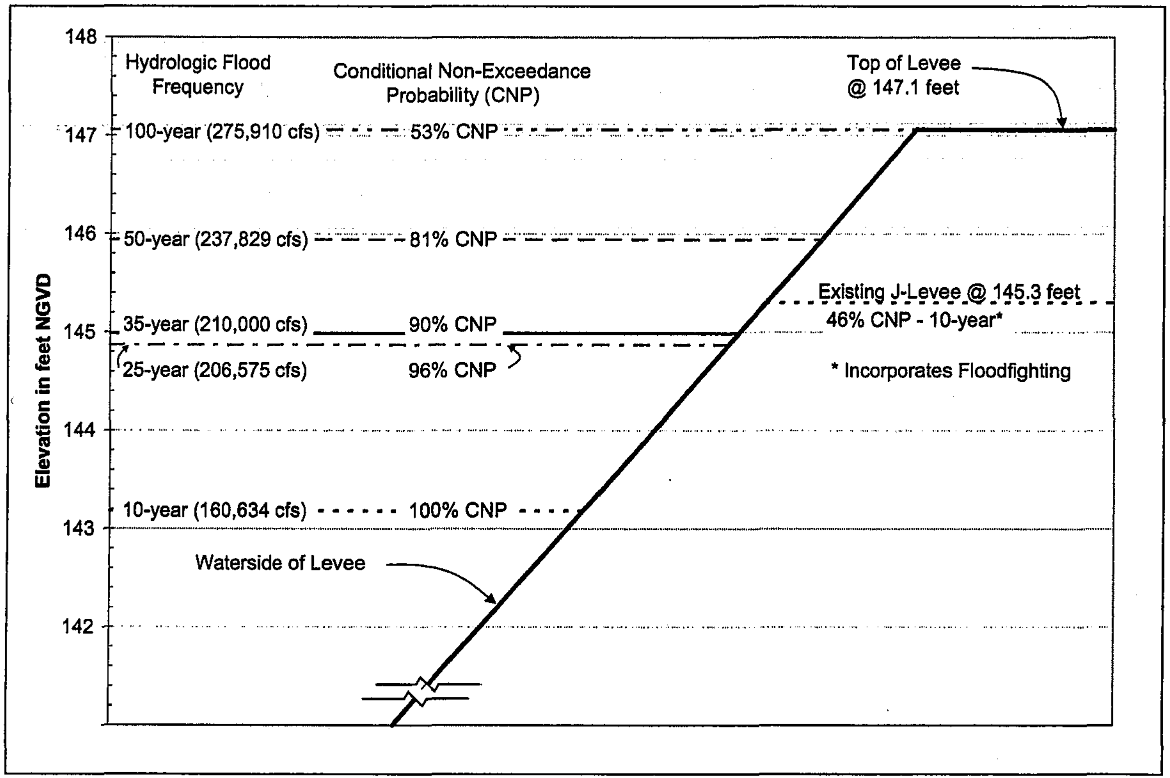


Figure 10. Project Performance for TOL of Elevation 147.1 at Index Pt. 197.25.

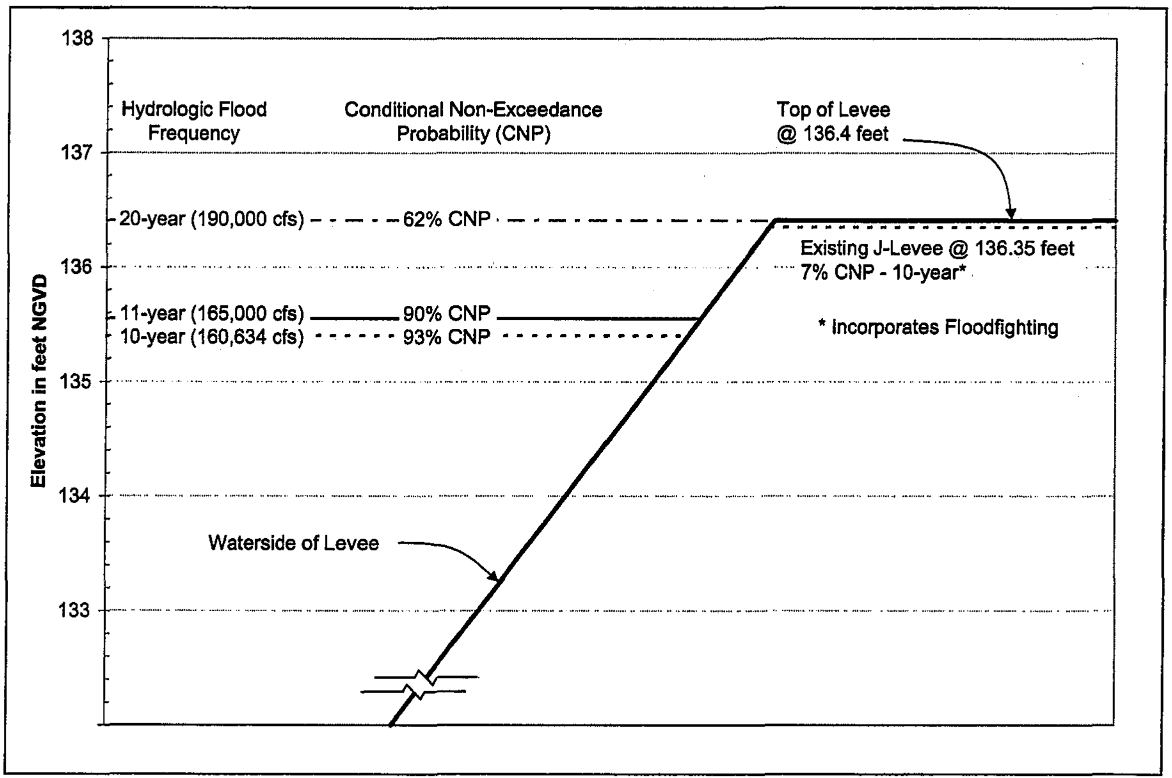


Figure 11. Project Performance for TOL of Elevation 136.4 at Index Pt. 194.25.

C3.11.1. Index Points

There were three index points selected for this study. The relationship between discharge/frequency, discharge/stage, and stage/damage is well represented within the study area by three index points. With and without project discharge/stage relationships remain constant. A sensitivity analysis was made comparing the no levee water surface to the most restrictive levee water surface. For the 100-year event there was about a one-foot difference at the worst location.

C3.11.2. Stage Uncertainty

A standard deviation of 1-foot was selected based on experience and Table 5-2 in EM 1110-2-1619; Risk Based Analysis for Flood Damage Reduction Studies. The HEC-RAS has a "fair" reliability meaning that the model has good calibration with a limited high-water mark data that was available at Gianella Bridge.

C3.11.3. Stage Discharge Curves

Stage discharges at the index points are shown on **Table 1**, page 7.

C3.11.4. Bank Migration

Bank Migration was estimated for specific exceedance intervals based on peak flood flows and stream power. Stream power was calculated using reach-averaged results from the HEC-RAS steady state model and existing conditions. It is not expected that with project potential migration rates would be significantly different. Preliminary annual bank migration rates provided by Ayres Associates were used. The maximum migration rate was related to a 50-year peak flood event based on peak flood frequency and the historical period of maximum migration. It should be noted that much of the average yearly migration occurs during the more frequent flood event years. Stream power for some of the reaches does not increase with discharge, such as in reaches where backwater controls the channel hydraulics. **Tables 6 through 8**, page 29 through 31, show the results for three selected bends within the study area. The second part of the table shows the erosion rate associated with the exceedance probability. Stream power was selected as a good representation of the river's ability to do work. The values are annual and represent a duration of one-year. As can be seen from the migration rates associated with specific periods the actual migration values can cover a wide range. The migration in feet values shown on the lower tables should be taken as upper values.

Table 6. Meander Bend at River Mile 196 to 198.

Period	Years	Migration Distance (ft)	Migration Rate (ft/yr)
1896-1923	27	1202	44.5
1923-1937	14	43	3.1
1937-1946	9	1122	**124.7**
1946-1955	9	584	64.9
1955-1960	5	258	51.6
1960-1969	9	444	49.3
1969-1972	3	623	**207.7**
*1972-1981	9	797	88.6
1981-1984	3	355	**118.3**
1984-1986	2	0	0.0
1986-1991	5	0	0.0
1991-1999	8	28	3.5
1999-2002	3	30	10.0
1896-2002	106	5486	51.8
1946-2002	56	3119	55.7
1960-1981	**21**	**1864**	**88.8**
1981-2002	21	413	19.7

*** Neck cutoff of tightly compressed meander bend between RM 196 and RM 197 occurred during this period**

Flow (cfs)	Stream Power (lb/ft s)	Migration (feet)	Exceedance Interval (years)	Percent Chance Exceedance
520,000	14.29	344	1000.00	0.10
424,511	11.88	286	500.00	0.20
315,965	9.83	237	200.00	0.50
275,910	8.99	217	100.00	1.00
237,829	8.30	200	50.00	2.00
206,575	8.27	199	25.00	4.00
160,634	7.04	170	10.00	10.00
97,524	3.89	94	2.00	50.00
30,000	1.33	32	1.00	99.99

Table 7. Meander Bend at River Mile 201 to 202.

Period	Years	Migration Distance (ft)	Migration Rate (ft/yr)
1896-1923	27	0	0.0
1923-1937	14	51	3.6
1937-1946	9	119	13.2
1946-1955	9	0	0.0
1955-1960	5	0	0.0
1960-1969	9	-251	-27.9
1969-1972	3	36	12.0
1972-1981	9	-272	-30.2
1981-1984	3	224	74.7
1984-1986	2	278	**139.0**
1986-1991	5	-83	-16.6
1991-1997	6	679	**113.2**
1997-1999	2	391	**195.5**
1999-2002	3	158	52.7
1896-2002	106	1330	12.5
1946-2002	56	1160	20.7
1960-1981	21	-487	-23.2
1981-2002	**21**	**1647**	**78.4**

Note: Negative distance and rate indicates movement to the east, positive numbers indicate movement to the west.

Flow (cfs)	Stream Power (lb/ft s)	Migration (feet)	Exceedance Interval (years)	Percent Chance Exceedance
520,000	0.86	188	1000.00	0.10
424,511	1.06	233	500.00	0.20
315,965	1.03	228	200.00	0.50
275,910	0.96	211	100.00	1.00
237,829	0.89	195	50.00	2.00
206,575	0.66	145	25.00	4.00
160,634	0.88	194	10.00	10.00
97,524	0.64	141	2.00	50.00
30,000	0.81	178	1.00	99.99

Table 8. Meander Bend at River Mile 202 to 203.

Period	Years	Migration Distance (ft)	Migration Rate (ft/yr)
1896-1923	27	-312	-11.6
1923-1937	14	0	0.0
1937-1946	9	0	0.0
1946-1955	9	0	0.0
1955-1960	5	0	0.0
1960-1969	9	22	2.4
1969-1972	3	69	23.0
1972-1981	9	560	62.2
1981-1984	3	205	68.3
1984-1986	2	141	**70.5**
1986-1991	5	128	25.6
1991-1997	6	422	**70.3**
1997-2002	5	234	46.8
1896-2002	106	1469	13.9
1946-2002	56	1781	31.8
1960-1981	21	651	31.0
1981-2002	**21**	**1130**	**53.8**

Note: Negative distance and rate indicates movement to the east, positive numbers indicate movement to the west.

Flow (cfs)	Stream Power (lb/ft s)	Migration (feet)	Exceedance Interval (years)	Percent Chance Exceedance
520,000	1.49	45	1000.00	0.10
424,511	2.01	61	500.00	0.20
315,965	2.22	67	200.00	0.50
275,910	2.32	70	100.00	1.00
237,829	2.32	70	50.00	2.00
206,575	3.37	102	25.00	4.00
160,634	1.87	56	10.00	10.00
97,524	1.98	60	2.00	50.00
30,000	0.94	28	1.00	99.99

C3.12. Operation and Maintenance

The operation and maintenance of the levees will be looked at in more detail in future studies.

C3.13. References

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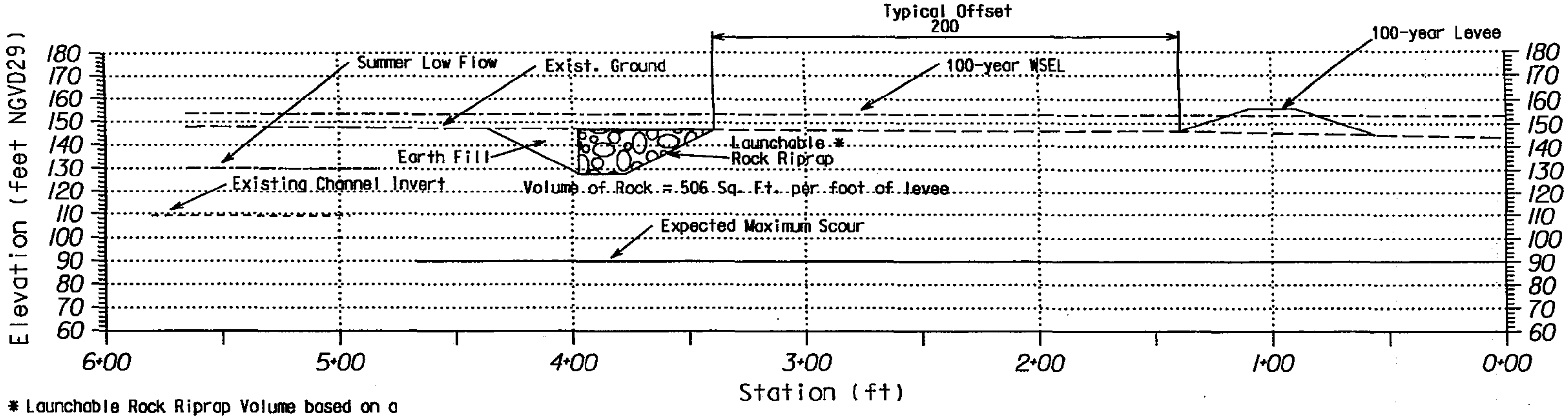
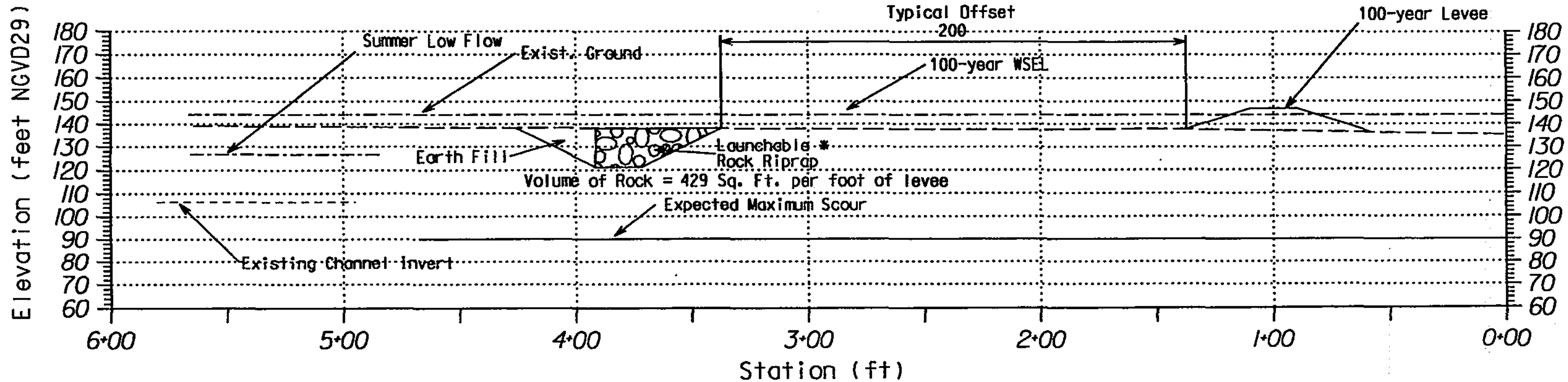
The Shore Protection Manual (SPM), 1984 Edition, Chapter 7 - Structural Design: Physical Factors.



* Launchable Rock Riprap Volume based on a rock thickness of 2 feet nominal placed on a 2 horiz to 1 vert side slope and doubled to account for launch height and lauch slope.

2003 Levee Upstream of Highway 32
Typical Bank Protection



* Launchable Rock Riprap Volume based on a rock thickness of 2 feet nominal placed on a 2 horiz to 1 vert side slope and doubled to account for launch height and lauch slope.

2003 Levee Downstream of Highway 32
Typical Bank Protection

Plate 1

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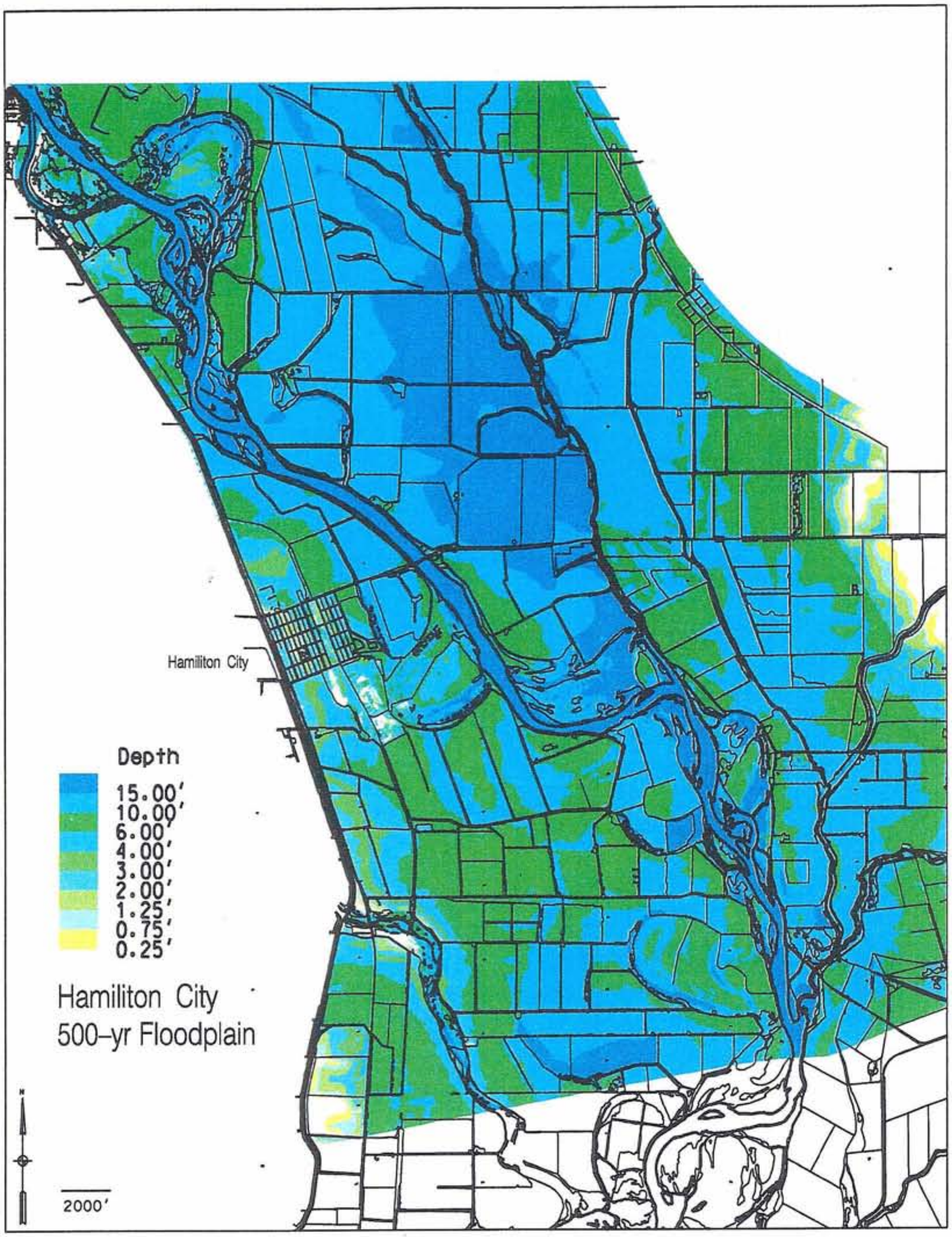

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Plate 2

LOCATION STATE
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Comprehensive Study
Hamilton City

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SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

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Rev.
Dwn by:
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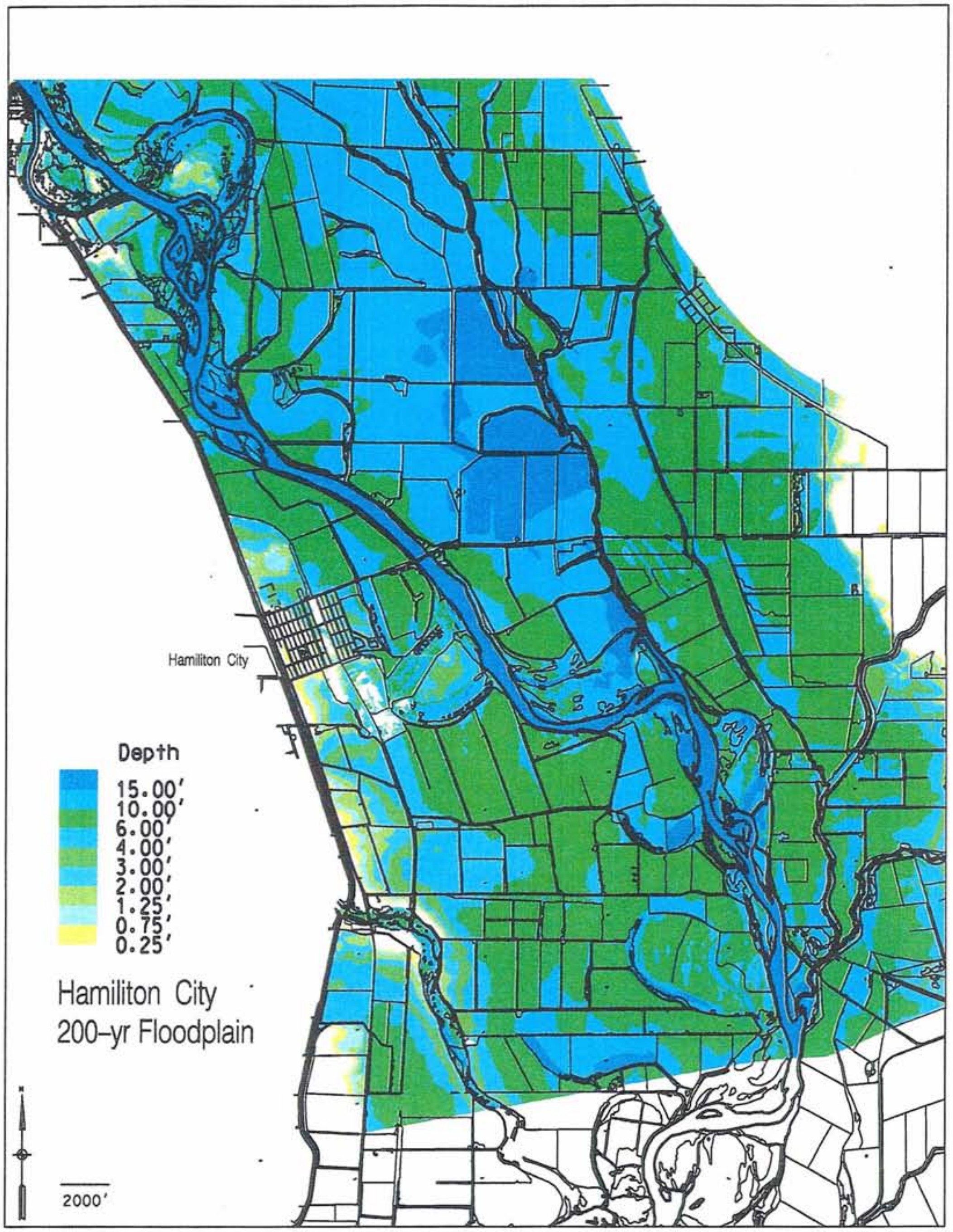

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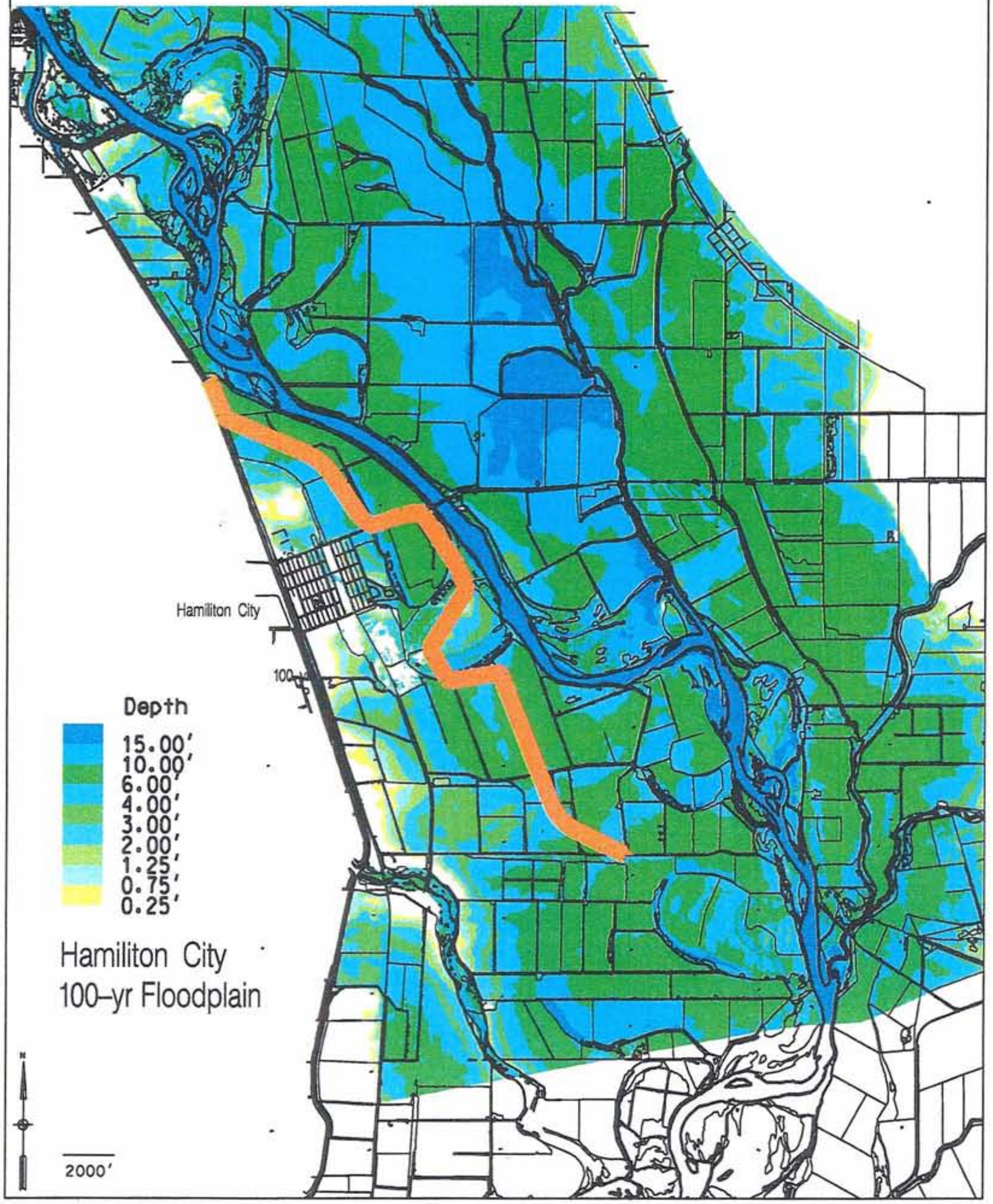

Hamiliton City
100–yr Floodplain

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Plate 4

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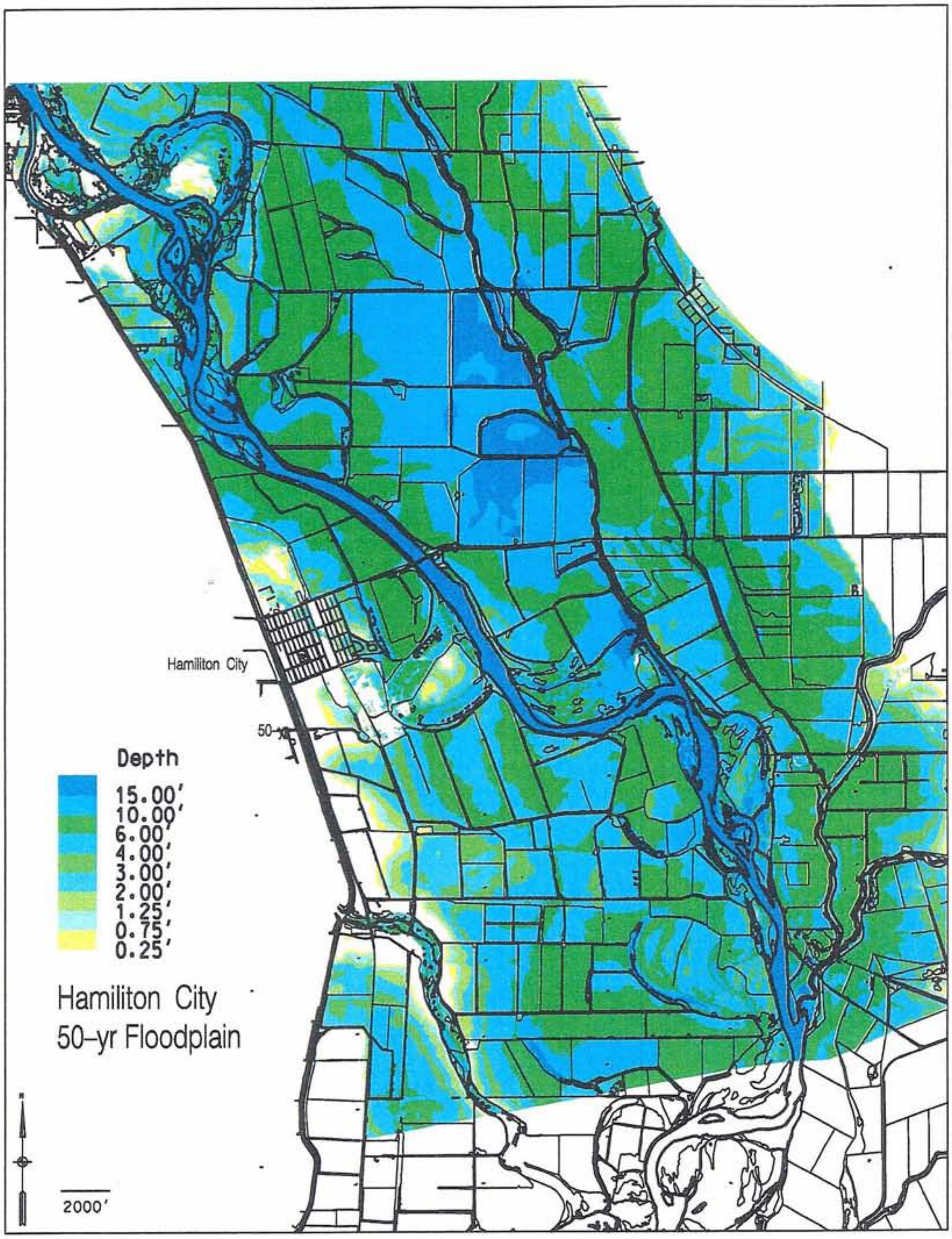

Hamilton City
50-yr Floodplain

UPDATE

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Plate 5

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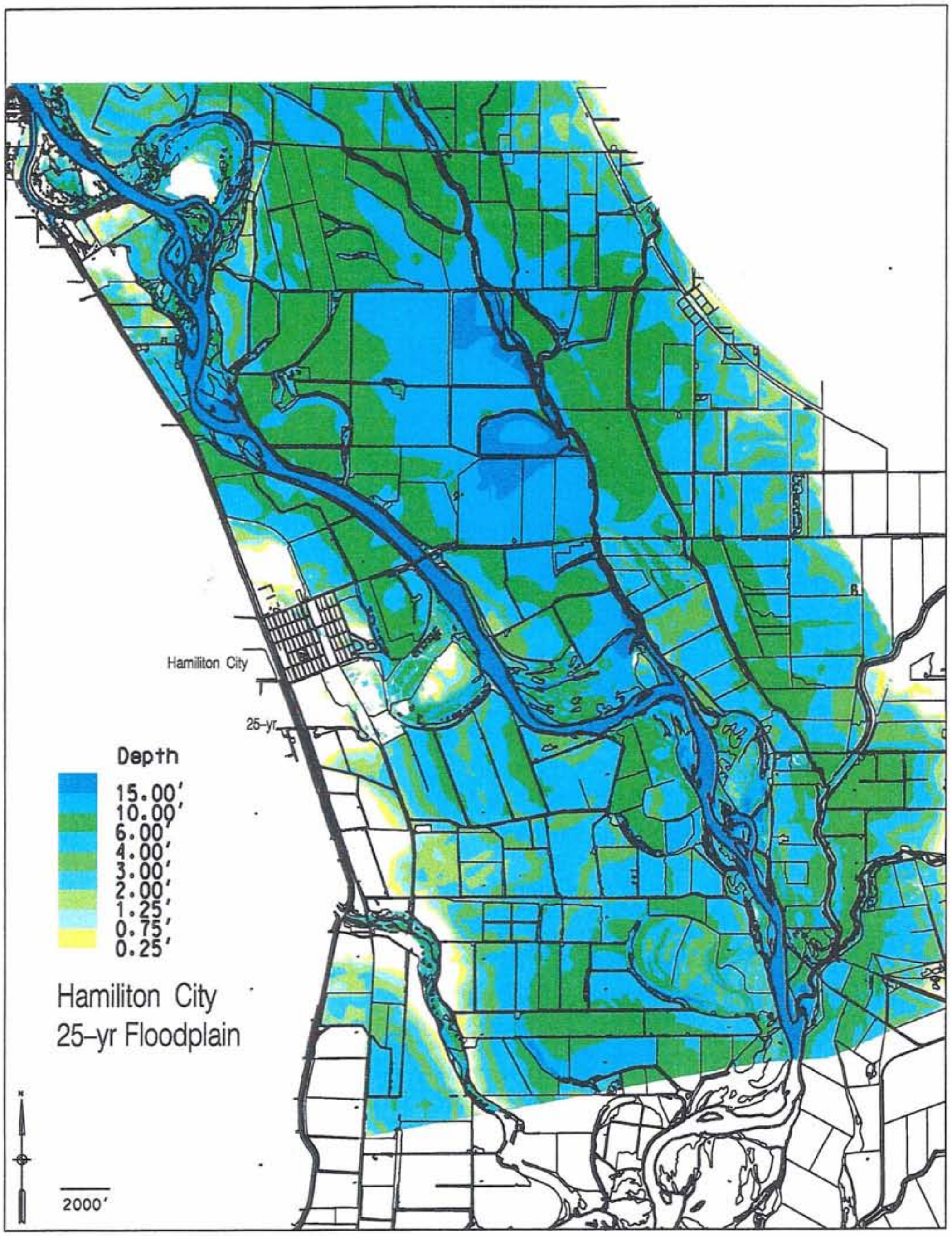

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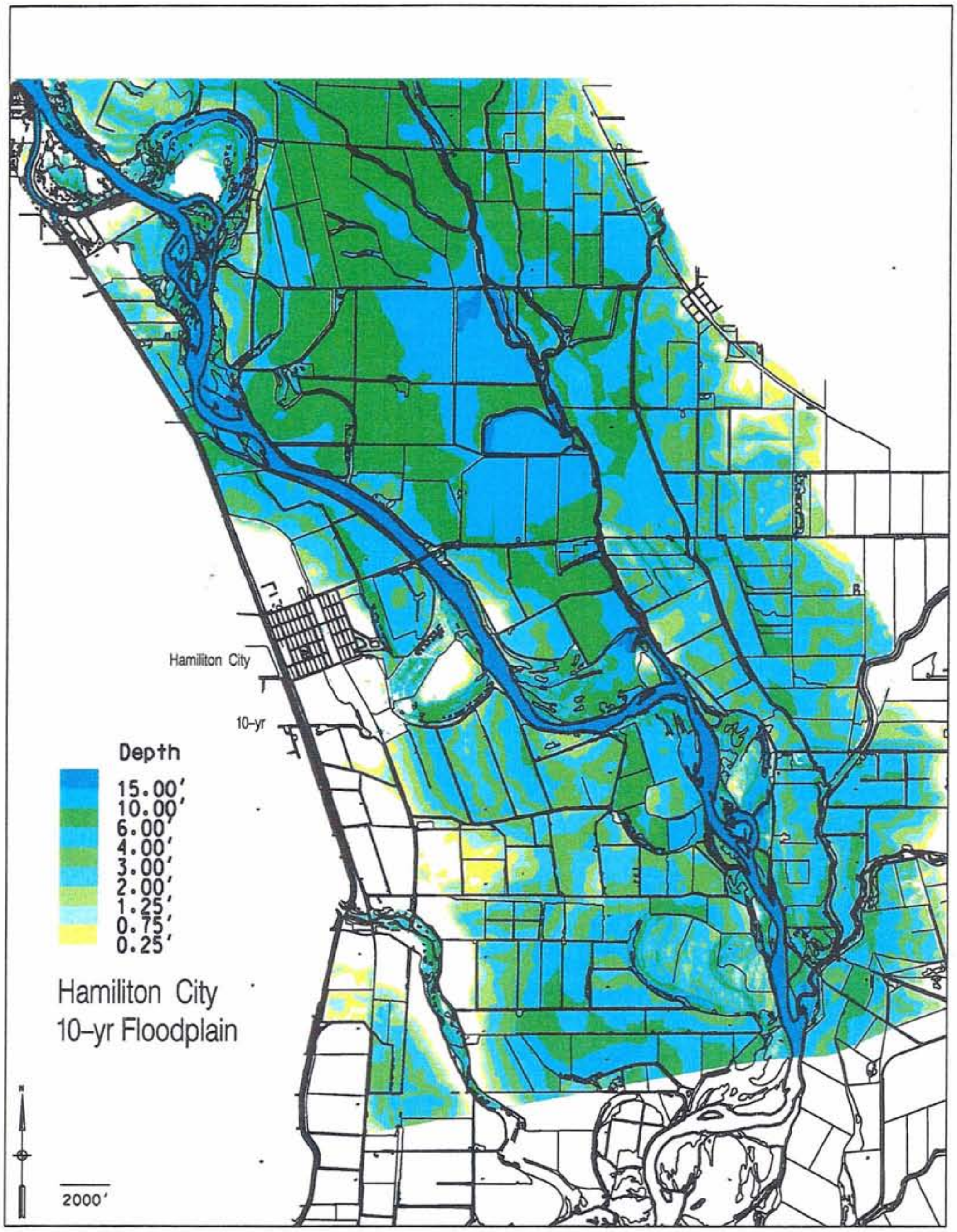

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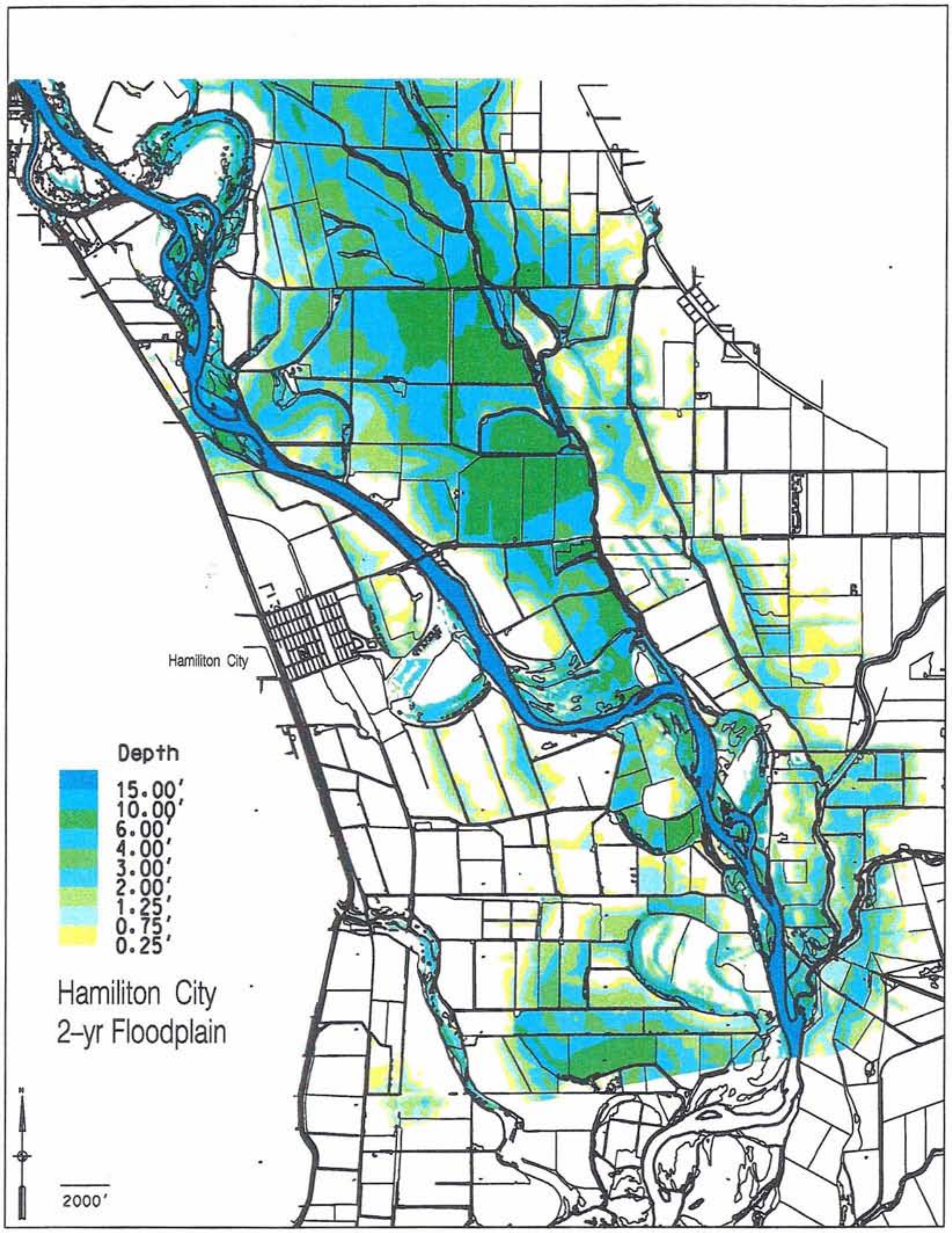

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Plate 8
Sheet reference number:

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File name:

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US Army Corps of Engineers
Sacramento District

FINAL REPORT

CHANNEL MIGRATION, SEDIMENTATION, AND CHANNEL STABILITY ANALYSIS HAMILTON CITY INITIAL PROJECT

Flood Damage Reduction and Ecosystem Restoration Feasibility Study

Sacramento and San Joaquin River Basins Comprehensive Study

FINAL REPORT

CHANNEL MIGRATION, SEDIMENTATION, AND CHANNEL STABILITY ANALYSIS HAMILTON CITY INITIAL PROJECT

Flood Damage Reduction and Ecosystem Restoration Feasibility Study

Sacramento and San Joaquin River Basins Comprehensive Study

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Ayres Project No. 32-0480.17
HAM5-TX.DOC

May 2004

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Sacramento River system plays an integral role in the economy and ecosystem of California's northern central valley. Flood protection is provided to adjacent communities and lands by various levees, reservoirs, flood control structures, and overflow channels. Despite the presence of these features, the river system has experienced frequent severe flooding due to a variety of factors. These include insufficient channel and levee capacity, unreliable facilities, poor maintenance practices, lack of a coordinated management system for upstream flood control reservoirs, and urban and agricultural encroachment on the floodplain. In addition, environmental resources within the basin have been significantly altered by human development and flood management activities. The results are substantial loss of habitat and species diversity, loss of historic natural hydrologic and geomorphic processes, exotic species invasion, and other ecosystem problems.

As part of the Sacramento and San Joaquin River Basins Comprehensive Study, the Sacramento District of the U.S. Army Corps of Engineers (Corps) conducted system-wide hydrologic, hydraulic, and sediment engineering analyses as well as a geomorphic assessment of the basin. During these comprehensive analyses, potential projects were identified that would improve conditions within the basin, as measured against a list of objectives produced by the study. A handful of these "initial" projects generated significant stakeholder interest, such as this project, which involves the development and evaluation of various alternatives to restore the ecosystem and reduce flood damages along the river in the vicinity of Hamilton City.

The goal of the Hamilton City initial project is to identify a cost effective, technically feasible, and locally acceptable project that meets the dual objectives of restoring the ecosystem and reducing flood damages and is in compliance with all federal, state, and local laws and regulations. This report describes the analysis of a proposed setback levee alignment intended to facilitate these objectives.

The Draft of this document included a section for the hydraulic analysis conducted for this project, including discussion of the modeling procedures and scenarios as well as the presentation of hydraulic model results. This section has been removed from the report and is now being provided separately as a Hydraulic Modeling Memo. This report provides a discussion of the sedimentation and channel stability conditions in the project reach and the potential impacts associated with the proposed project.

2. PROJECT DESCRIPTION

2.1 Project Setting

The project is located on the Sacramento River in the vicinity of Hamilton City, near River Mile (RM) 199. The project reach extends from roughly RM 204 downstream to RM 193 as shown in **Figure 2.1**. The floodplain is restricted on the west side of the river by the Glenn-Colusa Irrigation District (GCID) Canal and is relatively unrestricted on the east side of the river.

Levees are present in floodplains on both sides of the river and influence the distribution of flow in the overbanks during flood events. On the east side, a locally developed (Butte County) levee extends from approximately RM 204 to below the HWY 32 bridge crossing. As shown on Figure 2.1, the Butte County levee closely follows the left bank of the channel through most of the project reach.

On the west side there is an existing private levee, constructed by landowners in about 1904. Known as the "J" levee, this feature provides some flood protection to the town and surrounding area. This levee, however, is not constructed to any formal engineering standards and is largely made of silty sand. As a result, the levee is susceptible to erosion and flood fighting is necessary to prevent flanking when river levels rise. Since the construction of Shasta Dam in 1945, flooding in Hamilton City due to failure of the "J" levee has occurred once (1974). Extensive flood fighting has been required in several subsequent years (1983, 1986, 1995, 1997, and 1998) to prevent similar flooding.

Native habitat and natural river function in the study area have been altered by the presence of the "J" levee and conversion of the floodplain to agriculture and rural development. The ability of the river to meander has been constrained by the levee itself as well as the placement of bank protection features throughout the years. Native habitat has been reduced to remnant patches along the river and in historic oxbows. These alterations to the ecosystem have diminished the abundance, richness, and complexity of riparian, wetland, and floodplain habitat in the study area and the species dependent upon that habitat.

2.2 Hydrology

As shown in Figure 2.1, several creeks contribute flow to the Sacramento River within the project reach, including the Big Chico Creek, Mud Creek, Pine Creek, and Stony Creek. During flood events, Pine Creek receives flow from the Sacramento River where it breaks into the overbank upstream (between RM 208 and RM 215) and returns it to the main channel within the project reach (RM 196). With the exception of Stony Creek, the inflows from these tributaries are insignificant relative to the Sacramento River flood flow. Consequently, only Stony Creek inflows were considered in the hydraulic modeling. The GCID diverts water at its Hamilton City Pumping Plant just upstream of the project reach. GCID diversions are as high as 3,000 cfs during summer low-flow months.

Flows for various return intervals for the Sacramento River and Stony Creek are shown in **Table 2.1**. These are peak flows taken from recent hydrologic and unsteady hydraulic flow modeling conducted by the Sacramento District for the Comprehensive Study. These peak flow values are from the same storm centering used in the hydrologic analysis, but do not occur at the same time. Therefore, combining these flows in the hydraulic analysis of this project is slightly conservative.

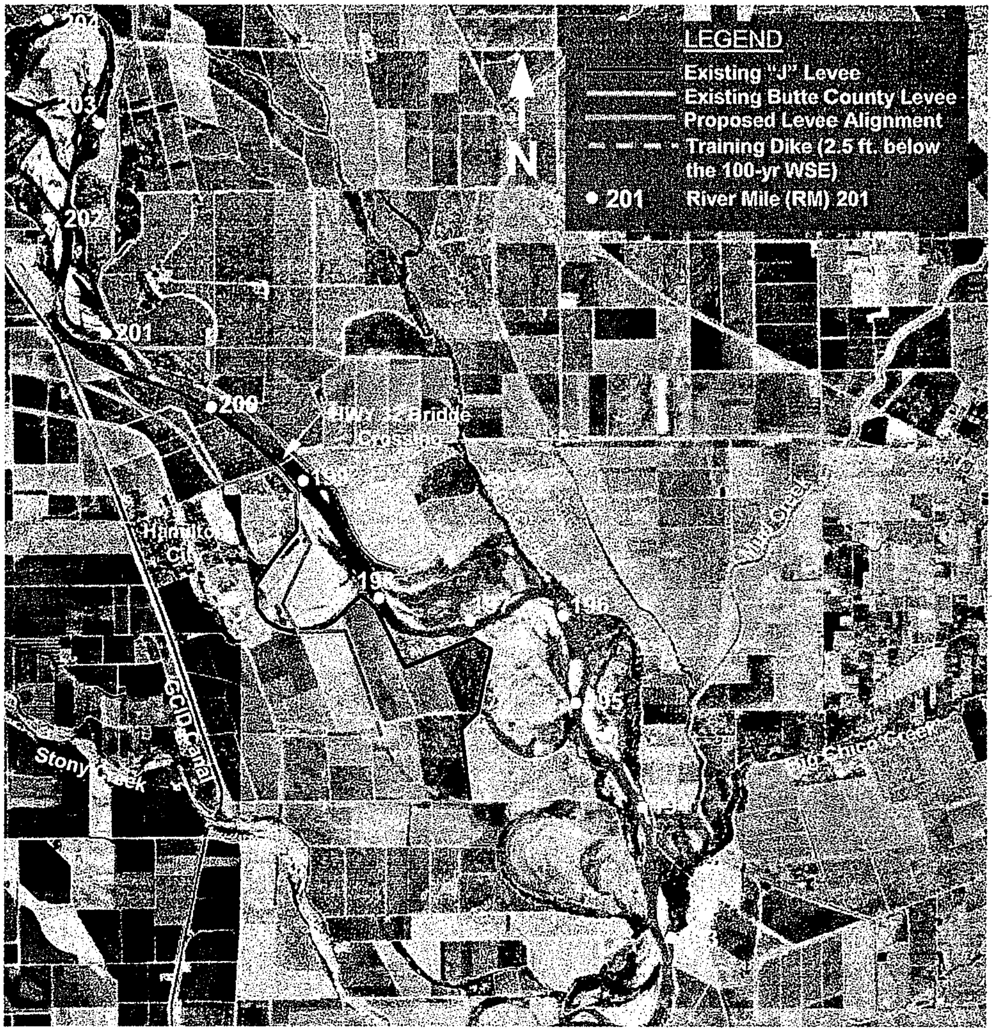

Figure 2.1. Plan view of project reach showing existing and proposed project features.

Table 2.1. Peak Flows on the Sacramento River and Stony Creek for Various Return Interval Flood Events.

Flood Event	Sacramento River Peak Flow at Hamilton City (cfs)	Stony Creek Peak Flow (cfs)
50-year	237,829	15,000
100-year	275,910	27,400
200-year	315,965	48,500
320-year	342,000	52,000
500-year	424,511	62,330

2.3 Project Alternatives

During the planning phases of this project several alternative levee alignments were proposed to replace the "J" levee. The concept of the proposed alternative integrates a setback levee that will contain major flood flows and be aligned in such a way as to increase land within the active floodplain and cause no impact on flood-flow characteristics through the project reach. The land within the setback levee alignment will be converted to native riparian habitat. The tentatively selected plan, referred to as "Alignment 6" in earlier stages of the project, is shown in Figure 2.1. The levee transitions to a training dike as shown in Figure 2.1. The elevation of the training dike is 2.5 feet below the 100-year water surface elevation.

2.4 Study Objectives

The objective of this feasibility-level study is to analyze the impacts associated with implementing the proposed levee alignment. Investigations conducted for this project include:

- Channel migration analysis to investigate historic bankline locations and determine channel migration rates for assessing the need for erosion countermeasures
- Sediment analysis to determine the impact of the proposed levee alignment on the river's sediment transport capacity and associated impacts on channel stability
- Scour analysis to estimate scour and channel response
- Channel stability assessment and the development of three conceptual channel stabilization measures

This report summarizes each of these investigations, including the procedures and assumptions used in the analyses.

3. CHANNEL MIGRATION ANALYSIS

3.1 Historic Bankline Data

Historic bankline alignments through the project reach were collected for a number of years as shown in **Table 3.1**. This data came from a variety of sources. Most of the older alignments were previously assembled by the Department of Water Resources (DWR) as a part of their Middle Sacramento River Spawning Gravel Study (DWR 1984). The appendix to this study is in the form of a river atlas, including bankline alignments that were digitized for this analysis. Most of the more recent banklines were from aerial photography and/or survey data. All data sets were digitized into a CADD environment and registered to a common coordinate system. Sample historic banklines throughout the entire reach are provided in **Appendix A.**

Table 3.1. Bankline Data used in the Migration Analysis.

Date of Bankline	Source of Bankline Data
1896	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1908	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1923	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1935	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1937	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1946	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1955	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1960	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1964	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1969	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1972	DWR
1981	Appendix of Middle Sacramento River Spawning Gravel Study (1984)
1984	1"=500' blueline aerials, Colusa to Red Bluff (DWR) – flown May 1984
1986	DWR / WET geomorphic investigation of Sacramento River
1991	Sacramento River Atlas (from Corps) – flown July 1991
1997	Sacramento River hydrographic survey
1999	DWR 1999 Sacramento River Atlas (RM 143-243) – flown May 1999
2002	Color aerials from Sacramento District, from erosion site atlas

3.2 Meander Migration Analysis

Once all of the historic bankline locations were registered in a common coordinate system within the CADD environment, the migration distance and migration rate for each time period were measured. The measurements were based on the migration of the outside bankline of the bend. **Figures 3.1 and 3.2** illustrate the migration patterns for the bends at RM 197 and RM 201, by presenting historic bankline locations for select years. **Tables 3.2 and 3.3** provide a tabulation of the migration distance and migration rate for all data sets for those same bends.

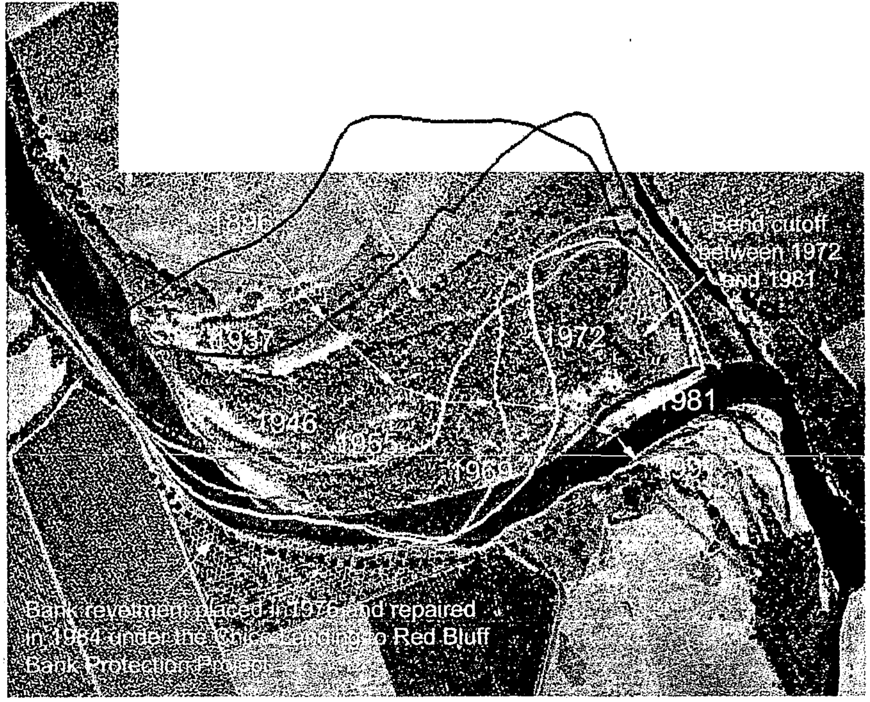

Figure 3.1. Select historic bankline locations for the bend at RM 197.

Figure 3.2. Select historic bankline locations for the bend at RM 201.

Table 3.2. Historic Migration Rates for the Meander Bend at RM 197.

Period	Years	Migration Distance (ft)	Migration Rate (ft/yr)
1896-1923	27	1202	44.5
1923-1937	14	43	3.1
1937-1946	9	1122	**124.7**
1946-1955	9	584	64.9
1955-1960	5	258	51.6
1960-1969	9	444	49.3
1969-1972	3	623	**207.7**
*1972-1981	9	797	88.6
1981-1984	3	355	**118.3**
1984-1986	2	0	0.0
1986-1991	5	0	0.0
1991-1999	8	28	3.5
1999-2002	3	30	10.0
---------- SUMMARY ----------			
1896-2002	106	5486	51.8
1946-2002	56	3119	55.7
1960-1981	**21**	**1864**	**88.8**
1981-2002	21	413	19.7

*Neck cutoff of tightly compressed meander bend between RM 196 and RM 197 occurred during this period.

Table 3.3. Historic Migration Rates for the Meander Bend at RM 201.

Period	Years	Migration Distance (ft)	Migration Rate (ft/yr)
1896-1923	27	0	0.0
1923-1937	14	51	3.6
1937-1946	9	119	13.2
1946-1955	9	0	0.0
1955-1960	5	0	0.0
1960-1969	9	-251	-27.9
1969-1972	3	36	12.0
1972-1981	9	-272	-30.2
1981-1984	3	224	74.7
1984-1986	2	278	**139.0**
1986-1991	5	-83	-16.6
1991-1997	6	679	**113.2**
1997-1999	2	391	**195.5**
1999-2002	3	158	52.7
---------- SUMMARY ----------			
1896-2002	106	1330	12.5
1946-2002	56	1160	20.7
1960-1981	21	-487	-23.2
1981-2002	**21**	**1647**	**78.4**

Negative distance and rate indicates movement to the east, positive numbers indicate movement to the west.

As shown in Table 3.2, the most significant movement of the bend at RM 197 occurred prior to the 1980s. Between 1896 and the mid-1970s, the entire bend was moving to the south and east. As it migrated, the bend became gradually tighter until a cutoff occurred (shown in Figure 3.1). In 1976, 6,500 lineal feet of stone protection was placed on the outside of the bend (right bank) under the Chico Landing to Red Bluff Bank Protection Project (USACE 1981). The alignment of the bend, especially the upper portion, has been relatively fixed since that time. Prior to the placement of the bank protection, the average annual migration rate was roughly 63 ft/yr based on the period from 1896 to 1976. Migration rates, as shown in Table 3.2, have dropped significantly. However, the downstream end of the revetment has failed and the channel at this location has continued to migrate. According to records for the Chico Landing to Red Bluff project, the revetment placed in 1976 was repaired twice in 1984 (USACE 1981). Extrapolating the migration rates and directions indicates that the "J" levee requires protection from channel migration of the bend at RM 197. The proposed levee alignment could also be threatened by future channel migration.

As shown in Table 3.3, the bend at RM 201 began to actively migrate toward its current location in the 1980s. The banklines shown in Figure 3.2 are from this time period. The average annual rate during that time period was 78.4 ft/yr. In the 1990s, the average annual migration rate was as high as 200 ft/yr. Migration of the bend at RM 201 threatens the adjacent "J" levee and could potentially threaten a short segment of the GCID canal. The proposed levee alignment could also be threatened by future channel migration.

Although channel migration could pose a threat to the proposed levee alignment, the threat is much lower than to portions of the "J" levee due to the setback. It appears that at RM 197 and 201, the channel has migrated up to the Modesto Formation. Depending on the geotechnical properties of the Modesto Formation in this area, migration rates and directions could be significantly different than recent observations.

4. SEDIMENT ENGINEERING ANALYSIS

4.1 General

A sedimentation analysis was conducted to assess possible impacts of proposed levee realignment. The sediment analysis was conducted using the SAM software package developed by the U.S. Army Corps of Engineers (USACE 2002). SAM computes sediment transport capacity using average channel hydraulic data for the project reach. Since the sedimentation analysis is solely focused on identifying incremental impacts of the proposed project condition, the results of the analysis only show the differences relative to the current condition and were not calibrated to measured data. Consequently, although data representative of the project were used, the results should be considered qualitative rather than quantitative. The relative difference between conditions provides a qualitative understanding of how sedimentation characteristics vary between conditions without the project and conditions with the project.

4.2 Hydraulic Data

The sediment transport capacity of the river at any given location is dependent on the hydraulic conditions of the channel. Sediment transport capacity is generally determined for "reaches" of the river rather than at specific locations. The determination of a reach is based upon the consistency of hydraulic conditions within the reach. For this analysis, the project reach was divided into five sediment-modeling reaches as shown in **Figure 4.1**. These reaches were determined by reviewing main channel velocities from the various hydraulic modeling results.

Sediment transport capacity calculations are based on main channel hydraulic conditions since the majority of sediment transport occurs within the limits of the main channel where flow is concentrated. Transport in the channel overbank areas is relatively minor. Hydraulic data for this analysis were taken from the 2-dimensional hydraulic models developed for this project. The results of the 2-dimensional modeling are presented in detail in the Hydraulic Modeling Memo, submitted under separate cover. The hydraulic data for each reach were taken from cross sections representative of the overall conditions prevalent within that reach.

Since sediment transport capacity is based upon main channel hydraulics, the analysis was only conducted for flood conditions where flows break out of the main channel and into the overbanks. For any condition less than bank-full the proposed levee alignment will have no impact on hydraulic conditions. Bank-full flow for the project reach is approximately 90,000 cfs.

4.3 Sediment Transport Capacity Analysis

Using the SAM.sed module of the SAM package, the sediment transport capacity was calculated for each reach for the 50-, 100-, 320-, and 500-year flood events. The bed material data used in the analysis came from previous geomorphic and hydraulic modeling investigations of this reach, conducted by the Corps (WET 1990). Using sub-armor gradation data from samples taken at RM 191.6, RM 195.2, RM 197.7, and RM 221.1, an average gradation curve was created as shown in **Figure 4.2**. The curve was extended up to the 100 percent passing and down to the 10 percent passing to create a full data set to enter into the model. The sub-armor data was used since it is most representative of the material that dominates the sediment transport conditions at high flow. Any armor layer that might be covering the subarmor will be disrupted by 2-year flows exposing the material underneath.

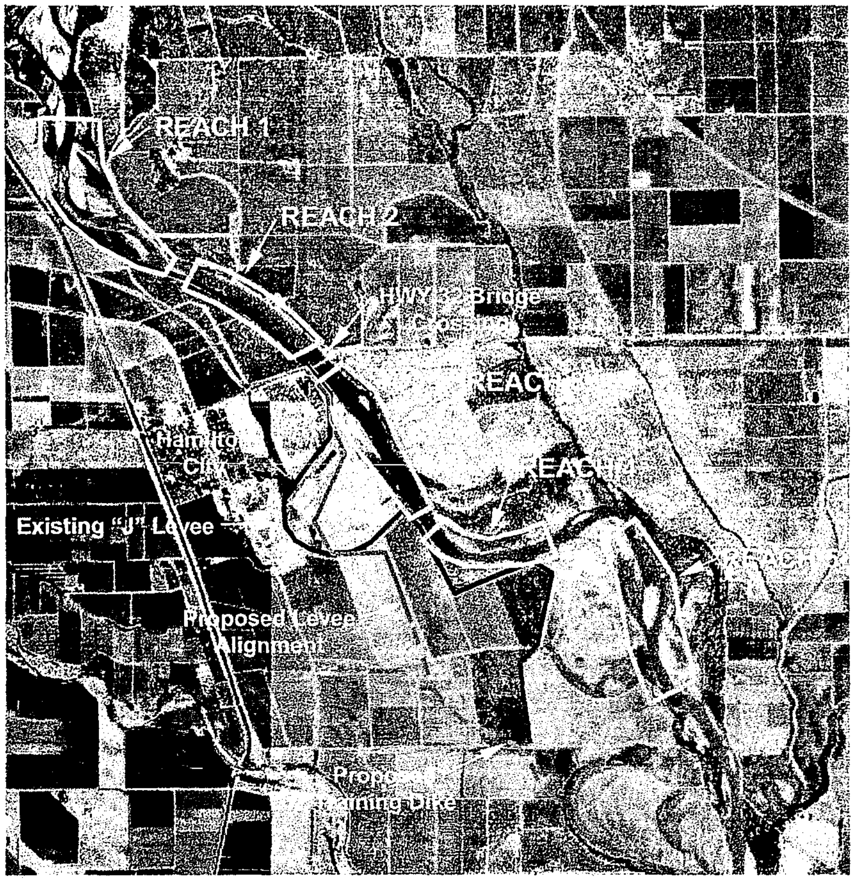

Figure 4.1. Plan view of project reach showing the sediment modeling sub-reaches.

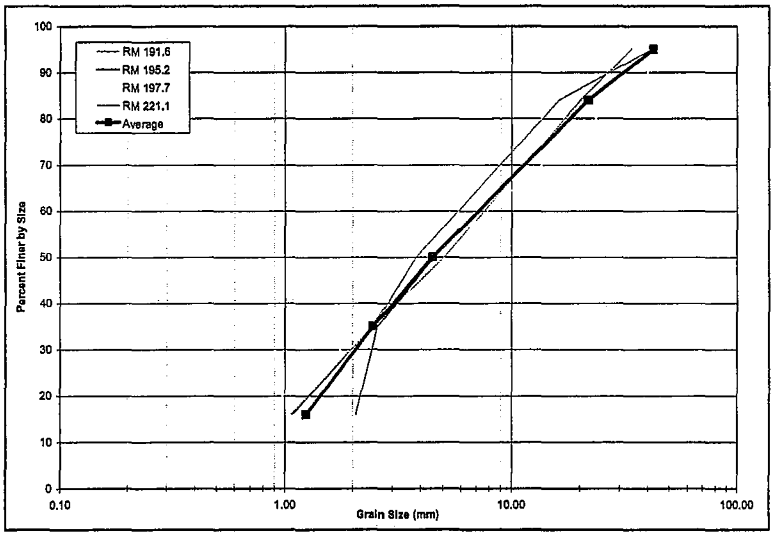

Figure 4.2. Bed material gradation used in the sediment modeling.

Several transport functions were reviewed in the analysis to determine which would provide the most reasonable results including the size of the sediment used in the analysis (D_{50} ~ 4.5 mm, D_{100} ~ 50 mm) and a comparison of all the equations. These variables indicate that Yang's transport function was the most appropriate.

The resulting sediment discharge rating curves for each reach for the without-project condition are presented in **Figure 4.3**. This curve illustrates that the overall project reach is not currently in a state of equilibrium in terms of its ability to transport sediment. Reach 2 has the highest sediment transport capacity. This is because it is well-confined with levees located on both banks. Reach 1 has the lowest transport capacity. The Butte County levee is set back from the channel in this reach, forcing less flow into the main channel than in Reach 2. As a result, it has lower transport capacity. The reach has a depositional tendency as evident by the point bars present within the reach. Reaches 3 and 4 also have less transport capacity than Reach 2. This is because the Butte County levee disappears along the left bank allowing flow into the eastern floodplain. This provides relief to the amount of flow remaining in the channel. Reach 5 is relatively unconfined with wide floodplains on both banks. This reach is characterized by active meandering and has a depositional tendency.

The sediment discharge rating curves were also developed for the proposed levee alignment. **Figure 4.4** presents a comparison in sediment transport capacity for each reach between the without-project and with-project conditions. The comparison is presented as a ratio. Values above 1 represent an increase in sediment transport capacity between the two with-project and without-project. Values below 1 represent a decrease.

The change in sediment transport capacity for each reach after the project is built is summarized below:

- Reach 1 – The sediment transport capacity increases in this reach with the addition of the proposed project. Due to downstream effects, slightly more flow is retained in the main channel by the Butte County levee. This increase in discharge and resulting increase in velocity cause an increase in sediment transport capacity.
- Reach 2 – Because the levee is set back under proposed conditions in this reach, flow breaks out of the main channel and into the west overbank between RM 201 and the HWY 32 bridge. Under existing conditions, the J levee on the west bank and the Butte County levee on the east bank keep most of the flow confined to the main channel. The relief provided by the proposed setback reduces the flow and resultant velocities in the reach, which reduce the sediment transport capacity of the reach.
- Reach 3 – The sediment transport capacity of Reach 3 increases with the proposed project. Under existing conditions the J levee breaks away from the channel following the old oxbow but then returns to the channel margin at RM 198. For lesser flood conditions (50- and 100-year), the water that flows into this local setback area is returned to the channel. For the greater flood flows, water that breaks into this area overtops the J levee and flows southward toward Stony Creek. The proposed project levee is slightly set back from the main channel in comparison to the J levee. The proposed levee is also higher, which prevents flow from overtopping and providing relief to the main channel. The net result is that the proposed levee alignment does not significantly change the amount of flow in the channel. The water surface elevation through this reach is slightly lower under project conditions due to the more significant setback downstream. As a result, main channel velocities increase slightly between with-project and without-project conditions, which increases the sediment transport capacity of the reach.

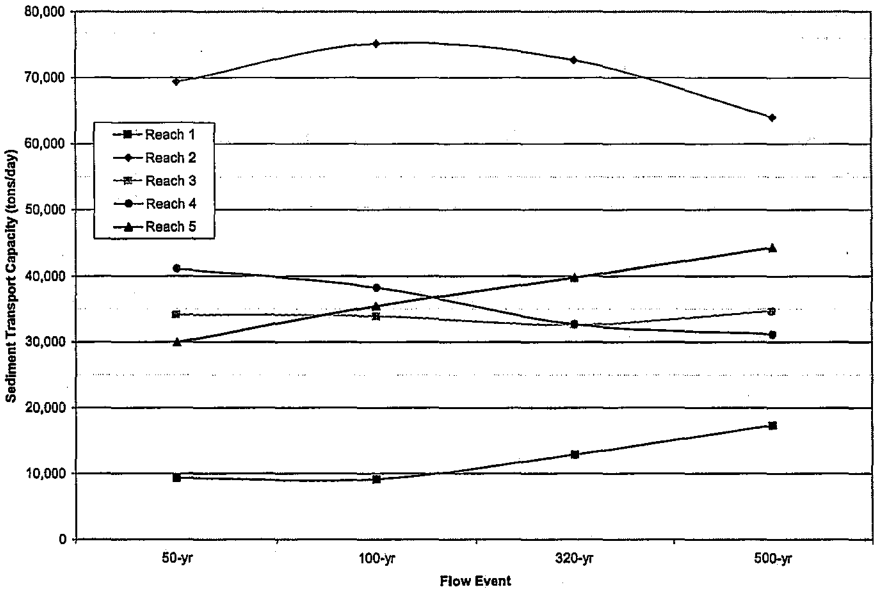

Figure 4.3. Sediment discharge rating curves for each reach for the without-project condition.

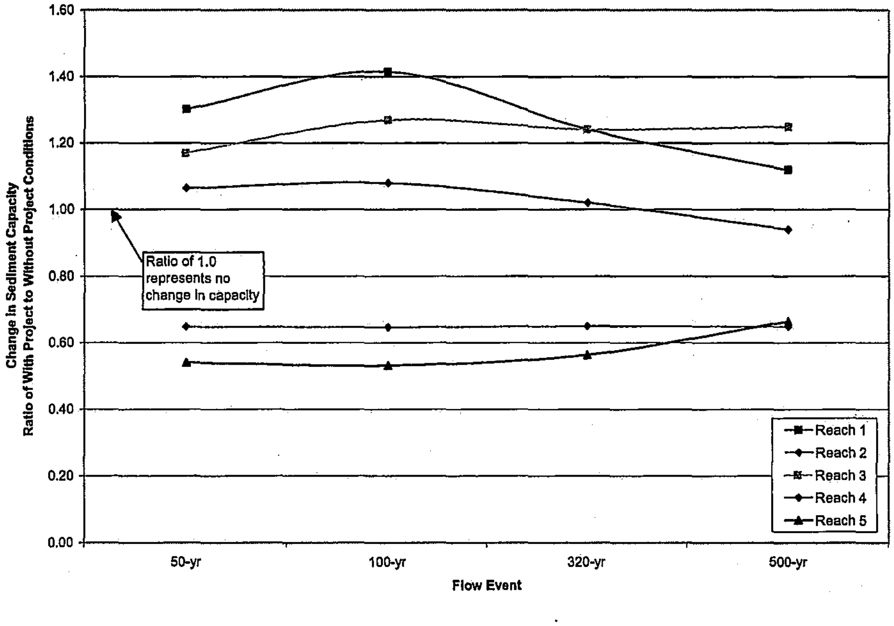

Figure 4.4. Comparison of sediment transport capacity, ratio of with-project to without-project conditions.

- Reach 4 – This reach experiences a slight increase in sediment transport capacity, primarily due to downstream effects from the proposed setback. The degree of setback provided with the proposed alignment is greatest in this area. This setback provides relief to the flow causing a slight decrease in water surface elevation that propagates upstream. Within the bend centered at RM 197 (Reach 4), the lower water surface elevation results in an increase in main channel velocity through the bend. This causes a slight increase in sediment transport capacity.
- Reach 5 – The proposed setback opens up a significant amount of floodplain within this reach, allowing more flow to leave the main channel than under existing conditions. As a result, the sediment transport capacity decreases in this reach.

4.4 Discussion

The results of the SAM analysis indicate that the proposed levee alignment will cause some changes in the river's ability to carry sediment. The extent of these changes is difficult to quantify without more detailed sediment transport modeling. As illustrated by Figure 4.3, the overall project reach is not in a state of equilibrium in terms of its ability to carry sediment. This conclusion is supported by the bar development in reaches 1 and 5. There is a significant degree of variability between the sub-reaches modeled. This variability remains with the proposed project, although there are some adjustments within each reach.

It is important to note that this sedimentation analysis was only conducted for flood flows (50-year and above). In reality, flood flows do not dominate sediment transport capacity in terms of affecting changes to channel geometry. The majority of sediment transport through the reach occurs at flows that are at or below bank-full conditions. This is illustrated in **Figure 4.5**, which shows the annual flow duration curve for the Hamilton City gage located at the HWY 32 bridge crossing. This curve was taken from work previously completed by the Sacramento District in a report titled, Draft Office Report, Streamflow Characteristics of the Sacramento River Floodways Hydrology (USACE 1990). This report was prepared by the hydrology section and includes stage/discharge rating curves and flow duration curves for most of the system. The flow duration curve at Hamilton City was based on daily historical data from 1947 to 1981 (12,626 days).

Figure 4.5 shows that flows exceed bank-full conditions (greater than 90,000) less than 1 percent of the time. For flows below bank-full, the proposed project will have no impact on the river's ability to carry sediment.

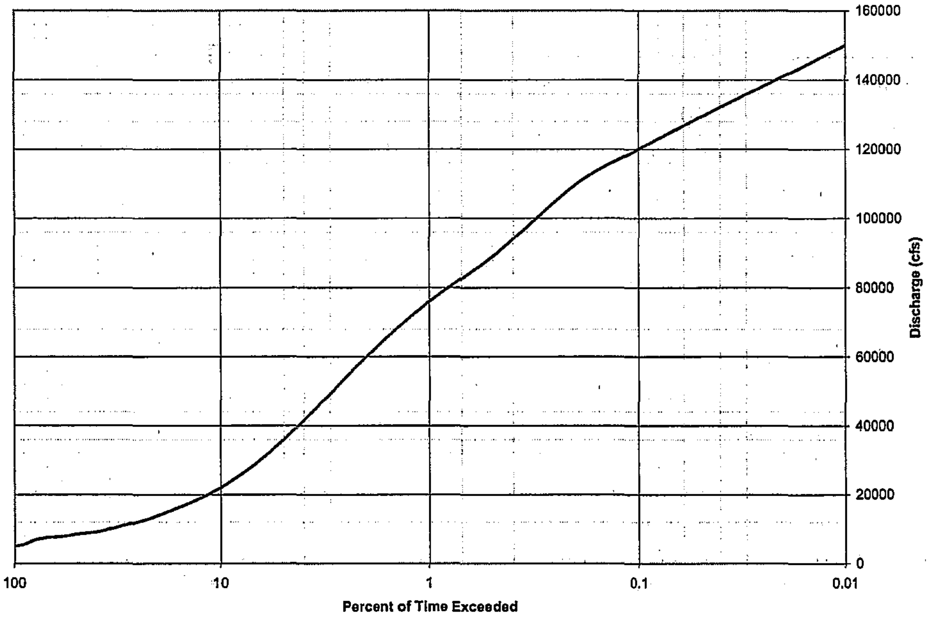

Figure 4.5. Annual flow duration curve for the Sacramento River at the Hamilton City gage.

5. CHANNEL SCOUR ANALYSIS

5.1 General

Analyses were conducted to assess anticipated changes in the stability of the channel within the project reach due to implementing either of the proposed levee alignments. These analyses are summarized in the following sections. Supporting calculations for the scour estimates are provided in **Appendix B**.

5.2 Scour Analysis at the Highway 32 Crossing

A scour analysis was conducted at the HWY 32 bridge crossing to estimate the impact of the proposed project on the bed elevation at the bridge opening. The most common form of general scour is contraction scour. Contraction scour typically occurs when the bridge opening is smaller than the flow area of the upstream channel and floodplain.

Contraction scour was estimated for both without-project and project conditions at the Highway 32 bridge crossing using the methodologies outlined in HEC-18 (FHWA 2001). To determine if the scour is live-bed or clear-water, the critical velocity of the bed material was compared to the mean velocity of the flow in the channel approaching the bridge. In all cases, the flow approaching the bridge is carrying sediment, and as a result, live-bed scour methods were used.

Contraction scour is estimated by comparing hydraulic conditions in the upstream (approach) channel with hydraulic conditions at the contracted cross section at the bridge. Hydraulic results from the 2-dimensional modeling were used to compute scour for without-project and project conditions for the 50-, 100-, 320-, and 500-year events. Scour estimates from this analysis are shown in **Table 5.1**.

Table 5.1. Contraction Scour Summary for Existing and Project Conditions at the Highway 32 Bridge Crossing.

Flow Condition	Without Project	With Project
50-year	1.6 ft	5.1 ft
100-year	1.5 ft	5.8 ft
320-year	0.9 ft	5.4 ft
500-year	0.8 ft	5.1 ft

Under existing conditions the J levee (on the right bank) and the Butte County levee (on the left bank) keep flood flows relatively confined to the main channel. This results in a relatively minor amount of constriction as the flow approaches the bridge. With the local setback on the right bank associated with the proposed levee alignment, the amount of constriction imposed on the flow as it approaches the bridge is increased. Since the new levee allows flow into the right overbank, there is less flow in the approach section than at the bridge where the overbank flow is forced to return to the channel. As such, the ability of the channel to carry sediment increases locally at the bridge because of the returning flow. These conditions will cause scour through the bridge section.

5.3 Bendway Scour

The migration analysis presented in Section 3 indicates that continued migration should be expected at the bends centered at RM 197 and RM 201, even though some bank protection measures exist at each site. If those features fail to arrest ongoing bank erosion, the channel could migrate toward the proposed levee setback although the proposed levee is less threatened than the J levee. Stabilizing the banks, either by repairing existing revetment or by constructing new features, may be necessary to prevent future flanking of the levees. Section 6 presents possible bank revetment alternatives for accomplishing this.

Whenever a migrating river bend is fixed in place by revetment, some sort of channel response is to be anticipated, typically in the form of vertical scour. This is due to the fact that stabilizing the bankline reduces or eliminates the supply of sediment in the bend from bank erosion, causing the channel to narrow or deepen. While riprap provides good protection for the river bank, it also causes scour along the toe. The riprap surface usually provides a more efficient hydraulic section than a vegetated, natural bank, attracting more flow and causing higher velocities along the toe of the riprap.

Estimates were made of the potential scour that could occur if additional efforts are made to stabilize the bends. This information will be used in the design of specific bank protection measures to determine how far the rock will need to be keyed into the river bed to protect against future scour.

Thorne et al. (1995) presents the following empirical equation for estimating scour depth in meander bends based on data from several rivers of various size:

$$d_{max} = \left[2.07 - 0.19\log(\frac{R_c}{W} - 2)\right]d_{mnc}$$

Where:

d_{max} = Maximum depth in bend due to scour
d_{mnc} = Depth of the approach channel at the crossing upstream of the bend
R_c = Radius of curvature of the centerline of the channel in the bend
W = Width of channel at the upstream crossing

The predicted scour depth at each of the sites using this method is presented in **Table 5.2.** This empirical equation is applicable for values of R/W greater than 2. The depth values used in the analysis are from a bank-full flow condition.

Table 5.2. Bend Scour Summary for the Bends at RM 197 and RM 201.

Bend Location	R_c/W	Average Depth (ft) Upstream of Bend (D_{mnc})	Calculated Max. Depth (ft) in Bend (D_{mxb})	Existing Max. Depth (ft) in Bend	Max. Potential Scour in Bend (ft)
RM 197	8.60	23	44	40	**4.0**
RM 201	3.77	22	44.5	37	**7.5**

5.4 Channel Stability

Aggradation and degradation are streambed elevation changes due to natural or human-induced causes that can affect the reach of the river under investigation. Aggradation involves the deposition of material eroded from the channel or watershed upstream of the reach. Degradation involves the lowering or scouring of the streambed due to a deficit in sediment supply from upstream or local changes in the sediment transport capacity of the reach.

As described in Section 4, a sedimentation analysis was conducted to assess changes in the sediment transport characteristics of the reach that would result from implementing the proposed levee alignment. This analysis looked at sediment transport capacity for a range of flood flows. As described previously, there were no data available for calibrating the sedimentation analysis. As such, the results should be considered qualitative rather than quantitative in understanding how the proposed levee alignment will influence sediment conditions within the reach. A quantitative understanding of the actual sediment supply from the reach upstream of the project would be beneficial in placing the transport capacity of the project reach in context.

The analysis indicated that for flood flow conditions, the project would increase sediment transport capacity for three of the five sub-reaches modeled (Figure 4.1). Sediment transport capacity would decrease for the other two reaches. For flows that are most dominant in transporting sediment and affecting channel geometry (bank-full and below), the project will have no impact on sediment transport capacity.

Some estimation can be made of potential channel response due to the change in sediment transport capacity between without-project and project conditions. By assuming that discharge remains constant, the resulting change in channel area can be estimated using the continuity equation. If it is assumed that all adjustments to channel geometry happen vertically, an estimation can be made of the amount of aggradation or degradation required to respond to the new sediment transport capacity conditions (those predicted for project conditions). These estimates of vertical channel response are presented in **Table 5.3.**

Table 5.3. Estimated Vertical Channel Response Due to Change in Sediment Transport Capacity for Flood Flows.

Reach	Potential Change in Bed Elevation
1	-1 to -2.5 ft
2	+2.5 to +3 ft
3	-1 to -1.5 ft
4	-0.5 to +0.5 ft
5	+2.5 to +3.5 ft

This estimate of aggradation/degradation is simplification in several ways. First, it assumes that as the channel geometry changes due to new sediment transport capacity conditions, the discharge in the channel will stay the same. In reality, the amount of flow in the channel will change along with the channel geometry. Second, it assumes that all channel adjustment will occur in the vertical. In reality, channel adjustment will occur laterally (through bank erosion or bar deposition) as well as vertically. Last, it assumes that the proposed condition channel would revert to the transport conditions of the existing channel, even though it is apparent that the existing channel is not in an equilibrium state of sediment transport. As such, the numbers presented in Table 5.3 provide a conservative estimate of how the channel might respond during flood flows. It should also be emphasized that no change is expected for flow less than the bankfull flow.

6. BANK PROTECTION MEASURES

6.1 General

The reach of the Sacramento River upstream of Colusa (RM 145) is relatively unconfined. Sacramento River Flood Control Project (SRFCP) levees are somewhat set back from the active channel between Colusa and their upstream limit near Ord Ferry (RM 180). Upstream of Ord Ferry, local levees are intermittent and the river is free to meander within the floodplain. As described previously, the bends at RM 197 and RM 201 continue to migrate, although migration is limited at both bends due to the presence of bank protection measures.

Active channel meandering is a natural process and is beneficial for ecosystem function and health. One of the objectives of this project is to restore natural river function and enhance existing ecosystem conditions. Allowing these river bends to continue to erode and migrate will aid in accomplishing that objective. On the other hand, the project is also intended to reduce flood damages by providing flood protection. Maintenance of the proposed levee throughout the life of the project will be required to provide ongoing flood protection. One threat to constructing a new levee is the potential that it could be flanked by the continued migration of a river bend. This section presents conceptual alternatives for stabilizing the bends in the reach, should it be necessary to protect the proposed levee alignments over the life of the project.

The bend at RM 201 has experienced significant erosion over the last two decades, averaging roughly 50 feet per year since 1981. The current location of the bankline is up against the existing J levee for a distance of roughly 400 feet, and is only 310 feet away from the toe of the levee/road next to the GCID canal, which is the location of the proposed levee alignment. If erosion continues at current rates, the upstream limit of the proposed levee alignment could be threatened in 5 to 10 years. As such, some type of bank protection will be needed to protect the bend at this site.

The bend at RM 197 experienced most of its erosion prior to the last couple of decades. Bank protection was installed along most of the bank in 1976 under the Chico Landing to Red Bluff Project as described in Section 4. This revetment has kept the alignment of the bend relatively fixed. Like much of the revetment installed under the Chico Landing to Red Bluff Project, it is beginning to deteriorate. Erosion along the toe is leading to local failures of the riprap and portions of the upper bank are also caving in. The distance between the existing bank and the proposed levee alignment is roughly 1,500 feet. In the estimated direction of migration, the distance between the river bank and the levee alignment increases to as much as 6,000 feet.

One possibility at RM 197 is to remove the existing revetment and allow the bend to meander. This would allow the bend to move southward toward the proposed levee alignment, which may require intervention in the future to protect the levee. Migration rates prior to the placement of riprap at this site in 1976 were as high as 210 feet per year. One alternative for providing future protection of the proposed levee would be to install buried revetment, offset from the levee some distance, that would arrest channel migration before it reached the levee. The other alternative at RM 197 would be to maintain the current revetment. Without repair, the existing revetment is not likely sufficient to protect the levee over the life of the project. At a minimum, maintaining the existing revetment would require installing a rock toe along the entire site and repairing areas where the existing revetment has failed or is in poor condition.

Due to the proximity of the current alignment of the bend at RM 201 to existing infrastructure as well as the proposed levee alignment, it is recommended that the bank be stabilized in its current location. Full riprap bank revetment is proposed at this site. Some type of flow alteration, such as using spur dikes or bendway weirs, is not recommended due to potential realignment of the channel downstream that could affect the local Butte County levee on the opposite bank. If the existing infrastructure, such as the private residence and orchard, as well as the J levee, does not need protection, then some type of buried revetment may be installed along the toe of the proposed levee to provide protection for the new levee.

6.2 Riprap Toe (Repair Existing Revetment)

The instability of the existing riprap at the RM 197 bend appears to be due to the absence of sufficient toe protection. Scour along the toe of the bankline has resulted in local failures in the revetment and the loss of rock below the waterline. It may be possible and more cost effective to repair the existing revetment than replace it with new revetment. This alternative is illustrated in **Figure 6.1**.

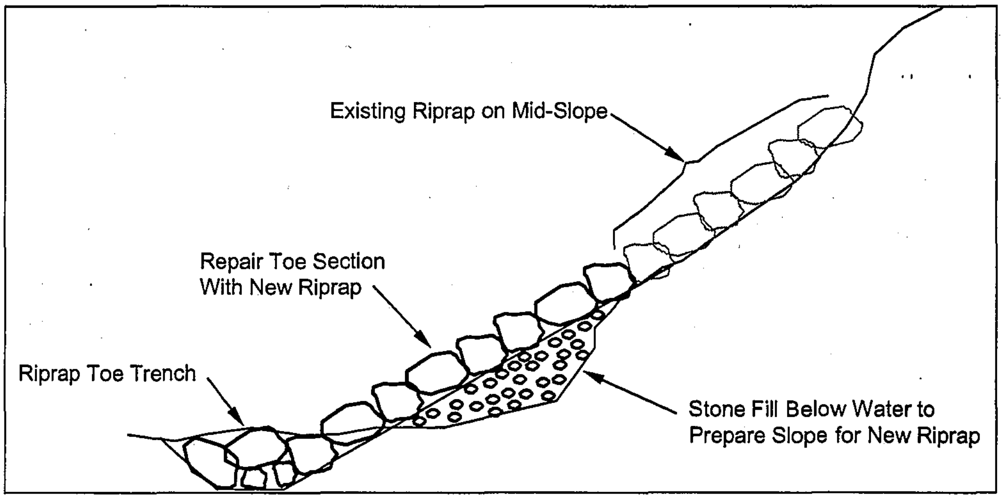

Figure 6.1. Typical cross section of riprap toe and revetment repair.

6.3 Riprap Bank Revetment

This alternative is illustrated in **Figure 6.2** and involves re-grading and reshaping the existing bank to prepare the slope for the placement of riprap. Design slopes are typically 2H:1V or flatter. When fill is required to shape the bank slope, stone fill is typically used below the low water level and embankment material above. An excavated riprap trench is placed along the toe to protect against further scour of the channel bed. Riprap is placed on the prepared slope up to the top of the bank.

The upper bank slope can be planted with woody riparian shrub species to create near-shore aquatic cover and the top of bank can be planted with cottonwoods and other trees. To further enhance aquatic conditions along the revetted bank, trees with large root masses can be anchored below the low water level.

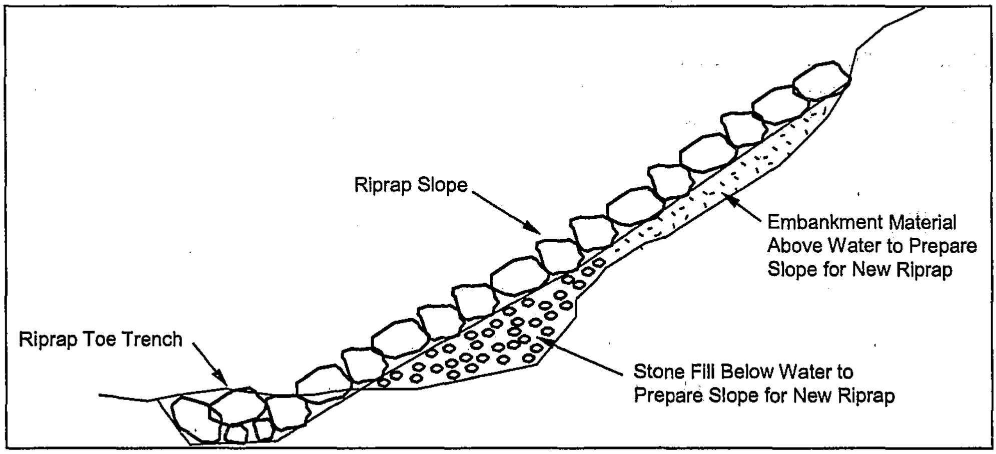

Figure 6.2. Typical cross section of riprap bank protection.

6.4 Buried (Setback) Revetment

Buried revetment consists of a mass of rock placed in a trench that is intended to launch into a bank configuration when intersected by an eroding bankline as shown in **Figure 6.3**. The trench is offset some distance from the toe of the levee alignment that is being protected. Enough rock is included in the trench to launch to a configuration similar to that shown for the riprap bank protection in Figure 6.2. The backslope of the trench is set to the desired slope of the bank protection. The deeper the mass of rock is buried, the better the likelihood that it will launch to the desired configuration.

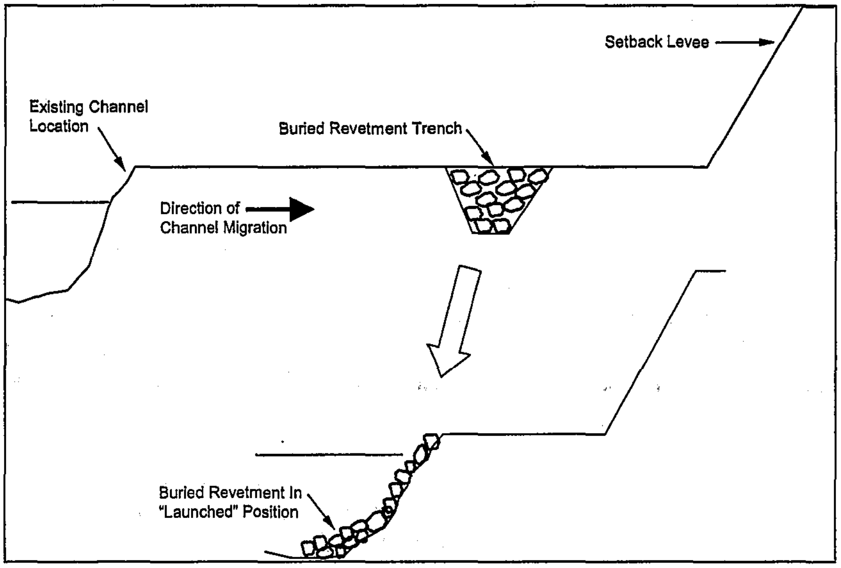

Figure 6.3. Typical cross section and plan view of buried revetment.

6.5 Riprap Sizing

Riprap requirements for the conceptual bank protection alternatives were evaluated using the procedure outlined in EM 1110-2-1601, Hydraulic Design of Flood Control Channels (USACE 1991). This procedure requires data describing the bank slope, channel morphology, angle of repose and specific gravity of the rock, design velocity conditions, flow depth, safety factors, and other information. The velocity required is the depth-averaged local velocity at the eroding bank located at a point 20 percent up the bank slope from the toe.

The hydraulic results from the 2-dimensional modeling described previously were used to obtain the velocity and depth data required to size the riprap for the 100-year event. The riprap size was also checked against results from the HEC-RAS model for the 2-year event.

For the bend at RM 197, the design D_{30} was determined to be 0.5 foot while the D_{30} was 0.3 foot for the bend at RM 201. For both of these conditions, the standard 200-pound gradation used by the Corps and shown in **Figure 6.4** is adequate. This gradation has been used extensively for riprap banks constructed under the Sacramento River Bank Protection Project (SRBPP). The layer thickness for this gradation is 18 inches.

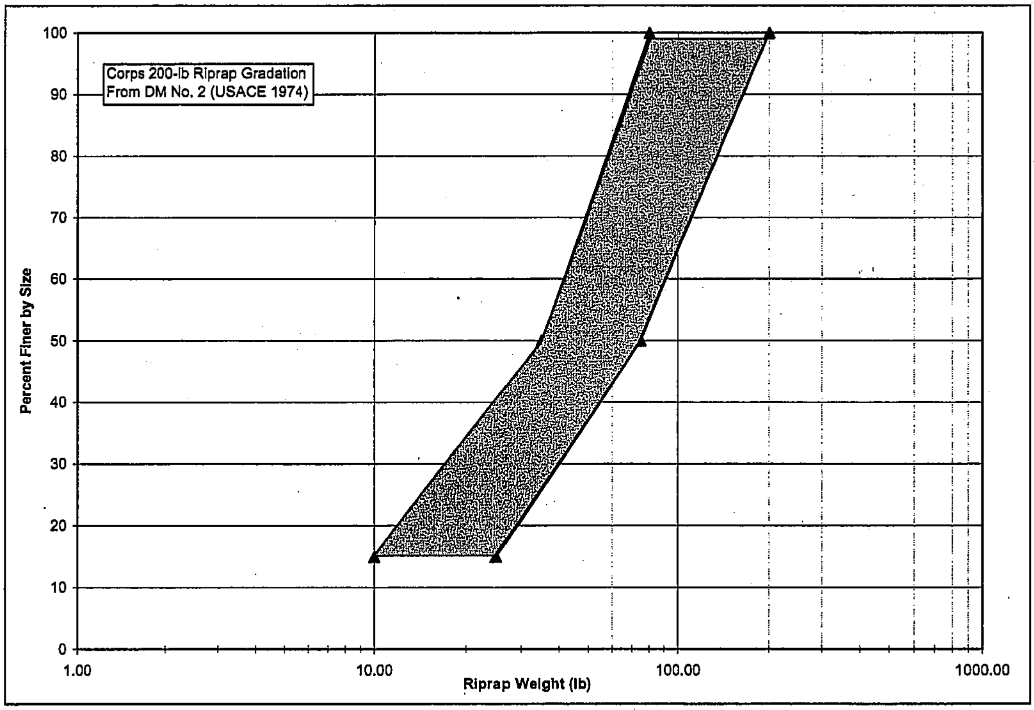

Figure 6.4. Gradation for standard Corps 200-pound gradation (from Design Memorandum No. 2).

7. SUMMARY

The analyses completed for this project provide a basis for comparing the without-project and project conditions for two alternative levee alignments (6 and 6a). Following is a brief summary of the hydraulic, sedimentation, and channel migration analysis.

- The bend centered at RM 197 has been relatively fixed since the mid-1970s when revetment was placed along the bank. The condition of that revetment, however, is poor and continued migration should be expected. In contrast, the bend centered at RM 201 has been most active in the last 20 years. Further erosion of the bank threatens the "J" levee and other infrastructure. It is roughly only 300 feet from the toe of the levee/road next to the GCID canal, which is the location of the proposed levee alignment.

- The proposed levee alignment will have no impact on the sediment transport capacity of the river for flows below the bank-full condition. The proposed project will impact the sediment transport capacity of the river under flood flow conditions, although these changes will result in only minor adjustments to channel.

- The proposed levee alignment will not exacerbate local bridge scour or reach-wide aggradational or degradational trends in comparison to existing conditions for flows below the bank-full condition. For flood flows, the contraction scour potential at the HWY 32 bridge increases from roughly 1 to 1.5 feet of scour for without-project conditions to 5 to 6 feet of scour for with-project conditions. Minor adjustment to channel geometry in the form of aggradation or degradation can be expected during flood events due to changes in sediment transport capacity associated with the project levee alignment.

- The potential vertical adjustment in the form of toe scour will need to be considered when designing bank protection at RMs 197 and 201, if the bends are to be fixed in places.

- Three conceptual bank protection alternatives are presented for stabilizing the bends at RM 197 and RM 201 in order to protect the proposed levee alignment from flanking in the future. These include repairing existing revetment (RM 197), full bank revetment, and buried (setback) revetment.

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AYRES
ASSOCIATES

MEMORANDUM

To: Nathan Cox – U.S. Army Corps of Engineers, Sacramento District

From: Scott Hogan and Jason McConahy

Date: May 28, 2004

Re: Hydraulic Modeling Memo for Public Review – Hamilton City Initial Project, Flood Damage Reduction and Ecosystem Restoration Feasibility Study

This memo describes the hydraulic modeling Ayres Associates completed to evaluate potential impacts associated with the proposed project levee alignment and ecological restoration near Hamilton City, California. The main project goals were to determine a levee alignment and configuration that will meet the ecological restoration objectives while providing improved flood protection without adverse hydraulic impacts. Given the complexity of hydraulic conditions through the project reach and the need for detailed hydraulic results, the 2-dimensional hydrodynamic model, RMA-2 (USACE 1996) was used for this analysis.

This memo summarizes the hydraulic model runs for the tentatively selected plan. Graphics summarizing the model results are included in the Attachments.

Model Development

A 2-dimensional model, previously developed for The Nature Conservancy (TNC) (Ayres 2002), was used in the development of the model for this hydraulic analysis. The SMS program, developed by Brigham Young University, was used to modify the geometric finite element mesh that represents the topographic and bathymetric data through the project reach. The TNC model was originally developed to analyze impacts of flows less than the 50-year event. Since the analysis for this project includes higher flows (up to the 500-year event), the mesh was expanded to incorporate the inundation limits for these flows. The TNC model, the HEC-RAS model provided by the Sacramento District, existing mapping data for the Sacramento River (Ayres 1999), and USGS quadrangle maps were all used to help develop the new finite element mesh.

The representation of the project reach was based on 1995 and 1997 topographic conditions. Extensive 2-foot contour mapping of the Sacramento River system was developed by the USACE from hydrographic and aerial photogrammetric surveys. Upstream of RM 194, the mapping data was derived from aerial and hydrographic surveys conducted in 1997. Downstream of RM 194 the mapping was derived from aerial and hydrographic surveys conducted in 1995. The horizontal datum for the survey data is the North American Datum of 1983 (NAD83), State Plane Coordinates. The vertical datum is the National Geodetic Vertical Datum of 1929 (NGVD29). The 2-foot contour mapping covered the limits of the 2-dimensional model.

The without-project condition finite element mesh developed for this project is shown in **Figure 1**. The limits of the modeling analysis extended from RM 212 downstream to RM 191. The proposed levee alignment was integrated into the mesh after the without-project condition mesh was completed.

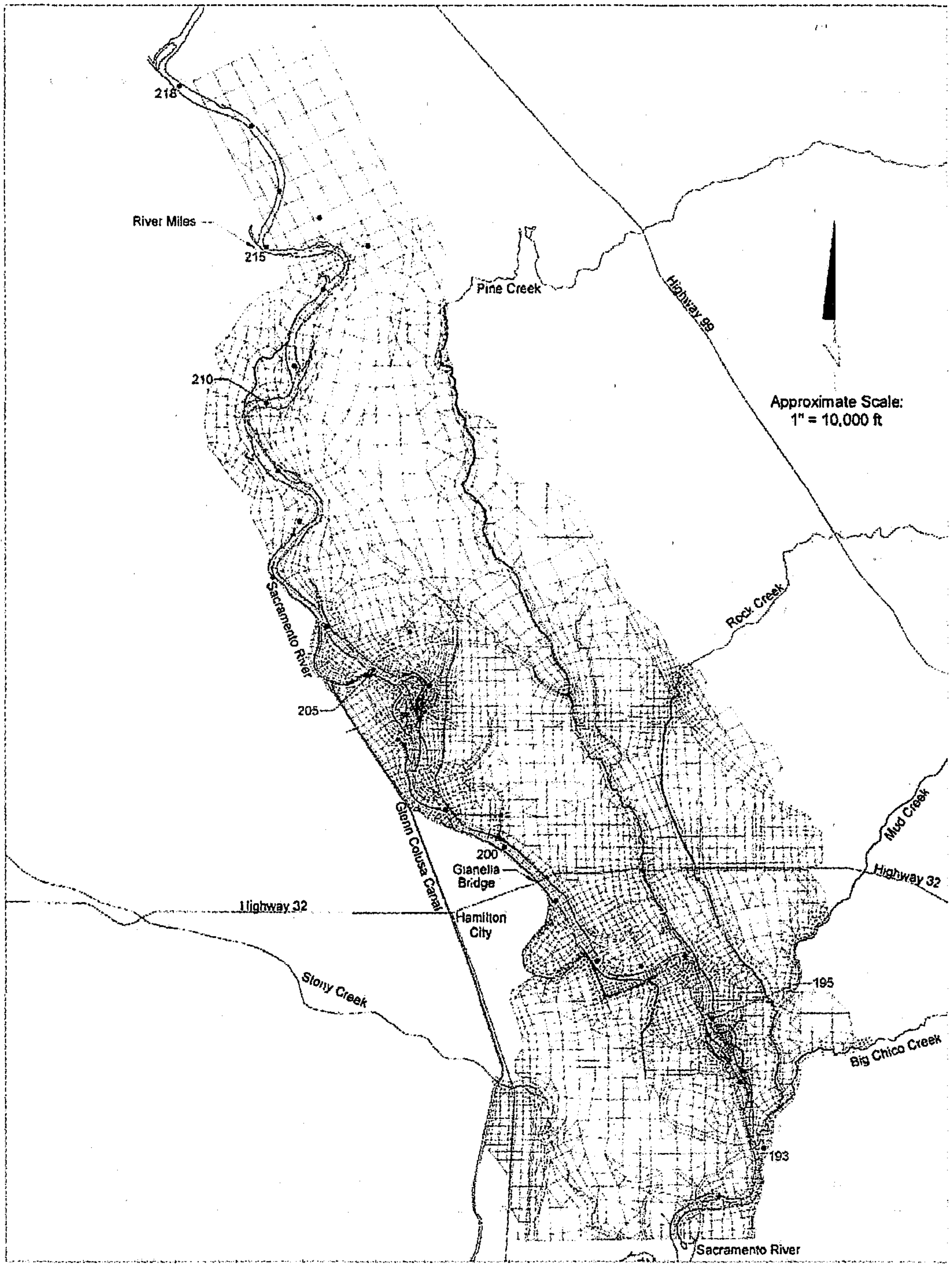


Figure 1. Without-project condition finite element mesh.

The Manning's n roughness values used in the TNC model were preserved in the without-project conditions model for this analysis. Revised n-values for the project condition models, which represent ecological restoration along the river corridor, were provided by the Sacramento District and the DWR. A complete list of the n-values used in the modeling is provided in **Table 1**. The distribution of element types for both the without-project and project models are provided in the attachments. Manning n values for "areas of turbulent flow" are set high to maintain model stability where extreme flow conditions occur in the model, such as at levee crests.

Table 1. Roughness Coefficients used in the 2-Dimensional Model.

Element Type	Land Use	n value
1	Main channel	0.035
2	Forest/Riparian	0.16
3	Orchard	0.15
4	Cultivated field	0.035
5	Sand/gravel	0.04
6	Stony creek bed	0.04
7	Pasture/grassland	0.035
8	Creek bed	0.035
9	Levee/road	0.025
10	Pine creek bed	0.035
11	Buildings	0.20
12	Area of turbulent flow	0.20
13	Area of turbulent flow (Without-Project)	0.50
	Scrub (Project)	0.10
14	Savannah (Project)	0.05
15	Area of turbulent flow (Project)	0.50

Modeling Scenarios

Without-Project Condition. The without-project model was run for various return period flows to provide a baseline for comparison with the hydraulic results of the project conditions. For the without-project condition, the existing J-levee was assumed to contain flows up to the 100-year event, as indicated by flood fighting reports and agreements from the local Hamilton City landowners. The flood fighting efforts extend along the J-levee from its upper terminus, downstream to the limit shown on **Figure 2**, which is just north of County Road 23. For events greater than the 100-year flow, the J levee was modeled with a crest elevation equal to the 100-year water surface elevation.

Figure 2. Plan view of the project reach showing the components of the without-project conditions model.

Tentatively Selected Plan. The details of the tentatively selected plan are illustrated in Figure 3. The levee follows what was previously referred to as Alignment 6. The proposed levee provides 40% CNP (Conditional Non-Exceedance Probability) of passing the 320-year flood event to a point that is roughly 5,000 feet upstream of County Road 23. At that location, the levee transitions into a "training levee" that provides 53% CNP of passing the 100-year flood for roughly 3,000 feet. From this point it drops to an elevation that is 2.1 feet below the without-project 100-year water surface elevation, providing roughly a 62% CNP of passing the 20-year flood event (see Figure 3). It was assumed that the J levee would be completely removed for the with-project condition.

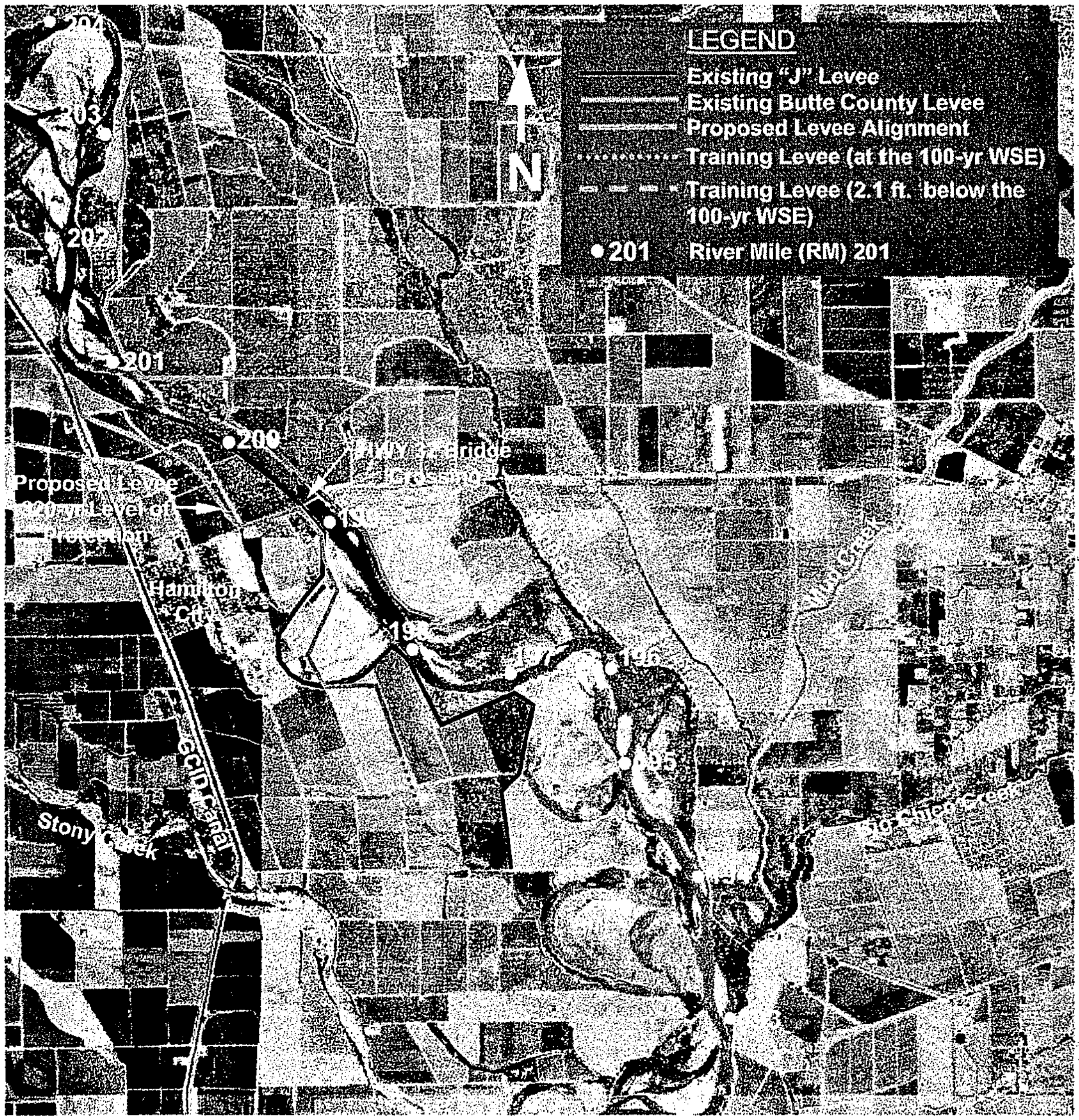


Figure 3. Plan view of the project reach showing the components of the tentatively selected plan.

Modeling Procedures

The Sacramento River and tributary inflows used in the 2-dimensional modeling simulations are shown in **Table 2**. The peak flows were provided by the Sacramento District USACE and were derived from the Sacramento and San Joaquin River Basin Comprehensive Study UNET model. Based on hydrologic analyses and evaluation by the Sacramento District, the inflows from the other tributaries (Rock Creek, Mud Creek, Big Chico Creek, etc.) were considered minor relative to the flows in the Sacramento. Furthermore, the peak inflows from these tributaries are of short duration and occur prior to the peak on the Sacramento River.

Table 2. 2-Dimensional Model Boundary Conditions.			
Flood Event	Sacramento Inflow	Stony Creek Inflow	Tailwater Elevation
1997 Event	167,000 cfs	15,500 cfs	130.5 ft
20-year	190,000 cfs	14,500 cfs	131.0 ft
25-year	206,575 cfs	15,500 cfs	131.3 ft
50-year	237,829 cfs	15,000 cfs	131.9 ft
100-year	275,910 cfs	27,400 cfs	132.5 ft
200-year	315,965 cfs	48,500 cfs	133.4 ft
320-year	342,600 cfs	52,000 cfs	133.6 ft
500-year	424,511 cfs	62,330 cfs	134.1 ft

Downstream water surface elevation boundary conditions were referenced from previous 2-dimensional modeling conducted for the Butte Basin reach of the Sacramento River (Ayres 1997). The Butte Basin model covered the Sacramento River south of the Hamilton City project reach, and provided enough overlap to be used as a reference for the tailwater elevation for this modeling effort. A rating curve was developed as shown in **Figure 4** based on the computed water surface elevation and discharge from the Butte Basin model at the location of the downstream limit of the current model (approx. RM 191). The lowest flow modeled in the Butte Basin model was the 1995 flood event, with a total flow in the Sacramento River of 195,000 cfs at the downstream location of the current model. The tailwater elevations used as boundary conditions for the model are presented in Table 2.

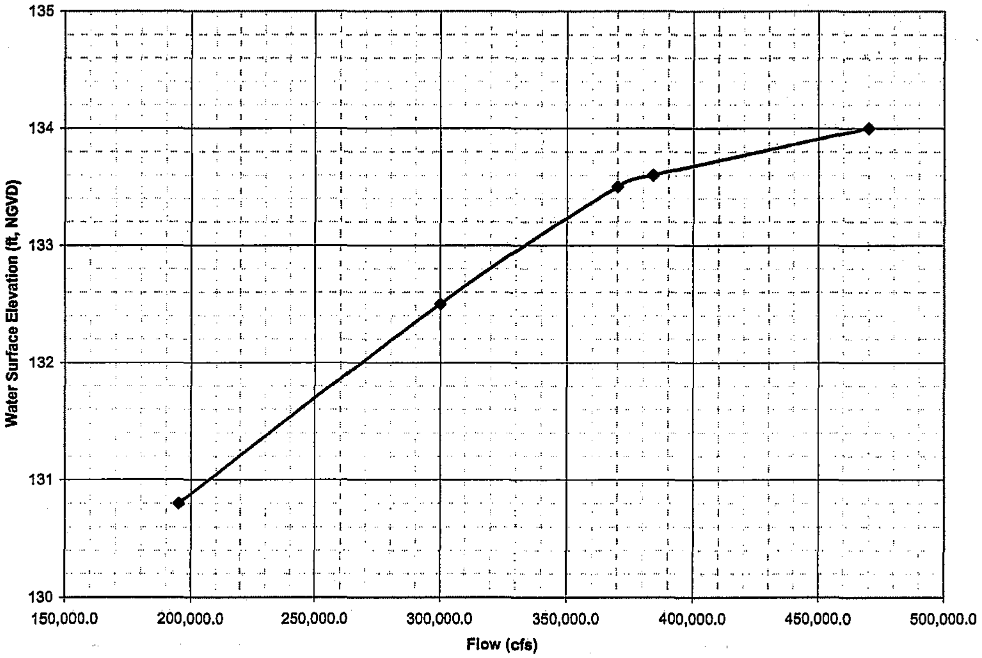


Figure 4. Rating curve for the downstream water surface elevation boundary condition.

Flow conditions in the project reach are fairly complex during flood events. The complexity is due to the presence of levees on both banks of the main channel, HWY 32 that crosses the east floodplain, and the spill of water into the Butte Basin at the downstream limit of the model. Levees within the model limits include the J levee on the west side of the river and the Butte County levees on the east side. As mentioned previously, it was assumed that the J levee would not overtop up to the 100-year event with flood fighting activities (for the without-project model). Otherwise, for most of the modeled flows both the J levee and the Butte County levee overtop and are assumed to function hydraulically as a broad crested weir.

The RMA-2 program does not accurately simulate rapidly varied flow conditions that occur over the crest of a weir. Attempts were made during initial modeling of the project scenarios to manually calculate the flow across the levee using the weir equation. This required an iterative process of extracting water surface data from the model, computing the flow in a spreadsheet, then adjusting the discharge and rerunning the model. As the project assumptions evolved and as more flows were analyzed, this method proved too tedious and inaccurate. One problem is that flow direction over the levees could vary along the levee. For higher flows, water exchanges freely across the levees in both directions. Forcing the model by manually determining flow direction and discharge would have yielded results different from those computed by the model on its own, which more accurately reflect the complex hydraulics within the reach. As a result, it was decided to let RMA-2 compute the flow across the levees on its own. This required increasing the roughness of the levee crest to maintain model stability. Continuity strings were used to check the results. While the results across the crest of the levee (local velocities and depths) cannot be taken as accurate, the overall continuity of the model checked well. This methodology was used for both without-project and project models.

One area of overtopping that required manual calculation for determining the flow is at the lower eastern edge of the model. Water overtops a natural levee feature along the alignment of Big Chico Creek from where it enters the model downstream to the model limit. The water that spills over this feature enters the Butte Basin. A flow boundary condition was set along this alignment to pull flow out of the model. Determining the flow is an iterative process. First, a flow out of this boundary was assumed and the simulation was run. The water surface elevation along the natural levee was entered into a spreadsheet containing the levee elevations. By breaking the natural levee into sections, the overtopping discharge was computed incrementally using the weir equation. The incremental flows were added together to get the total flow across the feature, then the boundary condition was revised and the simulation run again. This was done until the computed discharge matched the modeled discharge.

Modeling Results

The results of the various modeling scenarios are presented as attachments to this memo. For without-project conditions, plots are included showing depth and velocity contours for each flow. For the tentatively selected plan, plots are included showing depth and velocity contours as well as the change in water surface elevation and change in velocity magnitude as compared to the without-project condition for each flow.

General observations

- *Upstream of HWY 32 Bridge Crossing* – In this reach immediately upstream of the bridge crossing the proposed levee alignment is set-back from the river's edge where the J levee is currently located. This opens a small floodplain for the right bank providing relief to flow. Less flow is in the main channel approaching the bridge. This results in a slight decrease in velocity and increase in depth in the main channel in comparison to the without-project condition. This increase in water surface elevation continues upstream to between RM 200 and RM 201, depending on the flow condition. This increase is local to the main channel and does not increase the flood inundation area except where the levee is set back. Therefore, this increase is not an adverse impact.

- *Downstream of Dunning Slough* – This is the area most impacted by the removal of the J levee and the location of the proposed levee alignment. Locally, the proposed levee causes an increase in water surface elevation on the river-side. This is because the levee is set-back and is opening up conveyance area that was not available under the without-project condition. On the landward side of the new levee, between the training dike and the GCID canal a slight increase in water surface is noticed.

- *Between Dunning Slough and the GCID Canal (Hamilton City Area)* – For flows below the 100-year event there is no impact in this area. Above the 100-year event, the proposed levee removes the flooding that occurs when the J levee overtops and allows flow through this area.

- *East Floodplain Downstream of HWY 32* – The increased conveyance provided by the set-back alignment of the proposed levee results in a slight decrease in water surface elevation extending into the east floodplain between County Road 23 and HWY 32.

- *East Floodplain Upstream of HWY 32* – The decrease in water surface elevation in the east floodplain continues upstream of HWY 32.

- *Big Chico Creek / Butte Basin Overflow* – The eastern edge of the model follows Big Chico Creek where it connects to the Sacramento. Along this edge flow overtops a natural levee feature and goes into the Butte Basin overflow area. Due to the widening of the floodplain by the set-back alignment of the proposed levee the water surface elevation along this edge decreases. This results in a slight decrease in the amount of flow spilling into Butte Basin.

Results Summary for the 320-year Flood Event

- See attached plots titled: "40% CNP of Passing the 320-Year Event"
- Flow in Sacramento River is 342,600 cfs; flow in Stony Creek is 52,000 cfs.
- Upstream of the HWY 32 bridge crossing, there is a slight increase in water surface elevation of roughly 0.2 to 0.4 feet in the channel
- Downstream of Dunning Slough there is a local increase in water surface elevation of roughly 3 feet where the levee is set-back. There is a similar increase in depth in the west floodplain immediately upstream of the HWY 32 Bridge where the levee is set-back.
- Flow is removed from the Hamilton City area under the project condition
- Downstream of HWY 32 there is a decrease in water surface elevation of 0.4 to 0.6 feet in the floodplain east of the river channel. A decrease of 0.1 to 0.3 feet carries upstream of HWY 32
- The water surface elevation along the eastern edge of the model in the vicinity of Big Chico Creek decreases slightly by less than 0.2 feet
- The overflow to Butte Basin decreases from 23,250 cfs for the without-project condition to 21,000 cfs for the project condition

Results Summary for the 100-year Flood Event

- See attached plots titled: "84% CNP of Passing the 100-Year Event"
- Flow in Sacramento River is 275,910 cfs; flow in Stony Creek is 27,400 cfs
- Upstream of the HWY 32 bridge crossing, there is a slight increase in water surface elevation of roughly 0.2 to 0.3 feet in the channel
- Downstream of Dunning Slough there is a local increase in water surface elevation of greater than 4 feet. This is in an area that is under backwater conditions for the without-project condition that is now inundated due to the levee set-back. There is a similar increase in depth in the west floodplain immediately upstream of the HWY 32 Bridge where the levee is set-back
- Downstream of HWY 32, there is a decrease in water surface elevation of 0.6 feet in the floodplain east of the river channel. A decrease of 0.1 to 0.4 feet carries upstream of HWY 32.
- The water surface elevation along the eastern edge of the model in the vicinity of Big Chico creek decreases by as much as 0.4 feet
- There is no overflow to Butte Basin under the without-project condition. The project condition does not change this

Results Summary for the 50-year Flood Event

- See attached plots titled: "96% CNP of Passing the 50-Year Event"
- Flow in Sacramento River is 237,829 cfs; flow in Stony Creek is 15,000 cfs
- Upstream of the HWY 32 bridge crossing there is a slight increase in water surface elevation of roughly 0.1 to 0.2 feet in the channel
- Downstream of Dunning Slough there is a local increase in water surface elevation of greater than 4 feet. This is in an area that is under backwater conditions for the without-project condition that is now inundated due to the levee set-back. There is a similar increase in depth in the west floodplain immediately upstream of the HWY 32 Bridge where the levee is set-back
- Downstream of HWY 32 there is a decrease in water surface elevation of 0.6 feet in the floodplain east of the river channel. A decrease of 0.1 to 0.4 feet carries upstream of HWY 32
- The water surface elevation along the eastern edge of the model in the vicinity of Big Chico Creek decreases by less than 0.2 feet upstream of its confluence with Mud Creek. Between the confluence with Mud Creek and RM 193 on the Sacramento River, there is an increase in water surface elevation along the eastern edge of the model of roughly 0.1 foot
- There is no overflow to Butte Basin under the without-project condition. The project condition does not change this

Results Summary for the 25-year Flood Event

- See attached plots titled: "100% CNP of Passing the 25-Year Event"
- Flow in Sacramento River is 206,575 cfs; flow in Stony Creek is 15,500 cfs.
- Upstream of the HWY 32 Bridge crossing, there is a slight increase in water surface elevation of roughly 0.1 feet in the channel.
- Downstream of Dunning Slough, there is a local increase in water surface elevation of greater than 4 feet. This is in an area that is under backwater conditions for the without-project condition that is now inundated due to the levee set-back. There is a similar

increase in depth in the west floodplain immediately upstream of the HWY 32 Bridge where the levee is set-back

- Downstream of HWY 32, there is a decrease in water surface elevation of 0.4 feet in the floodplain east of the river channel. A decrease of 0.1 to 0.2 feet carries upstream of HWY 32
- The water surface elevation along the eastern edge of the model in the vicinity of Big Chico Creek increases by less than 0.2 feet in the vicinity of RM 193
- There is no overflow to Butte Basin under the without-project condition. The project condition does not change this
- The inundation limits in the vicinity of County Road 23 (CR 23), west of the levee/dike are slightly reduced for the with project condition

Results Summary for the 20-year Flood Event

- See attached plots titled: "100% CNP of Passing the 20-Year Event"
- Flow in Sacramento River is 190,000 cfs; flow in Stony Creek is 14,500 cfs
- There is no noticeable change in water surface elevation in the channel upstream of the HWY 32 bridge crossing
- Downstream of Dunning Slough, there is a local increase in water surface elevation of greater than 4 feet. This is in an area that is under backwater conditions for the without-project condition that is now inundated due to the levee set-back. There is a similar increase in depth in the west floodplain immediately upstream of the HWY 32 Bridge where the levee is set-back.
- Downstream of HWY 32, there is a decrease in water surface elevation of 0.4 feet in the floodplain east of the river channel. A decrease of 0.1 to 0.2 feet carries upstream of HWY 32.
- The water surface elevation along the eastern edge of the model in the vicinity of Big Chico Creek increases by less than 0.2 feet in the vicinity of RM 193.
- There is no overflow to Butte Basin under the without-project condition. The project condition does not change this.
- The inundation limits in the vicinity of County Road 23 (CR 23), west of the levee/dike are slightly reduced for the with project condition

Results Summary for the "1997" Flood Event

- See attached plots titled: "1997 Flood Event"
- Flow in Sacramento River is 167,000 cfs; flow in Stony Creek is 15,500 cfs
- There is no noticeable change in water surface elevation in the channel upstream of the HWY 32 bridge crossing
- Downstream of Dunning Slough, there is a local increase in water surface elevation of greater than 4 feet. This is in an area that is under backwater conditions for the without-project condition that is now inundated due to the levee set-back. There is a similar increase in depth in the west floodplain immediately upstream of the HWY 32 Bridge where the levee is set-back.
- Downstream of HWY 32, there is a decrease in water surface elevation of 0.4 feet in the floodplain east of the river channel. A decrease of 0.1 to 0.2 feet carries upstream of HWY 32.
- The water surface elevation along the eastern edge of the model in the vicinity of Big Chico Creek increases by less than 0.2 feet in the vicinity of RM 193.

- There is no overflow to Butte Basin under the without-project condition. The project condition does not change this.
- The inundation limits in the vicinity of County Road 23 (CR 23), west of the levee/dike are slightly reduced for the with project condition

List of Attachments

1) Material types for the without-project conditions model.
2) Material types for the project conditions model.
3) Without-Project Condition, Depth Contours for the 320-Year Event
4) Without-Project Condition, Velocity Contours for the 320-Year Event
5) Without-Project Condition, Depth Contours for the 100-Year Event
6) Without-Project Condition, Velocity Contours for the 100-Year Event
7) Without-Project Condition, Depth Contours for the 50-Year Event
8) Without-Project Condition, Velocity Contours for the 50-Year Event
9) Without-Project Condition, Depth Contours for the 25-Year Event
10) Without-Project Condition, Velocity Contours for the 25-Year Flood Event
11) Without-Project Condition, Depth Contours for the 20-Year Event
12) Without-Project Condition, Velocity Contours for the 20-Year Event
13) Without-Project Condition, Depth Contours for the 1997 Event
14) Without-Project Condition, Velocity Contours for the 1997 Event
15) Tentatively Selected Plan, Depth Contours for the 320-Year Event
16) Tentatively Selected Plan, Change in Water Surface Elevation in Comparison to the Without-Project Condition for the 320-Year Event
17) Tentatively Selected Plan, Velocity Contours for the 320-Year Event
18) Tentatively Selected Plan, Change in Velocity in Comparison to the Without-Project Condition 20-Year Event

19) Tentatively Selected Plan, Depth Contours for the 100-Year Event
20) Tentatively Selected Plan, Change in Water Surface Elevation in Comparison to the Without-Project Condition for the 100-Year Event
21) Tentatively Selected Plan, Velocity Contours for the 100-Year Event
22) Tentatively Selected Plan, Change in Velocity in Comparison to the Without-Project Condition for the 100-Year Event

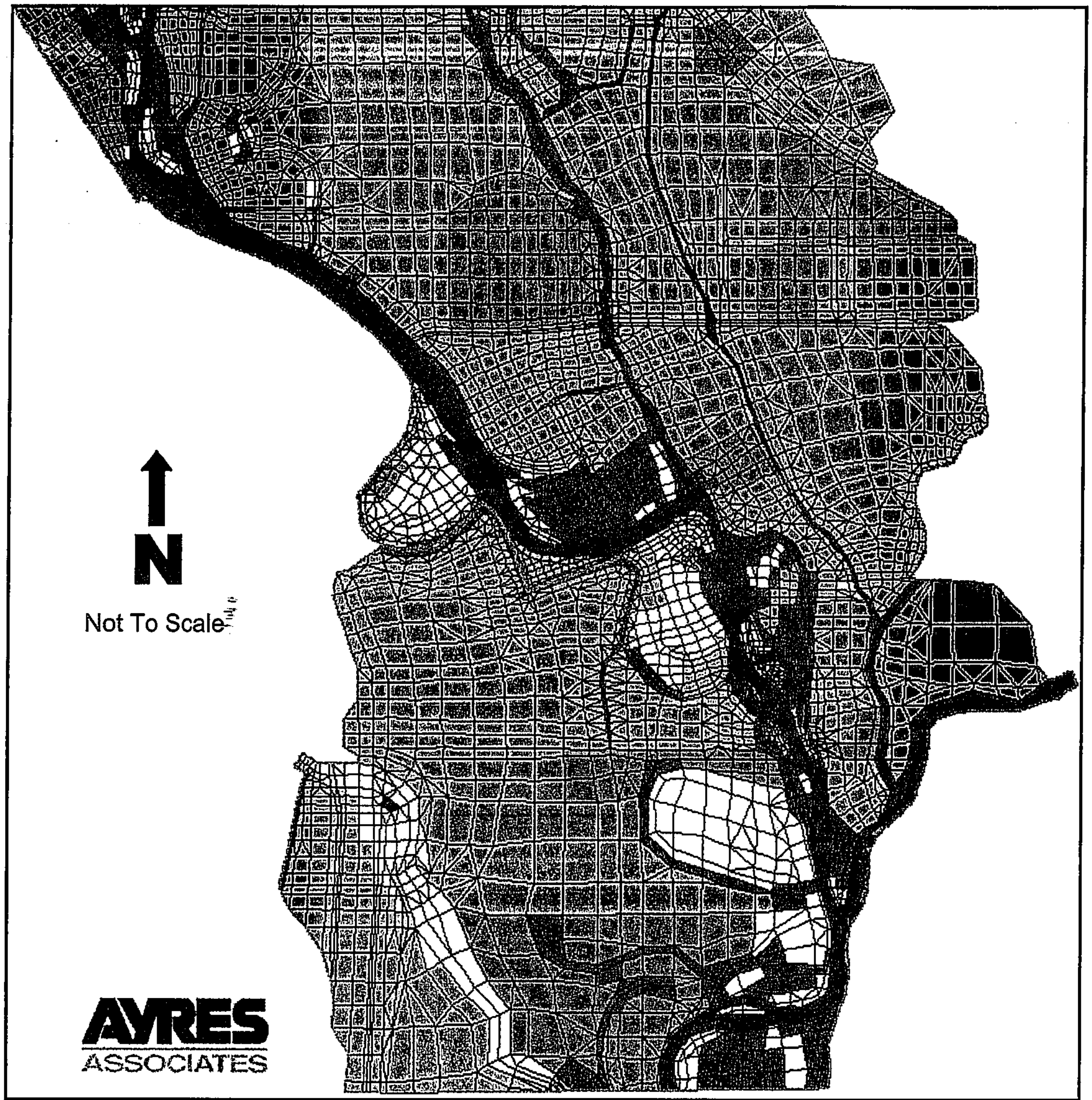
23) Tentatively Selected Plan, Depth Contours for the 50-Year Event
24) Tentatively Selected Plan, Change in Water Surface Elevation in Comparison to the Without-Project Condition for the 50-Year Event
25) Tentatively Selected Plan, Velocity Contours for the 50-Year Event
26) Tentatively Selected Plan, Change in Velocity in Comparison to the Without-Project Condition for the 50-Year Event

27) Tentatively Selected Plan, Depth Contours for the 25-Year Event
28) Tentatively Selected Plan, Change in Water Surface Elevation in Comparison to the Without-Project Condition for the 25-Year Event
29) Tentatively Selected Plan, Velocity Contours for the 25-Year Event
30) Tentatively Selected Plan, Change in Velocity in Comparison to the Without-Project Condition for the 25-Year Event

31) Tentatively Selected Plan, Depth Contours for the 20-Year Event

32) Tentatively Selected Plan, Change in Water Surface Elevation in Comparison to the Without-Project Condition for the 20-Year Event
33) Tentatively Selected Plan, Velocity Contours for the 20-Year Event
34) Tentatively Selected Plan, Change in Velocity in Comparison to the Without-Project Condition for the 20-Year Event

35) Tentatively Selected Plan, Depth Contours for the 1997 Event
36) Tentatively Selected Plan, Change in Water Surface Elevation in Comparison to the Without-Project Condition for the 1997 Event
37) Tentatively Selected Plan, Velocity Contours for the 1997 Event
38) Tentatively Selected Plan, Change in Velocity in Comparison to the Without-Project Condition for the 1997 Event



AYRES ASSOCIATES

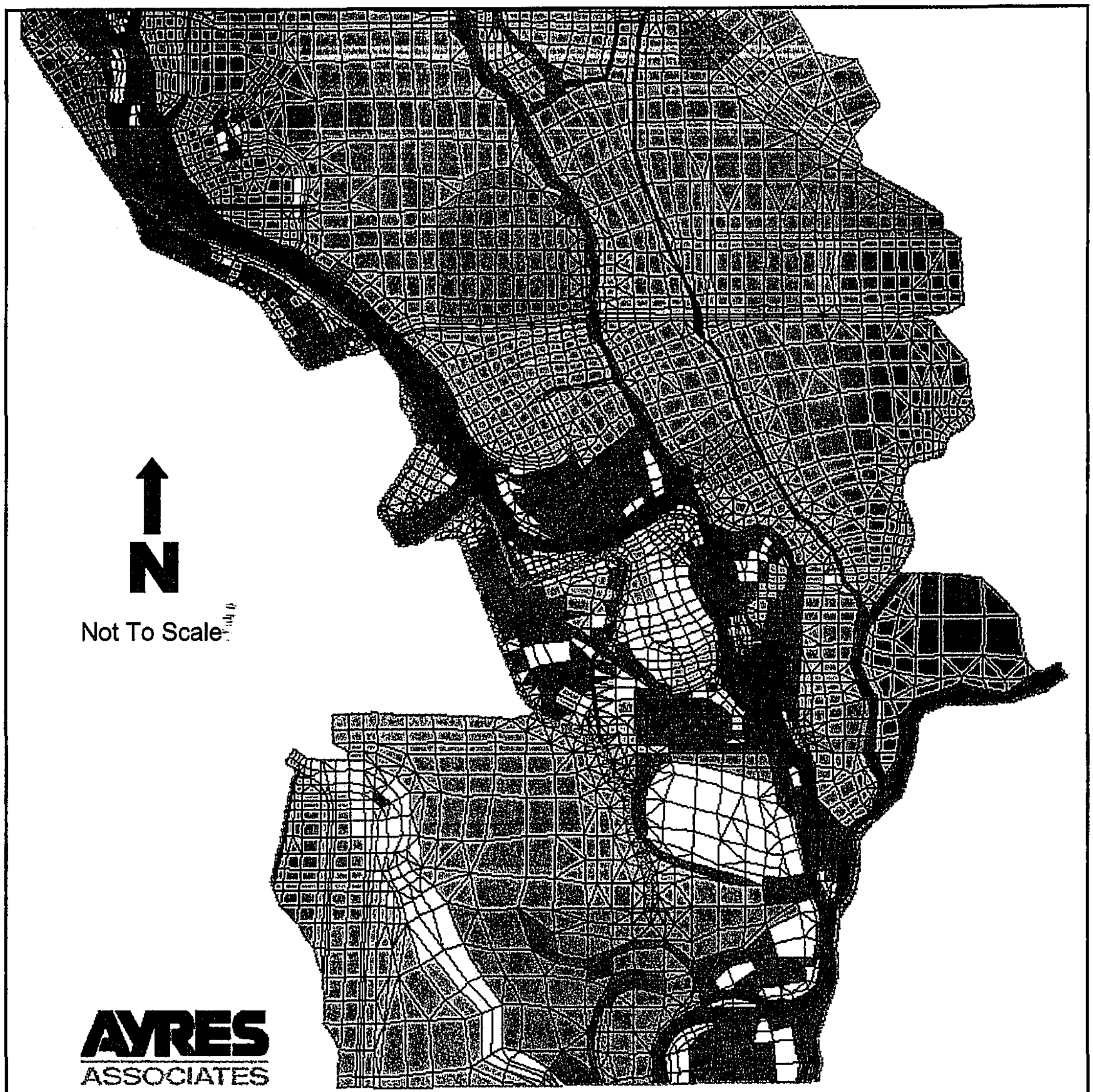
- □ Disable
- ■ 01 Main_Channel 0.035
- ▨ 02_Forest 0.16
- ■ 03_Orchard__0.15
- ■ 04_Cultivated_Field__0.035
- □ 05_Sand/Gravel__0.04
- ▨ 06_Stony_Creek_Bed__0.04
- □ 07_Pasture/Grassland__0.035
- ■ 08_Creek_Bed__0.035
- ■ 09_Levee/Road__0.025
- ■ 10_Pine_Creek_Bed__0.035
- ▨ 11_Buildings__0.2
- ■ 12_Area_of_Turbulent_Flow__0.2
- ■ 13_Area_of_Turbulent_Flow__0.5

Material Types (Manning's n Value)

Without Project Conditions

100 year flow - 275,910 cfs Sacramento River

- 27,400 cfs Stony Creek



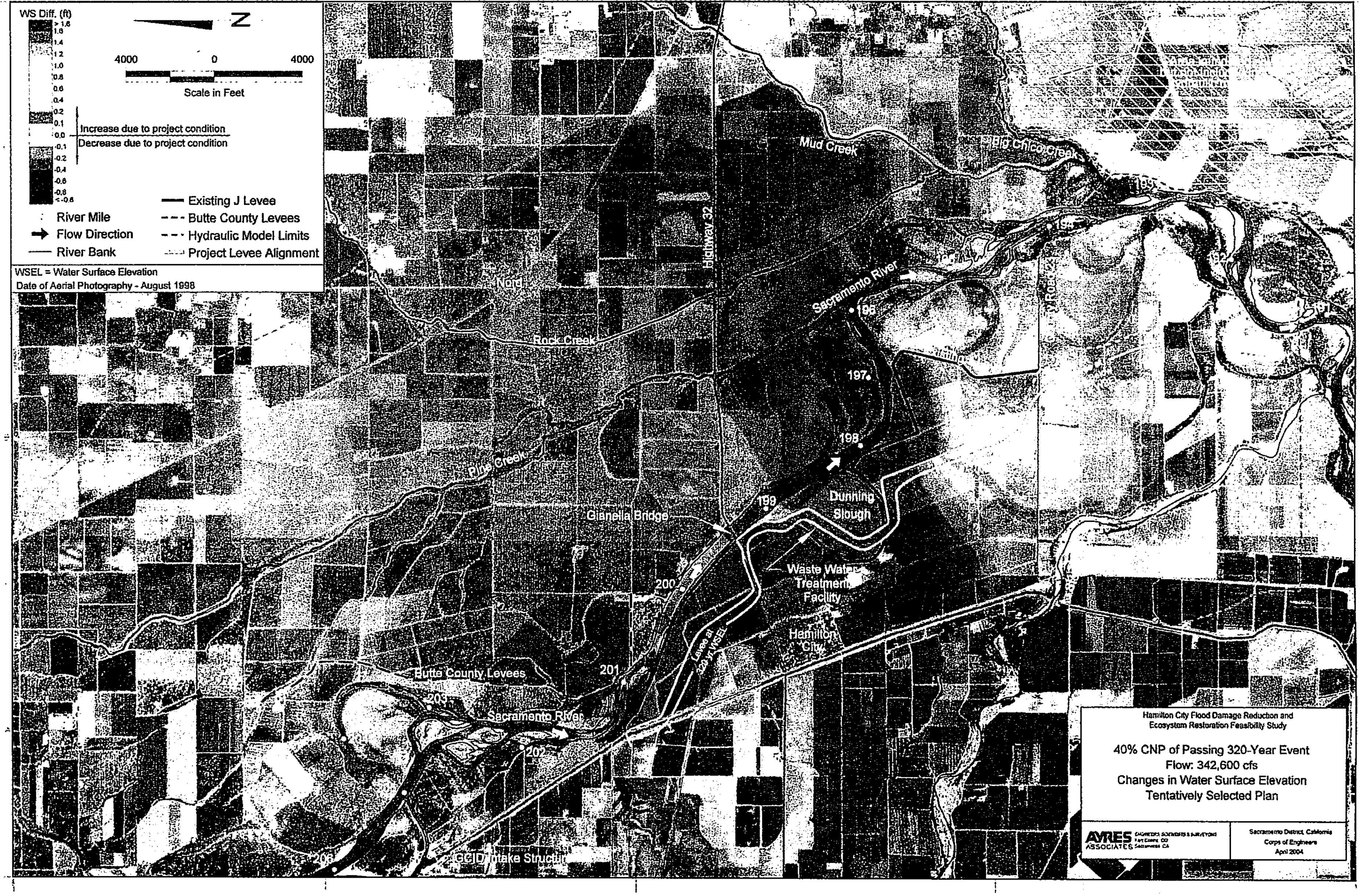
- □ Disable
- ■ 01_Main_Channel__0.035
- ■ 02_Forest/Riparian__0.16
- ■ 03_Orchard__0.15
- ■ 04_Cultivated_Field__0.035
- □ 05_Sand/Gravel__0.04
- ▨ 06_Stony_Creek_Bed__0.04
- □ 07_Pasture/Grassland__0.035
- ■ 08_Creek_Bed__0.035
- ■ 09_Levee/Road__0.025
- ■ 10_Pine_Creek_Bed__0.035
- ■ 11_Buildings__0.2
- ■ 12_Area_of_Turbulent_Flow__0.2
- ■ 13_Scrub 0.1
- ▨ 14 Savannah 0.05
- ■ 15 Area of Turbulent Flow 0.5

Material Types (Manning's n Value)

Project Conditions

100 year flow - 275,910 cfs Sacramento River

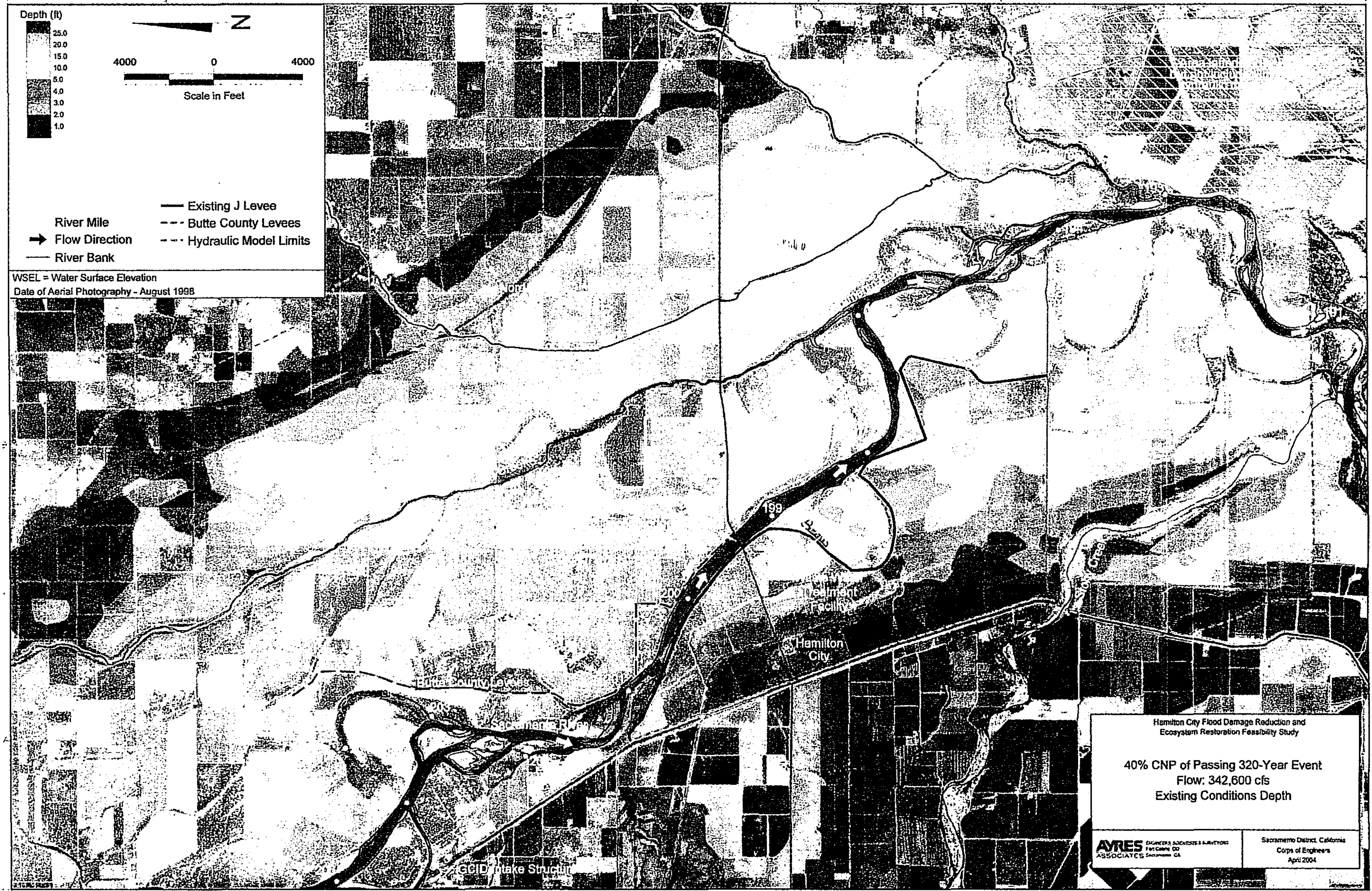
- 27,400 cfs Stony Creek



Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

40% CNP of Passing 320-Year Event
Flow: 342,600 cfs
Changes in Water Surface Elevation
Tentatively Selected Plan

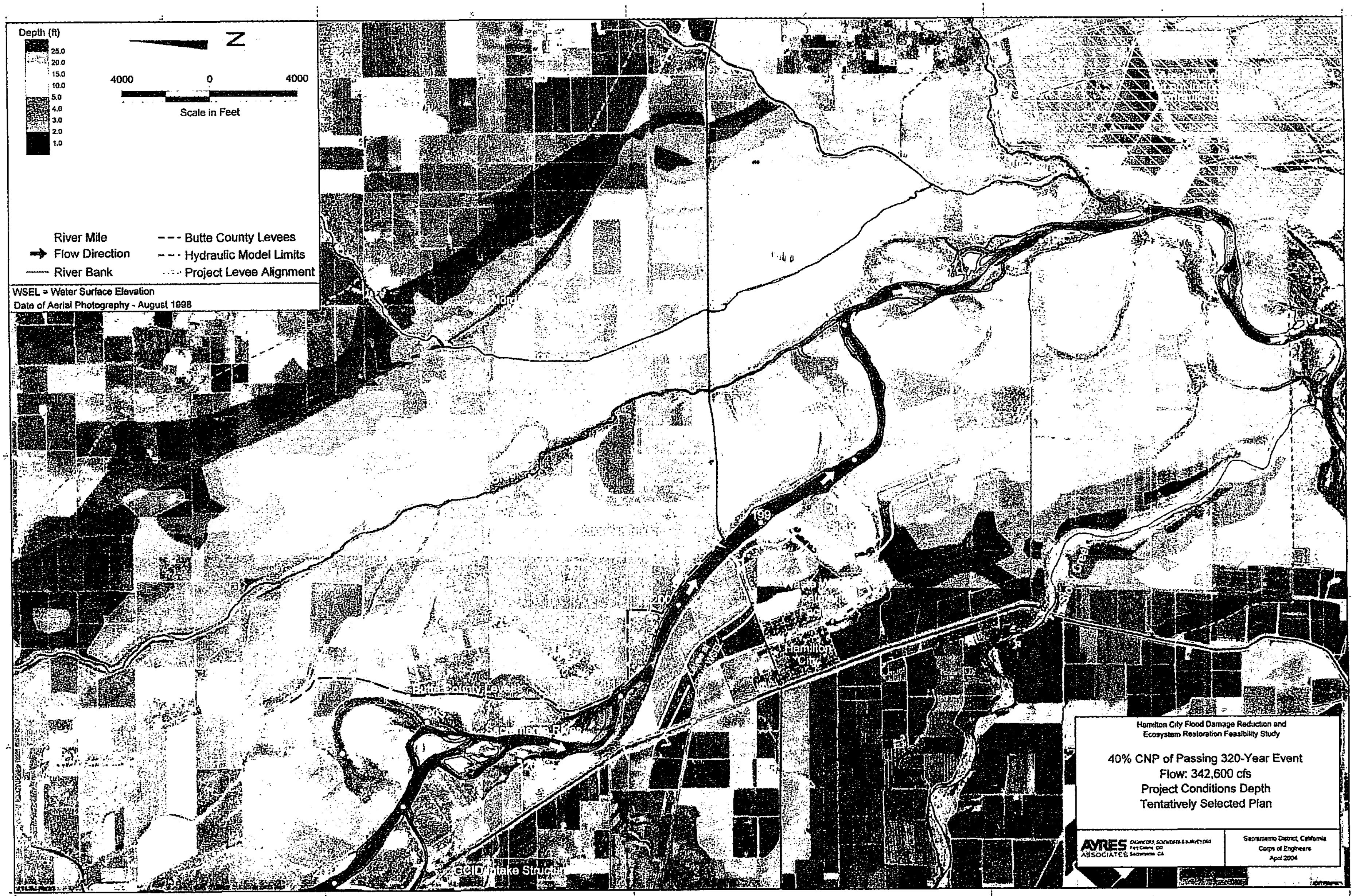
Sacramento District, California
Corps of Engineers
April 2004



Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

40% CNP of Passing 320-Year Event
Flow: 342,600 cfs
Existing Conditions Depth

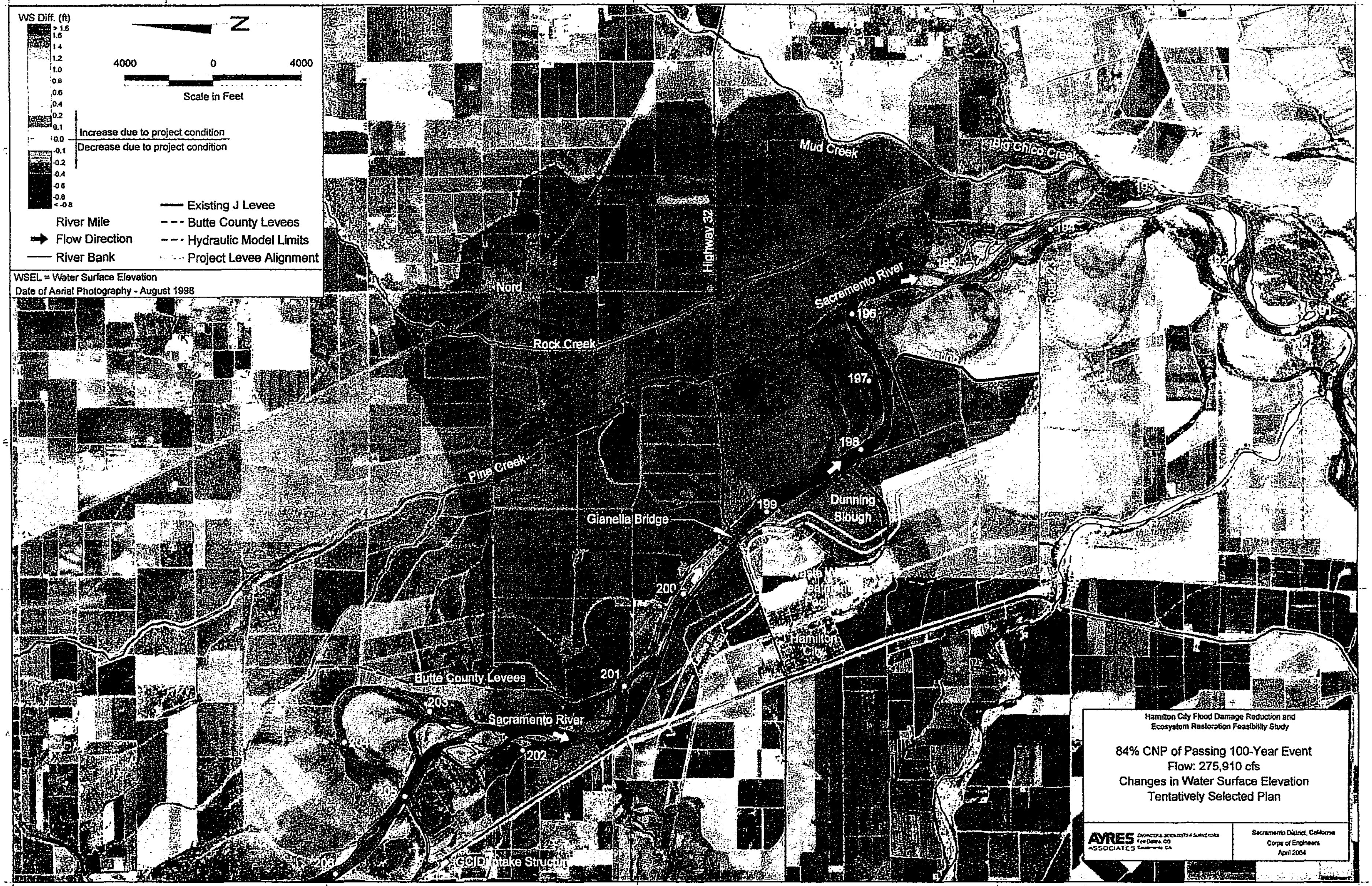
Sacramento District, California
Corps of Engineers
April 2004



Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

40% CNP of Passing 320-Year Event
Flow: 342,600 cfs
Project Conditions Depth
Tentatively Selected Plan

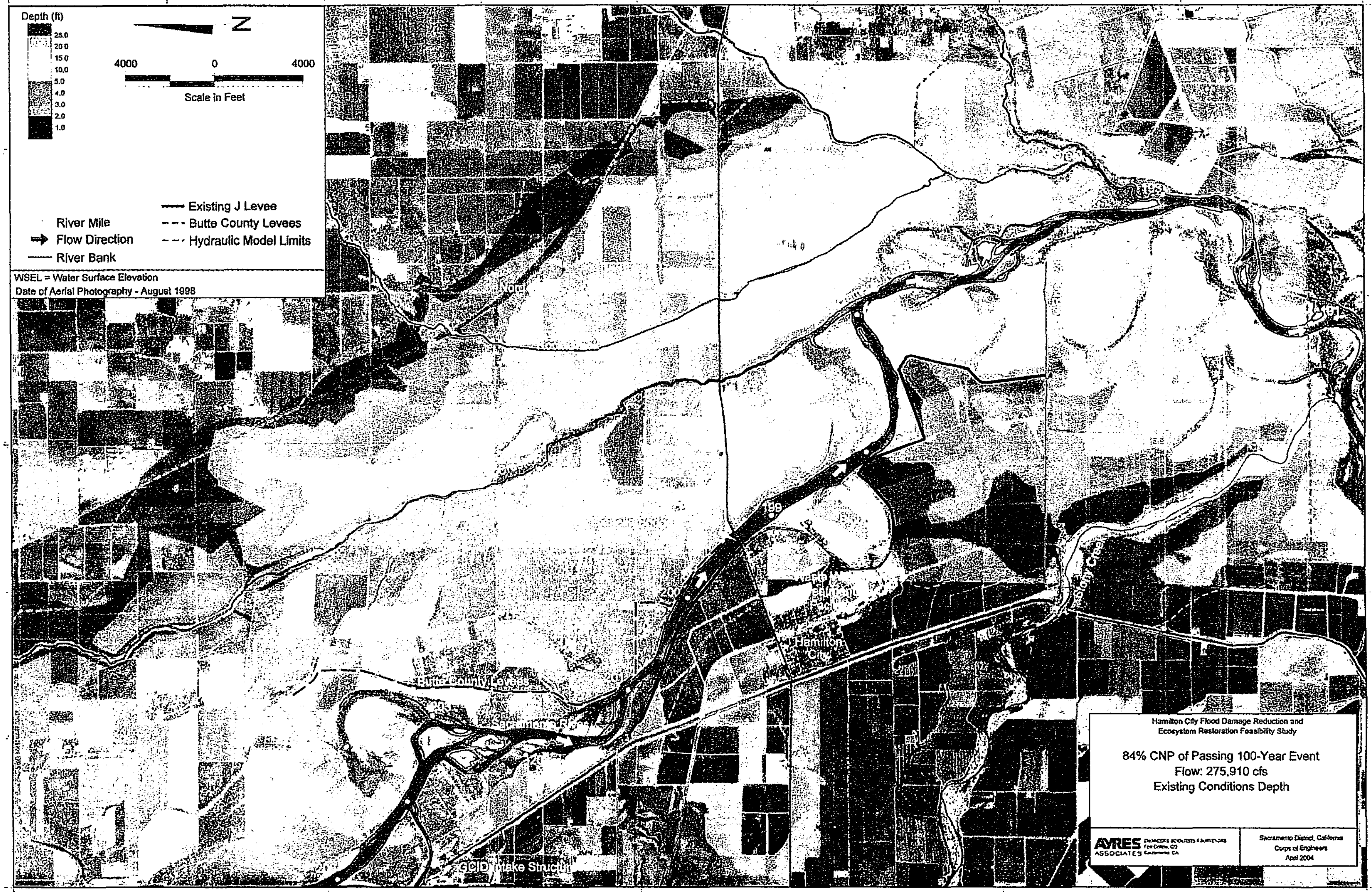
Sacramento District, California
Corps of Engineers
April 2004



Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

84% CNP of Passing 100-Year Event
Flow: 275,910 cfs
Changes in Water Surface Elevation
Tentatively Selected Plan

Sacramento District, California
Corps of Engineers
April 2004

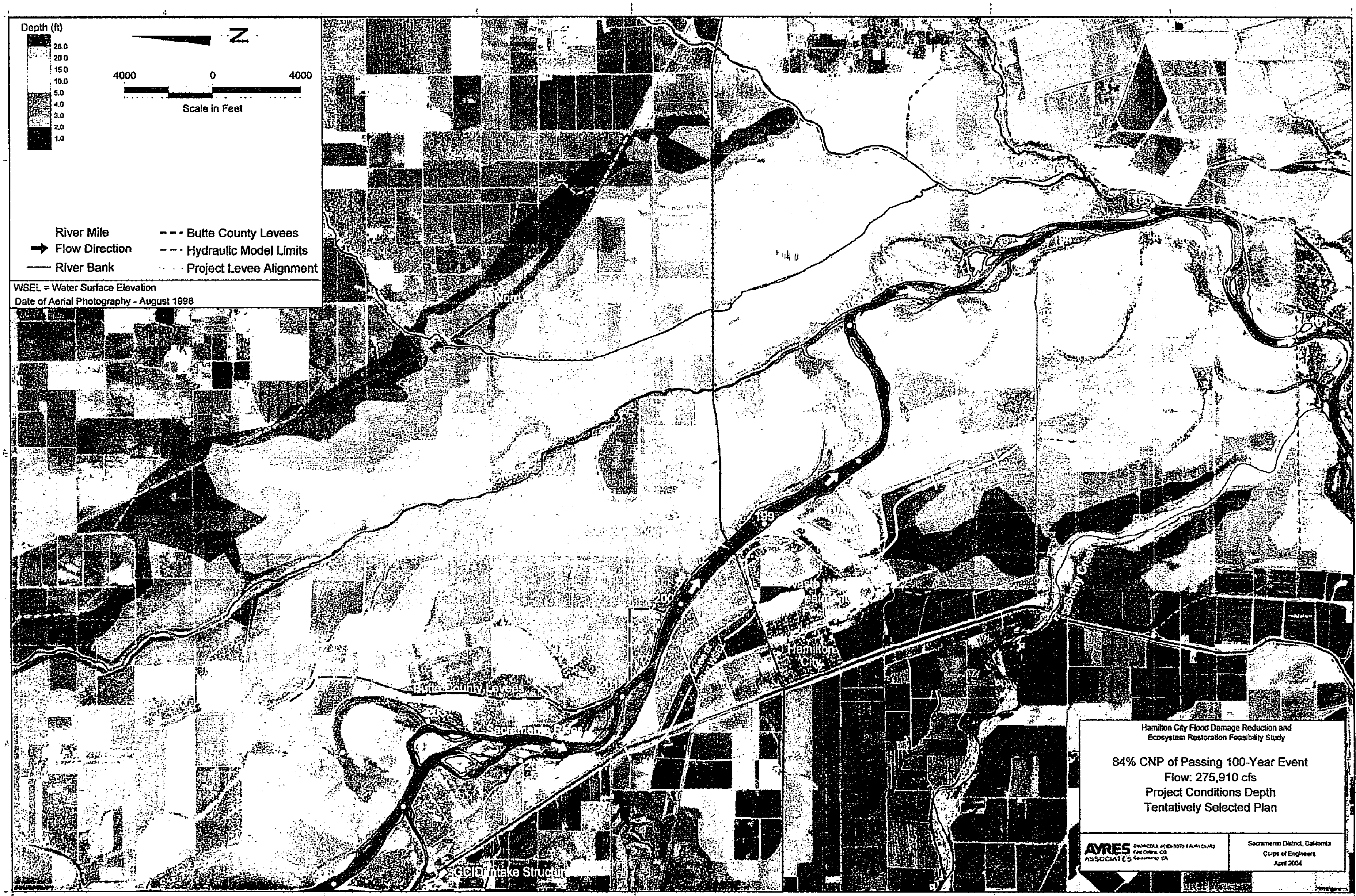


Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

84% CNP of Passing 100-Year Event
Flow: 275,910 cfs
Existing Conditions Depth

AYRES ASSOCIATES
Fort Collins, CO
Sacramento, CA

Sacramento District, California
Corps of Engineers
April 2004

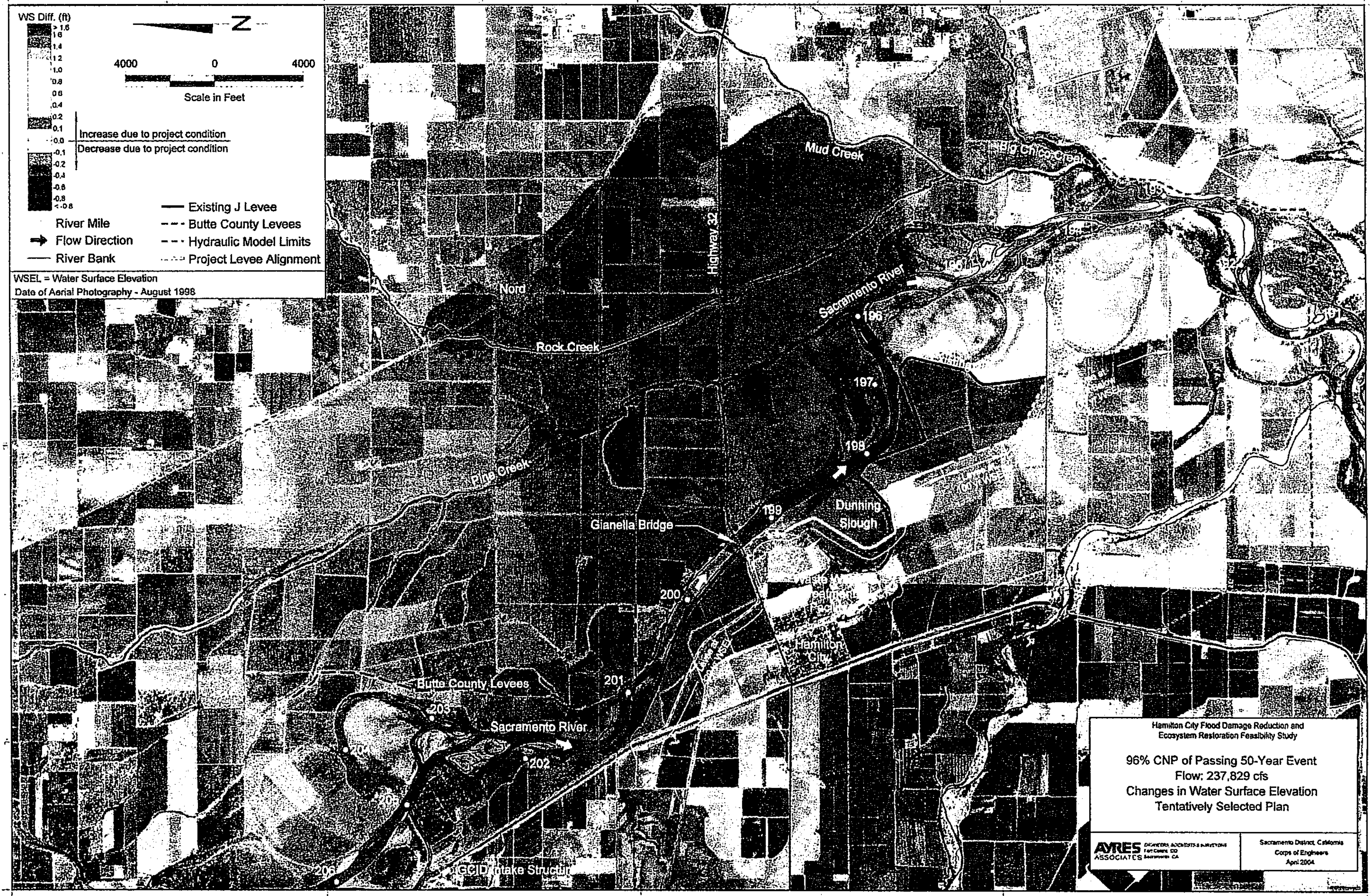


Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

84% CNP of Passing 100-Year Event
Flow: 275,910 cfs
Project Conditions Depth
Tentatively Selected Plan

AYRES ASSOCIATES
Fort Collins, CO
Sacramento, CA

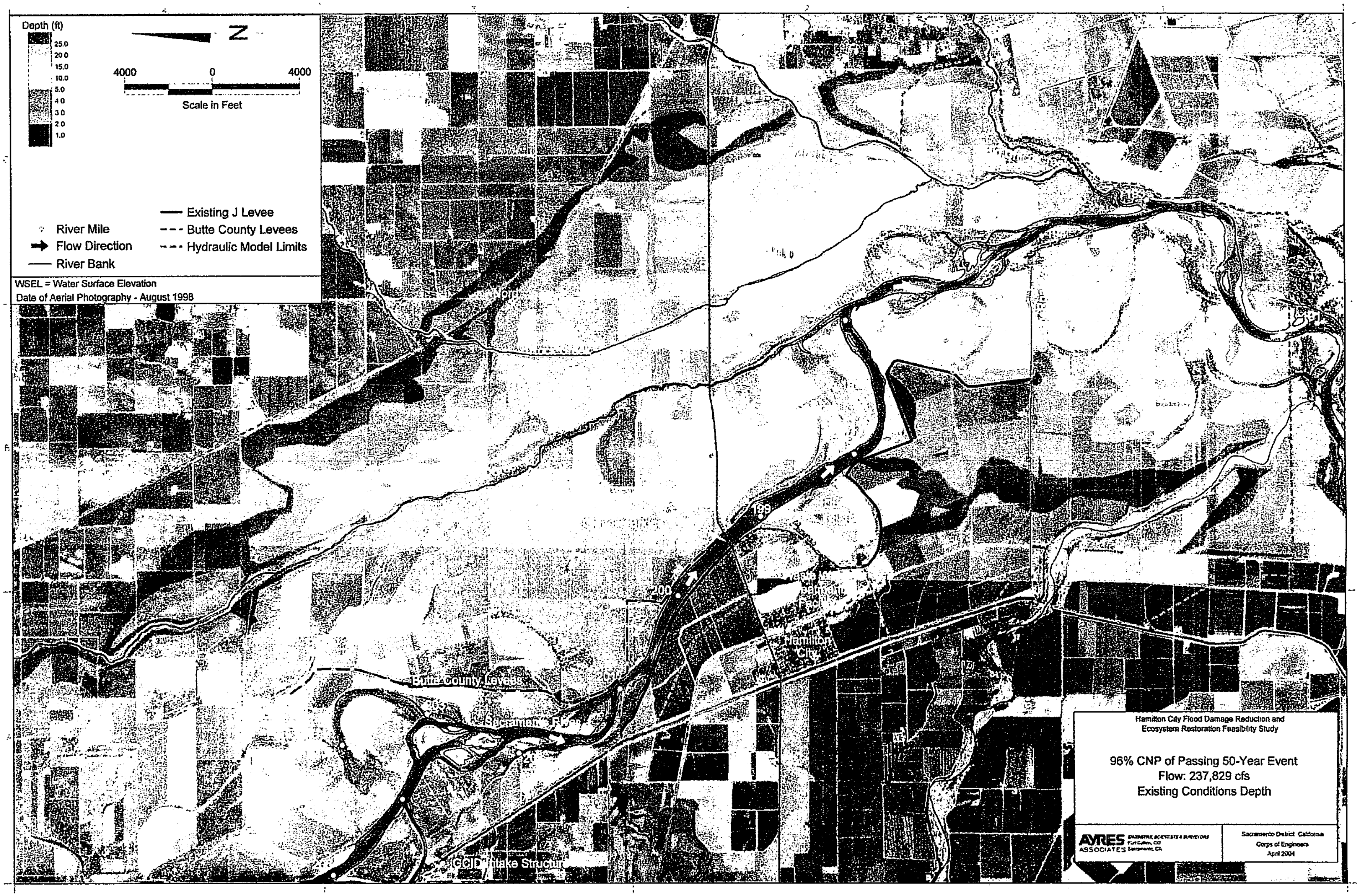
Sacramento District, California
Corps of Engineers
April 2004



Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

96% CNP of Passing 50-Year Event
Flow: 237,829 cfs
Changes in Water Surface Elevation
Tentatively Selected Plan

Sacramento District, California
Corps of Engineers
April 2004

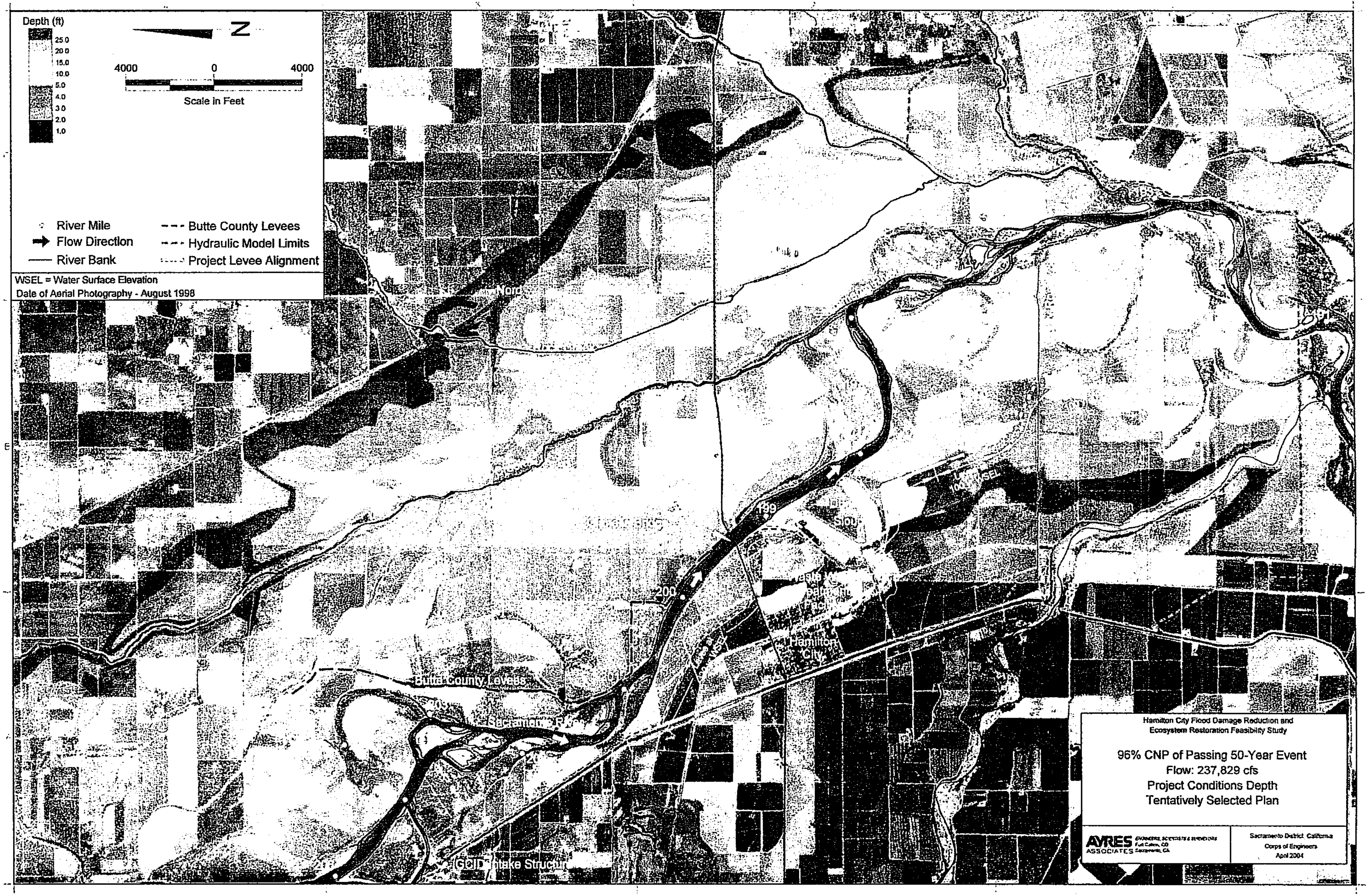


Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

96% CNP of Passing 50-Year Event
Flow: 237,829 cfs
Existing Conditions Depth

AYRES ASSOCIATES
Engineers, Scientists & Surveyors
Fort Collins, CO
Sacramento, CA

Sacramento District, California
Corps of Engineers
April 2004

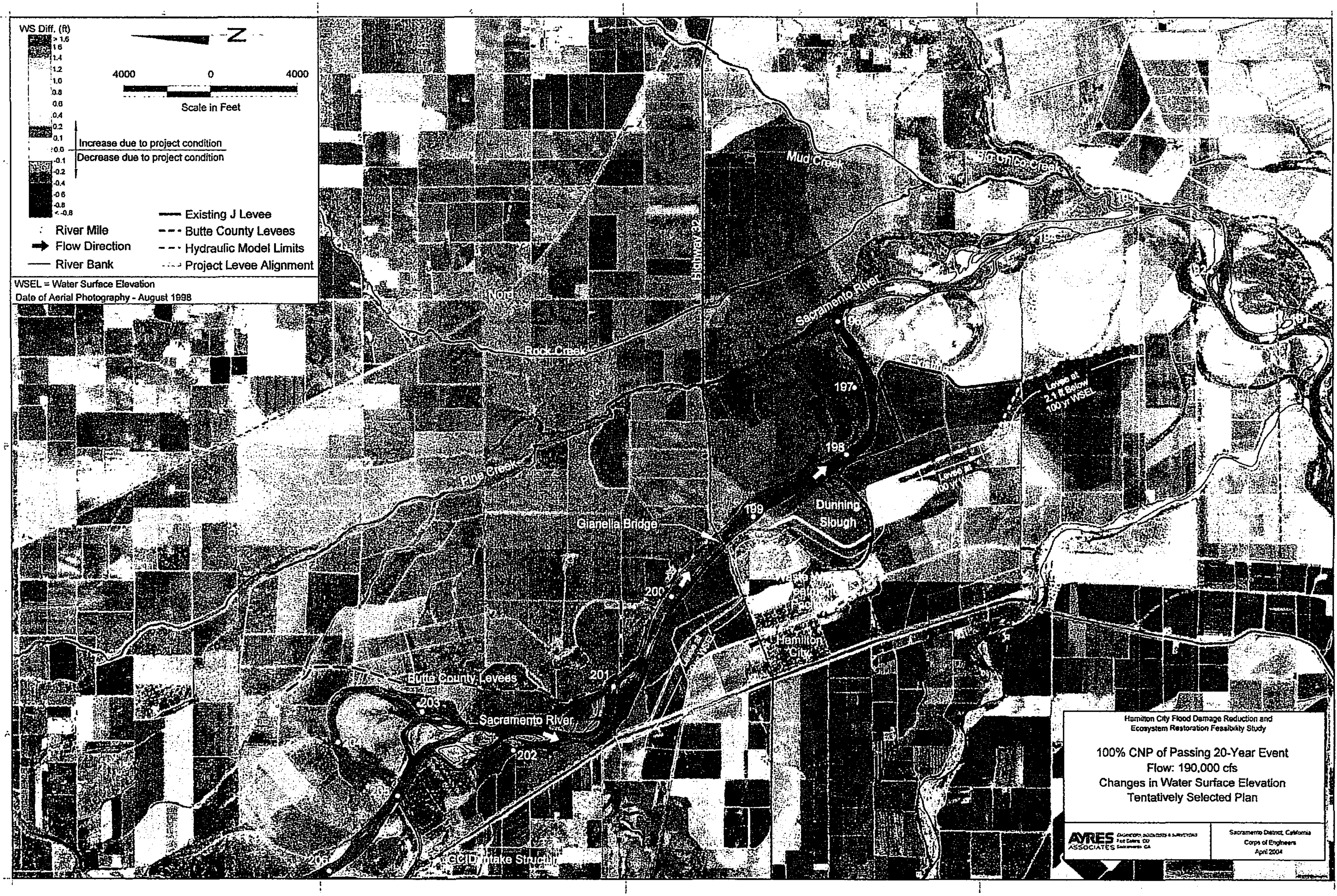


Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

96% CNP of Passing 50-Year Event
Flow: 237,829 cfs
Project Conditions Depth
Tentatively Selected Plan

AYRES ASSOCIATES
ENGINEERS, SCIENTISTS & SURVEYORS
Fort Collins, CO
Sacramento, CA

Sacramento District, California
Corps of Engineers
April 2004

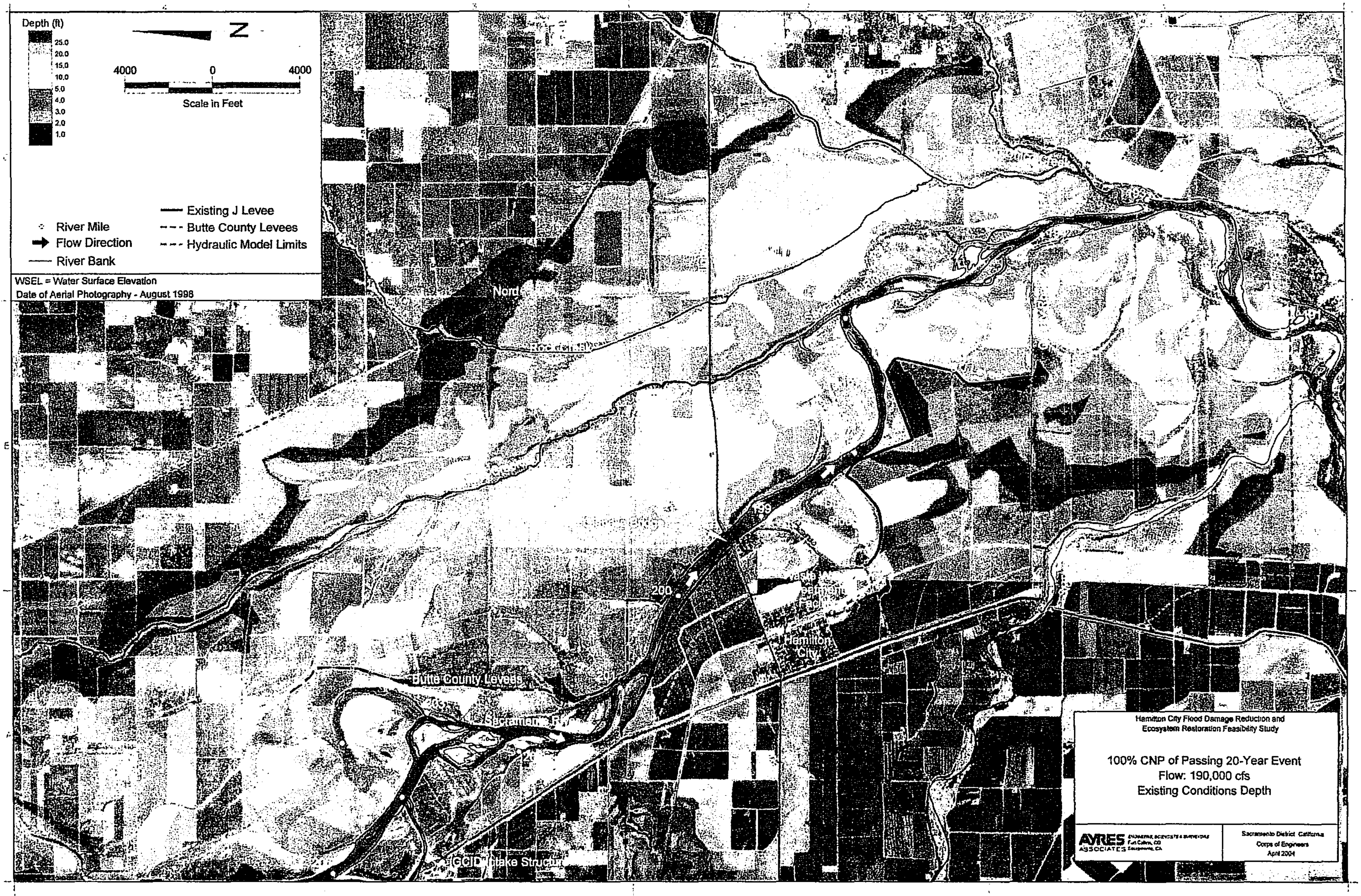


Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

100% CNP of Passing 20-Year Event
Flow: 190,000 cfs
Changes in Water Surface Elevation
Tentatively Selected Plan

AYRES ASSOCIATES

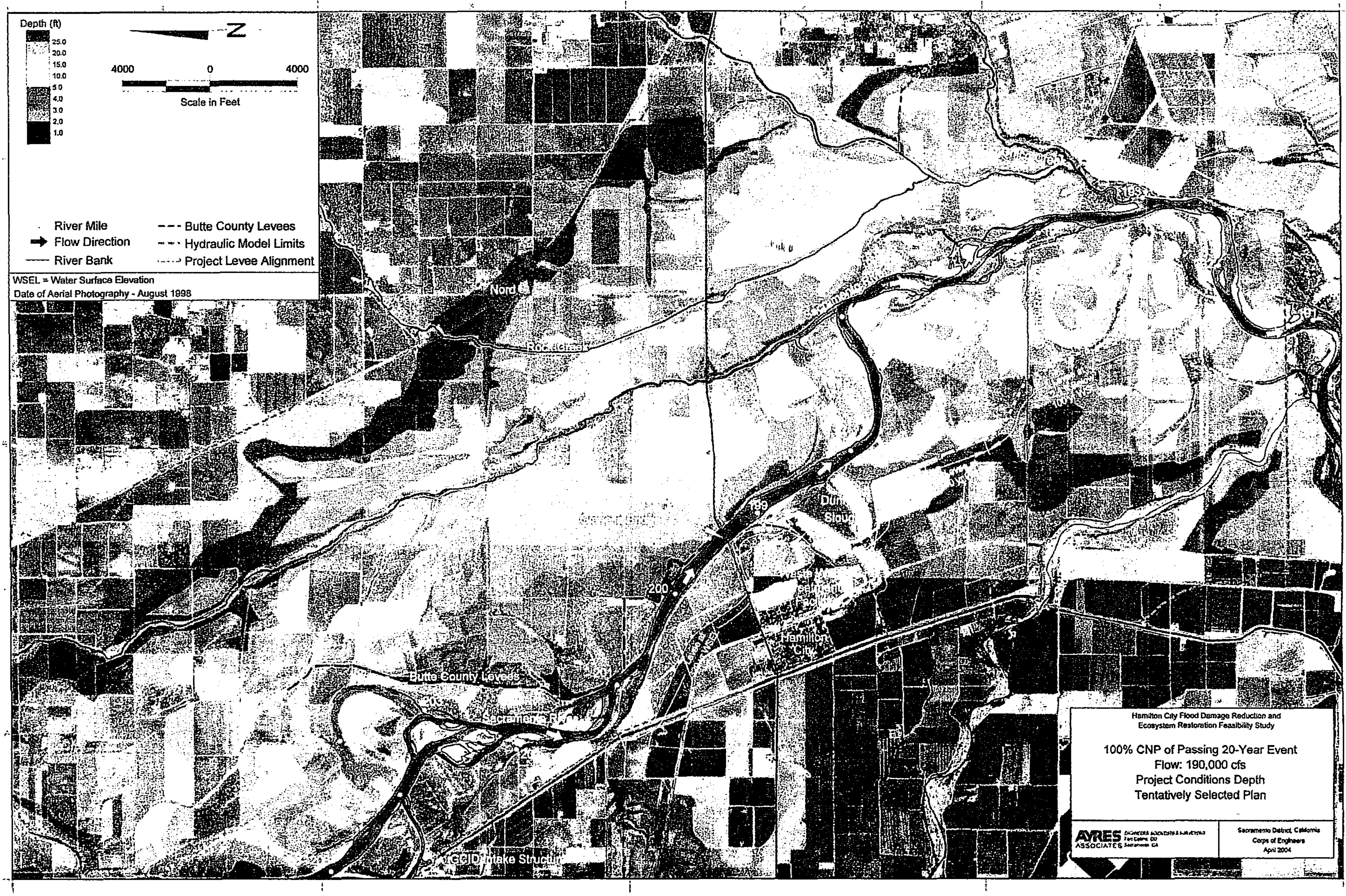
Sacramento District, California
Corps of Engineers
April 2004



Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

100% CNP of Passing 20-Year Event
Flow: 190,000 cfs
Existing Conditions Depth

Sacramento District California
Corps of Engineers
April 2004

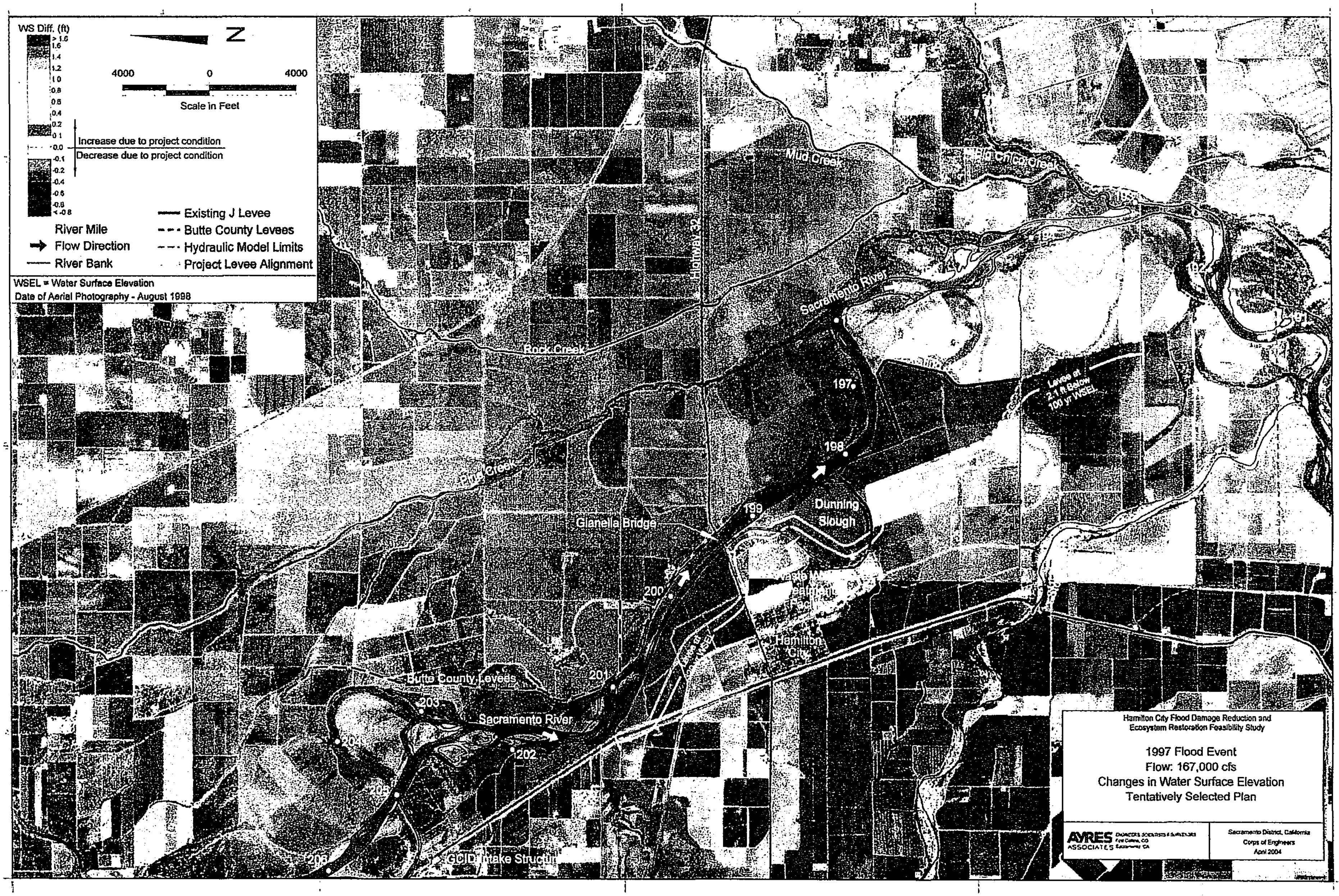


Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

100% CNP of Passing 20-Year Event
Flow: 190,000 cfs
Project Conditions Depth
Tentatively Selected Plan

AYRES ASSOCIATES
Engineers Scientists & Surveyors
Fort Collins, CO
Sacramento, CA

Sacramento District, California
Corps of Engineers
April 2004

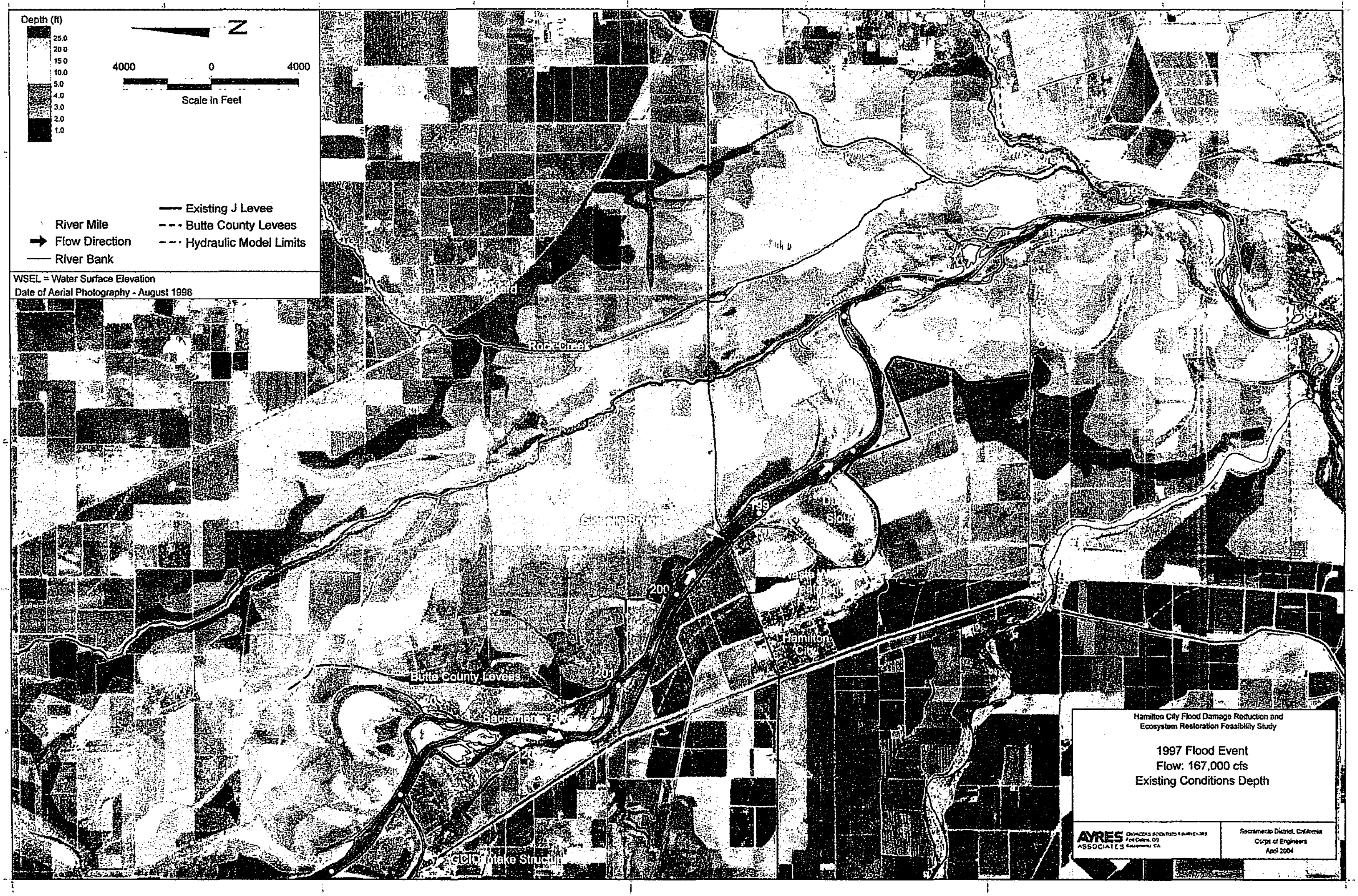


Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

1997 Flood Event
Flow: 167,000 cfs
Changes in Water Surface Elevation
Tentatively Selected Plan

AYRES ASSOCIATES Engineers Scientists & Surveyors Fort Collins, CO Sacramento CA

Sacramento District, California
Corps of Engineers
April 2004

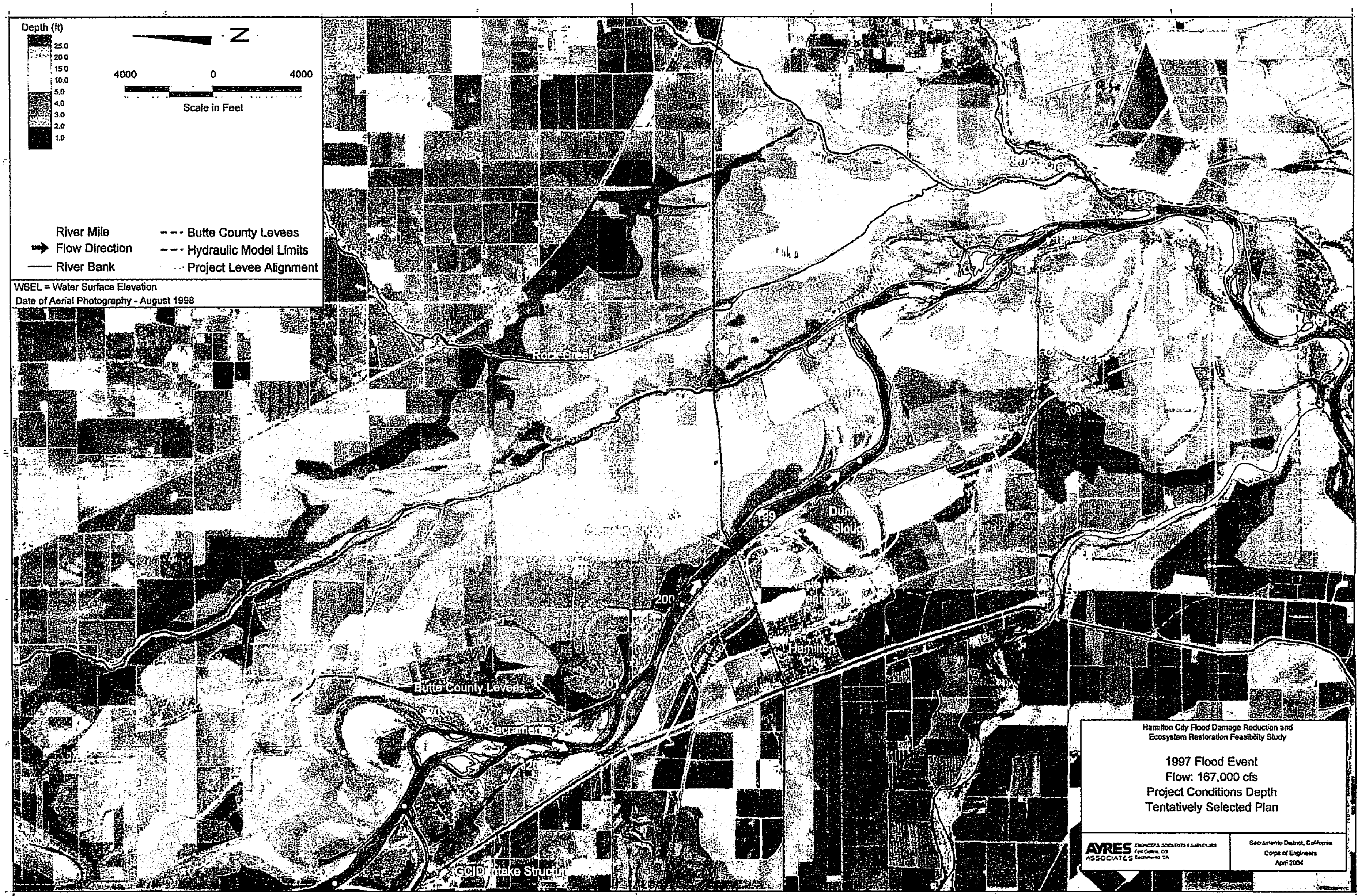


Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

1997 Flood Event
Flow: 167,000 cfs
Existing Conditions Depth

AYRES ASSOCIATES
Engineers Scientists Surveyors
Fort Collins, CO
Sacramento, CA

Sacramento District, California
Corps of Engineers
April 2004



Hamilton City Flood Damage Reduction and
Ecosystem Restoration Feasibility Study

1997 Flood Event
Flow: 167,000 cfs
Project Conditions Depth
Tentatively Selected Plan

AYRES ASSOCIATES

Sacramento District, California
Corps of Engineers
April 2004

Appendix C4.

GEOTECHNICAL
Basis of Design

HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION, CA

Geotechnical Report

Basis of Design

February 2004

U.S. Army Corps Of Engineers
South Pacific Division - Sacramento District
Geotechnical Branch - Soil Design Section

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Tables

Figures

Appendices

1.0 INTRODUCTION

The purpose of this report is to present the findings of a geotechnical study on an existing private levee and a proposed setback levee. The existing private levee is know as the "J-Levee" and is located in the vicinity of Hamilton City, CA (85 miles north of Sacramento) along the west bank of the Sacramento River in Glenn County (Figure 1). Land use in the area is primarily agricultural with fruit and nut orchards being the primary crops. Hamilton City has a population of about 2,000 people.

The J-levee extends approximately two miles north and six miles south of Highway 32 and is bordered on the west by the Glenn Colusa Canal and on the east by the Sacramento River. In recent years the Sacramento River has begun to migrate to the west and is currently eroding into the toe of the levee in the northern part of study area. A 1,000-foot emergency backup levee was built in 2002 by Glenn County to augment the existing J-levee in case of failure.

The J-levee was constructed about 1904 by Glenn County landowners and provides some flood protection for Hamilton City. However, it was not constructed to formal engineering standards and is highly erodible when river levels rise. Failure of the J-Levee in 1974 caused flooding in the area and emergency maintenance procedures (flood fighting) are routinely needed during high river levels. Previous experience has shown that when the river stage is sustained at an elevation higher than 142 MSL for several days, seepage will develop under the J-levee into a walnut orchard on the north side of Highway 32. Furthermore, sand boils have developed during past flood events just south of town in the area of the Hamilton City wastewater treatment plant.

This report will discuss the analysis and design of a new setback levee, risk-based evaluations of the existing J-levee, existing explorations and conclusions/recommendations. Upon completion of the feasibility report, additional subsurface explorations and engineering will be performed during the Pre-construction Engineering and Design Phase (PED).

1.1 Regional and Site Geology

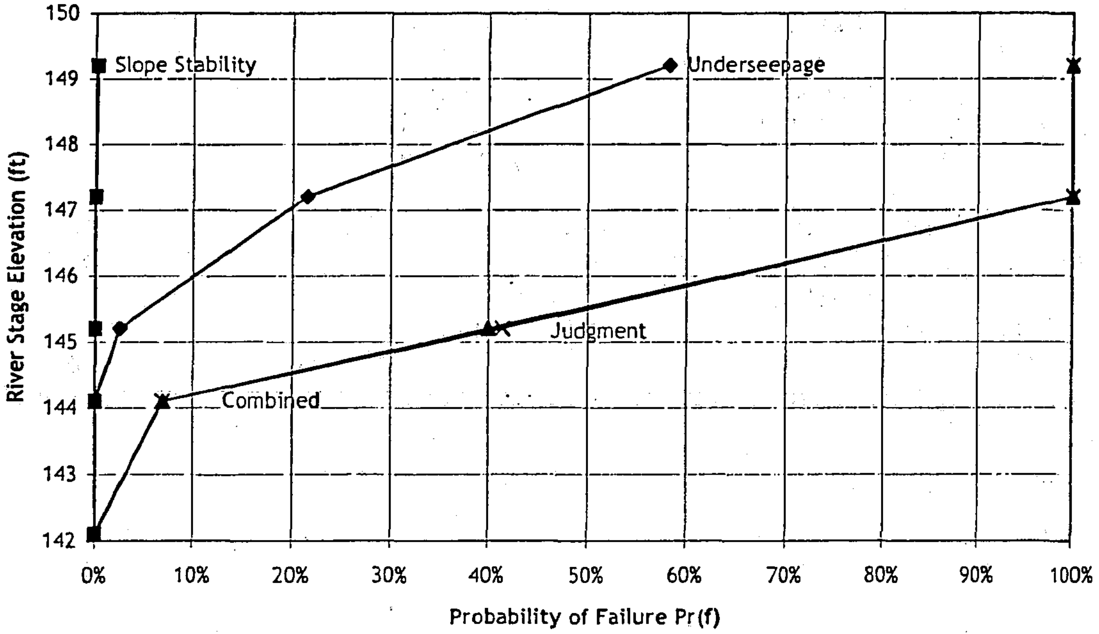
Information relative to regional and site geology can be found in Chapter 4 - Affected Environment, page 4-1.

The J-Levee and it's foundation are actively eroding in several areas north of Dunning Slough. Between Highway 32 and Dunning Slough, the levee itself has eroded. North of Highway 32, foundation erosion has cut into the projected toe of the levee in several spots. The index point at River Mile 198.25 is being used for R.M. 198 to 201 primarily due to erosion activity. In addition, the levee geometry (height, side slopes) is similar over this reach, and existing soil borings indicate the levee is made of sandy silt, clay, and silty sand over this reach.

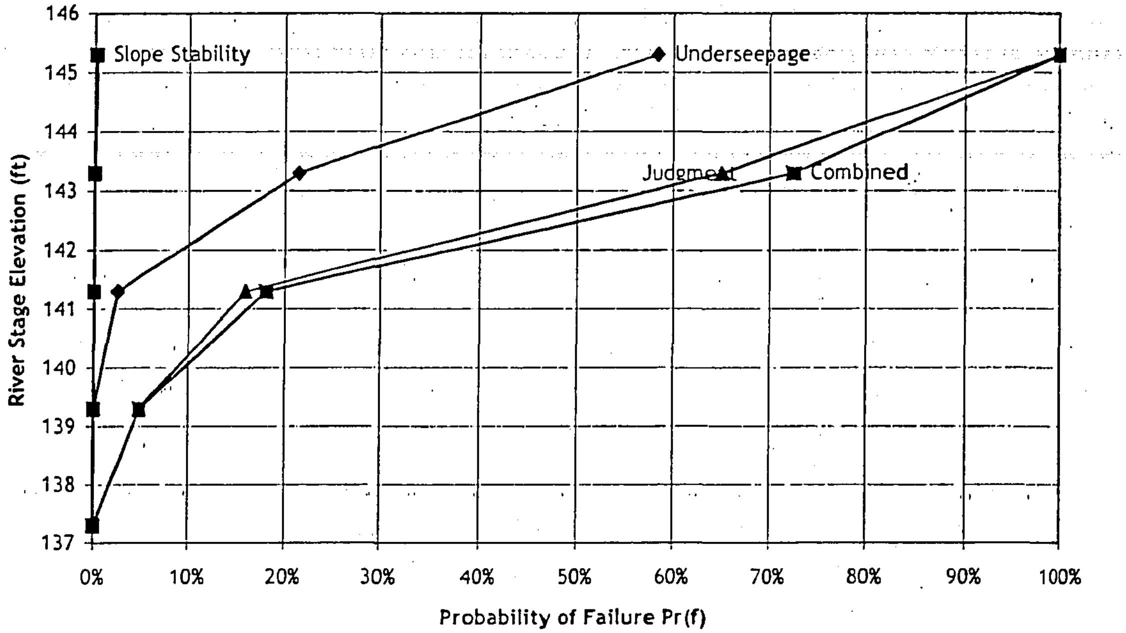
The second index point is at River Mile 197.25 and was chosen primarily because the top of the levee is low in this area. The Pr(f) curve for that point is shown on Figure 4. At that point, the top of the levee is at elevation 145.3 feet. The PFP is at elevation 144.3 feet (1 foot below the top of levee) and the PNP is at elevation 140.8 feet (4.5 feet below the top of levee). This curve is applicable south of Dunning Slough (river miles 198 to 194). As can be seen from the curves, slope stability is not a concern for the J-Levee. Erosion/poor construction/spotty maintenance (in the judgment curve) and underseepage are the likely causes of failure for the J-Levee.

Figure 2: Pr(f) Plots for Existing J-Levee

River Mile 198.25, North of Dunning Slough



River Mile 197.25, South of Dunning Slough



2.2 Risk-Based Analysis of the Wastewater Treatment Plant Levee

The Hamilton City wastewater treatment plant (WWTP) is situated along the waterside toe of the J-Levee (RM 198) and is surrounded by an independent levee system. It is comprised of seven settling ponds of which three are usually dry. The ponds are 243 feet wide and range in length from 260 to 500 feet. The average invert of the ponds is located at elevation138 feet (MSL).

The WWTP levee is approximately 6 feet high (measured from the waterside) and has 2:1 landside slopes, 3:1 waterside slopes and a crest width of twelve feet.. The crest of the WWTP levee is roughly one foot lower than the J-Levee and has waterside toe and crest elevations of about 142 and 148 feet, respectively. It is comprised of a silty clay and resides on a foundation similar to that of the J-Levee. The upper stratum beneath the WWTP levee is estimated to be 9.5-feet, but is only three feet thick below the settling ponds due to the invert elevation of 138. The lower substratum is a semipervious, silty sand and is thought to extend to a depth of 50 feet or more. A representative cross section is found in Appendix 1.

The WWTP levee was evaluated using the same reliability analysis described earlier. Individual Pr(f) curves were developed for underseepage and judgment, but slope stability was excluded. It was deemed reasonable to exclude this analysis because the same procedure performed on the J-Levee indicated that slope stability was not a concern (see Figure 3). The WWTP levee is not only in better physical condition than the J-Levee, but has a shorter height resulting in a more stable configuration.

The Pr(f) curve for underseepage is based upon seepage modeling that was performed at three different water elevations of 144, 146 and 147 feet. Statistical analysis based on 51 seepage models showed a probability of failure of 2.9, 21.8 and 33.5% for the three waster surfaces evaluated, respectively.

The Pr(f) curve for judgment is based on erosion, maintenance, vegetative cover, rodent activity and past performance. Erosion on this structure is practically nonexistent and it has been adequately maintained since its construction. Vegetative cover is adequate and rodent activity is minimal. In regards to performance, a reliability of 100% at elevation 143 is assumed to be reasonable since only one foot of differential head would be acting against the levee. Zero percent reliability is expected at an elevation of 147.5, which is 0.5 feet below the crest. This failure point is supported by levee performance during 1997 high water levels. Though a catastrophic failure was not experienced, boiling did occur in the settlement ponds resulting in a condition that could lead to progressive failure.

The "combined" curve in Figure 4 is the multiplicative result of the underseepage and judgment reliabilities for a given water surface elevation. The PNP and PFP are based upon this curve and are found through interpolation at the points of 15% and 85% probability of failure. Through the statistical analysis described herein, the PNP and PFP for the WWTP levee were found to be 144.3 and 147.2, respectively.

Figure 3: Pr(f) Plot for the wastewater treatment facility levee

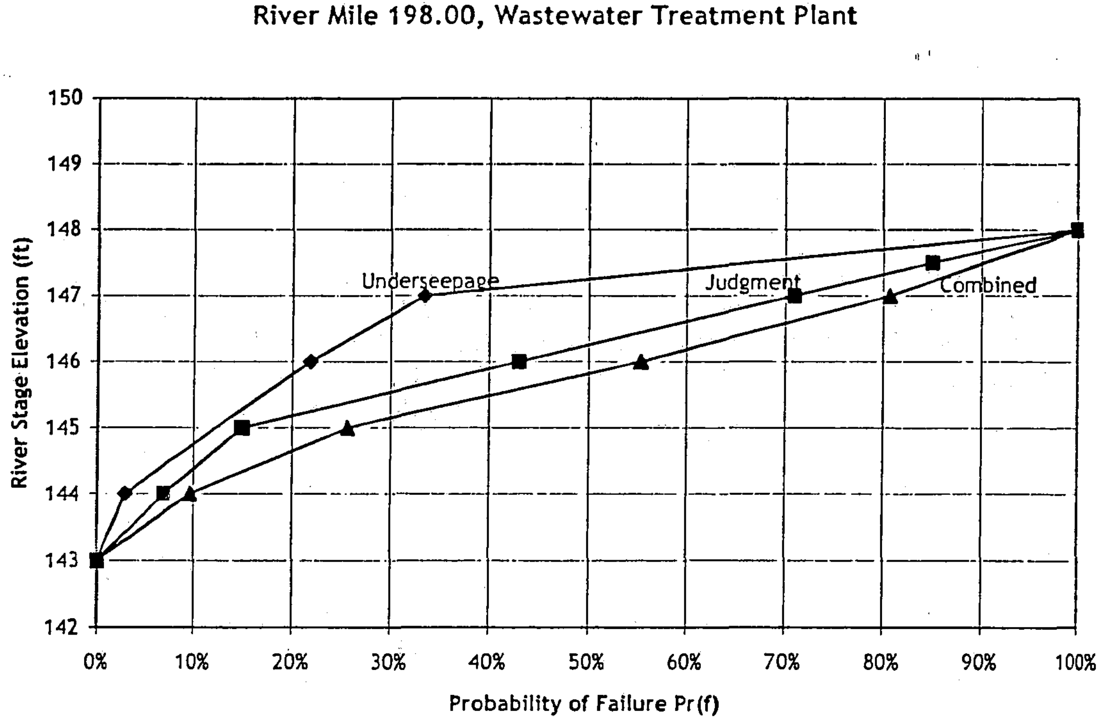


Table 1. PNP/PFP Information

Levee Failure Curve	R.M. 198.25	R.M. 197.25	Wastewater Treatment Plant
Top of Levee	149.2	145.3	148.0
PFP	146.8	144.3	147.2
PNP	144.3	140.8	144.3

3.0 EXISTING EXPLORATIONS

Soil properties for seepage and slope stability analysis were derived from three different exploration projects conducted over the past decade. Copies of the soil logs from these projects are found in Appendices 2 through 4. Location of the borings are shown in Figure 2. Ayres Associates conducted the most recent in October 2001. Their project consisted of 18 soil borings ranging from 16.5 to 46.5 feet in depth. Eight of the borings were located on the existing J-levee and ten were located in areas west of the existing J-levee. These holes are designated SB-1 through SB-18 with approximate locations listed in Table 2 and shown in Figure 4.

In September 2000, the Department of Water Resources conducted a brief geologic investigation in which four boreholes were drilled in the area of the northern most section of the existing J-Levee. These holes ranged from 46.5 to 51.5 feet in depth and are labeled as BH-1 through BH-4. In September 1991, a monitoring well installation project by Brown & Caldwell took place in the area of Dunning Slough and the Hamilton City wastewater treatment plant. This data set, however, is largely incomplete and provided limited information. These holes ranged in depth from 36.5 to 41 feet in depth and are label as MW-4 through MW-7.

Boreholes were driven using hollow stem augers with Shelby tube samples being taken every five to ten feet. The Modesto Formation was encountered in the first 10 to 15 feet and was usually underlain by the Tehama Formation. Geologic control is provided by the more erosion resistant Tehama unit that is comprised of sandstone or siltstone with lenses of cross-bedded pebble and cobble conglomerate. The Modesto Formation contains slightly weathered gravel, sand, silt and clay (DWR, 2000). The lithology encountered in most holes consisted of a relatively impervious top stratum (10 to 15 feet thick) consisting of fine grain materials such as clay or silty clay (CL, CL-ML) and a pervious substratum of poorly graded sands or gravelly sand.

Figure 4: Local map showing location of soil borings.

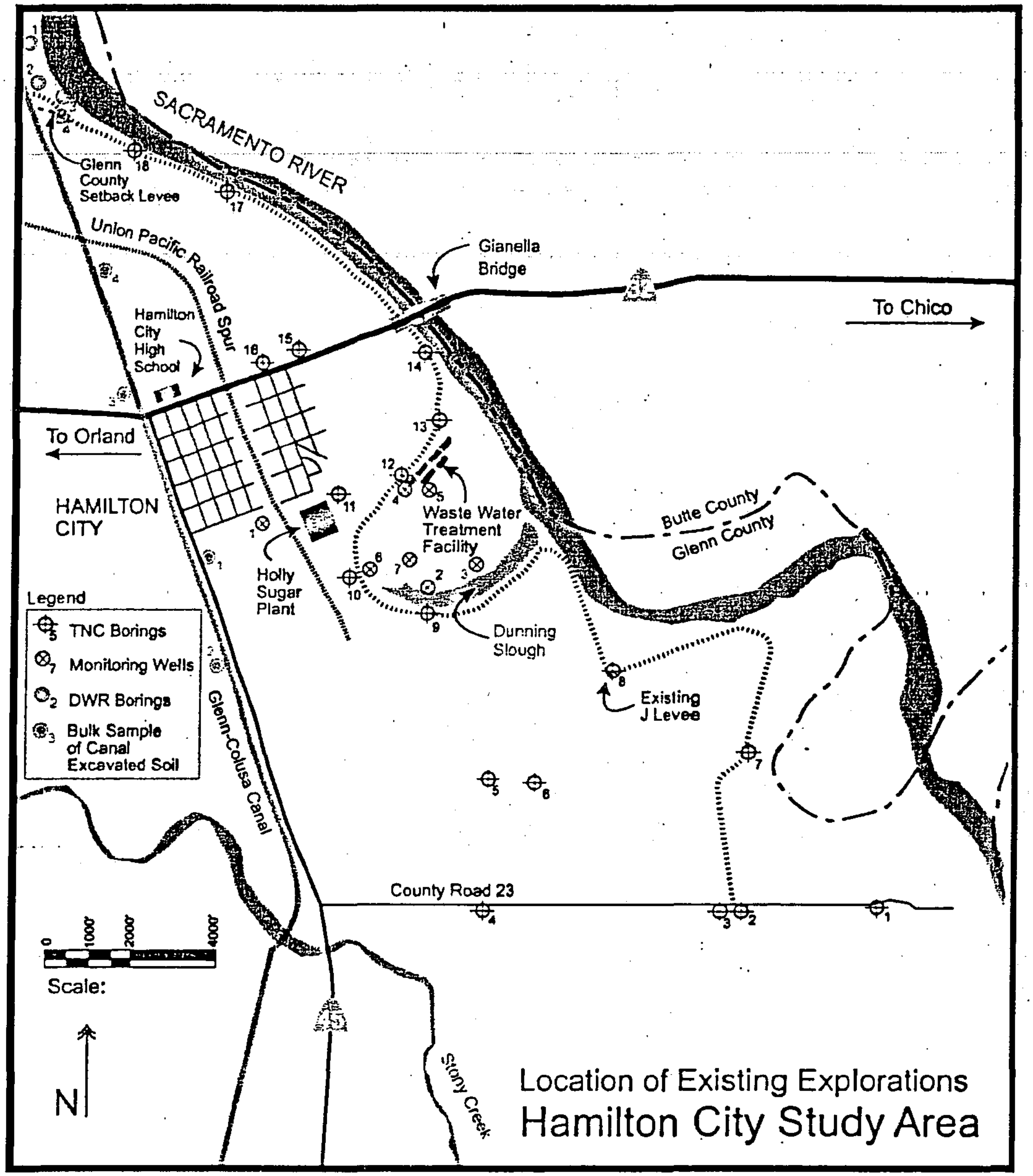


Table 2: Location of existing explorations

Hole #	Location	Latitude	Longitude	Total Depth (ft)	Water Depth (ft)
SB-1	County Road 23	N 39-42-45.5	W 121-57-32.6	26.5	11.9
SB-2	County Road 23	N 39-42-45.3	W 121-58-11.8	31.5	13.9
SB-3	County Road 23	N 39-42-45.6	W 121-58-13.5	26.5	15.8
SB-4	County Road 23	N 39-42-46.0	W 121-59-28.2	36.5	16.3
SB-5	0.5 North of SB-4	N 39-43-15.7	W 121-59-27.3	41.5	19.1
SB-6	0.3 mile east of SB-5	N 39-43-15.2	W 121-59-13.2	36.5	19.7
SB-7	Top of Levee	N 39-43-22.1	W 121-58-09.1	26.5	25.1
SB-8	Top of Levee	N 39-43-41.0	W 121-58-49.6	21.5	-
SB-9	Top of Levee	N 39-43-54.8	W 121-59-47.3	41.5	22.3
SB-10	Sugarwell Road	N 39-44-02.6	W 122-0-04.7	41.5	21.7
SB-11	Sugarwell Road	N 39-44-22.1	W 122-0-11.7	41.5	22.3
SB-12	East of Sewer Ponds	N 39-44-26.0	W 121-59-53	21.5	-

SB-13	Top of Levee	N 39-44-40.3	W 121-59-42.9	16.5	-
SB-14	Top of Levee	N 39-44-55.9	W 121-59-46.6	16.5	-
SB-15	Westermann Farms	N 39-44-54.2	W 122-0-25.0	41.5	17.5
SB-16	Westermann Farms	N 39-44-52.0	W 122-0-31.8	41.5	23.4
SB-17	Top of Levee	N 39-45-33.0	W 122-0-45.6	41.5	29.5
SB-18	Top of Levee	N 39-45-40.6	W 122-01-19.3	46.5	27.0
BH-1	1,000' N. of North End	N 39-46-03.9	W 122-01-47.2	51.0	20
BH-2	150' N. of North End	N 39-45-56.1	W 122-01-40.7	52.0	-
BH-3	N. of Almond Orchard	N 39-45-54.1	W 122-01-34.8	46.5	27
BH-4	Almond Orchard	N 39-45-51.1	W 122-01-34.8	51.5	-
MW-4	Waste Water Plant	N 39-44-26.7	W 121-59-47.1	36.5	16
MW-5	Waste Water Plant	N 39-44-23.9	W 121-59-47.7	36.5	15
MW-6	Waste Water Plant	N 39-44-16.3	W 122-0-02.0	40.5	20
MW-7	Waste Water Plant	N 39-44-05.5	W 121-59-51.6	41.5	15

4.0 NEW LEVEE ANALYSIS

4.1 Selection of Alignment

Six preliminary levee alignments are currently under consideration and are illustrated in the plates of the civil section. Because the alignments are relatively close to each other, foundation conditions are not expected to change significantly among the alignments. For this reason, this initial geotechnical analysis is based upon a single cross section from river mile 199.5, which is several hundred feet upstream of Highway 32. This cross-section of the locally developed setback levee was chosen as the representative profile because of the levee's close proximity to the Sacramento River. For conservatism, the soil parameters chosen to use in the model were chosen such that they represent a worst-case scenario (i.e. high permeabilities and low shear strengths).

4.2 Levee Height

The design water surface elevation for this initial analysis was taken as top of levee. The levee heights under consideration are 14, 10 and 6 feet above the ground surface. The land and waterside slopes were given as 3:1. Settlement is not anticipated to be a problem in the Hamilton City area, therefore no overbuild for settlement will be necessary.

4.3 Seepage Analysis

The GMS 4.0 (Groundwater Modeling System) computer program (developed by WES and Brigham Young University) was used for seepage analysis to compute the exit gradient at the toe of the levee and to determine a piezometric surface to be used in the slope stability analysis. The maximum allowable hydraulic gradient given by ETL 1110-2-555: "Design Guidance on Levees" is 0.3 (USACE, 1997). Soil types used in the model were based on field classifications from the exploration projects previously discussed. Hydraulic conductivities for the material types were selected from various published sources and are listed in Table 3.

The seepage model used in the analysis was comprised of a homogeneous compacted clay embankment ranging from 6 to 14-feet in height underlain by a two-layer foundation. The wastewater containment ponds were not included in the model because the operator of the facility indicated they are lined with betonite. A determination will be made at a later date as to the accurateness of this statement and whether additional analysis and subsequent remediation is necessary. The top stratum of the foundation had a constant thickness of 12 feet and was assigned the same material type as the levee. However, because of the compaction the levee will receive during its construction, the upper zone was given permeability slightly higher than that of the levee. The substratum of the foundation was a poorly graded sand that extended to 50 feet below the top stratum.

The hydraulic gradient at the toe of the 6, 10 and 14-foot embankments were found to be 0.25, 0.39, and 0.54, respectively. The relatively high gradients for the 10 and 14-foot embankments imply that there exists a potential for uplift pressures in the pervious sand layer becoming greater than the effective weight of the clay layer of the foundation. To prevent heaving and/or rupturing it is suggested that a landside seepage berm be used for the 10 and 14-foot embankments.

Initial computations indicate that the 10-foot levee will require a landside seepage blanket that is 12-feet in width and 5-feet in height. The 14-foot levee will require a landside seepage blanket that is 5-feet in height and 30-feet in width. The use of a seepage blanket for the 6-foot levee will not be required. The additional width of the seepage berm will reduce uplift pressures to a tolerable value, as well as provide extra weight to counteract upward seepage forces.

The present alignment of the ring levee and the intermediate setback levee may make the use of a seepage berm difficult in certain areas. The close proximity of residential homes to these alignments may dictate the need of a cutoff wall rather than a berm. If required, the cutoff wall will be designed after soil borings are collected.

Table 3: Hydraulic conductivities used in seepage analysis

Zone	Material	k_h (ft/day)	k_v (ft/day)
Levee	CL	0.3	0.05
Upper Foundation	CL-ML	0.3	0.075
Lower Foundation	SP	7.5	1.875

4.4 Slope Stability

Slope stability analysis was performed using the UTexas4 software package (developed by Dr. Stephen Wright for the Corps of Engineers). The two loading conditions that were analyzed were End-of-Construction (short term analysis) and Steady State Seepage (long term analysis). The case of sudden draw down will be investigated at a later stage in the design process.

Similar to the seepage model, the UTexas4 soil profile was comprised of a levee with a clay foundation underlain by a poorly graded sand layer. Material types were based on field classifications with engineering properties taken from various published sources. The properties used in the model are given in Tables 4 and 5.

The embankment was modeled with 3:1 side slopes and a height of 14 feet. The steady state seepage model had a design water surface at the levee crest. This model included a piezometric surface through the levee whose elevation is given by the seepage analysis. The End-of-Construction model does not include a phreatic surface in its analysis.

Results of the modeling are shown in Figures 7 and 8. The minimum allowable safety factors given by EM 1110-2-1913: "Design and Construction of Levees" are 1.3 and 1.4 for the End-of-Construction (EOC) and Steady State Seepage (SS) analysis, respectively (USACE, 2000). Safety factors for both EOC and SS analysis came to 3.1 and 2.0 indicating that the given levee geometry is stable with the assumed soil properties. Because the tallest levee under consideration had a safety factor that is well above the minimum allowable, the shorter levees were not modeled.

Table 4: Material properties for end of construction

Zone	Material	Unit Weight (pcf)	Friction Angle	Cohesion (psf)
Levee	CL	125	0	1400
Upper Fnd	CL-ML	120	0	800
Lower Fnd	SP	120	35	0

Table 5: Material properties for steady state seepage

Zone	Material	Unit Weight (pcf)	Friction Angle	Cohesion (psf)
Levee	CL	125	31	0
Upper Fnd	CL-ML	120	28	0
Lower Fnd	SP	120	35	0

Figure 5: Results of End of Construction slope stability analysis.

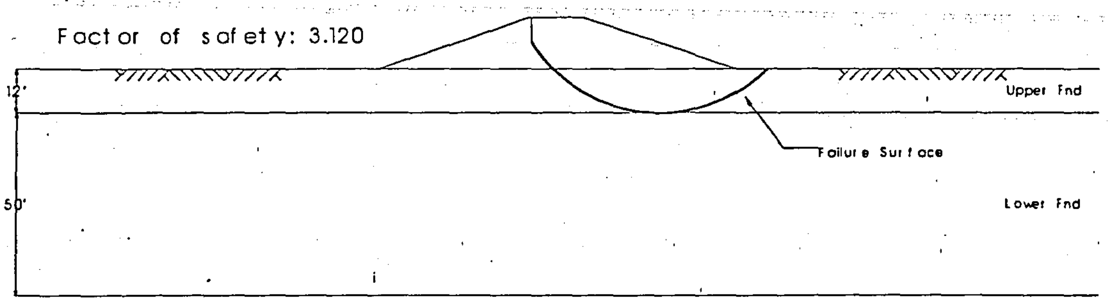
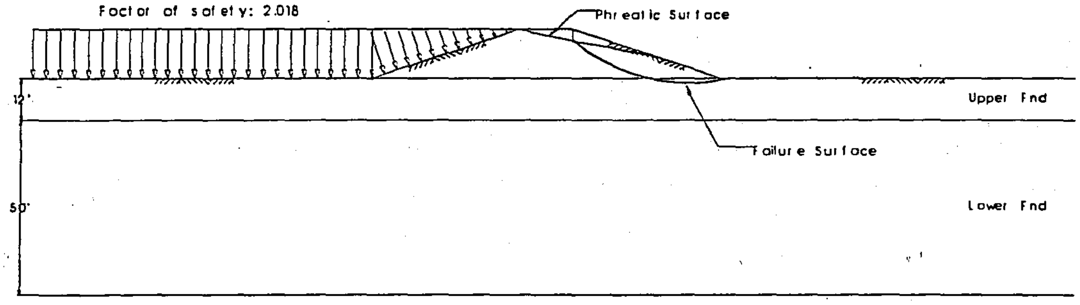


Figure 6: Results of Steady State slope stability analysis.



4.5 Bearing Capacity

Bearing capacity was analyzed for a 14-foot tall embankment with 3:1 sideslopes. The standard bearing capacity equation was used for the analysis was:

$$q_{ult} = (\frac{1}{2})\gamma B N_\gamma + C N_c + \gamma D_f(N_q)$$

where

γ = unit weight of soil in pounds per square foot
B = width of footing (embankment) in feet
C = cohesion (undrained shear strength S_u) in pounds per square foot
D_f = depth of footing (embankment) below the ground surface in feet
N_γ, N_c, N_q = dimensionless bearing capacity factors

For the undrained and drained conditions, the ultimate bearing capacities came to 4,112 and 99,314 pounds per square foot, respectively. Assuming a unit weight of 125 pounds per cubic foot for the levee material, the minimum factor of safety was found to be 2.3.

4.6 Settlement

Due to lack of appropriate data, settlement calculations are not available at this time. Because there is not a soft clay layer close to the surface in the area of the proposed levee alignments, it is expected that total settlement will be minimal. When this project moves into the Plans & Specs phase and undisturbed samples are collected, a thorough settlement analysis will be completed.

5.0 POTENTIAL BORROW SITES

A preliminary identification of potential borrow sites, based on existing information only, is being conducted for this study. For levee construction the USACE specifies soils with the following characteristics:

- a maximum particle diameter of 3 inches
- a minimum of 15% fines content (silt and clay size particles)
- fines must have a liquid limit less than 45 and a plasticity index between 7 and 15
- no organic material or debris may be present

If such soils are not available locally, soils that do not meet the criteria may be used. In these circumstances, the levee geometry is often modified (wider crest, gentler side slopes) to accommodate the less suitable soils. High plasticity clays may be mixed with 3-5% lime to prevent the formation of desiccation cracks in the completed levee. Explorations conducted by others (Ayres Associates, 2000 & DWR, 2000) indicate the overall soil conditions in the area to consist of a blanket layer of fine-grained material (silts, clays, sandy silts, sandy clays) overlying a layer of sand or gravelly sand.

It is possible that a sufficient quantity of suitable material will be available locally. Preliminary tests by others indicate the material content of the upper stratum does contain the required minimum fines content for levee construction. Furthermore, the GCID has offered the canal-excavated soil that currently resides along the Glen Colusa canal as borrow material for the new levee. This is the same material that was used to build the 1000-foot cutoff levee in the north end. Stipulation to its use, however, is that the berm is not to degrade to less than four feet above the canal design water surface. The four-foot berm is intended to keep people from driving into the canal from Highway 45.

A preliminary field investigation of the canal-excavated soil indicates that this material is suitable as a borrow source. Laboratory analyses (Appendix 5) of four bulk samples collected from various locations along the canal (Figure 4) indicate that the given material meets the USACE criteria as stated above. If it is found that additional material is needed, the local project sponsor will assist in identifying potential borrow sites and the Corps will evaluate the sites to determine suitability based on existing information. However, until specific borrow sites are identified and site explorations are performed, no assumptions should be made relating to borrow source suitability.

6.0 CONSTRUCTABILITY

Construction issues in the study area are primarily of a timing concern. Consideration should be given to avoiding construction during the rainy season because the development of soft or saturated soils can significantly slow or halt construction progress.

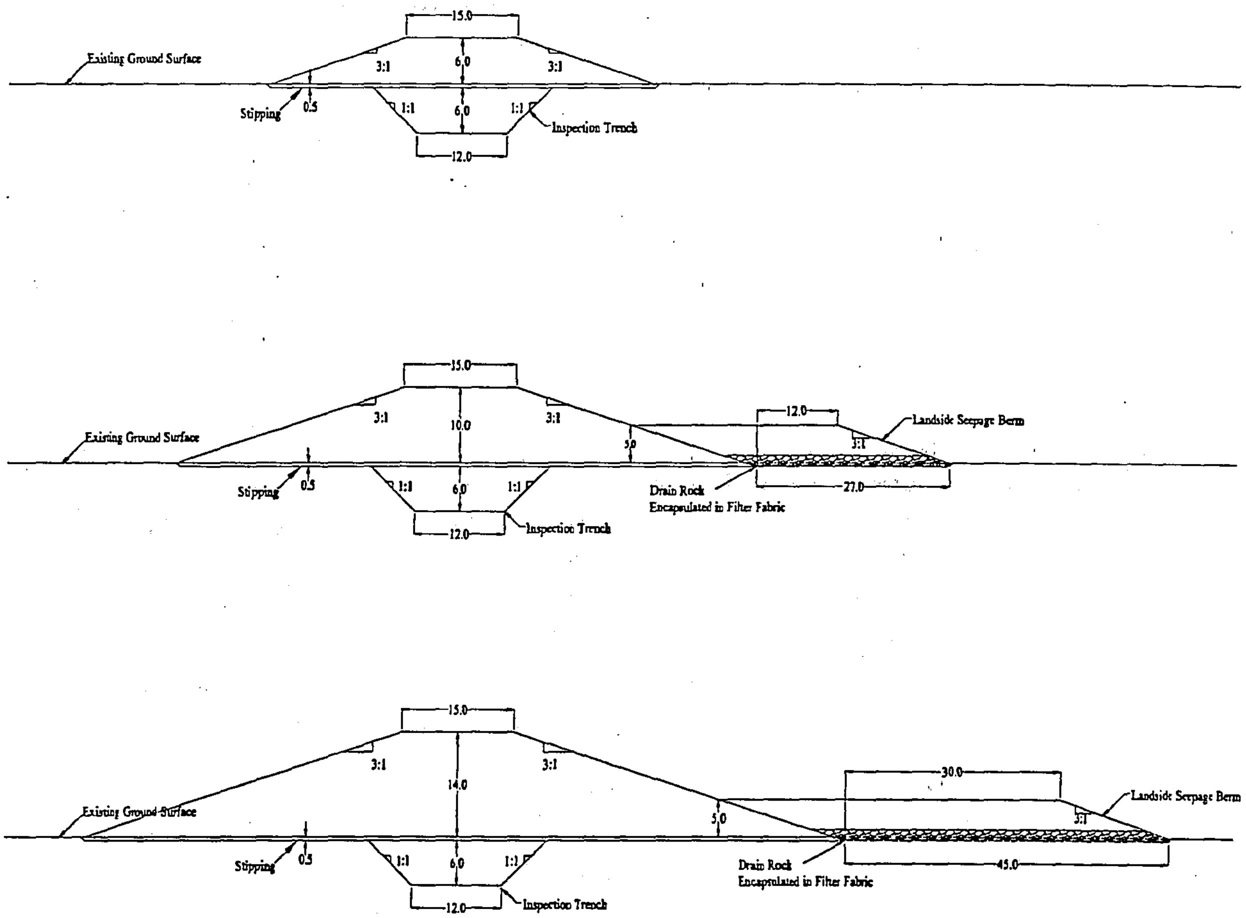
7.0 CONCLUSION

This analysis focused on three levee geometries with crest elevations set to 6, 10 and 14 feet (Figure 7). The components common to all trial cross sections include a crest width of 15-feet, embankment side slopes at 3H:1V (18 degrees) and a six-foot deep inspection trench with sides at 1:1. The crest width and relatively flat embankment angles allow maintenance and emergency repair equipment to safely traverse the levees. The inspection trench allows for the discovery of undocumented utilities and unexpected soil conditions.

From a structural standpoint, it was found that all three levees have a factor of safety against slope failure that is well above the USACE criteria. However, due to high exit gradients at the toe of the proposed levees, a landside seepage berm is suggested for the 10 and 14-foot embankments. The 10-foot levee will require a landside seepage blanket that is 27-feet in width (as measured from the landside toe of the levee to the toe of the berm) and 5-feet in height. The 14-foot levee will require a landside seepage blanket that is 45-feet in width (as measured from the landside toe of the levee to the toe of the berm) and 5-feet in height. The additional width of the seepage berm will reduce uplift pressures to a tolerable value, as well as provide extra weight to counteract upward seepage forces.

The present alignment of the ring levee and the intermediate setback levee may make the use of a seepage berm difficult in certain areas. The close proximity of residential homes to these alignments may dictate the need of a cutoff wall rather than a seepage berm. If required, the cutoff wall will be designed after soil borings are collected.

Figure 7: Final design of three proposed levee sizes.



8.0 RECOMMENDATIONS

The following recommendations are made for the next phase of the project:

1. Conduct subsurface investigations including standard penetration tests and collect both disturbed and undisturbed samples along the chosen alignment to further define the subsurface conditions. This includes the collection of undisturbed samples to perform triaxial and consolidation testing of foundation clay layers.

2. Perform additional seepage, slope stability and settlement analyses based on the results of the triaxial and consolidation testing listed in #1.

3. Investigate the borrow areas which were identified in this study. This consists of backhoe test pits and the collection of bulk samples for laboratory testing.

9.0 REFERENCES

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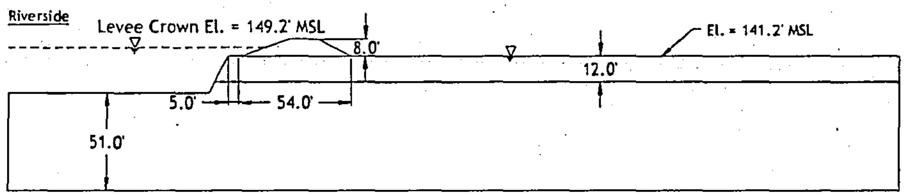
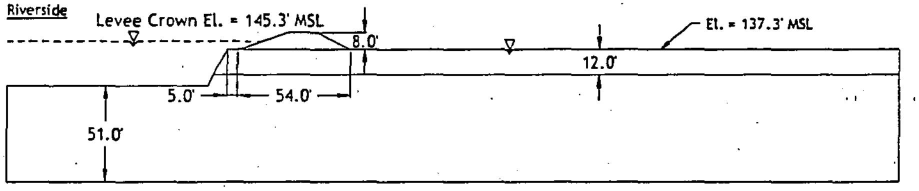
Appendix 1

Representative Cross Sections and Soil Parameters used in the PNP/PFP Analysis

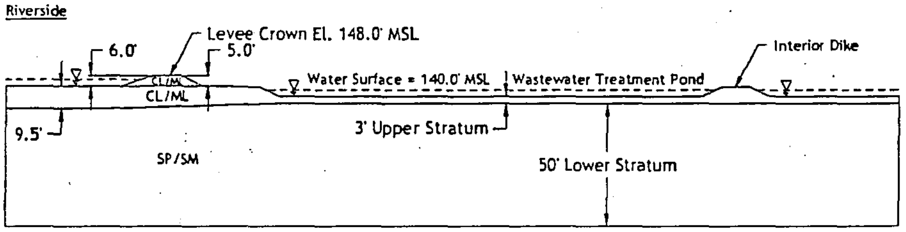
Figure 8: Typical Cross Sections used in PNP/PFP Analysis



North of Dunning Slough, RM 198.25, Seepage Model



South of Dunning Slough, RM 197.25, Seepage Model



Wastewater Treatment Plant Seepage Model

Notes:
1. Approximately 1,000' to river from levee.
2. See Table 6 for parameters used in the seepage model.

Table 6: Soil Parameters used in Reliability Analysis.

North and South of Dunning Slough

Variable	Expected Value	Expected Value +σ	Expected Value -σ
K_v of Upper Layer (ft/day)	0.075	0.142	0.0075
K_h of Lower Layer (ft/day)	7.5	12	3
Thickness of Upper Layer (ft)	12	16	8
Thickness of Lower Layer (ft)	51	61	41

NOTE: Blanket analysis was used for North and South Slough seepage analysis.

WWTP Levee

Variable	Expected Value	Expected Value +σ	Expected Value -σ
K_v of Upper Layer (ft/day)	0.028	0.14	0.014
K_h of Upper Layer (ft/day)	0.252	1.26	0.126
K_v of Lower Layer (ft/day)	1.87	6.22	0.622
K_h of Lower Layer (ft/day)	16.80	56.0	5.6
Thickness of Upper Layer underneath Pond (ft)	3.0	5.5	2.0
Thickness of Upper Layer at Riverside (ft)	9.5	10.5	5.0
Thickness of Lower (ft)	50.0	60	35.0

NOTE: Finite element analysis was used for the WWTP seepage analysis using Seep2D from the GMS computer application.

Appendix 2

Soil Logs From Ayres Associates

LOG OF SOIL BORING

Date Completed: 10/23/00
Logged By: Thomas W. Smith
Total Depth: 26.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: In field on south side of County Road 23
GPS Coordinates: Latitude: N 39° 42' 45.5" Longitude: W 121° 57' 32.6"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 131.0 ft
5							
	▨	SPT 5.0-6.5	2-4-3	7			Silty fine SAND (SM), light brown, moist
							Sandy SILT layer (ML)
10							Silty fine SAND (SM), light brown, moist
	▨	SPT 10.0-11.5	7-10-8	18			
					Groundwater at 11.9 ft on 10/23/00		Gravelly SAND (SP), medium brown, moist
15							
	▨	SPT 15.0-16.5	26*-6-3	9	Sample SB1-1 15.0-20.0 ft Small Bag	No tests	15.0 ft Increasing sand size with depth
20							
	▨	SPT 20.0-21.5	10-12-6	18			
						? ? ?	Sandy GRAVEL (GP), saturated, multicolored (black, gray, white, tan, red) rounded to sub-rounded ? ? ?
25							
	▨	SPT 25.0-26.5	7-5-3	8			
							Bottom of Boring at 26.5 ft
30							
35							
40							

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SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-1
1 of 1

* Rock in sampler, disregard value
? Estimated break in material type

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/23/00
Logged By: Thomas W. Smith
Total Depth: 31.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: In field on South Side of County Road 23, Approx. 1/2 mile West of SB-1 along County Road 23
GPS Coordinates: Latitude: N 39° 42' 45.3" Longitude: W 121° 58' 11.8"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 132.0 ft
5	▨	SPT 5.0-6.5	3-3-3	6	Sample SB2-1 0-4.0 ft Small Bag	No tests	**Silty CLAY (CL)**, medium brown, moist
10	▨	SPT 10.0-11.5	5-5-5	10			
							Fine SAND with 10% silt (SP-SM), medium brown, moist
					Groundwater at 13.9 ft on 10/23/00		**Fine Sandy SILT (ML)**, medium brown, moist
15	▨	SPT 15.0-16.5	3-2-7	9	Sample SB2-2 15.5-16.5 ft Small Bag	No tests	**Silty Fine SAND (SM)**, medium brown, saturated
	▨	SPT 17.5-19.0	2-5-5	10			
20	▨	SPT 20.0-21.5	8-8-6	14			
					Sample SB2-3 21.0-27.5 ft Small Bag	No tests	**Clean Gravelly SAND (SP)**, saturated, multicolored (black, gray, white, tan, red) rounded to sub-rounded **Increasing gravel content with depth**
25	▨	SPT 25.0-26.5	6-8-7	15			
30	▨	SPT 30.0-31.5	15-24-21	45			
35							Bottom of Boring at 31.5 ft
40							

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Project No. 33.0127.00

SB-2
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/23/00
Logged By: Thomas W. Smith
Total Depth: 26.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: County Road 23. Boring is 43' South from edge of pavement
GPS Coordinates: Latitude: N 39° 42' 45.6" Longitude: W 121° 58' 13.5"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 134.0 ft
					Sample SB3-1 1.0-3.0 ft Small Bag	G,H,A CL	
5							
		SPT 5.0-6.5	5-7-5	12			**Silty CLAY (CL)**, light brown, low moisture
10							
		SPT 10.0-11.5	7-10-9	19			
							Fine SAND (SP), light brown, moist
							Clayey SILT (ML), medium brown, moist
15							
		SPT 15.0-16.5	3-4-7	11	Sample SB3-2 15.0-15.5 ft Small Bag	G, H, A ML	**Fine Sandy SILT (ML)**, medium brown, moist
							Groundwater at 15.8 ft on 10/23/00
		SPT 17.5-19.0	4-4-7	11			
20							
		SPT 20.0-21.5	3-2-5	7			
					Sample SB3-3 21.0 - 26.5 ft Small Bag	G SP	**Gravelly, Medium to Coarse SAND (SP)**, saturated, multicolored (black, gray, white, tan, red) rounded to sub-rounded
25							**24.0 ft Increasing gravel content**
		SPT 25.0-26.5	11-12-12	24			
							Bottom of Boring at 26.5 ft
30							
35							
40							

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Project No. 33.0127.00

SB-3
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/23/00
Logged By: Thomas W. Smith
Total Depth: 36.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: County Road 23. Approx. 1 Mile East of Road 23 and Hwy 45 Intersection
GPS Coordinates: Latitude: N 39° 42' 46.0" Longitude: W 121° 59' 28.2"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 139.0 ft
5	▨	SPT 5.0-6.5	5-7-7	14			Silty CLAY (CL), light brown, slight moisture
10	▨	SPT 10.0-11.5	4-4-5	9	Sample SB4-1 10.5-11.5 ft Small Bag	No tests	Fine SAND (SP), light brown, moist
15	▨	SPT 15.0-16.5	3-7-8	15	Groundwater at 16.3 ft on 10/23/00		Silty SAND (SM), medium brown, saturated
							Medium grained SAND (SP) with up to 2 Inch Gravel saturated, multicolored (black, gray, white, tan, red) rounded to sub-rounded
20	▨	SPT 20.0-21.5	6-5-5	10			Increasing sand size with depth
25	▨	SPT 25.0-26.5	9-9-9	18	Sample SB4-2 25.0-26.5 ft Small Bag	No tests	
30	▨	SPT 30.0-31.5	No Test	Sampler wedged with inflowing sand against the inside of the flight auger			
35	▨	SPT 35.0-36.5	23-25-20	45	Sample SB4-3 35.0-36.5 ft Small Bag	No tests	Bottom of Boring at 36.5 ft
40							

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Project No. 33.0127.00

SB-4
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Intersection of field roads approx. 0.5 mi due North of SB-4
GPS Coordinates: Latitude: N 39° 43' 15.7" Longitude: W 121° 59' 27.3"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 139.5 ft
5		SPT 5.0-6.5	6-4-3	7			Silty CLAY (CL), medium brown, moist
10		SPT 10.0-11.5	2-3-4	7			Silty Fine SAND (SM), medium brown, moist
15		SPT 15.0-16.5	2-2-4	6			Clayey SILT (ML), medium brown, moist
		Groundwater at 19.1 ft on 10/24/00					
20		SPT 20.0-21.5	6-10-10	20	Sample SB5-1 20.0-21.0 ft Small Bag	G, H, A ML	Silty Fine SAND (SM), medium brown, saturated
25		SPT 25.0-26.5	18-23-28	51	Sample SB5-2 25.0-25.5 ft Small Bag	No tests	
					Sample SB5-3 25.5-26.5 ft Small Bag	No tests	Sandy GRAVEL (GW), saturated, multicolored (black, gray, white, tan, red) angular to rounded Gravel 2 inch size
30		SPT 30.0-31.5	25-13-12	25	Sample SB5-4 30.0-31.5 ft Small Bag	G GW	
35		SPT 35.0-36.5	26-29-19	48	Sample SB5-5 35.5-41.5 ft Small Bag	G GW	
40		SPT 40.0-41.5	34-29-31	60			Bottom of Boring at 41.5 ft

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SB-5
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometera 95833

LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 36.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Off Dirt Road Edge, 0.3 miles East of SB-5 on south side of road
GPS Coordinates: Latitude: N 39° 43' 15.2" Longitude: W 121° 59' 13.2"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 139.0 ft
					Sample SB6-1 1.0-10.0 ft Small Bag	G, H, A **CL**	
5	▨	SPT 5.0-6.5	12-11-7	18			**Silty CLAY (CL)**, light brown, dry
10	▨	SPT 10.0-11.5	3-3-5	8			
	▨	SPT 12.0-13.5	2-3-3	6			**Clayey SILT (ML)**, medium brown, moist
15	▨	SPT 15.0-16.5	1-2-3	5			**Silty CLAY (CL)**, medium brown, moist
20					Groundwater at 19.7 ft on 10/24/00		
	▨	SPT 20.0-21.5	3-2-3	5			
							Silty Fine SAND (SM), medium brown, saturated
25	▨	SPT 25.0-26.5	5-8-11	19			**25.25 - 26.0 ft Color change from brown to gray**
							Gravelly SAND (SP/GP), saturated
30	▨	SPT 30.0-31.5	35-24-24	N.A.	Low recovery most likely hit large gravel		
35	▨	SPT 35.0-36.5	15-14-8	22			
40							Bottom of Boring at 36.5 ft

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SB-6
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometera 95833

LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 26.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Top of Existing J Levee
GPS Coordinates: Latitude: N 39° 43' 22.1" Longitude: W 121° 58' 9.1"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 144.0 ft
					Sample SB7-1 1.0-3.0 ft Small Bag	No tests	0–4 inch Road gravel surfacing
					Sample SB7-2 3.0-5.0 ft	No tests	Alternating 1 inch layers of ML and CL Silty Fine Sandy CLAY (CL), medium brown, moist
5	▨	SPT 5.0-6.5	22-13-17	30	Small Bag		Clayey Fine Sandy SILT (ML), gray-brown, moist Sampler showed layers of brown and gray-brown
10	▨	SPT 10.0-11.5	3-2-2	4			
							Silty Fine Sandy CLAY (CL), medium brown, moist
15	▨	SPT 15.0-16.5	6-8-10	18			
							Fine SAND (SP), light brown, moist
	▨	SPT 17.5-19.0	6-9-10	19			Sandy GRAVEL (GP), moist, gravel to 1 1/2 inch
20	▨	SPT 20.0-21.5	3-4-10	14			
							Fine SAND (SP), medium brown, moist
25					Groundwater at 25.1 ft on 10/24/00		
	▨	SPT 25.0-26.5	3-5-5	10			
							Bottom of Boring at 26.5 ft
30							
35							
40							

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SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-7
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 21.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Top of Existing J Levee
GPS Coordinates: Latitude: N 39° 43' 41.0" Longitude: W 121° 58' 49.6"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 145.0'ft
5		SPT 5.0-6.5	5-5-6	11	Sample SB8-1 5.0-6.5 ft Small Bag	G, H, A CL	**Silty CLAY (CL), medium brown, moist**
10		SPT 10.0-11.5	3-2-4	6			
							Increasing silt content at 11.0 ft
15		SPT 15.0-16.5	5-4-4	8			
							Fine SAND (SP), medium brown, moist
						? ? ?	**Silty Fine SAND (SM)** ? ?
20		SPT 20.0-21.5	6-10-14	24			
							Bottom of Boring at 21.5 ft No Groundwater Encountered
25							
30							
35							
40							

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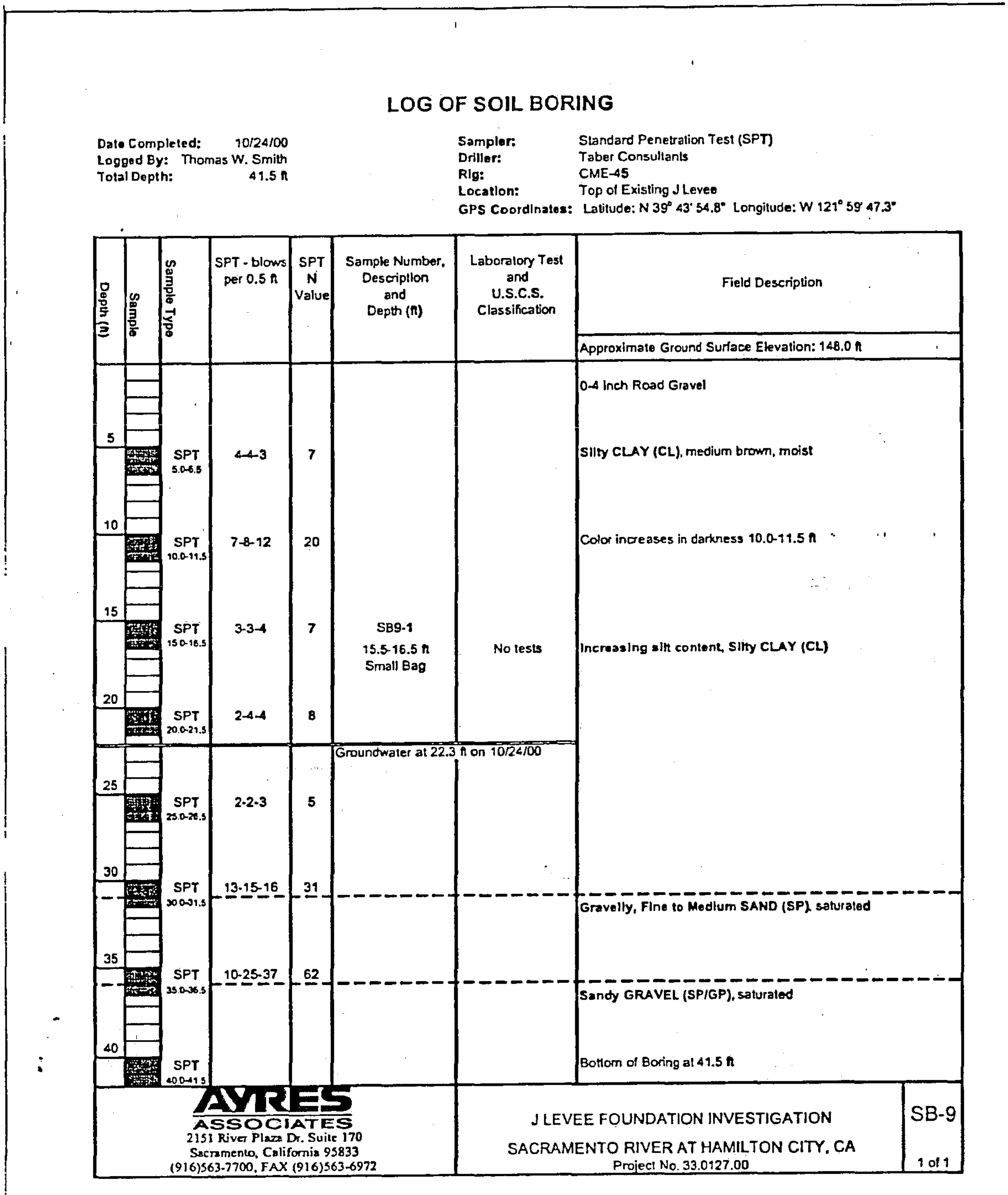
SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-8
1 of 1

? Estimated material type change

G - Grain Size Distribution A - Atterberg Limits H - Hydrometers 95833



LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Top of Existing J Levee
GPS Coordinates: Latitude: N 39° 43' 54.8" Longitude: W 121° 59' 47.3"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 148.0 ft
							0-4 Inch Road Gravel
5	▨	SPT 5.0-6.5	4-4-3	7			Silty CLAY (CL), medium brown, moist
10	▨	SPT 10.0-11.5	7-8-12	20			Color increases in darkness 10.0-11.5 ft
15	▨	SPT 15.0-16.5	3-3-4	7	SB9-1 15.5-16.5 ft Small Bag	No tests	Increasing silt content, Silty CLAY (CL)
20	▨	SPT 20.0-21.5	2-4-4	8			
					Groundwater at 22.3 ft on 10/24/00		
25	▨	SPT 25.0-26.5	2-2-3	5			
30	▨	SPT 30.0-31.5	13-15-16	31			
							Gravelly, Fine to Medium SAND (SP), saturated
35	▨	SPT 35.0-36.5	10-25-37	62			
							Sandy GRAVEL (SP/GP), saturated
40	▨	SPT 40.0-41.5					Bottom of Boring at 41.5 ft

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J LEVEE FOUNDATION INVESTIGATION
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Project No. 33.0127.00

SB-9
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Holly Sugar property just east of the J levee on Sugarwell Road
GPS Coordinates: Latitude: N 39° 44' 2.6" Longitude: W 122° 00' 4.7"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 140.0 ft
							0-2 feet Road Base Gravel (GW)
5	▨	SPT 5.0-6.5	3-3-3	6			Silty CLAY (CL), dark brown, moist Color change to medium brown at 5.0 ft
10	▨	SPT 10.0-11.5	3-5-8	13			
15	▨	SPT 15.0-16.5	1-2-2	4			
20	▨	SPT 20.0-21.5	2-4-4	8	Groundwater at 21.7 ft on 10/24/00		Fine Sandy Clayey SILT (ML), light brown, saturated
25	▨	SPT 25.0-26.5	2-2-3	5	Sample SB10-1 26.0-26.5 ft Small Bag	G, H, A ML	Sandy SILT (ML), medium brown, saturated
30	▨	SPT 30.0-31.5	2-3-18	21			Gravelly, Fine to Medium SAND (SP), saturated light brown
35	▨	SPT 35.0-36.5	17-18-23	41			
40	▨	SPT 40.0-41.5	26-22-21	43	Sample SB 10-2 41.0-41.5 ft Small bag	No tests	Bottom of Boring at 41.0 ft

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J LEVEE FOUNDATION INVESTIGATION
SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-10
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/24/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: 0.4 mi North of SB-10 on Sugarwell Road (Holly Sugar Property)
GPS Coordinates: Latitude: N 39° 44' 22.1" Longitude: W 122° 00' 11.7"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 139.5 ft
							Clayey SILT (ML), dark brown with occasional small gravel pieces to about 5 ft.
5	▨	SPT 5.0-6.5	4-4-4	8		? ? ?	? ? ? **Silty CLAY (CL), medium brown, moist**
10	▨	SPT 10.0-11.5	3-4-5	9			
15	▨	SPT 15.0-16.5	4-4-6	10			
20	▨	SPT 20.0-21.5	3-4-7	11			**Very Fine Sandy Clayey SILT (ML)**, medium brown, moist
					Groundwater at 22.3 ft on 10/24/00		
25	▨	SPT 25.0-26.5	1-1-2	3			**Very Fine Sandy SILT (ML)**, medium brown, saturated decreasing clay and increasing sand
30	▨	SPT 30.0-31.5	2-5-7	12			**Increasing Sand (SM)**
35	▨	SPT 35.0-36.5	18-16-12	28	Sample SB11-1 35.0-36.5 ft Small Bag	G GW	**Sandy GRAVEL (GW)**, saturated, multicolored (black, gray, white, tan, red) angular to rounded
40	▨	SPT 40.0-41.5			Sample SB11-2 40.0-41.5 ft Small Bag	No tests	**Silty SAND (SP-SM)**, medium brown, saturated Bottom of Boring at 41.5 ft

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J LEVEE FOUNDATION INVESTIGATION
SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-11
1 of 1

? Estimated break in material type

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 21.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Top of Existing J Levee, Due East of Sewer Ponds
GPS Coordinates: Latitude: N 39° 44' 26.0" Longitude: W 121° 59' 53.0"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 149.0 ft
5	▨	SPT 5.0-6.5	3-3-3	6			Silty CLAY (CL), medium brown, moist
							Increasing darkness with depth
10	▨	SPT 10.0-11.5	4-4-4	8			
							Clayey SILT (ML), medium brown, moist
15	▨	SPT 15.0-16.5	3-4-7	11		? ? ?	Silty CLAY (CL), medium brown, moist ? ?
							Fine SAND (SP), light to medium brown, moist
20	▨	SPT 20.0-21.5	4-5-5	10	Sample SB12-1 20.0-21.5 ft Small Bag	No tests	Bottom of Boring at 21.5 ft No Groundwater Encountered
25							
30							
35							
40							

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SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-12
1 of 1

? Estimated break in material type

G - Grain Size Distribution A - Atterberg Limits H - Hydrometers 95833

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 16.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Top of Existing J levee Between Hwy 32 and Sewer Ponds
GPS Coordinates: Latitude: N 39° 44' 40.3" Longitude: W 121° 59' 42.9"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 148.0 ft
							Clayey, Fine Sandy SILT (ML), medium brown, moist
5	▨	SPT 5.0-6.5	2-3-3	6			Silty SAND (SM), medium brown, moist
							Increasing darkness with depth
10	▨	SPT 10.0-11.5	4-3-5	8			Fine SAND (SP), moist
15	▨	SPT 15.0-16.5	5-8-10	18			
							16.0 ft, Some medium to coarse sand with small gravel pieces.
20							
							Bottom of Boring at 16.5 ft No Groundwater Encountered
25							
30							
35							
40							

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SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-13
1 of 1

G - Grain Size Distribution . A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 16.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Top of Existing J levee near Hwy 32
GPS Coordinates: Latitude: N 39° 44' 55.9" Longitude: W 121° 59' 46.6"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 150.0 ft
							Clayey, Fine, Sandy SILT (ML), medium brown, moist
5	▨	SPT 5.0-6.5	1-1-2	3	Sample SB14-1 5.0-6.5 ft Small Bag	G, H, A ML	
10	▨	SPT 10.0-11.5	2-3-5	8			
							Silty Fine SAND (SM), medium brown, moist
15	▨	SPT 15.0-16.5	4-6-7	13			
							Moist Fine SAND (SP), medium brown, moist
20							
25							Bottom of Boring at 16.5 ft No Groundwater Encountered
30							
35							
40							

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Project No. 33.0127.00

SB-14
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Westermann Farms North of Hwy 32
GPS Coordinates: Latitude: N 39° 44' 54.2" Longitude: W 122° 00' 25.0"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 141.0 ft
5							
	▨	SPT 5.0-6.5	4-5-6	11			**Silty CLAY (CL), dark brown, moist** **Color change to light brown at 5.0 ft**
10							
	▨	SPT 10.0-11.5	3-3-6	9			
15					SB15-1	G, H, A	
	▨	SPT 15.0-16.5	5-6-8	14	15.0-16.5 ft Small Bag	CL	
					Groundwater at 17.5 ft on 10/25/00		
20							
	▨	SPT 20.0-21.5	3-4-4	8			
25							
	▨	SPT 25.0-26.5	1-1-2	3			
							Sandy Clayey SILT (ML), dark brown, saturated
30							
	▨	SPT 30.0-31.5	4-5-4	9			
							Fine SAND (SP) with 2-3 inch layers of Silty SAND (ML), Light brown
35							
	▨	SPT 35.0-36.5	17-18-23	41			
							At 36.0 ft includes small gravel
40							
	▨	SPT 40.0-41.5	18-14-13	27			Bottom of Boring at 41.5 ft

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J LEVEE FOUNDATION INVESTIGATION
SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-15
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Westermann Farms North of Hwy 32
GPS Coordinates: Latitude: N 39° 44' 52.0" Longitude: W 122° 00' 31.8"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 142.0 ft
							Silty CLAY (CL), dark brown, moist
5							Color change to Medium brown at 4.0 ft
		SPT 5.0-6.5	6-5-4	9			
10							
		SPT 10.0-11.5	3-4-6	10			
15							
		SPT 15.0-16.5	\23.50+	50+			
							Gravelly, fine to medium SAND (SP), moist, multicolored (black, gray, white, tan, red) rounded to sub-rounded Gravel up to 2 inches
20					Sample SB16-1	G	
		SPT 20.0-21.5			20.0-21.5 ft Small Bag	SP	
					Groundwater at 23.4 ft on 10/25/00		
25							
		SPT 25.0-26.5	20-26-19	45			
					Sample SB16-2 25.5-26.5 ft Small Bag	G GW	Sandy GRAVEL (GW), saturated, multicolored (black, gray, white, tan, red) rounded to sub-rounded
30							
		SPT 30.0-31.5	22-17-16	33			
35							
		SPT 35.0-36.5	14-11-8	19	Sample SB16-3 35.0-36.5 ft Small Bag	No tests	
40							
		SPT 40.0-41.5	24-26-29	55			Bottom of Boring at 41.5 ft

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J LEVEE FOUNDATION INVESTIGATION
SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-16
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 41.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Westermann Farms on Top of Existing J Levee
GPS Coordinates: Latitude: N 39° 45' 33.0" Longitude: W 122° 00' 45.6"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 152.0 ft
							0-1.0 ft Road Base 3 inch angular Gravel (GP)
5							Silty CLAY (CL), medium brown, moist
	▨	SPT 5.0-6.5	6-5-4	9			
10							
	▨	SPT 10.0-11.5	3-4-6	10	Sample SB17-1 10.0-11.5 ft Small Bag	G, H, A CL	
15							
	▨	SPT 15.0-16.5	23, 50+	50+			
							Clayey, Silty, Very Fine SAND (SM), light brown, moist
20							
	▨	SPT 20.0-21.5					
25							
	▨	SPT 25.0-26.5	20-26-19	45			Interbedded layers of fine SAND and and Silty Fine SAND (SP-SM)
					Groundwater at 29.5 ft on 10/25/00		
30							
	▨	SPT 30.0-31.5	22-17-16	33			
							Silty Fine SAND (SM), gray / green with 1/4 inch root piece saturated
35							
	▨	SPT 35.0-36.5	14-11-8	19			
40							
	▨	SPT 40.0-41.5	24-26-29	55			Bottom of Boring at 41.5 ft

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J LEVEE FOUNDATION INVESTIGATION
SACRAMENTO RIVER AT HAMILTON CITY, CA
Project No. 33.0127.00

SB-17
1 of 1

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

LOG OF SOIL BORING

Date Completed: 10/25/00
Logged By: Thomas W. Smith
Total Depth: 46.5 ft

Sampler: Standard Penetration Test (SPT)
Driller: Taber Consultants
Rig: CME-45
Location: Westermann Farms on Top of Existing J Levee
GPS Coordinates: Latitude: N 39° 45' 40.6" Longitude: W 122° 01' 14.3"

Depth (ft)	Sample	Sample Type	SPT - blows per 0.5 ft	SPT N Value	Sample Number, Description and Depth (ft)	Laboratory Test and U.S.C.S. Classification	Field Description
							Approximate Ground Surface Elevation: 152.0 ft
							0-1.0 ft Road Base 3 inch angular Gravel (GP)
							Silty CLAY (CL), dark brown, moist
5	▨	SPT 5.0-6.5	4-5-4	9	no recovery		
10	▨	SPT 10.0-11.5	3-3-5	8	Sample SB18-1 10.0-11.5 ft Small Bag	G, H, A CL	
15	▨	SPT 15.0-16.5	4-6-8	14			
20	▨	SPT 20.0-21.5	3-3-4	7			Color change to medium brown, increase in silt content
25	▨	SPT 25.0-26.5	3-5-6	11			
							Sandy Silty CLAY (CL), medium brown, moist to saturated
					Groundwater at 27.0 ft on 10/25/00		
30	▨	SPT 30.0-31.5	4-6-8	14			
							Layers of Silty CLAY (CL), medium brown and light olive 30.5-31.0 ft Medium Brown 31.0-31.5 ft Light Olive
35	▨	SPT 35.0-36.5	7-9-9	18	Sample SB18-2 35.0-36.5 ft Small Bag	No tests	
40	▨	SPT 40.0-41.5	27-29-42	71	Sample SB18-3 41.0-41.5 ft	No tests	

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TNC Foundation Investigation
J Levee Relocation
Project No. 33.0127.00

SB-18
1 of 2

G - Grain Size Distribution A - Atterberg Limits H - Hydrometer

Appendix 3

Soil Logs From Department of Water Resources

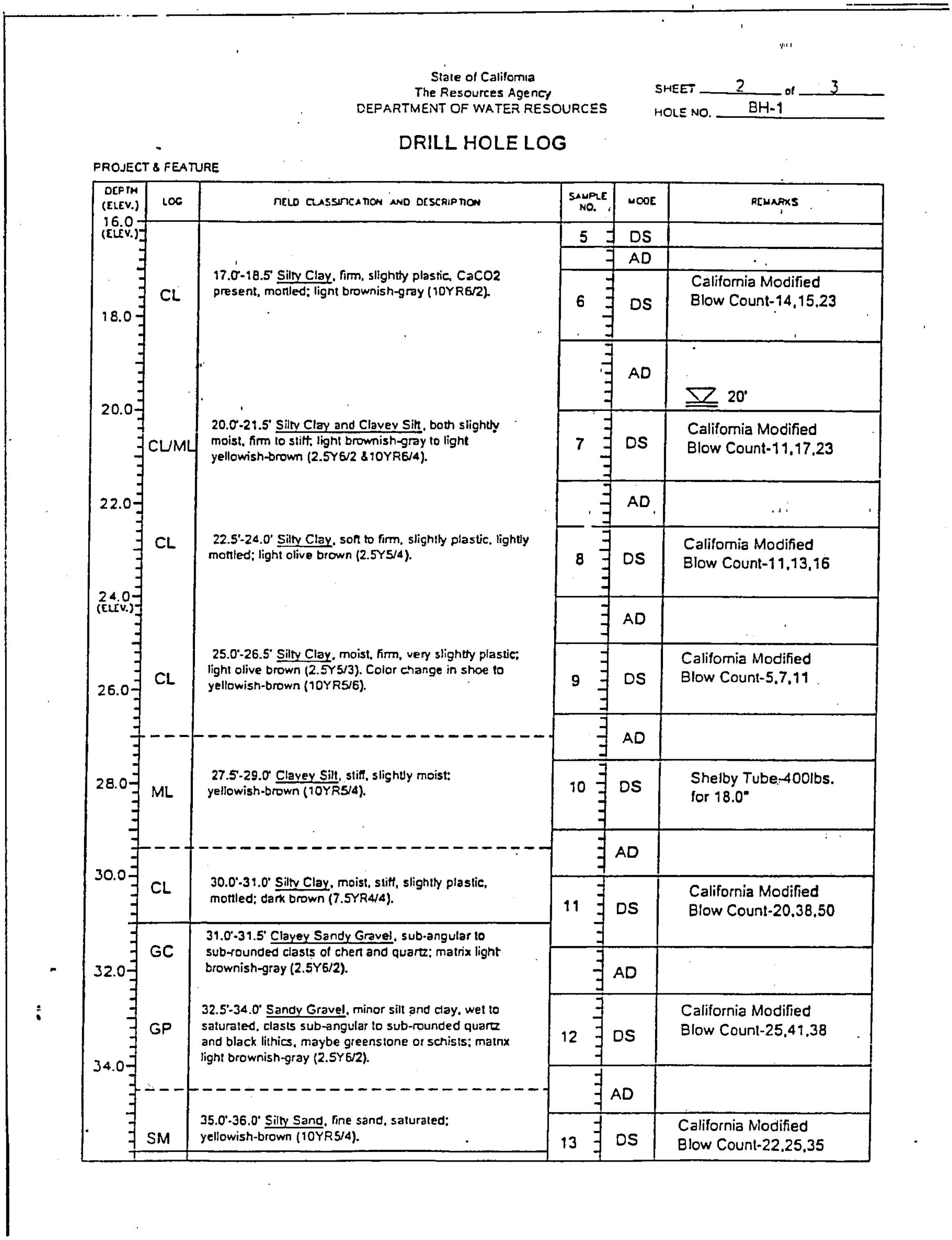
State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

DRILL HOLE LOG

SHEET 1 of 3
HOLE NO. BH-1
ELEV. ______ FEET
DEPTH 51 FEET

PROJECT "J" LEVEE INVESTIGATION
FEATURE N/A
LOCATION
CONTR. LAYNE-CHRISTENSEN DRILL RIG CME-750
DATE DRILLED 7/26/2000
ATTITUDE VERTICAL
LOGGED BY B. RCSS.C. GOLSH
DEPTH TO WATER 20.0'

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
0.0 (ELEV) 2.0	CL	QUATERNARY TERRACE DEPOSITS 0-10.0' 0-2.5' Silty Clay, dry to slightly moist, firm; dark grayish-brown (2.5Y4/2).	1	DS	Shelby Tube-150lbs.
4.0				AD	
6.0	ML	5.0'-7.5 Clayey Silt, dry, crumbly; light olive brown (2.5Y5/3).	2	DS	Shelby Tube-200lbs.
8.0 (ELEV)				AD	
10.0	ML	TEHAMA FORMATION 10.0'-51.0' 10.0'-10.5' Silt, minor clay, slightly moist, stiff, very slightly plastic; yellowish-brown (10YR5/6).	3	DS	Shelby Tube-350lbs. for 6.0"
				AD	
12.0	GC	12.0'-13.5' Clayey Silt with fine gravel, slightly moist, stiff; yellowish-brown (10YR5/6).	4	DS	California Modified Blow Count-8,9,16
14.0				AD	
	CL	15.0'-16.5' Silty Clay, slightly moist, firm, slightly plastic, CaCO2 present, mottled; yellowish-brown and grayish-brown (10YR5/4 & 10YR5/2).	5	DS	California Modified Blow Count-14,16,20



State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

SHEET 2 of 3
HOLE NO. BH-1

DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
16.0 (ELEV.)			5	DS	
				AD	
18.0	CL	17.0'-18.5' Silty Clay, firm, slightly plastic, CaCO2 present, mottled; light brownish-gray (10YR6/2).	6	DS	California Modified Blow Count-14,15,23
				AD	▽ 20'
20.0	CL/ML	20.0'-21.5' Silty Clay and Clayey Silt, both slightly moist, firm to stiff; light brownish-gray to light yellowish-brown (2.5Y6/2 &10YR6/4).	7	DS	California Modified Blow Count-11,17,23
22.0				AD	
	CL	22.5'-24.0' Silty Clay, soft to firm, slightly plastic, lightly mottled; light olive brown (2.5Y5/4).	8	DS	California Modified Blow Count-11,13,16
24.0 (ELEV.)				AD	
26.0	CL	25.0'-26.5' Silty Clay, moist, firm, very slightly plastic; light olive brown (2.5Y5/3). Color change in shoe to yellowish-brown (10YR5/6).	9	DS	California Modified Blow Count-5,7,11
				AD	
28.0	ML	27.5'-29.0' Clayey Silt, stiff, slightly moist; yellowish-brown (10YR5/4).	10	DS	Shelby Tube-400lbs. for 18.0"
				AD	
30.0	CL	30.0'-31.0' Silty Clay, moist, stiff, slightly plastic, mottled; dark brown (7.5YR4/4).	11	DS	California Modified Blow Count-20,38,50
32.0	GC	31.0'-31.5' Clayey Sandy Gravel, sub-angular to sub-rounded clasts of chert and quartz; matrix light brownish-gray (2.5Y6/2).		AD	
34.0	GP	32.5'-34.0' Sandy Gravel, minor silt and clay, wet to saturated, clasts sub-angular to sub-rounded quartz and black lithics, maybe greenstone or schists; matrix light brownish-gray (2.5Y6/2).	12	DS	California Modified Blow Count-25,41,38
				AD	
	SM	35.0'-36.0' Silty Sand, fine sand, saturated; yellowish-brown (10YR5/4).	13	DS	California Modified Blow Count-22,25,35

State of California
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SHEET 3 of 3
HOLE NO. BH-1

DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
36.0 (ELEV.)	GP	36.0'-36.5' Sandy Gravel, minor silt and clay, clasts of quartz, chert; matrix yellowish-brown (10YR5/4).	13	DS	
				AD	
38.0	GP	37.5'-39.0' Sandy Gravel, minor silt and clay, clasts of quartz, chert; matrix light olive brown (2.5Y5/4).	14	DS	California Modified Blow Count-26,27,30
				AD	
40.0	SP	40.0'-41.0' Silty Sand, fine sand, saturated; light olive brown (2.5Y5/3). Coarsens down sample, very little fines, quartz and black lithic fragments. Down 6" sample fines again to sand/silt combination.	15	DS	California Modified Blow Count-10,16,40
	SW	41.0'-41.5' Gravelly Sand, fine sand with minor silt; olive brown (2.5Y4/4).		AD	
42.0	SW	42.5'-43.5' Gravelly Sand, wet, all clasts, no fines.	16	DS	California Modified Blow Count-14,21,32
44.0 (ELEV.)	CL	43.5'-44.0' Silty Clay, interbedded fine sand, wet; brown (10YR4/3).		AD	
	SM	45.0'-46.0' Silty Sand, interbedded fine sand to gravel, moist, no cohesion, coarsens up sample, less fines, not consolidated; olive brown (2.5Y4/4).	17	DS	California Modified Blow Count-14,21,32
46.0		46.0'-46.5' Silty Sand, fine sand, minor gravel and clay blebs; olive brown (2.5Y4/4).		AD	
48.0	GP	48.0'-49.0' Sandy Gravel, minor silt, wet, clasts sub-angular to sub-rounded quartz and chert; matrix dark grayish-brown (2.5Y4/2).	18	DS	California Modified Blow Count-12,75,33
	SM	49.0'-49.5' Silty Sand, fine sand, some gravel, moist to wet; dark grayish-brown (2.5Y4/2).		AD	
50.0	GP	50.0'-51.0' Sandy Gravel, fine to medium sand, gravel sub-angular to sub-rounded clasts of quartz and chert to 2" diameter, saturated, no matrix. Down sample increased silt; matrix olive brown (2.5Y4/4).	19	DS	California Modified Blow Count-33,50 for 6"
					BOH-51.0'
52.0					
54.0					

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DRILL HOLE LOG

SHEET 1 of 3
HOLE NO. BH-2
ELEV. ______ FEET
DEPTH 52.0 FEET
DATE DRILLED 7/26/2000
ATTITUDE VERTICAL
LOGGED BY B. ROSS,C. GOLSH
DEPTH TO WATER Not Taken

PROJECT "J" LEVEE INVESTIGATION
FEATURE N/A
LOCATION
CONTR. LAYNE-CHRISTENSEN DRILL RIG CME-750

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
0.0 (ELEV)		QUATERNARY TERRACE DEPOSITS 0-12.0'			Shelby Tube-150lbs.
	CL	0-2.5' Silty Clay, dry to slightly moist, stiff; light olive brown (2.5Y5/3).	1	DS	
2.0					
4.0				AD	
	CL	5.0' Silty Clay, dry, stiff; very dark grayish-brown (2.5Y3/2).			Shelby Tube-200lbs.
6.0			2	DS	
	ML	7.5' Clayey Silt, stiff, slightly moist; dark yellowish-brown (10YR4/4).			
8.0 (ELEV)				AD	
10.0	ML	10.0'-12.0' Clayey Silt, minor fine sand, slightly moist, crumbly; dark grayish-brown (10YR4/2).	3	DS	Shelby Tube-350lbs.
12.0	SM	TEHAMA FORMATION 12.0'-52.0' 12.0'-12.5' Silty Sand, very fine sand, minor clay, stiff, organics; yellowish-brown (10YR5/6).			
14.0				AD	
	CL	15.0'-17.0' Silty Clay, stiff, slightly moist, slightly plastic, mottled, lots of CaCO2; light yellowish-brown (2.5Y6/3).	4	DS	Shelby Tube-350lbs. for 24.0"

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SHEET 2 of 3
HOLE NO. BH-2

DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
16.0 (ELEV.)			4	DS	
18.0				AD	
20.0	CL	20.0'-22.0' <u>Silty Clay</u>, stiff, slightly plastic, mottled, lots of CaCO2; light yellowish-brown (2.5Y6/3).	5	DS	Shelby Tube-400lbs. for 24.0"
22.0				AD	
24.0 (ELEV.)					
26.0	GM	25.0'-27.5' <u>Sandy Gravel</u>, minor silt and clay, wet to saturated; matrix yellowish-brown (10YR5/4).	6	DS	Shelby Tube-350lbs.
28.0				AD	
30.0	CL/ML	30'-31.5' <u>Silty Clay and Clayey Silt</u>, moist, stiff, plastic, some organics; light reddish-brown to yellowish-brown (2.5YR6/3 &10YR5/6).	7	DS	California Modified Blow Count-15,28,37
32.0				AD	
34.0					
	CL/ML	35.0'-36.5' <u>Silty Clay and Clayey Silt</u>, moist, stiff, slightly plastic, some organics; (continued next page)	8	DS	California Modified Blow Count-15,19,24

State of California
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DEPARTMENT OF WATER RESOURCES

SHEET 3 of 3
HOLE NO. BH-2

DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
36.0 (ELEV.)	CL/ML	Light reddish-brown to yellowish-brown (2.5YR6/3 to 10YR5/6).	8	DS	
38.0				AD	
40.0					
	ML	40.0'-42.5' Clayey Silt, moist, stiff, slightly mottled; brown (10YR5/3).	9	DS	Shelby Tube-300lbs.
42.0					
				AD	
44.0 (ELEV.)					
	GM	45.0'-46.0' Silty Sandy Gravel, wet, clasts sub-angular to sub-rounded, quartz and chert to 2.5" diameter; matrix brown (7.5YR5/4).	10	DS	Shelby Tube-450lbs. for 12.0"
46.0					
48.0				AD	
50.0	GC	50.0'-50.75' Clayey Silty Gravel, wet, dense; matrix yellowish-brown (10YR5/4).	11	DS	California Modified Blow Count-32,50 for 3.0"
	GM	51.0'-52.0' Silty Sandy Clayey Gravel, wet, lots of quartz & lithics; yellowish-brown (10YR5/4).	12	DS	California Modified Blow Count-39,50 for 5.0"
52.0					BOH-52.0'
54.0					

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SHEET 3 of 3
HOLE NO. BH-3

DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
36.0 (ELEV.)			12	DS	Shelby Tube-200 lbs.
38.0	ML	37.5'-40.0' Silt, minor clay and very fine sand, soft; dark yellowish-brown (10YR4/4).	13	DS	Shelby Tube-250 lbs.
40.0	ML	40.0'-42.0' Clayey Silt, minor fine sand, moist; light olive brown (2.5Y5/4).	14	DS	Shelby Tube-200-300 lbs. for 24.0"
42.0				AD	
44.0 (ELEV.)					
	CL	45.0'-46.0' Silty Clay, moist, slightly plastic; light olive brown (2.5Y5/4).	15	DS	California Modified Blow Count-6,16,33
46.0	SW	46.0'-46.5' Gravelly Sand, fine sand to fine gravel, angular; light yellowish-brown (2.5Y6/3).			BOH-46.5'
48.0					
50.0					
52.0					
54.0					

State of California
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DRILL HOLE LOG

SHEET 1 of 3
HOLE NO. BH-4
ELEV. ______ FEET
DEPTH 51.5 FEET
PROJECT "J" LEVEE INVESTIGATION
DATE DRILLED 7/25/2000
FEATURE N/A
ATTITUDE VERTICAL
LOCATION ______
LOGGED BY B. ROSS,C. GOLSH
CONTR. LAYNE-CHRISTENSEN
DRILL RIG CME-750
DEPTH TO WATER Not Taken

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
0.0 (ELEV.)	CL	QUATERNARY TERRACE DEPOSITS 0-17.75' 0-1.5' Silty Clay, firm, slightly plastic, fresh rootlets; very dark grayish-brown (10YR3/2).	1	DS	Shelby Tube-50lbs. for 18.0"
2.0				AD	
4.0					
6.0	ML	5.0'-6.25' Clayey Silt, some fine sand, moist, soft, plastic; yellowish-brown (10YR5/4). 6.25'-7.5' Clayey Silt, soft to firm, slightly plastic; brown (10YR4/3).	2	DS	Shelby Tube-150lbs.
8.0 (ELEV.)				AD	
10.0	CL	10.0'-11.5' Sandy Clay, fine to medium sand, slightly moist, stiff; dark brown (7.5YR4/4).	3	DS	Shelby Tube-350lbs. for 18.0"
12.0				AD	
	CL	12.5'-14.0' Silty Clay, minor fine sand, slightly moist, slightly plastic, stiff; brown (10YR4/3).	4	DS	California Modified Blow Count-14,17,17
14.0				AD	
	CL	15.0'-15.75 Silty Clay, slightly moist, slightly plastic, stiff; brown (10YR4/3).	5	DS	California Modified Blow Count-7,13,15

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SHEET 2 of 3
HOLE NO. BH-4

DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
16.0 (ELEV.)	SC	15.75'-16.5' Clayey Sand, fine sand, slightly moist; light yellowish-brown (2.5Y6/3).	5	DS	
		TEHAMA FORMATION 17.75'-51.5'		AD	
18.0	ML	17.5'-19.0' Clayey Silt, moist, soft; light olive to grayish-brown (2.5Y5/2-3).	6	DS	California Modified Blow Count-7,8,13
				AD	
20.0	ML	20.0'-20.75' Clayey Silt, moist, soft, slightly plastic; grayish-brown (2.5Y5/2).	7	DS	California Modified Blow Count-7,15,23
	CL	20.75'-21.5' Silty Clay, moist, firm, mottled; brown (10YR5/3).		AD	
22.0	ML	22.5'-25.0' Clayey Silt, slightly moist, non-plastic, mottled; brown to light brownish gray (10YR4/3& 10YR6/2).	8	DS	Shelby Tube-200 lbs.
24.0 (ELEV.)					
26.0	ML	25.0'-27.5' Clayey Silt, moist, slightly plastic, mottled; greyish-brown (10YR5/2).	9	DS	Shelby Tube-150lbs.
28.0				AD	
30.0	CL	30.0'-31.5' Silty Clay, slightly moist, firm, mottled; yellowish-brown (10YR5/4).	10	DS	Shelby Tube-400lbs. for 18.0"
				AD	
32.0	CL	32.5'-34.0' Silty Clay, slightly moist, firm, mottled; light olive brown (2.5Y5/3) to yellowish-brown (10YR5/4).	11	DS	California Modified Blow Count-14,18,29
34.0				AD	
	ML	35.0'-36.5' Clayey Silt, slightly moist, soft, not mottled; yellowish- brown (10YR5/4).	12	DS	Shelby Tube-350lbs. for 18.0"

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SHEET 3 of 3
HOLE NO. BH-4

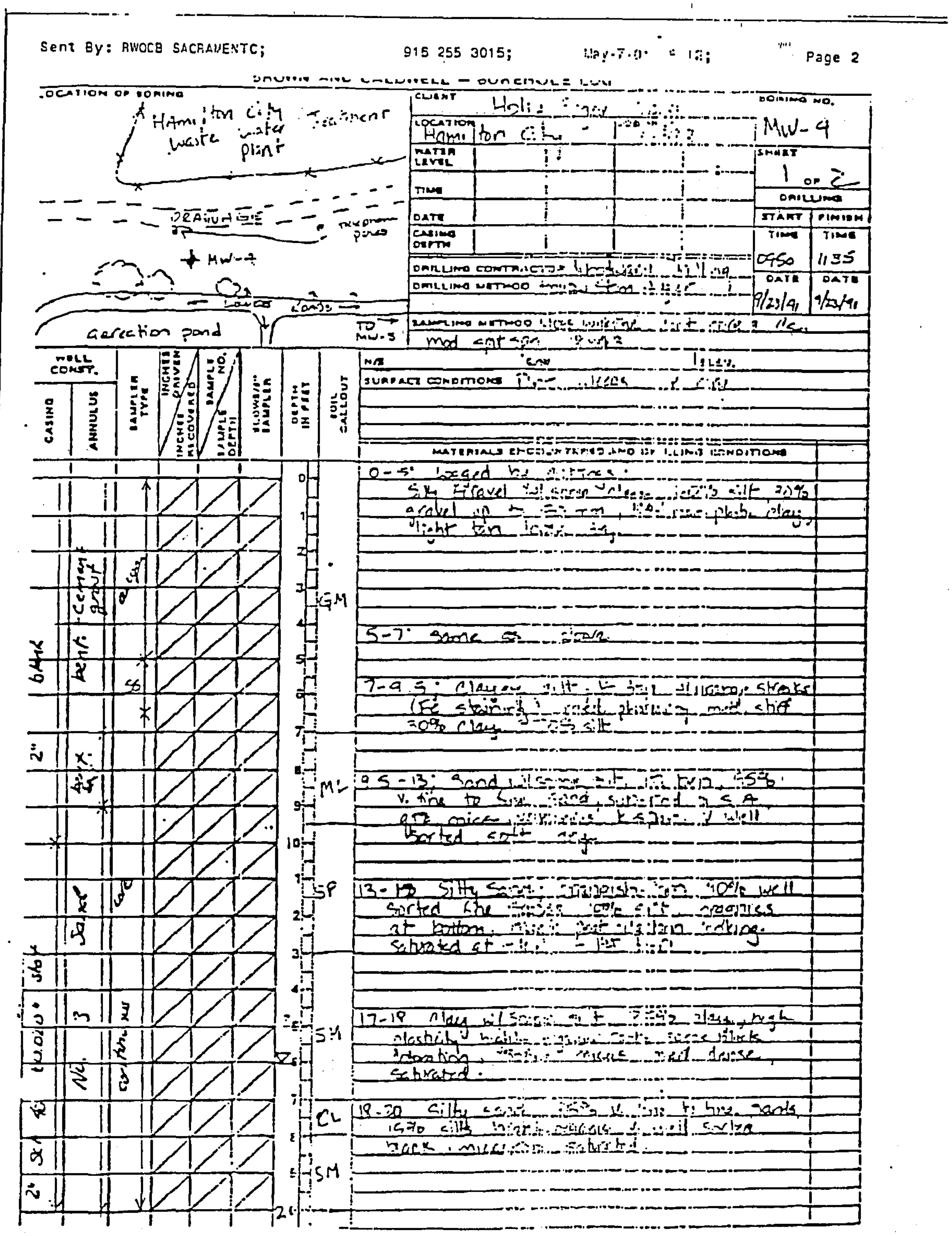
DRILL HOLE LOG

PROJECT & FEATURE

DEPTH (ELEV.)	LOG	FIELD CLASSIFICATION AND DESCRIPTION	SAMPLE NO.	MODE	REMARKS
36.0 (ELEV.)			12	DS	
				AD	
38.0	CL	37.5'-39.0' Clay, some silt, moist, soft, slightly plastic; light olive brown (2.5Y5/3) to light yellowish-brown (2.5Y6/3).	13	DS	California Modified Blow Count-10,14,19
				AD	
40.0	ML	40.0'-41.5' Clayey Silt, moist, crumbly, not plastic, possibly old soil; brown (10YR5/3).	14	DS	Shelby Tube-400lbs. for 18.0"
42.0				AD	
	ML	42.5'-44.0' Clayey Silt, moist, soft, slightly plastic; brown (10YR4/3).	15	DS	California Modified Blow Count-10,11,14
44.0 (ELEV.)				AD	
46.0	ML	45.0'-47.5' Clayey Silt, moist, firm, crumbly; brown (10YR5/3).	16	DS	Shelby Tube-250lbs.
48.0				AD	
50.0	ML	50.0'-51.5' Clayey Silt, minor fine sand, moist, crumbly, slight mottling, some organics; brown (10YR5/3).	17	DS	California Modified Blow Count-28,12,18
52.0					BOH-51.5'
54.0					

Appendix 4

Soil Logs From Brown & Caldwell



Sent By: RWQCB SACRAMENTO; 915 255 3015; May-7-0[illegible] [illegible] Page 2

BROWN AND CALDWELL — BOREHOLE LOG

LOCATION OF BORING

CLIENT Holly [illegible]

LOCATION Hamilton City

BORING NO. MW-4

SHEET 1 OF 2

WATER LEVEL			
TIME			
DATE			
CASING DEPTH			

DRILLING

START TIME	FINISH TIME
0950	1135
DATE	DATE
9/23/91	9/23/91

DRILLING CONTRACTOR [illegible] Drilling

DRILLING METHOD [illegible] Stem [illegible]

SAMPLING METHOD [illegible]

Mod. spt [illegible]

N/S E/W ELEV.

SURFACE CONDITIONS [illegible]

WELL CONST. — CASING — ANNULUS — SAMPLER TYPE — INCHES DRIVEN / INCHES RECOVERED — SAMPLE NO. / SAMPLE DEPTH — BLOWS/6" SAMPLER — DEPTH IN FEET — SOIL CALLOUT

MATERIALS ENCOUNTERED AND DRILLING CONDITIONS

0-5' logged by [illegible]:
Silty Gravel [illegible] 20% gravel up to [illegible] mm, [illegible] plastic clay, light tan [illegible]

5-7' same as above

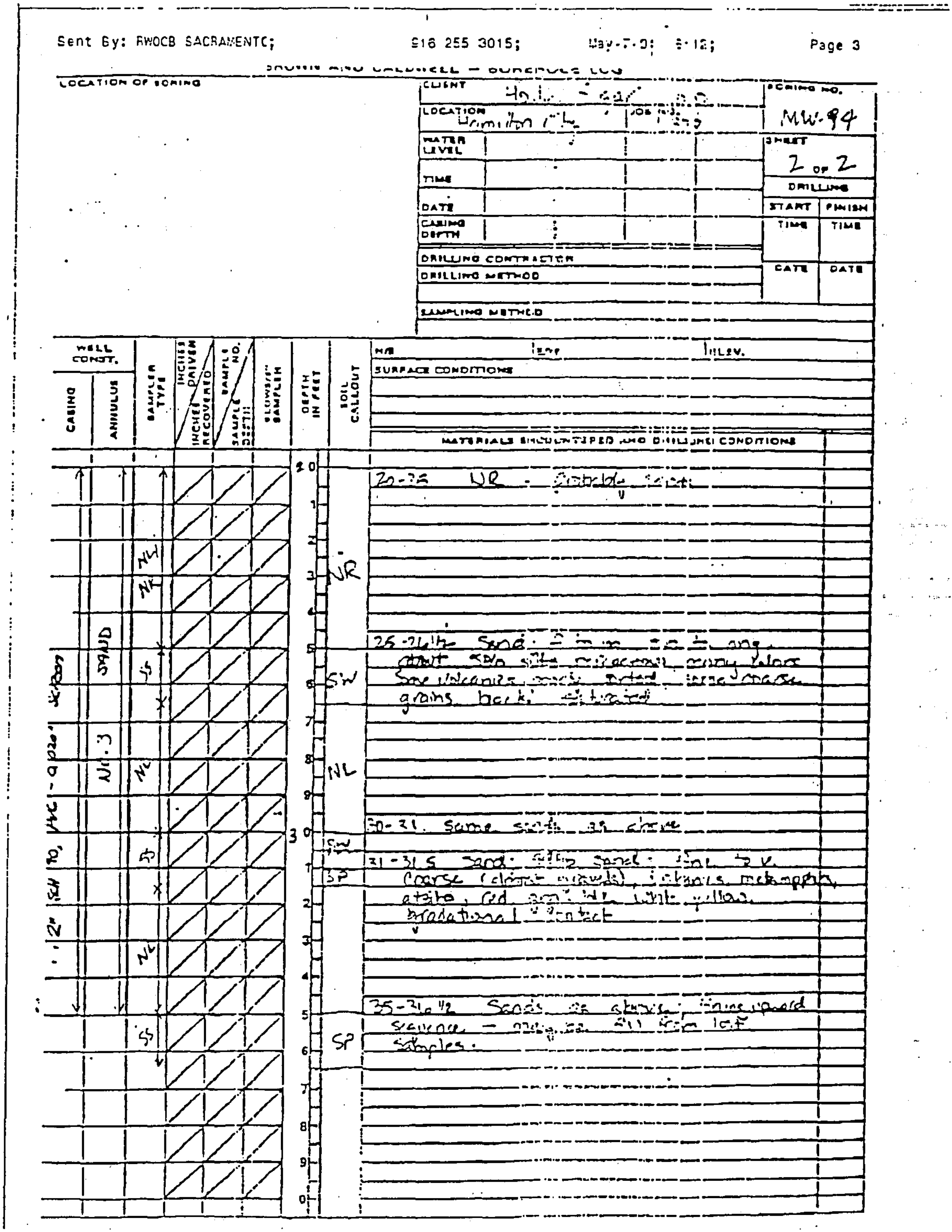
7-9.5' Clayey silt [illegible] streaks (Fe staining) [illegible] mod. stiff 30% Clay [illegible] silt

9.5-13' Sand w/ some silt [illegible] v. fine to [illegible] sand, subrounded [illegible] mica [illegible] well sorted soft [illegible]

13-17' Silty Sand [illegible] 10% well sorted fine [illegible] 10% silt [illegible] at bottom [illegible] saturated at [illegible]

17-19 Clay w/ Some silt [illegible] clay, high plasticity [illegible] black [illegible] dense, saturated.

19-20 Silty sand [illegible] v. fine to fine sands 15% silt [illegible] saturated.



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BROWN AND CALDWELL — BOREHOLE LOG

LOCATION OF BORING

CLIENT [illegible]

LOCATION Hamilton City

JOB NO. [illegible]

BORING NO. MW-94

SHEET 2 OF 2

WATER LEVEL			
TIME			
DATE			
CASING DEPTH			

DRILLING

START	FINISH
TIME	TIME
DATE	DATE

DRILLING CONTRACTOR

DRILLING METHOD

SAMPLING METHOD

N/S

E/W

ELEV.

SURFACE CONDITIONS

WELL CONST.: CASING; ANNULUS | SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | SAMPLE NO. / SAMPLE DEPTH | BLOWS/6" SAMPLER | DEPTH IN FEET | SOIL CALLOUT

MATERIALS ENCOUNTERED AND DRILLING CONDITIONS

Casing: 2" SCH 40, PVC - 0.020" Screen

Annulus: SAND No. 3

Sampler type: NR, NR, SS, NL, SS, NL, SS

Soil callout: NR, SW, NL, SW, SP, SP

Depth in feet: 20, 1, 2, 3, 4, 5, 6, 7, 8, 9, 30, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0

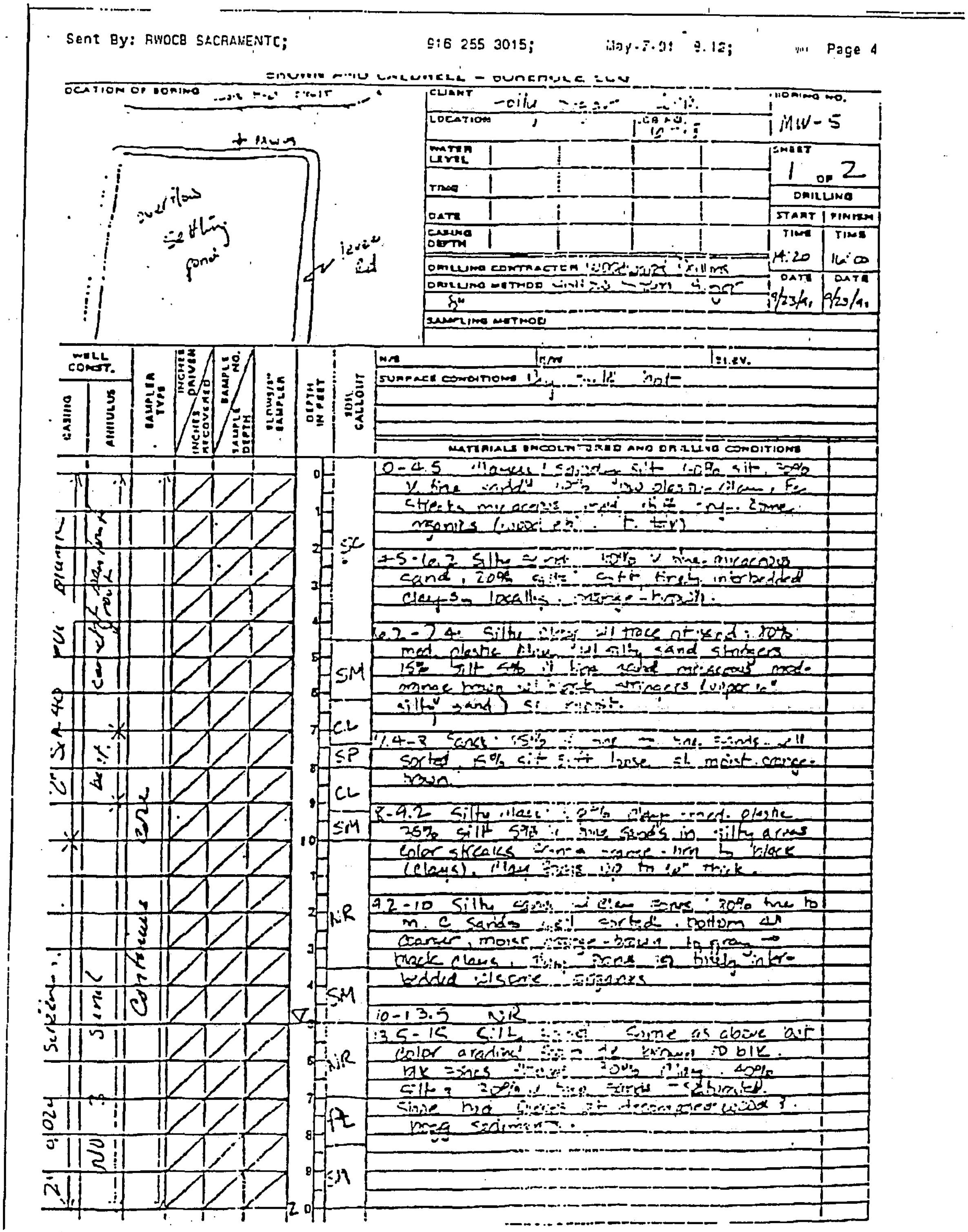
20-25 NR - [illegible]

25-26½ Sand: [illegible] ang. about 5% silt [illegible] many black some volcanics [illegible] [illegible] [illegible] coarse grains back [illegible]

30-31. Same sand as above

31-31.5 Sand: Silty sand: fine to v. coarse (almost gravels), [illegible] metamorphic, [illegible], red [illegible] white yellow. Gradational contact

35-36½ Sands as above; fining upward sequence - [illegible] [illegible] from [illegible] samples.



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BROWN AND CALDWELL — BOREHOLE LOG

LOCATION OF BORING [illegible]

CLIENT [illegible]

LOCATION [illegible]

BORING NO. MW-5

SHEET 1 OF 2

WATER LEVEL

TIME

DATE

CASING DEPTH

DRILLING CONTRACTOR [illegible]

DRILLING METHOD [illegible]

DRILLING START TIME 14:20 FINISH TIME 16:00

DATE 9/23/91 DATE 9/23/91

SAMPLING METHOD

N/S E/W ELEV.

SURFACE CONDITIONS [illegible]

WELL CONST. CASING ANNULUS | SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | SAMPLE NO. / SAMPLE DEPTH | BLOWS/6" SAMPLER | DEPTH IN FEET | SOIL CALLOUT

2" Sch 40 PVC blank

Screen

0.020"

Sand

Continuous

MATERIALS ENCOUNTERED AND DRILLING CONDITIONS

0-4.5 [illegible] Sandy silt 60% silt, 30% v. fine sand, 10% low plastic clay, Fe streaks micaceous [illegible] organics (wood [illegible]) — SC

4.5-6.2 Silty sand 70% v. fine micaceous sand, 20% silt, [illegible] interbedded clays locally, orange-brown. — SM

6.2-7.4 Silty clay w/ trace of sand; 70% med. plastic clay w/ silty sand stringers 15% silt 5% v. fine sand micaceous, orange brown w/ black stringers (upper [illegible] silty sand) sl. moist. — CL

7.4-8 Sand: 95% [illegible] sands, well sorted, 5% silt [illegible] loose, sl. moist, orange-brown. — SP

8-9.2 Silty clay: 60% clay, med. plastic 35% silt 5% [illegible] sands in silty areas color streaks [illegible] orange-brn to black (clays), clay [illegible] up to 1/2" thick. — CL

9.2-10 Silty sand w/ clay zones: 70% fine to m. c. sands well sorted, bottom [illegible] coarser, moist, orange-brown to gray — black clays, [illegible] in [illegible] inter-bedded [illegible] — SM

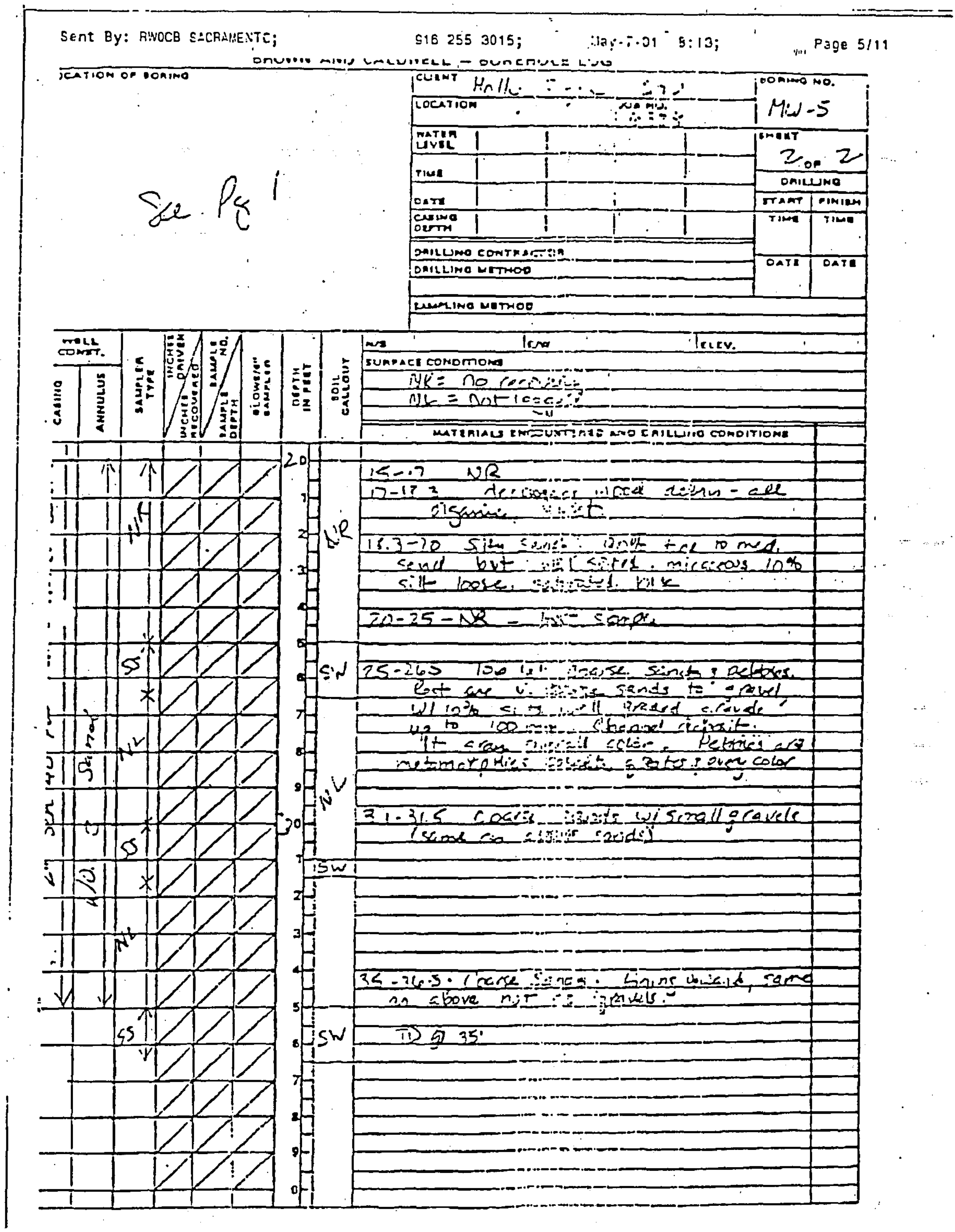
10-13.5 NR — NR

13.5-15 Silt [illegible] Same as above but color grading [illegible] brown to blk. blk zones [illegible] 30% clay, 40% silt, 30% [illegible] fine sands [illegible] some [illegible] decomposed wood? [illegible] sediment. — SM

NR

Pt

SM



Sent By: RWOCB SACRAMENTO; 916 255 3015; May-7-01 5:13; Page 5/11

BROWN AND CALDWELL — BOREHOLE LOG

CATION OF BORING

See Pg 1

CLIENT Halls [illegible]

LOCATION JOB NO. [illegible]

BORING NO. MW-5

SHEET 2 OF 2

WATER LEVEL

TIME

DATE

CASING DEPTH

DRILLING START TIME FINISH TIME

DATE DATE

DRILLING CONTRACTOR

DRILLING METHOD

SAMPLING METHOD

N/S E/W ELEV.

SURFACE CONDITIONS

NR = No recovery

NL = Not logged

WELL CONST. CASING ANNULUS | SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | SAMPLE NO. / SAMPLE DEPTH | BLOWS/6" SAMPLER | DEPTH IN FEET | SOIL CALLOUT | MATERIALS ENCOUNTERED AND DRILLING CONDITIONS

Depth	Soil callout	Materials encountered and drilling conditions
20	NR	15-17 NR
1		17-17.3 decomposed wood debris - all organic [illegible]
2		17.3-20 Silty sand: 90% fine to med. sand but well sorted. micaceous 10% silt loose, saturated. [illegible]
3		
4		20-25 - NR - lost sample
5		
6	SW	25-26.5 100 [illegible] coarse sands & pebbles. Rest are v. coarse sands to gravel w/ 10% silt well graded gravels up to 100 mm. Channel deposit. It gray overall color. Pebbles are metamorphics, basalt, granites & grey color
7	NL	
8		
9		
30		31-31.5 Coarse sands w/ small gravels (same as above sands)
1	SW	
2		
3		
4		35-36.5 Coarse sands. [illegible], same as above not as gravels.
5		
6	SW	TD @ 35'
7		
8		
9		
0		

NH

SS

NL

Sand

SS

NL

SS

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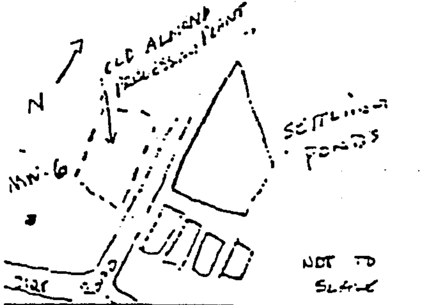
BROWN AND CALDWELL — BOREHOLE LOG

LOCATION OF BORING



CLIENT Holly Sugar Corp					BORING NO. MW-6
LOCATION Hamilton City		JOB NO. [illegible]			SHEET 1 OF 3
WATER LEVEL					DRILLING
TIME					START | FINISH
DATE					TIME 1505 | TIME 1630
CASING DEPTH					DATE 5/24/91 | DATE 5/24/91
DRILLING CONTRACTOR Woodward Drilling					
DRILLING METHOD Hollow Stem Auger Wireline System					
SAMPLING METHOD [illegible] 2' [illegible] mod. split spoon					

N/S E/W ELEV.

SURFACE CONDITIONS bare weeds, dry hot (100°F+)

Above Ground Completion w/ Steel Monument

WELL CONST.: CASING | ANNULUS — SAMPLER TYPE — INCHES DRIVEN / INCHES RECOVERED — SAMPLE NO. / SAMPLE DEPTH — BLOWS/6" SAMPLER — DEPTH IN FEET — SOIL CALLOUT

CASING: BLANK PVC 40 SCH 2" — SCREEN

ANNULUS: [illegible] — [illegible] bentonite — 3/8 — GROUT — 3 SAND — No 3

SAMPLER TYPE: [illegible] — [illegible]

DEPTH IN FEET: 0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 20

SOIL CALLOUT: ML (0–5) — CL (5–20)

MATERIALS ENCOUNTERED AND DRILLING CONDITIONS

0-5': Silt w/ some Clay - 90% silt 10% plastic clay lt brown, dry loose.

5-10: silty Clay: 80% mod plastic clay 20% silt lt brown dry hard. dense, some root traces, slightly moist at 10'

10-20 Same as above except for mottling of orange and black becoming more plastic.
at 18' trace amounts of v fine sands.

19' - TD Completed [illegible]

Sent By: RWQCB SACRAMENTO; 916 255 3015; May-7-01 9:14; Page 7/11

BROWN AND CALDWELL – BOREHOLE LOG

LOCATION OF BORING

See pg. 1

CLIENT Holly [illegible] Co

LOCATION

JOB NO.

BORING NO. MW-6

SHEET 2 OF 3

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING

START	FINISH
TIME	TIME
DATE	DATE

DRILLING CONTRACTOR

DRILLING METHOD

SAMPLING METHOD

N/S E/W ELEV.

SURFACE CONDITIONS

NL = not logged

WELL CONST. CASING	WELL CONST. ANNULUS	SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	SAMPLE NO. / SAMPLE DEPTH	BLOWS/6" SAMPLER	DEPTH IN FEET	SOIL CALLOUT	MATERIALS ENCOUNTERED AND DRILLING CONDITIONS
Scr'n		core				20	NR	20-25 – No recovery; pushing in sands that <1.0 [illegible] [illegible] core barrel switch to sampling every 5 ft
		cont						
Slotted		SS				25	SW	25-26½ Sand poorly sorted, 5% silt is matrix, upward fining sequence w/ silt layer on top. lt gray saturated; some pebbles
0.020"	Sand						NR	
40 PVC		SS				30	SW	30-31.5 Sand: same as above but more pebbles (up to 5 mm in zones), poorly sorted. lt gray, saturated.
	3						NV	
Sch	NO.	SS				35	SW	35-36½ · Same as above.
2"							NV	
						40		

Sent By: RWQCB SACRAMENTO; 916 255 3015; May-7-01 9:14; Page 7/11

[illegible]

LOCATION OF BORING

See pg. 1

CLIENT [illegible]

LOCATION

JOB NO.

BORING NO. MW-6

WATER LEVEL

TIME

DATE

CASING DEPTH

SHEET 2 OF 3

DRILLING START FINISH

TIME TIME

DATE DATE

DRILLING CONTRACTOR

DRILLING METHOD

SAMPLING METHOD

N/S E/W ELEV.

SURFACE CONDITIONS

NL = not logged

WELL CONST. CASING	WELL CONST. ANNULUS	SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	SAMPLE NO. / SAMPLE DEPTH	BLOWS/6" SAMPLER	DEPTH IN FEET	SOIL CALLOUT	MATERIALS ENCOUNTERED AND DRILLING CONDITIONS
		core cont				20	NL	20 - 25 - No recovery: mobbing in sands that clog core barrel switch to sampling every 5 ft
2" Sch 40 PVC 0.010" Slotted	No. 3 Sand	SS				25	SW	25-26 1/2 Sand poorly sorted, 5% silt is matrix, upward fining sequence w/ silt layer on top. lt gray saturated; bad pebbles
							NL	
		SS				30	SW	30-31.5 Sand: same as above, but more pebbles (up to 5mm in zones), poorly sorted. lt gray. Saturated.
							NL	
		SS				35	SW	35-36 1/2 · same as above.
							NL	
						40		

Sent By: RWQCB SACRAMENTO; 916 255 3015; May-7-01 9:14; Page 8/11

BROWN AND CALDWELL — BOREHOLE LOG

LOCATION OF BORING

See 98

CLIENT [illegible]

LOCATION

CS NO.

BORING NO. MW-6

SHEET 3 OF 3

WATER LEVEL			
TIME			
DATE			
CASING DEPTH			

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

DRILLING CONTRACTOR

DRILLING METHOD

SAMPLING METHOD

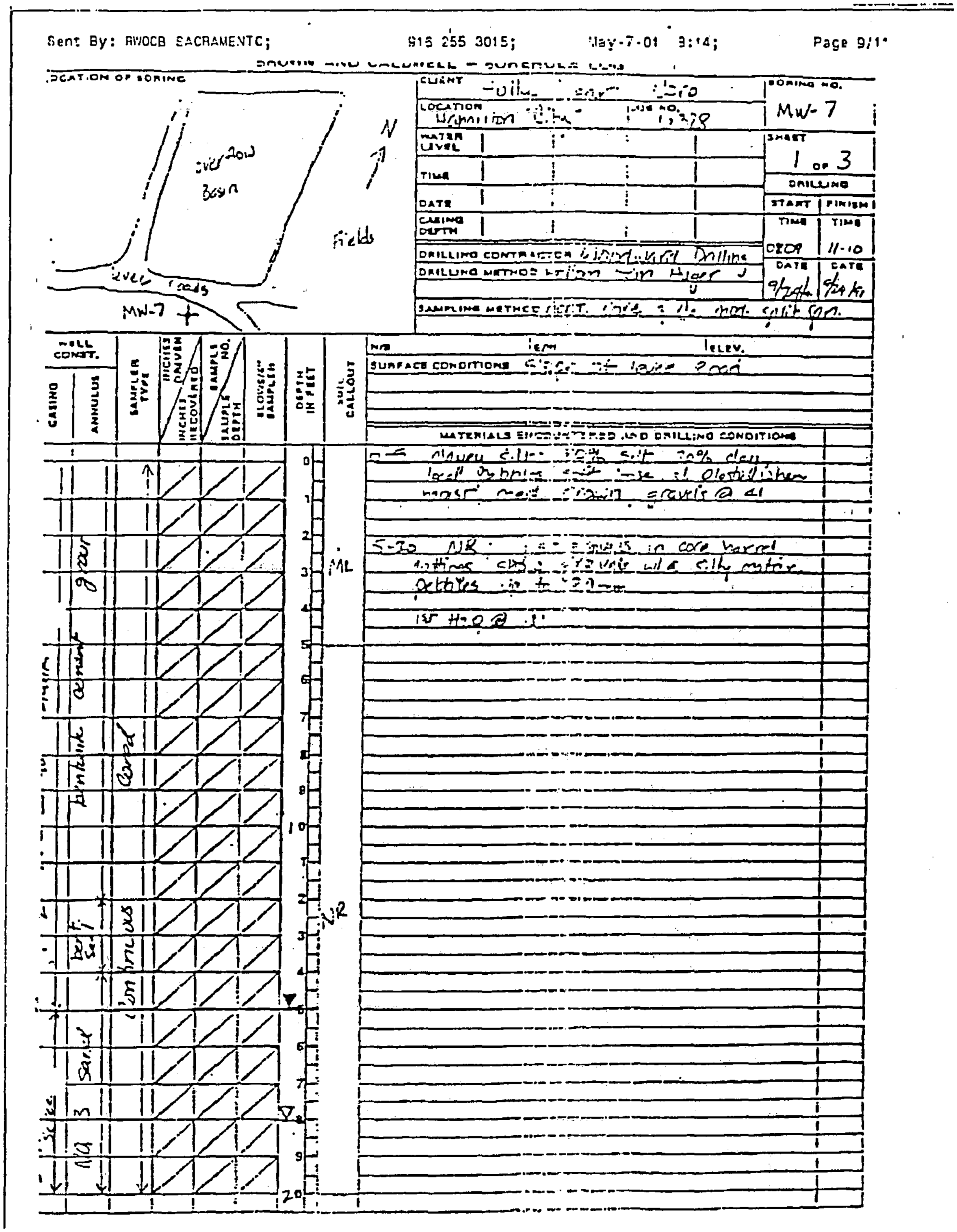
N/S

E/W

ELEV.

SURFACE CONDITIONS

WELL CONST. CASING	WELL CONST. ANNULUS	SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	SAMPLE NO. / SAMPLE DEPTH	BLOWS/6" SAMPLER	DEPTH IN FEET	SOIL CALLOUT	MATERIALS ENCOUNTERED AND DRILLING CONDITIONS
		8				40		Gravel as above, -V sand [illegible] coarse
						1	GW	to pebble [illegible] in pebbles
						2		northward
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		



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BROWN AND CALDWELL — SUBSURFACE LOG

LOCATION OF BORING

CLIENT [illegible]

LOCATION Hamilton City

JOB NO. [illegible]

BORING NO. MW-7

SHEET 1 OF 3

WATER LEVEL

TIME

DATE

CASING DEPTH

DRILLING START TIME 0809 FINISH TIME 11-10

DATE 9/24/[illegible] DATE 9/24/[illegible]

DRILLING CONTRACTOR [illegible] Drilling

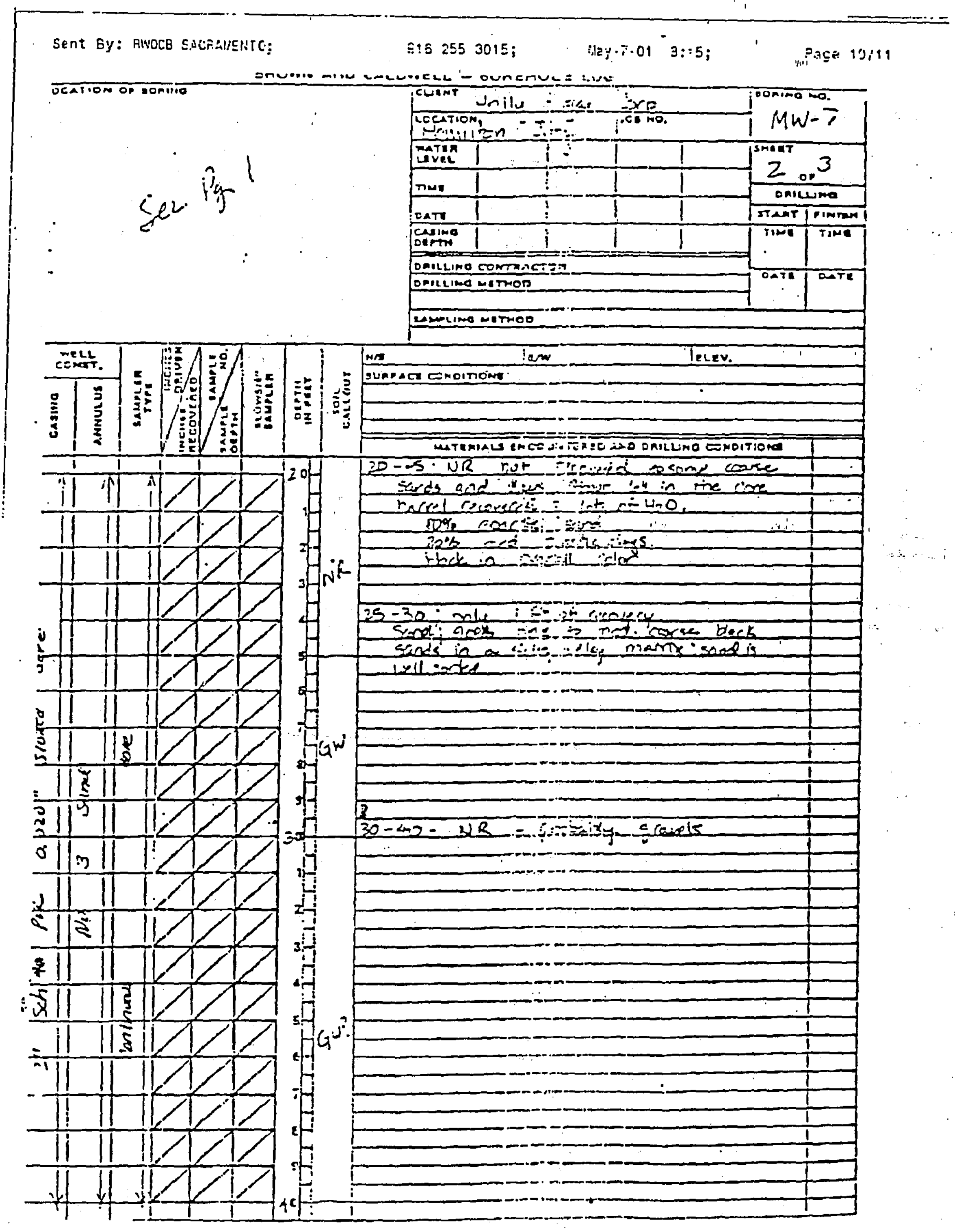
DRILLING METHOD hollow stem auger

SAMPLING METHOD [illegible] split spoon

N/S E/W ELEV.

SURFACE CONDITIONS [illegible]

CASING	ANNULUS	SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	SAMPLE NO. / SAMPLE DEPTH	BLOWS/6" SAMPLER	DEPTH IN FEET	SOIL CALLOUT	MATERIALS ENCOUNTERED AND DRILLING CONDITIONS
						0		0-5 clayey silt: 80% silt 20% clay, local organic [illegible] slightly plastic moist, med brown, gravels @ 4'
						1		
	grout					2		5-20 NR [illegible] in core barrel cuttings [illegible] silty matrix pebbles [illegible] 1st H2O @ [illegible]
						3	ML	
						4		
	cement					5		
						6		
	bentonite	Cored				7		
						8		
						9		
						10		
						1		
		continuous				2	NR	
						3		
						4		
						5		
	sand					6		
	#3					7		
						8		
						9		
						20		



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BROWN AND CALDWELL – BOREHOLE LOG

LOCATION OF BORING

See Pg 1

CLIENT Unilu [illegible] Crp

LOCATION Hamilton [illegible]

JOB NO.

BORING NO. MW-7

SHEET 2 OF 3

WATER LEVEL

TIME

DATE

CASING DEPTH

DRILLING

START TIME / FINISH TIME

DATE / DATE

DRILLING CONTRACTOR

DRILLING METHOD

SAMPLING METHOD

WELL CONST. — CASING — ANNULUS | SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | SAMPLE NO. / SAMPLE DEPTH | BLOWS/6" SAMPLER | DEPTH IN FEET | SOIL CALLOUT

N/S E/W ELEV.

SURFACE CONDITIONS

MATERIALS ENCOUNTERED AND DRILLING CONDITIONS

Depth	Soil callout	Materials encountered and drilling conditions
20		20-25: NR not [illegible] some coarse sands and [illegible] [illegible] left in the core barrel [illegible] [illegible] lots of H2O. 50% coarse sand 20% [illegible] [illegible]. thick in [illegible] [illegible]
3	NR	
4		25-30: only [illegible] of gravelly Sand; approx [illegible] is med. coarse black sands in a [illegible] [illegible] matrix sand is well sorted
7	GW	
30		30-40: NR = [illegible] gravels
5	GW?	
40		

2" Sch 40 PVC 0.020" Slotted Screen

#3 Sand

Continuous Core

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

CLASSIFICATION TEST SUMMARY

DIVISION OF ENGINEERING
CIVIL ENGINEERING
DAMS AND CANALS SECTION

PROJECT: Hamilton City **FEATURE:**

Sheet 1 of X

				PERCENT FINER																				
				MECHANICAL ANALYSIS												HYDROMETER								CLASSIFICATION
				GRAVEL					SAND							SILT & CLAY								
				6.0"	3.0"	1.5"	3/4"	3/8"	4	8	16	30	50	100	200	5M	2M	1M	ATTERBERG LIMITS		MOISTURE CONTENT	PERCENT ORGANICS	GROUP SYMBOL	GROUP NAME
LAB. NO	HOLE NO	F.S. NO	DEPTH (feet)	152 mm	75 mm	37.5 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.6 mm	0.3 mm	0.15 mm	0.075 mm	0.005 mm	0.002 mm	0.001 mm	L.L.	P.I.	%			
03-1150		#1	0.5 - 1.0				100	99	99	99	98	98	98	94	91				35	18			CL	Lean clay
03-1151		#2					100	98	92	87	84	82	77	73	56				33	16			s(CL)	Sandy lean clay
03-1152		#3			100	98	92	81	70	61	56	51	47	45	41				30	14			(GC)s	Clayey gravel with sand
03-1153		#4					100	99	97	95	92	91	88	82	74				32	15			(CL)s	Lean clay with sand

DATE: 11/14/2003
INITIAL: djs
REQUEST NO.: 2003-16

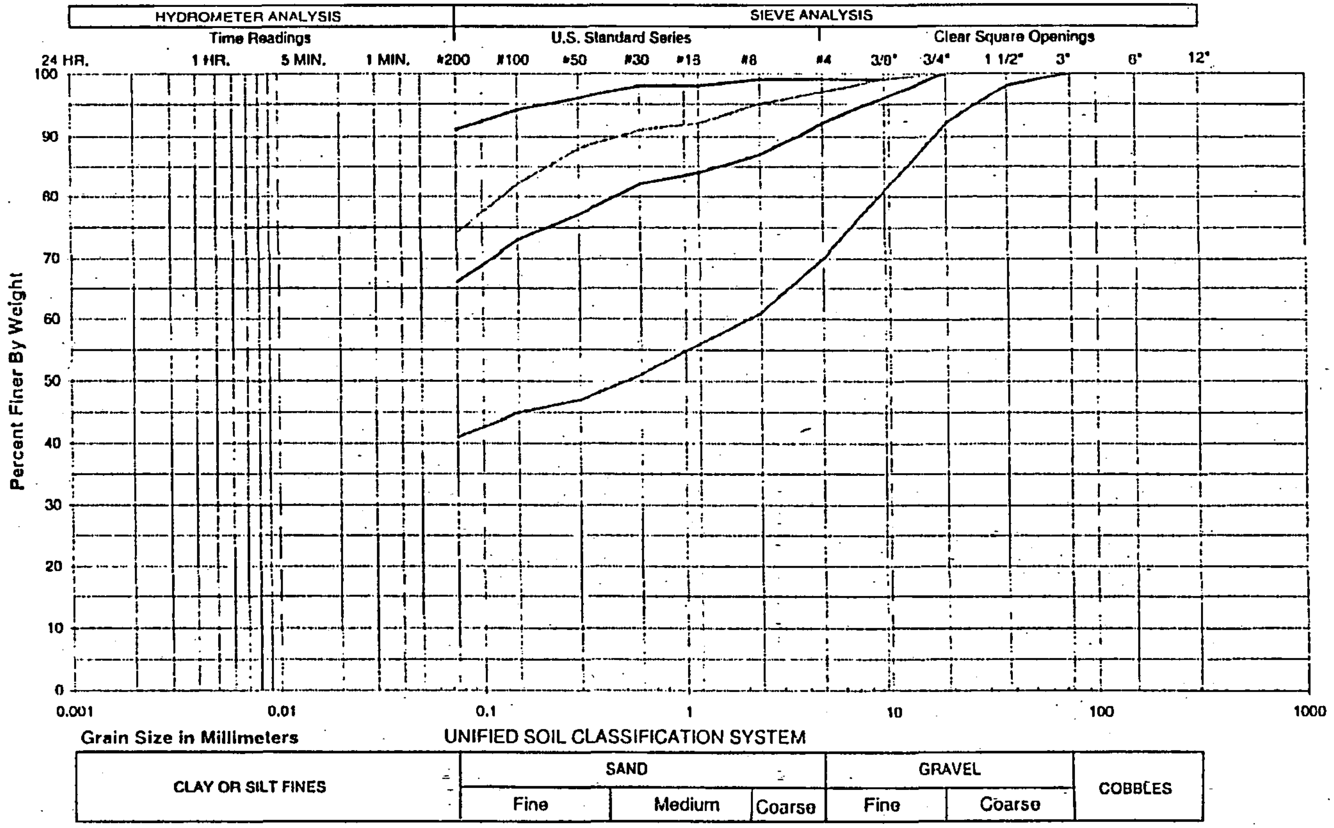
REMARKS

NI - INSUFFICIENT MATERIAL
NP - NON PLASTIC
NG - NO GOOD

State of California
The Resources Agency
Department of Water Resources

Particle Size Analysis Graph

Division of Engineering
Civil Engineering
Dams and Canals Section



HC LAB RESULTS.xls
Gradation Curve

Western Tulare Lakebed
Westside Detention Basin

11/17/2003

Appendix C5.

CIVIL DESIGN

Hamilton City Flood Damage Reduction And Ecosystem Restoration Feasibility Study

Civil Design
Table of Contents

Hamilton City Flood Damage Reduction
And Ecosystem Restoration Feasibility Study
Appendix C5 - Civil Design

I. Introduction

A. Site Location.

The Hamilton City study area is located in Glenn County about 5 miles west of Chico on State Highway 32 along the right bank of the Sacramento River and about 85 miles north of Sacramento. See Figure C5-1.

B. Study Area Description

The study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the east and the Glenn Colusa Canal to the west and extends about two miles north and six miles south of Hamilton City. Hamilton City has a population of about 2,000 people. Surrounding land use is typically agricultural with fruit and nut orchards being the primary crops.

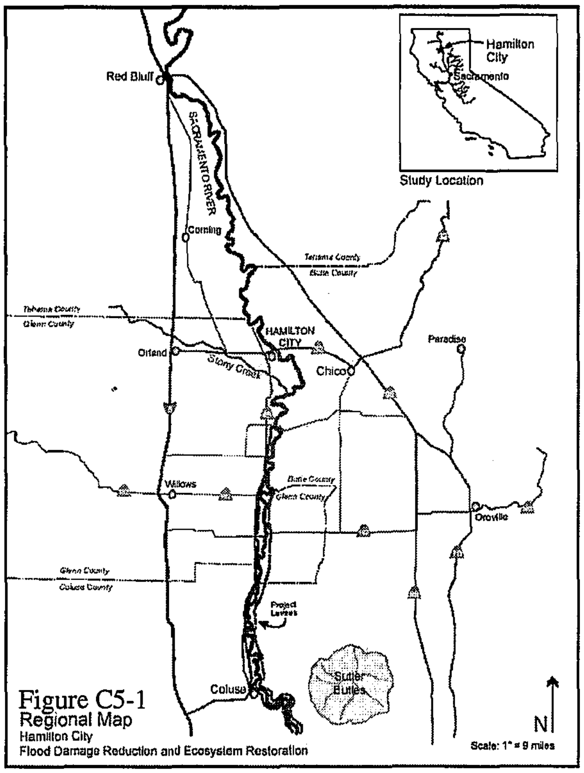


Figure C5-1
Regional Map
Hamilton City
Flood Damage Reduction and Ecosystem Restoration

An existing private levee, constructed by landowners in about 1904 and known as the "J" levee, provides some flood protection to the town and surrounding area. The "J" levee, however, is not constructed to any formal engineering standards and is largely made of silty sand soil. It is extremely susceptible to erosion and flood fighting is necessary to prevent levee failure and flooding when river levels rise. Since the construction of Shasta Dam in 1945, flooding in Hamilton City due to failure of the "J" levee has occurred once (1974). In addition, extensive flood fighting has been necessary to avoid flooding in 1983, 1986, 1995, 1997, and 1998. Currently, the Sacramento River is actively eroding into the toe of the levee at the northern end of the study area. Glenn County has built a backup levee, about 1,000 feet in length, to protect the community in the event the toe erosion causes failure at the northern end of the "J" levee.

II. Site Selection.

A. *Design Alternatives*

Design alternatives for different levels of flood protection were also investigated. Each design provides a reliability of passing an event at 90-percent confidence relative to the *n*-year design. These include the following criteria:

Table C5-1: Design Reliability

Damage Impact Area	*n*-Year Design	Frequency of Exceedance (90% Confidence)	Conditional Non-Exceedance					
			10-year flood	25-year flood	50-year flood	100-year flood	250-year flood	500-year flood
Northern Area	320	1 in 75	100	100	96	84	49	17
Southern Area #1	100	1 in 35	100	96	81	53	20	6
Southern Area #2	20	1 in 11	93	46	20	6	1	0

Discuss the selection of the project site and evaluation of alternative layouts, alignments, components, aesthetics, relocation of facilities, etc., and describe components and features, including the improvements required on lands to enable the proper disposal of dredged or excavated material. In the event only a minimum design documentation report (DDR) is to be prepared, the site selection information in the engineering appendix to the feasibility report shall be sufficiently detailed to support the development of project real estate requirements and preparation of P&S.

B. *Description of Alternative Plans*

The individual alternatives with Ecosystem Restoration (ER) and Flood Damage Reduction (FDR) benefits are briefly summarized below in Table C5-2 and are described in more detail in the main report.

Table C5-2 Alternatives and Major Features with Relative Benefits

Preliminary Combined Alternatives[2]	**Increase in Habitat Units (AAHU)**	**Flood Damage Reduction Benefits**[3] **($1,000)**
1-Locally Developed Setback Levee with 500-yr FDR	783	676
2-Intermediate Setback Levee with 500-yr FDR	795	483
3-Ring Levee with 500-yr FDR	895	470
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough with 500-yr FDR	642	493
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough with 500-yr FDR	937	666
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32 with 500-yr FDR	888	676

C. Recommended Plan

The levee is approximately 6.77 miles long. It starts at County Road 203, runs offset of the "J" Levee to Dunning Slough where it goes in a southerly direction to St. John Road (County Road 23) and turns southerly to end about 1.1 miles south of County Road 23. The levee generally has a 15-foot top width, 3/1-side slope on the waterside and 3/1-side slope on the landside. It also has a 0 to 27-foot-wide seepage berm on the landside depending on the levee height. It is to be capped with a 4-inch gravel road for maintenance and all-weather protection. The foundation is to be cleared/grubbed and then excavated underneath with a 6-foot-deep inspection trench to the Tehama Formation. An erosion protection trench (*in-situ*) filled with entrenched riprap will be placed about 200 feet from the levee on the waterside at various locations. See Figures C5-6through 11 for levee alignment, entrenchment detail, and reference location. A typical cross-section for entrenched rock is shown in the Hydraulic Report, Appendix C3. This riprap feature is to protect the levee from the river's tendencies to meander throughout the floodplain belt as it has in the past. Additional erosion protection will be done in reaches where velocities are higher than the scour velocities, such as under the Highway 32 Bridge. These erosion protection sites, whether larger stone or some other alternative, will be designed to be self-mitigating and add to Shaded Riverine Aquatic habitat (SRA) as best as possible.

III. Real Estate.

Typical real estate footprint requirements for the setback levee and the new levee with and without landside seepage berms are shown in typical cross section detail in Figure C5-2. Refinement of these footprints will be provided in final design in order to incorporate necessary foundation treatment prior to construction of the levee. Cross section #1 shows a typical section of new embankment paralleling the west approach to the Highway 32 Bridge. Cross section #2 is typical for controlling seepage within the Irvine Fitch boat ramp facility. Cross section #3 illustrates the typical levee section for most of the reach above and downstream of Highway 32. Cross section # 4 is typical for the training levee. Approximately forty feet landward of all the new levees and/or berm toes will be temporarily needed for staging of equipment and materials necessary for construction. Cross section #5 shows the design for ramping up and over the training levee at the County Road 23 crossing.

To support the construction, operation and maintenance of the selected plan, real estate requirements vary slightly from alternative to alternative but are consistent with standard practices described in the Real Estate Appendix. In general, the proposed alignment of the selected plan consists of a setback levee constructed on the right bank of the Sacramento River. This work will begin at approximately river mile (RM) 200.3 (near the intersection of Road 203 and the "J" levee continuing downstream to about a mile south of Road 23 (RM 193). The environmental features of the project will have requirements that impact all or portions of lands within the project area. The setback and new replacement levees will require a flood protection levee easement, affecting 19 of the 21 parcels and covering an area of about 144.64 acres. For the areas where restoration is to occur, fee title will be required, affecting 15 parcels and covering an area of 1,469.92 acres. There is also a requirement for a one-year temporary work area easement, affecting 17 parcels and covering an area of 27.96 acres. The existing "J" levee, constructed by landowners in about 1904, will provides minimal flood protection to the northern part of Hamilton City and surrounding area. This levee will be breached to allow for flows after the setback levee is completed. It is anticipated that this entire levee, both north and south of Highway 32 can be constructed in one work season. See Figures C5-6 through C5-11 for a more detail look at the selected plan alignment and specific features of the proposed levee and rock protection.

IV. Relocations.

In general, actual relocations of existing utilities and other facility features with the selected plan are minimal. Most of the lands are currently designated agriculture. The largest utility within the area is the existing sewage treatment ponds located nestled into the upstream arc of Dunning Slough. These ponds and ancillary structures within its limits are currently protected by a ring levee and it is not anticipated there will be any impact to its operation. Road 23 will need to ramp over the new training levee. A PG&E gas main located upstream of the Highway 32 bridge will require more detail to ensure that the inspection trench of the proposed setback levee will not interfere with the operation and maintenance of the gas line. Figure C5-3 illustrates a few of the primary features that will be impacted by the selected plan and the recommended method of repair.

Table C5-3 summarizes the various facilities, public and private utilities, and roads that are potentially impacted with the selected plan. As shown, the project will affect the following utility/facility items:

Table C5-3 Relocation and Cost Schedule

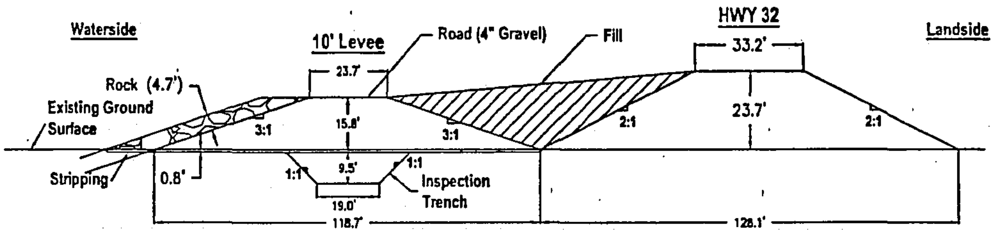
Utility/Facility Feature	Impact	Cost (1,000) [1]
Water	None	-
Power	None	-
Sewage Treatment Ponds	None [2]	-
Telephone	None	-
Irvine Fitch Park, Hwy 32, and Interior Drainage	Resurface, Culvert and Surface Drainage Ditches	$ 250
Fiber Optics line Hwy 32	None	-
High Pressure Gas line north of Hwy 32	None [3]	-
County Road 203	Elevate road 1 to 1 ½ feet for 1,000-foot reach at	$ 158
911 Telephone line on County Rd 23	Protect in place	-
USRR spur line	Protect in place	-
Private Residence RM 203 utilities	Protect in place [4]	-
Road 23	Raise and Relocate	$ 80
City Roads	Raise and Relocate	$ 75
Local Interior Drainage		
Total Costs		$ 563

[1] Include 25% contingency.

[2] Sewage Treatment Ponds - Adjustments to the internal storm drains to accommodate any waterside improvements.

[3] The High Pressure Gas line will not be moved. The setback alignment intersects gas line and measures will need to ensure levee inspection trench and compaction effort does not affect gas line.

[4] This assumes residence has not been lost to waterside erosion of the structure's foundations.



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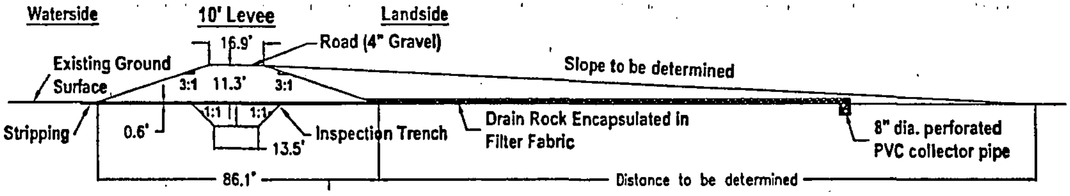

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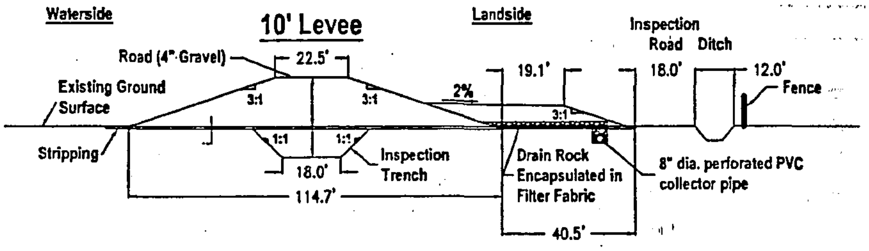

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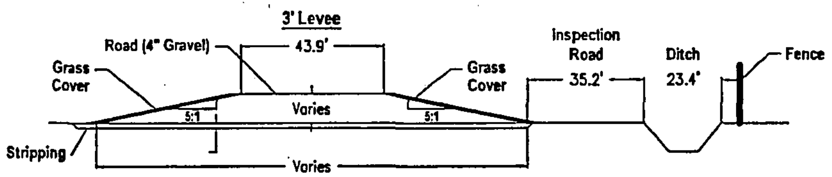

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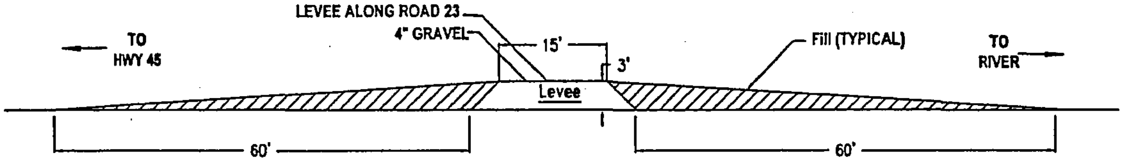


CROSS SECTION #5
NOT TO SCALE

SELECTED PLAN
ALIGNMENT 6

HAMILTON CITY PLAN

Sheet reference number:
C5-2

CALIFORNIA
SACRAMENTO RIVER
FLOOD CONTROL PROJECT
CROSS SECTIONS
1, 2, 3, 4 AND 5
CONCEPTUAL PHASE

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA
ENGINEERING DIVISION
CIVIL DESIGN BRANCH
CIVIL DESIGN SECTION B

U.S. Army Corps of Engineers
Sacramento District

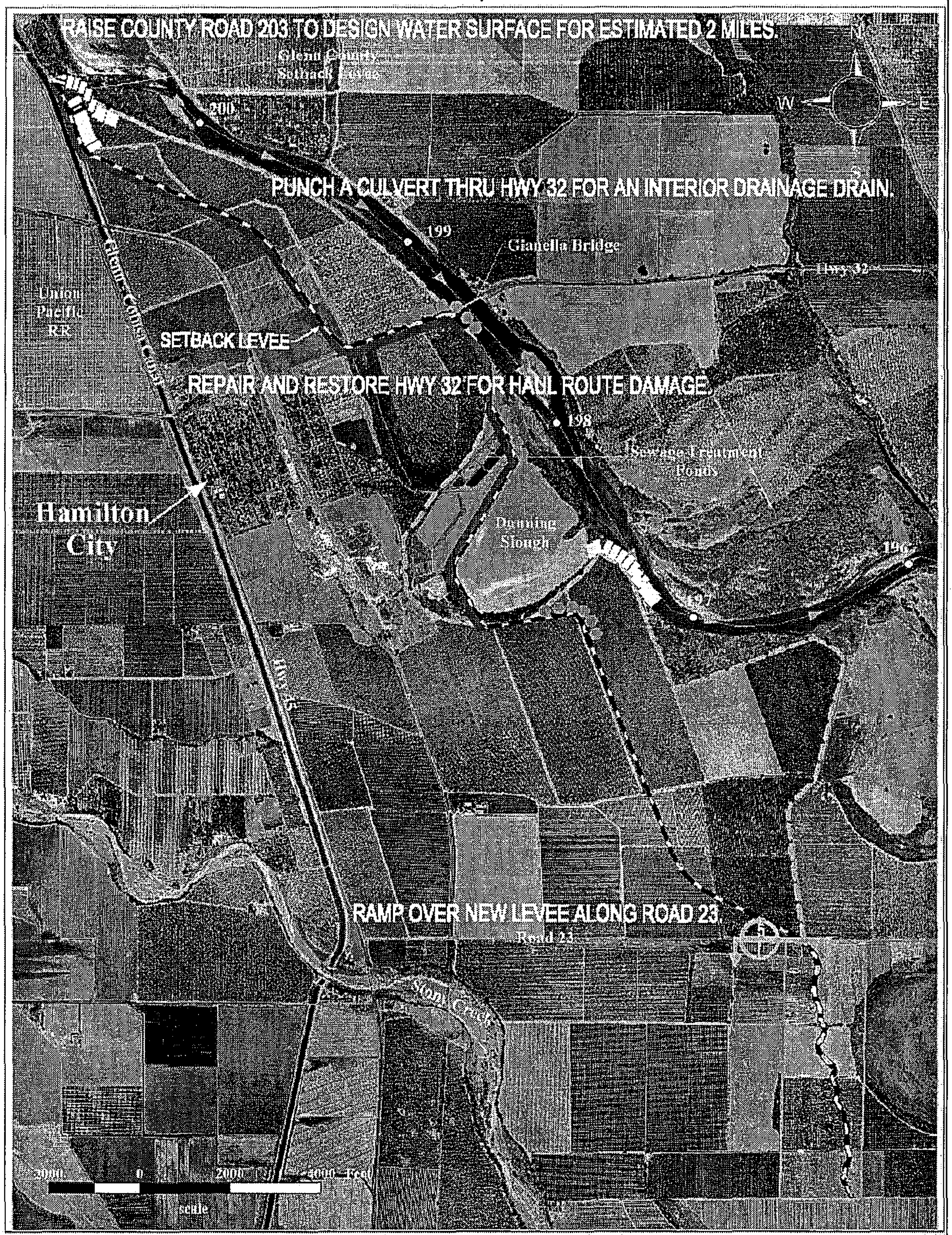


Figure C5-3. Road Modifications for Selected Plan

V. Interior Drainage

A. Without Project (Existing) Drainage Features

The Hamilton City storm water system now drains toward the river to its outfall near the access road of the sewage treatment ponds and the "J" levee. From there it is pumped over the road and "J" Levee into a ditch that follows the "J" Levee around Dunning Slough then tapers out to seep into the ground in front of the "J" Levee. This ditch is on the riverside of the "J" levee with a small outfall into the river. The majority of the storm water is very low and seeps into this ditch before getting to the river. Several times (3 or 4) during the rainy season the pump is turned on to pump the impounded storm water into the ditch. At this time the two sides of the "J" Levee are dry from river flows.

When the river is in flood stages but not overtopping the "J" Levee, the interior drainage is filling the storm drains to capacity. Two Interior Drainage pumps are added to the existing storm pump to take the combined flows over the road and "J" levee into the same existing ditch around Dunning Slough. At this stage the ditch is nearly filled by the river overflows.

When the river is at a flood stage over the "J" Levee, the flows inundate the storm drain outfall and interior drainage systems flooding the lower parts of the city then sweeping around Holly Sugar plant into the river overflows.

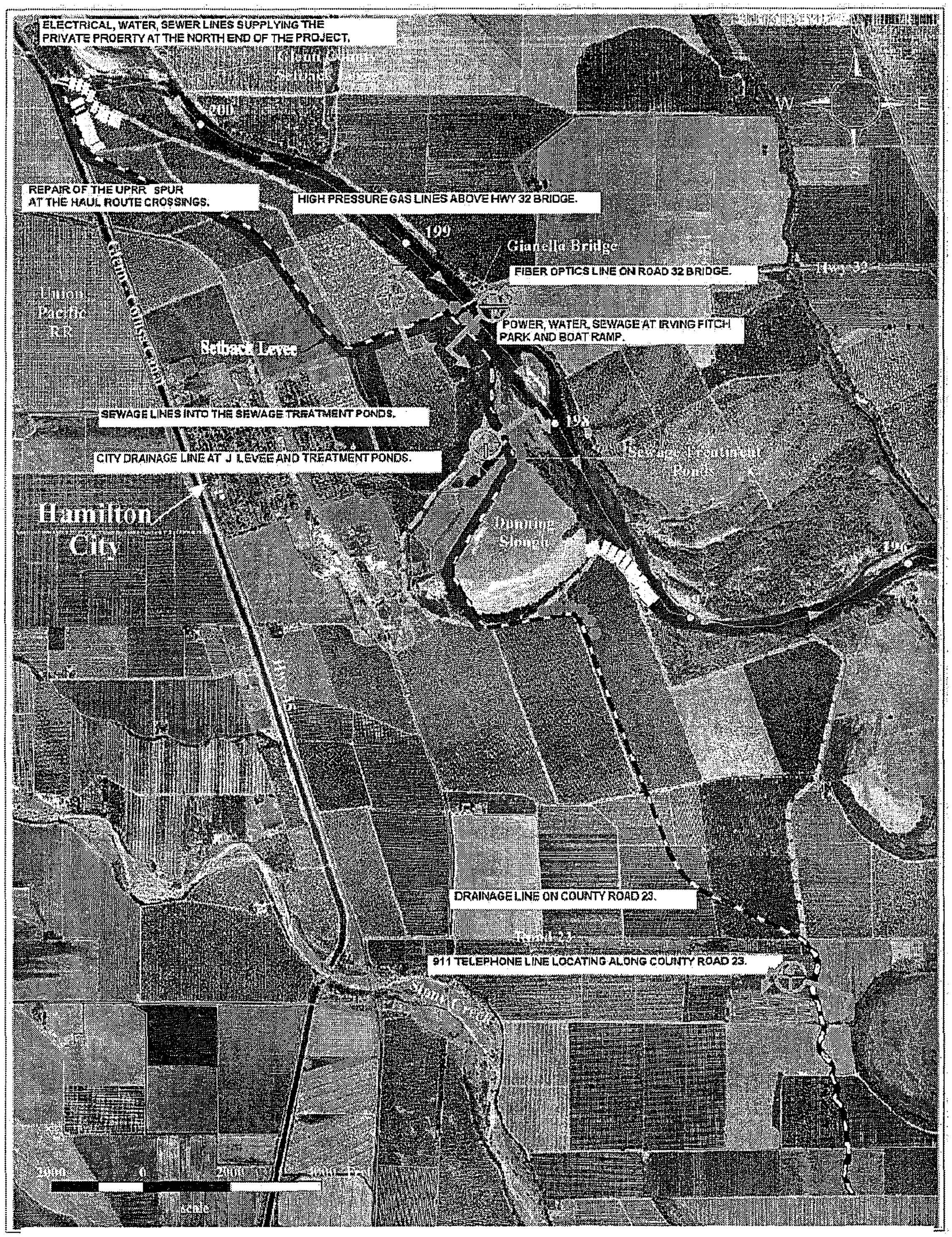


Fig C5-4 Utility Locations & Features

Legend

Existing Levee

Riprap (armoring)

Entrenched Launched Rock

Seepage Berm

B. With Project (Recommended Plan) Drainage Features

The Hamilton City Storm system drains as it does now. A small cut-off dike across the Holly Sugar pond to the "J" levee will be built to keep the small drainage area behind the sewer ponds from flanking into the existing ditch. In addition, the landside drain ditch on the proposed levee will be enlarged to carry the drainage from behind the sewer ponds into the new interior drain about midway around Dunning Slough.

At flood stages where the interior drainage and the storm drain is about to overwhelm the City storm channel thus flooding the city, several large culverts are to be placed through the road and "J" levee to take the drain flows into the existing ditch, then along ditch. The pump can be turned off if it already hasn't been cut-off. This is to be design as a fail-safe system, unlike the existing system, and no pumps or "flap" valves are to be used. This ditch is to be realigned to about a point midway along Dunning Slough to carry the drainages along the backside of the Project Levee down to a point at the mergence with the wrap-around waters coming from the end of the levee. It can also be terminated at the location of the next enlarged penetration of the storm drainpipe of the Project levee.

VI. Haul Routes

Haul routes to and from the various sources for embankment fill, stone armoring, or spoiling excavated materials and debris will be refined later. It is tentatively decided that most of the embankment fill will be processed material from the GCID spoil site. This material will be tested prior to construction to ensure the material properties conform to recommended soils specified for this use. Rock sources are within relatively short distances from the project. Rock selected for placement will be laboratory tested as recommended in the Geotechnical Appendix C4 to ensure compatibility to specifications. The following map, Figure C5-5, shows the tentatively designated construction haul routes necessary for project work. The SPRR spur, Highway 32 Bridge, as well as the other county/city roads and structures will need to be protected in place and repaired if damaged.

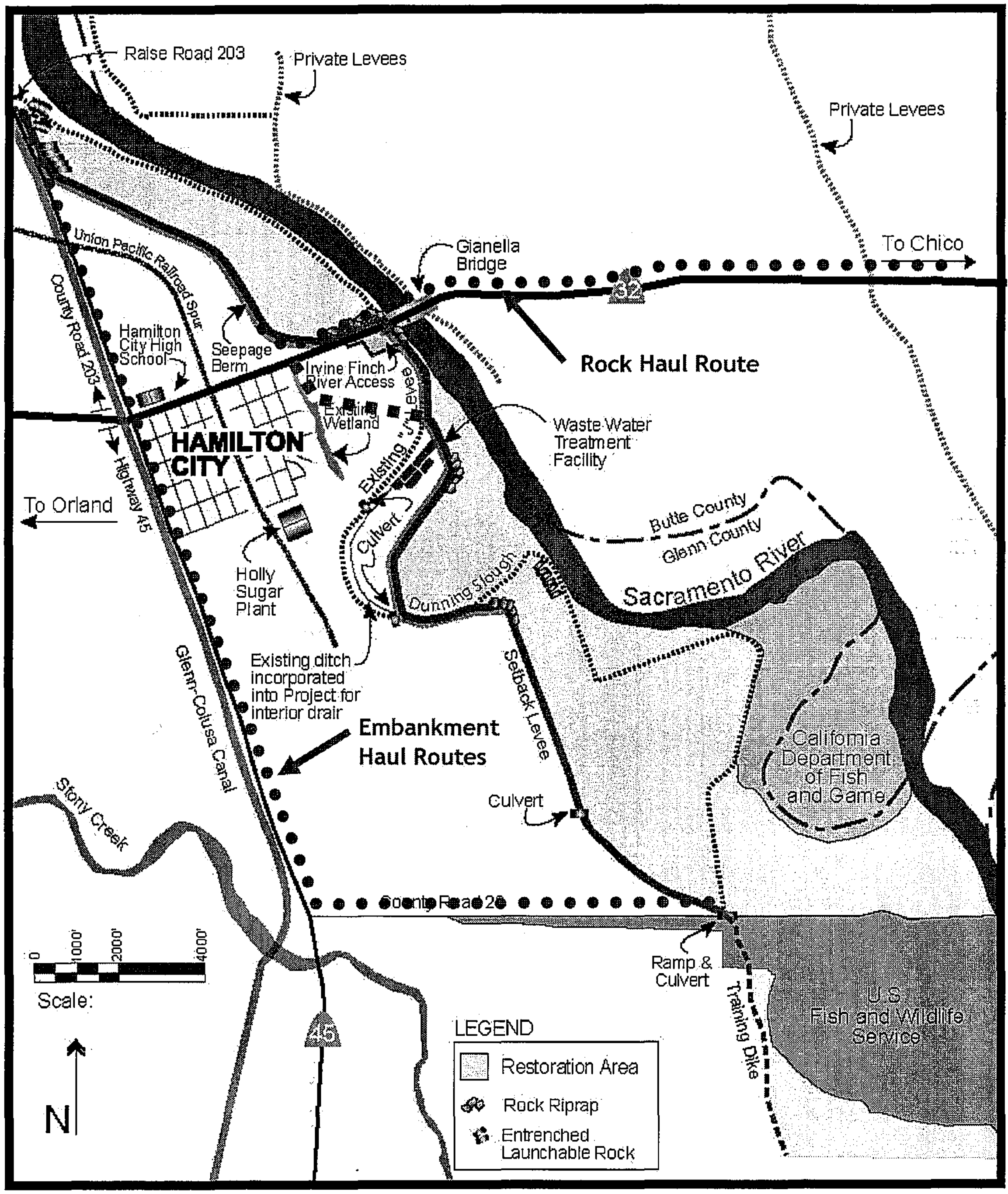


Figure C5-5 Embankment and Rock Haul Routes Within the Project Area/Site

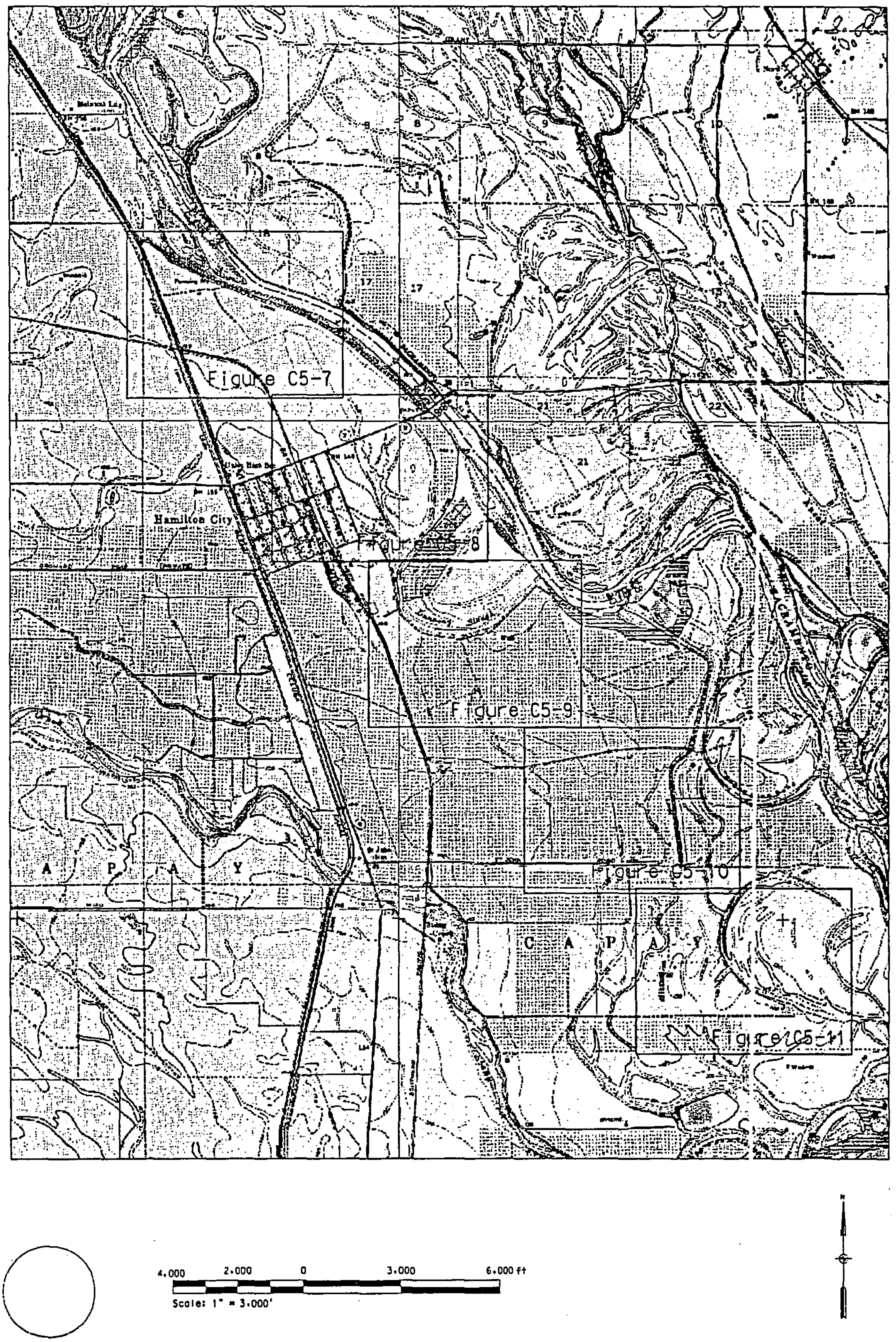


Figure
C5-6

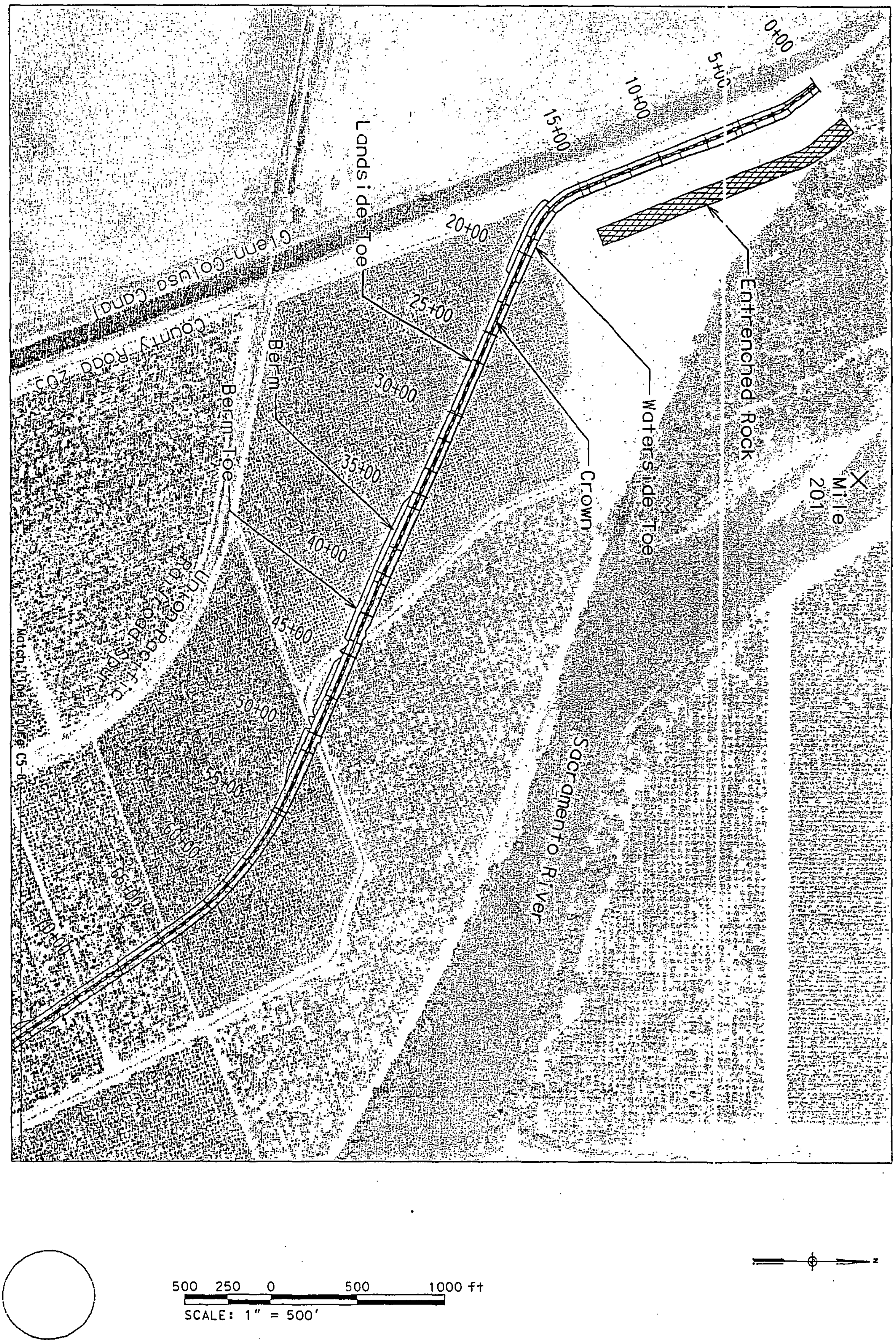
Sheet reference number:

LOCATION STATE
Sacramento/San Joaquin Rivers
Comprehensive Study
Hamilton City

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 "J" STREET
SACRAMENTO, CA 95814-2922

US Army Corps
of Engineers
Sacramento District



Sheet reference number:
Figure
C5-7

LOCATION
STATE
Sacramento/San Joaquin Rivers
Comprehensive Study
Hamilton City

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

Designed by: DESIGNER		Date: DATE_APPROVED Rev.: REV_#
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Reviewed by: REVIEWED_BY		Drawing Code: DRAWING_CODE
Submitted by: SIGNATURE		File name: FILE_NAME

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D5	DESCRIPTION5	DATE5APPROVAL5
D4	DESCRIPTION4	DATE4APPROVAL4
D3	DESCRIPTION3	DATE3APPROVAL3
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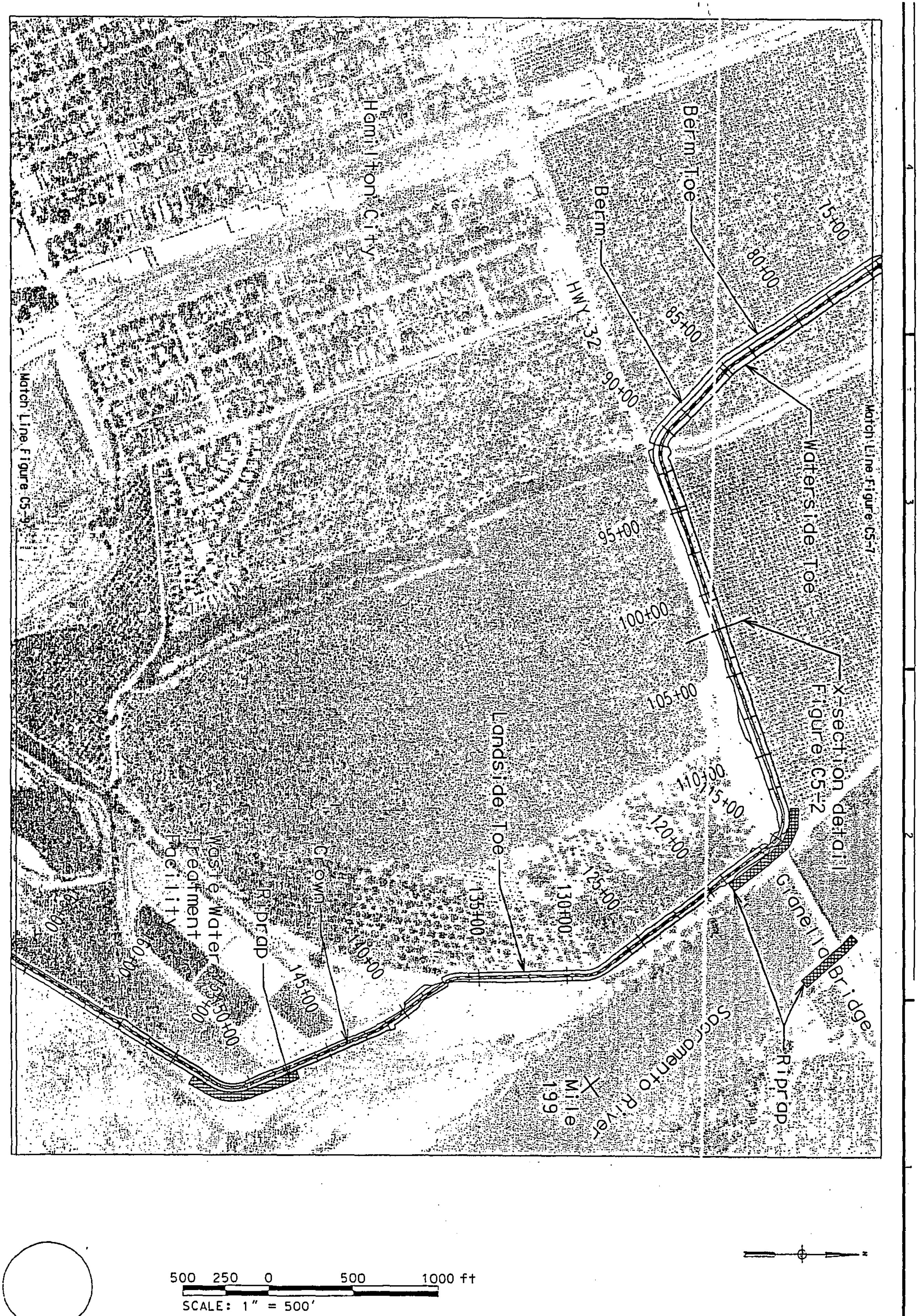
D1	DESCRIPTION1	DATE1APPROVAL1

US Army Corps
of Engineers
Sacramento District

UPDATE



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Sheet reference number:
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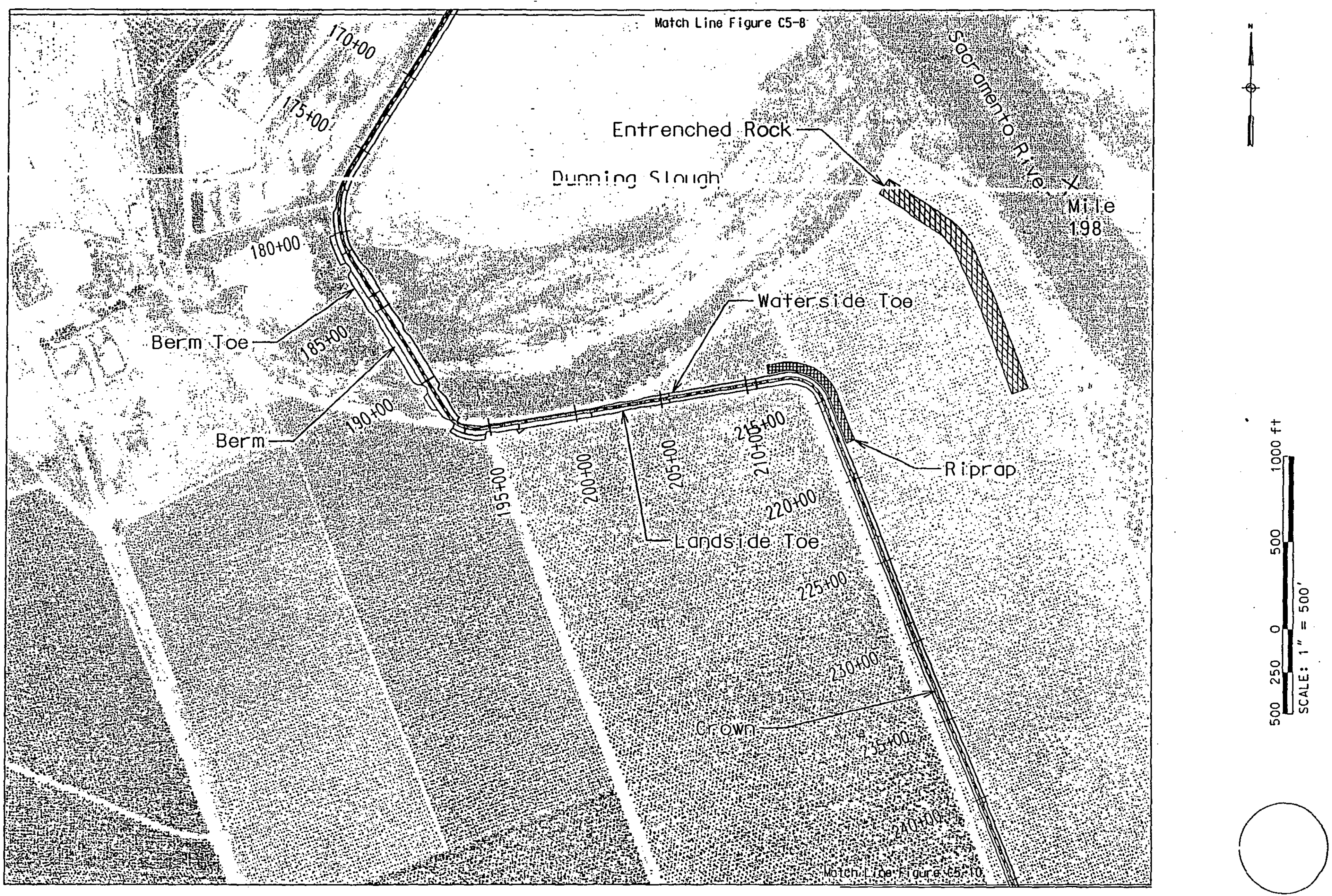
LOCATION STATE
Sacramento/San Joaquin Rivers
Comprehensive Study
Hamilton City

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

US Army Corps of Engineers
Sacramento District



US Army Corps of Engineers
Sacramento District

LOCATION STATE
Sacramento/San Joaquin Rivers
Comprehensive Study
Hamilton City

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

Sheet reference number:
Figure
C5-9

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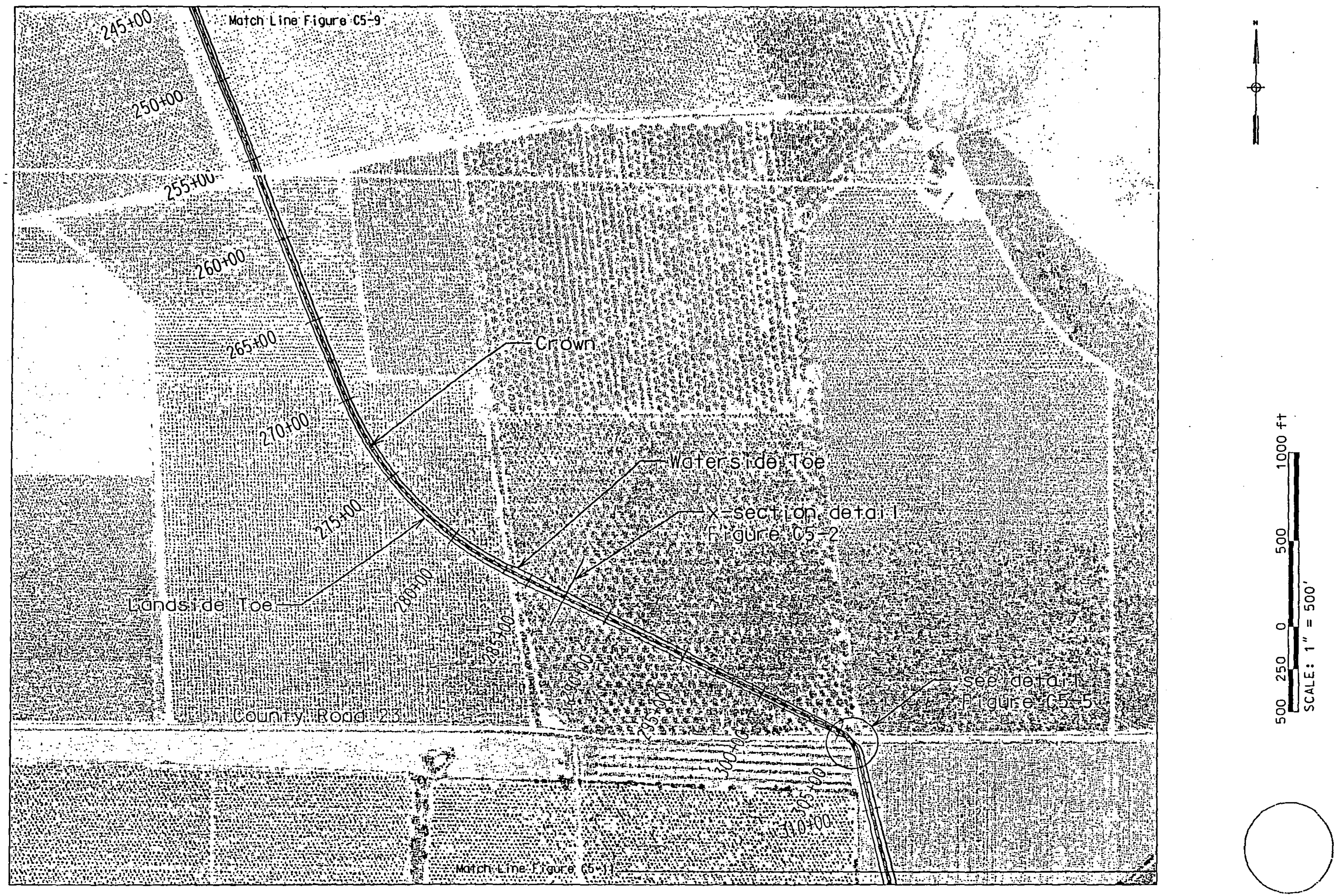


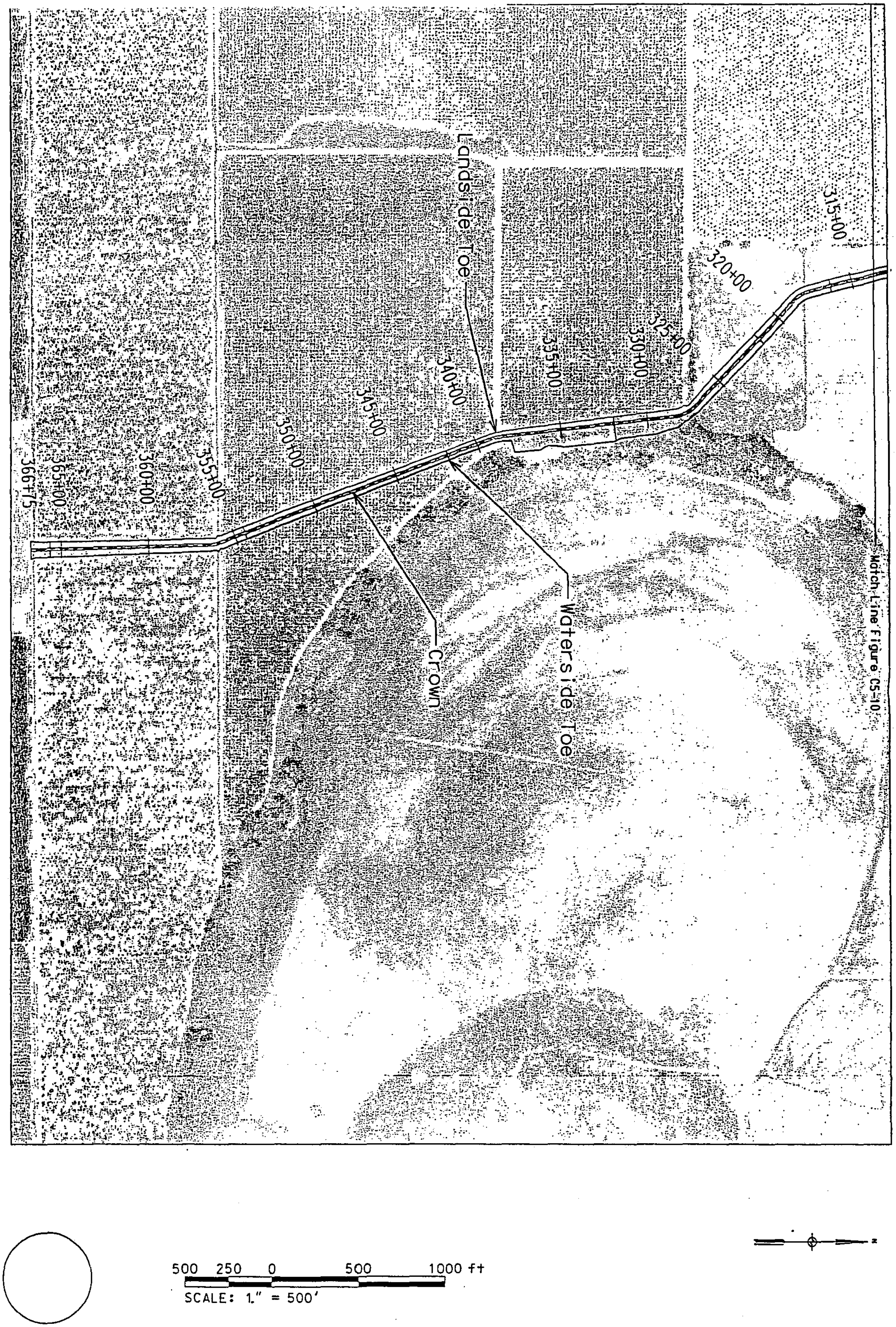
US Army Corps of Engineers Sacramento District

LOCATION
Sacramento/San Joaquin Rivers
Comprehensive Study
Hamilton City

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

Sheet reference number:
Figure
C5-10



UPDATE

Sheet reference number:
Figure
CS-11

LOCATION STATE
Sacramento/San Joaquin Rivers
Comprehensive Study
Hamilton City

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

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Sacramento District

Appendix C6.

HAZARDOUS, TOXIC AND/OR RADIOLOGICAL WASTE (HTRW)

HTRW SECTION

Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

FINAL

US Army Corps
of Engineers ®

Sacramento District
Environmental Design Section

January 2004

TABLE OF CONTENTS

FIGURE

Figure 1: Study Area - Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study

ACRONYMS and ABBREVIATIONS

AST	Aboveground Storage Tank
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
DDT	dichlorodiphenyltrichloroethane
DDTr	DDT derivatives including DDD (dichlorodiphyltrichloroethylene)
DHS	Department of Health Services
DO	Dissolved Oxygen
DOGGR	Division of Oil, Gas and Geothermal Resources
DPR	Department of Pesticide Regulation
DTSC	Department of Toxic Substances Control
EDR	Environmental Data Resources, Inc.
FS	Feasibility Study (Sacramento & San Joaquin Comprehensive Study - the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study)
GCC	Glenn-Colusa Canal
Gpd	Gallons per day
HTRW	Hazardous, Toxic and/or Radioactive Waste
LUFT	Leaking Underground Fuel Tank
mg/kg	milligrams per kilogram
NEPA	National Environmental Policy Act
NPL	National Priorities List
pCi/L	Pico-curies per liter
ppb	parts per billion
PWS	Public water supply system
SWF/LF	Solid Waste Facilities/Landfill Sites
SWIS	Solid Waste Information System

1.0 HAZARDOUS, TOXIC AND/OR RADIOLOGICAL WASTE

1.1 Overview

This Appendix identifies potential hazardous, toxic and/or radiological waste (HTRW) issues that may need to be taken into consideration when evaluating the various alternatives associated with the Sacramento & San Joaquin Comprehensive Study - the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study (FS). Hamilton City is located in Glenn County, California. The FS Study Area for HTRW (Study Area) surrounds Hamilton City and is bounded by the Glenn-Colusa Canal (GCC) on the west and by the Sacramento River on the east. The north and south borders are located about two miles and 6 miles from Hamilton City respectively (Figure 1: Study Area for Hamilton City Flood Damage and Ecosystem Restoration Feasibility Study).

In order to complete this HTRW assessment, available aerial photos and regulatory agency database records were reviewed, the Study Area was visited, and interviews were conducted with appropriate personnel from State and local agencies. Federal, State, and County database searches were conducted by Environmental Data Resources, Inc. (EDR), which provided three reports: NEPA Check Report, Area Study Report and Well Search Report with two maps: Study Area for Hamilton City Flood Reduction Study Area and Well Search for Hamilton City Flood Reduction Study Area (See Attachments A-E). As a result of these assessment activities, four areas are identified as areas of potential concern: the Sewage Treatment Facility, the Former Holly Sugar Lime Disposal Area, farms with agricultural chemicals and storage tanks and J.R. Simplot Fertilizer Company. If those four areas are not protected, some or all of the Study Area may be adversely affected in the event of a flood.

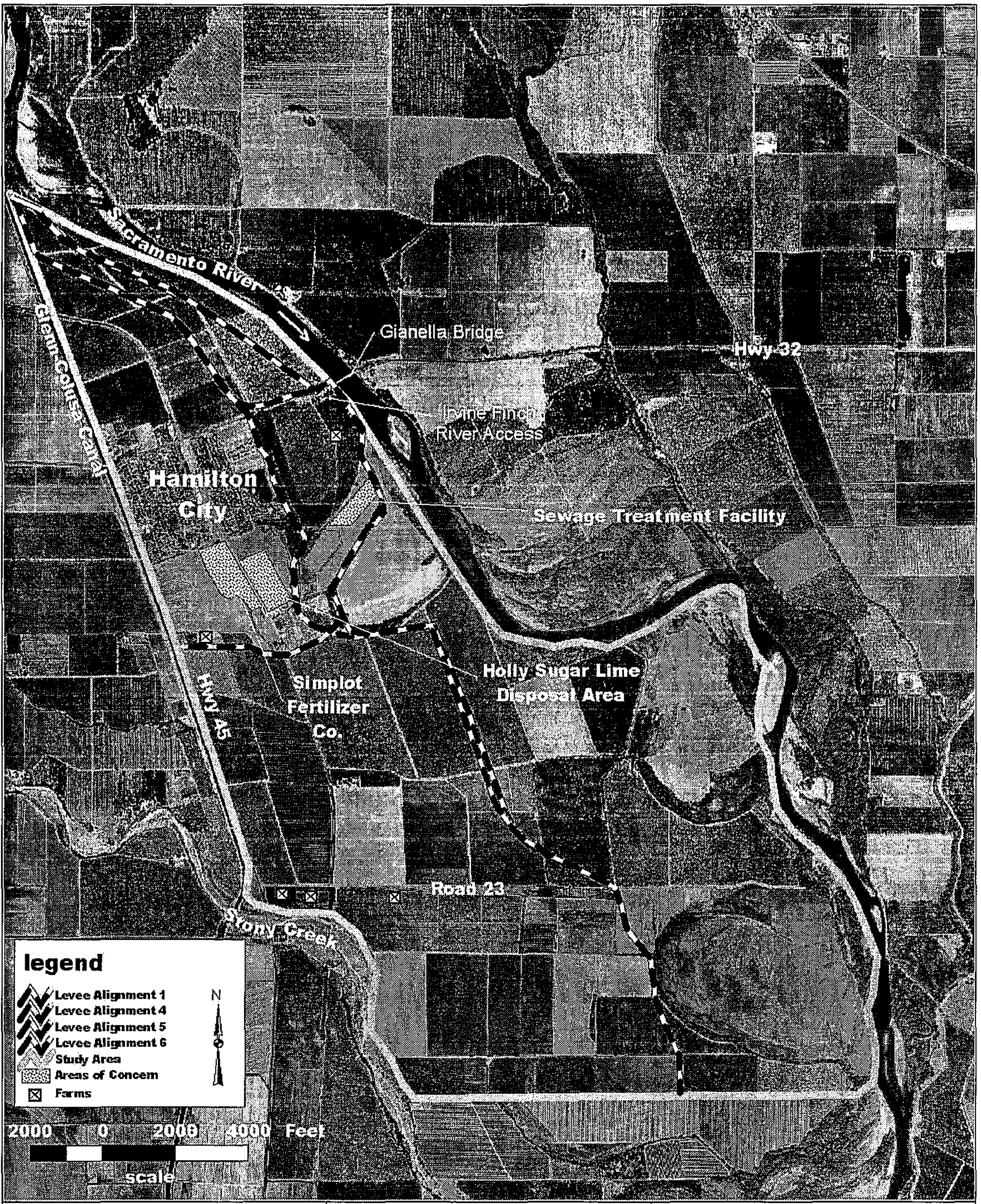

Figure 1

STUDY AREA

Hamilton City
Flood Damage Reduction
and Ecosystem Restoration, CA

map created January 23, 2004

1.2 Review of Regulatory Agency Records

Regulatory agency records searches were conducted by Environmental Data Resources, Inc. The EDR reports: Area Study Report, NEPA Check Report and the EDR Well Search Report (EDR, 2003) are attached as attachments A through E. The following list presents the agencies from which data were obtained:

United States Environmental Protection Agency
California Environmental Protection Agency
California Department of Health Services
California Integrated Waste Management Board
California Regional Water Quality Control Board

1.3 Soils

Soils in the Study Area on the west side of Dunning Slough primarily consist of Modesto Formation. These soils are marked by high silt content and a distinct red color. Stream channel deposits are located within the historic meander belt (the Sacramento River Conservation Area), east of Dunning Slough, towards the Sacramento River.

1.4 Flood Map Review

A US Army Corps of Engineers flood map and the EDR map (Attachment B: EDR Map of Study Area) show the flood prone area around Hamilton City. Most of the Study Area would likely be affected by a 100-year flood from the Sacramento River.

1.5 Aerial Photographs

Two aerial photos taken in 1995 and 2002 are very similar geographically and there were no significant changes in Hamilton City and the surrounding areas between 1995 and 2002.

1.6 Groundwater Wells

There are 12 wells (Attachment C: EDR Well Search Map) in the Study Area that are used for domestic, irrigation and industrial purposes. Based on the well database, the well depths are 40 feet to 246 feet and depths to the water table are 13 feet to 23 feet. Water levels in one well fluctuated between 37 feet and 42 feet during the summer of 1977.

A review of EDR groundwater quality records indicated that water quality data exists for several wells within the subject Study Area. At least five wells were tested for groundwater quality between 1984 and 1996 and most samples were analyzed for inorganic compounds, organic compounds, pH, sodium, total dissolved solids, color specific conductance, total alkalinity, bicarbonate alkalinity, total hardness, metals, corrosivity, and nitrate. The analytical data indicate good quality water.

1.7 Public Water Supply System

A public water supply system (PWS) is any water system that provides water to at least 25 people for a minimum of 60 days annually. PWSs provide water from wells, rivers, and other sources. Hamilton City has one PWS: Irvine Finch River Access. This PWS has not had a violation or enforcement action.

1.8 National Priorities List Site

According to the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list and National Priorities List (NPL) there are no suspected abandoned, inactive, or uncontrolled hazardous waste sites or Superfund sites within the Study Area. The Emergency Response Notification System (ERNS) database identifies South 1st Street & Walsh Ave as a site having had a reported release of oil or hazardous substances. No details on the reported release are available.

1.9 Disposal Sites

The Solid Waste Facilities/Landfill Sites (SWF/LF) records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. The data comes from the Integrated Waste Management Board's Solid Waste Information System (SWIS) database. No landfills were listed within the Study Area. However, a review of the SWF/LF list has revealed one waste disposal site within the Study Area: the Holly Sugar Lime Disposal Site, located ½ mile southeast of First Street. The site was formerly owned and operated by the Holly Sugar Company. During the site visits, mounds of lime (calcium carbonate) were observed; some were overgrown with vegetation. The exact size of the lime disposal area is not known, but from the 1995 aerial photo, the disposal area is estimated to be about 30 acres. Currently the site is off-limits to the public. According to Holly Sugar/Spreckel Sugar Co. in Tracy, CA, the Hamilton City plant was closed about seven years ago. The disposal site was used for lime disposal and has not been used for the past 12 years. There are no records that lime was the only product disposed of here. The lime has been hauled and used for soil conditioning at a different location. The October 2002 aerial photo still shows whitish areas. There is no estimated time frame for when all the lime will be finally removed.

The main buildings of the former Holly Sugar Plant are currently leased to J.R. Simplot Fertilizer Company, Mineral & Chemical Group, a distributor of fertilizers. Various fertilizers (i.e., Di-Ammonium Phosphate, Urea, Ammonium Sulfate, Mono-Ammonium Phosphate, Ammoniacal Nitrogen and Phosphoric Acid) are shipped to, and distributed from, the site via rail or trucks. According to the warehouse manager, only seasonal fertilizer is stored at the Hamilton City warehouse. About 80 tons to 400 tons of fertilizer has been stored daily in the company's warehouse, according to the company records for recent years. The fertilizer is stored loosely on the warehouse floor, which is several inches above the ground surface. The fertilizers are loaded into trucks by either shovel or motorized loaders.

In case of flood, some or all of the lime or the fertilizer may be washed away which could impact the water quality in the Sacramento River.

1.10 Leaking Underground Fuel Tanks

The California Regional Water Quality Control Board Leaking Underground Fuel Tank (LUFT) list shows that there are five LUFT sites within the Study Area: Double E Market, Jackpot Food Mart, Kaplan Almond Farmland, Benjamin's Service, Inc., and Cal-Farm Supply. According to Geotracker (http://www.geotracker.swrcb.ca.gov), all five sites were closed and no further actions are needed at those sites. GeoTracker is a geographic information system that provides online access to environmental data provided by the State Water Resource Control

Board. GeoTracker is the interface to the Geographic Environmental Information Management System, a data warehouse which tracks regulatory data concerning underground fuel tanks, fuel pipelines, and public drinking water supplies. The website provides regulatory history, location information, analytical data, detailed release information, remediation at each LUFT site, and wells estimated to be nearby each LUFT site.

1.11 Underground Storage Tanks and Aboveground Storage Tanks

According to the State Water Resources Control Board's Substances Storage container Database, there are four registered underground storage tank (USTs) and aboveground storage tank (AST) sites in the Study Area:

Double E Market, 575 Sacramento St.,
Jackpot Food Mart, 585 Sierra St.,
Hamilton Gas Mini Mart, 601 6th, St., and
Hamilton Union Elementary School, 277 Capay St.

Contents of the USTs and ASTs are gasoline, diesel, waste oil or other unspecified products. It is common that a typical farm has underground or aboveground storage tanks. There are a few farms located in the Study Area. According the EDR reports, there are no records of USTs or ASTS on the farm properties.

According to the EDR reports, the following are listed as historical UST sites:

Hamilton Union High School, Highways 32/45
James Mills/Growers Service Co, 3rd/Walsh
James Mills Orchards, Third/Walsh, and
Hamilton City Ranch, 1st/Sacramento.

1.12 Oil and Gas Wells

Based on information obtained at the Division of Oil, Gas and Geothermal Resources (DOGGR), Department of Conservation, State of California (DOGGR, 2001) there are seven oil and gas wells in the Study Area. All oil and gas wells are located on the outskirts of Hamilton City between the Glenn-Colusa Canal and the Sacramento River. These wells were drilled in the early to mid-1900's and all were found dry. According to files stored at the Regional Office, 801 K Street, 20th Floor, Sacramento, CA, all the oil and gas wells were properly abandoned and certified by the Division of Oil, Gas and Geothermal Resources, Department of Conservation, State of California.

1.13 Cal-Sites

The California Environmental Protection Agency Cal-Sites List, which combines the Abandoned Sites Program Information System and the State "Superfund" list, provides locations of known hazardous waste sites. No sites were identified within the Study Area.

1.14 Hazardous Waste Generators

The California Department of Health Services (DHS) Toxic Substances Control Division, Hazardous Waste Information System lists hazardous waste generators. The data is extracted from the copies of hazardous waste manifests received each year by the Department of Toxic Substances Control (DTSC). DHS identified three hazardous waste generators in the Study Area as follows:

- Bob's Auto & Truck Repair, 595 Los Robles Ave., Hamilton City
- Martin Byron Vangundy III, 440 Main St., Hamilton City
- Hamilton Union Elementary School District, 277 Capay St., Hamilton City

1.15 DDT and Agricultural Chemicals

Organochlorine pesticides such as 4, 4' dichlorodiphenyltrichloroethane (DDT) and its breakdown products may be present in the soil at the Study Area, which has a history of prolonged agricultural use. A program of sampling and analysis was conducted on agricultural properties in Glenn County by the California Department of Food and Agriculture in 1985. The results of this sampling and analysis are reported in "Agricultural Sources of DDT Residues in California's Environment." (DPR, 1985)

Soil samples were collected from the top 6 inches of soil on properties in areas of "historic widespread and repeated applications of DDT" and analyzed for DDT and its breakdown products (DDTr). Two soil samples were collected in the eastern section of Glenn County (exact locations of sampling are not available at this time) and found to have concentrations ranging from 0.278 milligram per kilogram (mg/kg) to 0.581 mg/kg of DDT and its breakdown products.

Soils with total DDT and DDTr at concentrations above 1 mg/kg or soluble concentrations above 0.1 mg/l are classified as hazardous waste under California regulations. The samples collected in Glenn County are all below the 1 mg/kg waste classification limit. Ecological risk numbers for DDT and DDTr may be lower than the California Hazardous Waste Criteria. This does not rule out the possibility that greater concentrations may be encountered in the Study Area. Most of the Study Area outside of Hamilton City has been orchards and farmlands for many years. If the Sacramento River overflows, pesticides and herbicides residue from past applications, or agricultural chemicals that may be stored in the flood prone area, may be dispersed. The toxic nature of some pesticides (including DDT residues) and other agricultural chemicals have the potential to adversely affect riparian and aquatic ecologies.

1.16 Radon

The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986-1992. According to the study, data have been supplemented by information collected at private sources such as universities and research institutions, where it is necessary.

According to the database, ten (10) sites in Glenn County, in which the Study Area is located, were tested for radon at the lst floor level and/or basement. Average radiological activity was 0.430 pico-curies per liter (pCi/L) at 1st floor and 2.4 pCi/L in basement, which are below the action level of 4 pCi/L in the EPA guidelines. It is unlikely that radon presents a significant concern within the Study Area.

1.17 Radioactive Material/Waste Sites

Radioactive material/wastes sites in the Study Area were researched in the following web sites:

* ATSDR - Public Health Concern At Department of Energy Sites at (http://www.atsdr.cdc.gov/HAC/DOE/doe4.html),

* Radioactive Waste website at (http://www.cs.virginia.edu/~jones/tmp352/projects98/group14/disposal.html#_1_1), and

* Low-Level Radiation Waste Disposal Sites at (http://www.millennium-ark.net/News_Files/NBC/NRC.low.level.waste.dispos.html).

No radioactive material/waste site was found in the Study Area.

1.18 Lead

Due to the lack of structures and civil improvements on the flood prone area of the Study Area, it is unlikely that lead in the form of lead-based paint presents a significant concern to the flood water.

1.19 Asbestos

Because the flood prone area of the Study Area is characterized by orchards and farmland, the potential for encountering asbestos-containing construction materials in the flood prone area is remote. However, if the entire Study Area is flooded, there is a possibility that asbestos-containing material from older buildings may be released to the water.

2.0 SITE VISITS

Site visits to Hamilton City were conducted on 12 July 2001 and 28 March 2003. The purpose of the site visits was to become familiar with the Study Area, follow up on issues identified in the database searches, look for any visible issues that may not have been previously identified, and to collect additional information.

The Sewage Treatment Facility (Order # 98-081, permitted by the Regional Water Quality Control Board, State of California) is located southeast of Hamilton City. It has been operational since 1968. According to the Maintenance Superintendent, Hamilton City Community Services District (Puente, 2001 and 2003), raw sewage from Hamilton City is transported by gravity flow and pumped into one of seven ponds at the Sewage Treatment Facility. The plant has a sewage treatment capacity of 500,000 gallons per day (gpd), but currently is operating at an average of 225,000 gpd. The sewage is treated biologically. There is no effluent from the treatment plant and all treated water is dissipated by evaporation and percolation. The sludge in the open ponds could potentially contain accumulated heavy metals from storm water runoff. The influent to the treatment plant is tested for dissolved oxygen (DO) and temperature weekly. No other tests are conducted. Water in ponds is a blue-green color and populated with ducks, turtles, and frogs. A number of dragonflies were seen over the ponds. A herbicide, ***Round-Up***, is occasionally used to eliminate unwanted weeds at the site.

The Sewage Treatment Facility is surrounded by a levee which prevents floodwater from entering. According to the Superintendent, this treatment plant has never been flooded since its opening in 1968.

The J.R. Simplot Fertilizer Company was visited and the company provided types and amounts of fertilizers stored at the warehouse. The warehouse sits on a concrete pad and mounds of various fertilizers are placed on the warehouse floor.

The lime disposal area near the eastside section of the former Holly Sugar Company property was visually inspected, and some lime mounds, overgrown with vegetation, could be seen from a road near Dunning Slough.

3.0 AREAS OF CONERN AND RECOMMENDATIONS

The environmental assessment indicates evidence of areas of potential environmental concern within the Study Area. Research and assessment have identified the following four areas of concern.

3.1 Sewage Treatment Facility

Raw sewage is pumped into open ponds at the treatment plant at an average of 225,000 gpd. If the treatment plant is flooded, raw sewage and accumulated sludge could be dispersed to the environment, which could pose chemical and biological hazards to the public and the environment. The treatment plant needs to be protected from floods at all times.

3.2 Former Holly Sugar Lime Disposal Site

Most of the contents at the lime disposal site are believed to be calcium carbonate, which can be found in dietary or food products as an additive. Some of the lime has been hauled away to a different location for soil conditioning, however, it is not known how much lime remains at the disposal site. A large amount of lime may pose an adverse threat to aquatic life. If Alignment #3 (new levee construction) is selected, mitigation of the lime (i.e., removal) may be necessary.

3.3 Agricultural Chemicals and Fuel Storage Tanks

Fertilizers, pesticides and fuels for machinery are hazardous materials commonly stored on farm property. There are several farms located in the Study Area. Since the flood prone area of the Study Area has been used as orchards and farmland, pesticides, agricultural chemicals, and fuels for machinery may exist. Neither exact concentrations of pesticides nor the quantity of agricultural chemicals at the flood prone area is known at this time. About two million pounds of pesticides were applied in Glenn County in 1998 and 1999 according to a Pesticide Regulation report compiled by the State.

There are no records of hazardous materials stored on any farms in the Study Area. If pesticides, herbicides, fuel or any other hazardous materials are stored in non-seal-tight containers in the flood prone area, some or all of those hazardous materials may be released to the environment via overflow water from the Sacramento River. If large quantities of agricultural chemicals and/or fuel for machinery are released to the environment, the riparian and aquatic habitats, and associated biota may be adversely impacted. Agricultural chemicals in particular should be stored in watertight containers.

3.4 J.R. Simplot Fertilizer Company

The J.R. Simplot Fertilizer Company stores various types of highly water-soluble fertilizers on the warehouse floor. The amount of fertilizers stored in the warehouse fluctuates seasonally. The company records show that between 80 tons and 400 tons of fertilizers were stored in the warehouse at all times in recent years. If the warehouse is flooded, the water-soluble fertilizers will be dispersed and may adversely affect the environment and the surrounding areas including Hamilton City, the Sacramento River and the Glenn-Colusa Canal.

4.0 ENVIRONMENTAL IMPACT OF ALTERNATIVES

From the 2002 aerial photo, agricultural chemical and fuel storage areas do not appear to exist on the section of farmland between Alignment #1 - *Locally Developed Setback Levee* and the Sacramento River. If Alignment #1 is selected, there will be very little impact on the Hamilton City community and the surrounding farmlands.

If Alignment #2 - *Intermediate Setback Levee* is selected, the Sewage Treatment Facility and agricultural areas may flood. This would, as in Alignment #3, result in raw sewage, accumulated sludge, agricultural chemicals and fuel contaminating the Sacramento River, which could pose significant chemical and/or biological hazards to the public and the environment. Relocation or protection of the Sewage Treatment Facility is recommended and protection of agricultural chemicals and fuels from floods may be necessary.

If Alignment #3 - *Ring Levee* is selected and implemented, in the event of a flood, fertilizers stored at the J.R. Simplot Fertilizer Company, raw sewage and accumulated sludge from the Sewage Treatment Facility, and agricultural chemicals and fuels that may be stored on farm properties could contaminate the Sacramento River and pose chemical and/or biological hazards to the public and the environment. Relocation or protection of the Sewage Treatment Facility is recommended. Removal of lime at the Lime Disposal Area and containment of fertilizers at the Simplot Fertilizer Company may be necessary.

If any of the alternatives are selected, the community park which is located near the Sacramento River and the State Highway 32 may flood, but, impacts to the environment would be minimal.

5.0 REFERENCES

EDR Search Data: The EDR Area Study Report, EDR NEPA Check and EDR Well Search Report, EDR Area Study, Inquiry Number: 647007.ls, July 2001

EDR Search Data: The EDR Well Search Report, EDR Area Study, EDR NEPA Check reports, Inquiry Number: 94699.1w, EDR, March 2003

Office Visit and document review at Division of Oil, Gas and Geothermal Resources (DOGGR), Department of Conservation, State of California, 2001

Department of Pesticide Regulation (DPR), CA, 1985, *Agricultural Sources of DDT Residues in California's Environment*, 1985

Interview with Mr. Jose Puente, Maintenance Superintendent, Hamilton City Community Services District, Hamilton City, California, (530) 826-3208

Appendix C7.

MECHANICAL
(Not Applicable)

Appendix C8.

COST ENGINEERING
(M-CACES)

****TOTAL PROJECT COST SUMMARY****

06/23/2004

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE DRAFT FEASIBILITY REPORT
PROJECT: HAMITON CITY - LEVEE RERSTORATION ALT's
LOCATION: CALIFORNIA H_Alt 6_300

U. S. ARMY CORPS OF ENGINEER
SACRAMENTO DISTRICT
P.O.C. FRANK Y.F. FONG, CHIEF, COST ENGINEERING

Current MCACES Estimate Prepared: 1-Oct-2003
Effective Price Level (EPL): 1-Oct-2003

ACCOUNT NO.	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
						........FULLY FUNDED ESTIMATE(4.....				
	FEDERAL COSTS									
6	FISH & WILDLIFE, Mit.	20,530	4,010	19.532	24,540		5.6%	21,676	4,234	25,910
11	LEVEES & FLOODWALLS	740	181	24.000	921		5.3%	782	188	970
18	CULT. RESRC PRESERV. (1	136	34	25.000	170			144	36	180
	SUBTOTAL FEDERAL & NON-FEDERAL CONSTRUCTION COSTS	21,406	4,225		25,631			22,602	4,458	27,060
30	PLAN/ENGINEERING/DESIGN	2,450	619	25.000	3,069		11.8%	2,744	686	3,430
31	CONSTRUCTION MANAGE'MT	1,730	431	25.000	2,161		18.9%	2,056	514	2,570
	SUBTOTAL FEDERAL & NON-FEDERAL CONTRIBUTION	25,586	5,275		30,861			27,402	5,658	33,060
	NON-FEDERAL CONTRIBUTION (3	1,295	337		1,632			1,400	350	1,750
	TOTAL FEDERAL COSTS	**$24,291**	**$4,938**		**$29,229**			**$26,002**	**$5,308**	**$31,310**
	NON-FEDERAL COSTS									
1	LANDS AND DAMAGES	11,000	2,347	21.000	13,347		5.8%	11,669	2,451	14,120
2	RELOCATIONS	450	113	25.000	563		6.6%	480	120	600
30	PLAN/ENGINEERING/DESIGN	43	11	26.000	54		11.1%	48	12	60
31	CONSTRUCTION MANAGE'MT	41	10	24.000	51		17.6%	48	12	60
	SUBTOTAL NON-FEDERAL	11,534	2,481		14,015			12,245	2,595	14,840
	NON-FEDERAL CONTRIBUTION (3	1,295	337		1,632			1,400	350	1,750
	TOTAL NON-FEDERAL COSTS	**$12,829**	**$2,818**		**$15,647**			**$13,645**	**$2,945**	**$16,590**
	TOTAL FEDERAL AND NON-FEDERAL COSTS	**$37,120**	**$7,756**		**$44,876**			**$39,647**	**$8,253**	**$47,900**

GENERAL NOTES

(1 Cultural Resources Preservation costs associated with mitigation and/or data recovery up to one percent of the total Federal cost are not subject to cost sharing.
(2 Federal administrative costs for non-Federal land acquisition.
(3 Preliminary Cost Allocation for a multipurpose project are presented on table 3-17 of the Main Report. Federal and Non-federal Cost Sharing requirements of allocated costs are shown in Tables 9-4, 9-5, and 9-6 of the Main Report
(4 The Fully Fundec cost estimate was prepared in compliance with EC 11-2-183 published in March 2002.

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DISTRICT APPROVED.

________________ CHIEF, COST ENGINEERING

C:\LOTSUITE\123R5W\hamilton\040615
H_D6_4AA SUM
H_D6_4PC PCE

DETAILED ESTIMATE OF FIRST COST

Effective Price Level (EPL) 1-Oct-2003

Levee Alt 6

ACCOUNT NUMBER	ITEM	QUANTITY	UNIT	UNIT PRICE $	AMOUNT $	CONTINGENCY $*	CONTINGENCY %*	REASON
06	**FISH AND WILDLIFE FACILITIES**							
0603	WILDLIFE FACILITIES AND SANCTUARIES,							
060301	Site Work: - Wildlife Facilities ER Levee Component							
	Mob., Demob. and Preparatory Work:	1	JOB	LS	344,185	86,000	25.0	-
	Site Work (Setback Levee)							
	Levee Foundations & Clearing Grubbing	5.705	miles	@130000/Mi		0	0.0	-
	Levee Found & Clear&Grub (5.705 Mi.)	159,740	CY	4.65	742,791	186,000	25.0	-
	Remove "J" Levee to onsite Stockpile	247,700	CY	6.00	1,486,200	372,000	25.0	-
	Erosion protection=Entreached	0.586	miles	@4680000/Mi		0	0.0	-
	Erosion prot=Entreach (0.586 Mi)							
	1 Clear Levee Fill Borrow Site	7.15	AC	2,970	21,236	5,000	23.5	-
	2 Load Levee Fill at Borrow Site	65,632	CY	4.40	288,781	72,000	24.9	-
	3 Haul Levee Fill from Borrow Site	24,612	C/M	1.07	26,335	7,000	26.6	-
	4 DERRICK STONE MATERIAL	96,690	TON	21.32	2,061,431	512000	24.8	-
	5 HAUL DERRICK STONE 80K LB GVW	403.00	HRS	254.84	102,701	26,000	25.3	-
	6 PLACE DERRICK STONE FROM LEVEE	96,690	TON	1.70	164,373	41,000	24.9	-
	7 Place Levee Fill	16,408	CY	3.74	61,366	15,000	24.4	-
	8 Compact Levee Fill	16,408	CY	1.89	31,011	8,000	25.8	-
	Levee Material from onsite Stockpile	247,700	CY	4.00	990,800	248,000	25.0	-
	Erosion protection=Riprap	0.473	miles	@900000/Mi		0	0.0	-
	Erosion prot=Riprap (0.473 Mi)							
	Erosion prot. Riprap 3'-2h on 1v							
	Erosion protection Riprap	26,015.000	TON	14.50	377,218	94,000	24.9	-
	PLACE Erosion protection Riprap	26,015.000	TON	2.00	52,030	13,000	25.0	-
	15 ft Crown Road	5.705	miles	@135000/Mi		0	0.0	-
	15 ft Crown Road (5.705 mi)							
	1 Patrol Road Agg. Frm Qry to site	16,744	TON	43.75	732,550	183,000	25.0	-
	2 PLACE AGG.BASE FROM COMM.SOURCE	16,744	TON	2.00	33,488	8,000	23.9	-
	Erosion Prodection HYDROSEEDING	5.705	miles	@50000/Mi		0	0.0	-
	1 HYDROSEEDING (5.705 mi)	2,139,375	SF	0.13	278,119	70,000	25.2	-
	Fencing	6.770	miles	@30000/Mi		0	0.0	-
	1 Fencing (6.770 MI)	35,745	LF	5.55	198,385	50,000	25.2	-
	Seepage Berm	44,700	CY	30.00	1,341,000	335,000	25.0	-
	Subtotal, Construction Costs:				$9,334,000			
	Contingencies @ average of 25.0 % +/- *					$2,331,000		A
060301	Site Work: - Wildlife Facilities ER Levee Component			TOTAL:		$11,665,000		
060373	Habitat and Feeding Facilities:							
	Site Work: - REVEGITATION							
	Mob & Demob	1	JOB	LS	48,550	7,000	14.4	-
	Cottonwood	200.0	AC	9,700	1,940,000	291,000	15.0	-
	Riparian	796.6	AC	7,500	5,974,500	896,000	15.0	-
	Grassland	70.4	AC	3,600	253,440	38,000	15.0	-
	Savannah	147.9	AC	6,900	1,020,510	153,000	15.0	-
	Sccrub	261.2	AC	7,500	1,959,000	294,000	15.0	-
	Subtotal, Construction Costs:				$11,196,000			
	Contingencies @ average of 15.0 % +/- *					$1,679,000		A
060373	Habitat and Feeding Facilities:			TOTAL:		$12,875,000		
		Grand Subtotal			$20,530,000			
		Contingencies				$4,010,000		
06	FISH AND WILDLIFE FACILITIES	Grand Total				$24,540,000		

DETAILED ESTIMATE OF FIRST COST(Cont'd)

ACCOUNT NUMBER	ITEM	QUANTITY	UNIT	UNIT PRICE $	AMOUNT $	CONTINGENCY $ *	CONTINGENCY % *	REASON
	Effective Price Level (EPL) 1-Oct-2003							
11	**LEVEES AND FLOODWALLS**							
1101	LEVEES							
1101	FDR Levee Component							
110101	Mob., Demob. and Preparatory Work:	1	JOB	LS	28,464	7,000	24.6	-
110102	Site Work							
	Levee Foundations & Clearing Grubbing	1.065	miles	@130000?Mi		0	0.0	-
	Levee Found & Clear& Grub (1.065 Mi)	29,820	CY	4.40	131,208	30,000	22.9	-
	Erosion protection=Riprap	0.019	miles	@900000/Mi		0	0.0	-
	Erosion protection=Riprap (0.019 Mi)							
	EXCAVATION	186.000	CY	48.00	8,928	2,000	22.4	-
	Riprap - slope	224.000	CY	49.00	10,976	3,000	27.3	-
	Riprap - toe	67.000	CY	60.00	4,020	1,000	24.9	-
	Increase in ER Levee Compoment	66,000	CY	4.00	264,000	64,000	24.2	-
	TRAINING DIKE							
	Training Dike	28,500	CY	4.00	114,000	29,000	25.4	-
	15 ft Crown Road	1.065	miles	@135000/MI		0	0.0	-
	15 ft Crown Road (5.705 mi)							
	1 Patrol Road Agg. Frm Qry to site	3,956	TON	31.00	122,636	31,000	25.3	-
	2 PLACE AGG.BASE FROM COMM.SOURCE	3,956	TON	5.00	19,780	5,000	25.3	-
	Erosion Prodection HYDROSEEDING	1.065	miles	@35000/Mi		0	0.0	-
	HYDROSEEDING (1.065 Mi)	449,856	SF	0.08	35,988	9,000	25.0	-
	Subtotal, Construction Costs:				$740,000			
	Contingencies @ average of	24.5 % +/- *				$181,000		A
1101	**LEVEES**			**TOTAL:**		**$921,000**		
18	**CULTURAL RESOURCE PRESERVATION**							
	Estimated Study @ 0.6% of Federal Obligations				136,000	34,000	25.0	
	Subtotal, Construction Costs:				$136,000			
	Contingencies @ average of	25.0 % +/- *				$34,000		A
18	**CULTURAL RESOURCE PRESERVATION**			**TOTAL:**		$170,000		
30	**PLANNING, ENGINEERING & DESIGN**							
302301	PLANS AND SPECIFICATION				444,590	111,000		
302302	Surveys and Mapping, except RE				123,850	31,000		
302302	Survey Markers				80,130	20,000		
302304	Hydraulics Studies				145,710	36,000		
302305	Geotechnical Studies(Geol and Soils)				183,450	46,000		
302306	Revegetation Plan				207,910	52,000		
302304	ENVIRONMENTAL STUDIES DOCUMENTS				163,910	42,000		
302305	HTRW STUDIES/REPORT				72,840	18,000		
302306	CULTURAL RESOURCE				91,070	23,000		
302307	COST ESTIMATE				145,680	36,000		-
302308	OTHER STUDIES/INVESTIGATIONS				50,990	13,000		
302309	CONTRACT AWARD DOCUMENTS				291,400	73,000		
3025	CLOSE OUT				189,390	47,000		
3026	PROGRAMS AND PROJECT MGMT				259,080	71,000		-
	Subtotal				$2,450,000			
	Contingencies @ average of	25.3 % +/- *				$619,000		A
30	**PLANNING, ENGINEERING & DESIGN**			**TOTAL:**		$3,069,000		
31	**CONSTRUCTION MANAGEMENT (S & I)**							
312311	SUPERVISION AND ADMINISTRATION				741,050			
	Subtotal				$1,730,000			
	Contingencies @ average of	24.9 % +/- *				$431,000		A
31	**CONSTRUCTION MANAGEMENT (S & I)**			**TOTAL:**		$2,161,000		

DETAILED ESTIMATE OF FIRST COST(Cont'd)

ACCOUNT NUMBER	ITEM	QUANTITY	UNIT	UNIT PRICE $	AMOUNT $	CONTINGENCY $ *	CONTINGENCY % *	REASON
	Effective Price Level (EPL) 1-Oct-2003							
	NON-FEDERAL							
01	**LANDS AND DAMAGES**							
01	SUNK COSTS							
012303	CONSTRUCTION CONTRACT(S) DOCUMENTS							
	Real Estate Planning Documents				370,000	37,000	10.0	-
	Real Estate Acquisition Documnts				380,000	38,000	10.0	-
	Real Estate Appraisal Documents				160,000	16,000	10.0	-
	Real Estate Payment Documents				10,090,000	2,256,000	22.4	-
	Subtotal, Construction Costs:				$11,000,000			
	Contingencies @ average of	21.3 % +/- *				$2,347,000		A
01	**LANDS AND DAMAGES**			**TOTAL:**		$13,347,000		
02	**RELOCATIONS**							
0203	Local / Interior Drainage							
	Interior Drainage	300	CFS	400	120,000	29,000	24.2	-
	Local Drainage including Trailer Park ditch & Surface Drainage Canal		LS		80,000	19,000	23.8	-
	Subtotal, Construction Costs:				$200,000			
	Contingencies @ average of	24.0 % +/- *				$48,000		A
0203	Local / Interior Drainage			TOTAL:		$248,000		
0205	Road 23							
	Raise Road 23	1	LS		65,000	15,000	23.1	-
	Subtotal, Construction Costs:				$65,000			
	Contingencies @ average of	23.1 % +/- *				$15,000		A
0205	Road 23			TOTAL:		$80,000		
0206	Road 203							
	Raise Road 203	1	LS		125,000	35,000	28.0	-
	Subtotal, Construction Costs:				$125,000			
	Contingencies @ average of	28.0 % +/- *				$35,000		A
0206	Road 203			TOTAL:		$160,000		
0207	City Roads							
	Raise and relocate		LS		60,000	15,000	25.0	-
	Subtotal, Construction Costs:				$60,000			
	Contingencies @ average of	25.0 % +/- *				$15,000		A
0207	City Roads			TOTAL:		$75,000		
			Grand Subtotal		$450,000			
			Contingencies			$113,000		
02	**RELOCATIONS**		Grand Total			$563,000		
30	**PLANNING, ENGINEERING & DESIGN**				43,000	11,000	25.6	-
	Subtotal				$43,000			
	Contingencies @ average of	25.6 % +/- *				$11,000		A
30	**PLANNING, ENGINEERING & DESIGN**			**TOTAL:**		$54,000		
31	**CONSTRUCTION MANAGEMENT (S & I)**				41,000	10,000	24.4	-
	Subtotal				$41,000			
	Contingencies @ average of	24.4 % +/- *				$10,000		A
31	**CONSTRUCTION MANAGEMENT (S & I)**			**TOTAL:**		$51,000		

Hamilton base estimate

Designed By: U.S. ARMY CORPS OF ENGINEERS
Estimated By:

Prepared By: CESPK-ED-C (LEAHY)

Preparation Date: 05/11/03
Effective Date of Pricing: 05/11/03
Est Construction Time: 365 Days

Sales Tax: 7.70%

MCACES GOLD EDITION

Release 5.31

SUMMARY REPORTS SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

	QUANTITY	UOM	TOTAL DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
F FEDERAL									
F- 6 Fish & Wildlife Fac.(Mitigation)									
F- 603 Fish & Wildlife Sancturaries									
F- 60301 Mob., Demob. and Preparatory Wo:									
F- 60301 1 Mob., Demob. and Preparatory Wo:	1.00	JOB	266,587	26,659	23,460	31,671	6,968	355,344	355343.68
TOTAL Mob., Demob. and Preparatory Wo:	1.00	JOB	266,587	26,659	23,460	31,671	6,968	355,344	355343.68
F- 60302 Levee Foundations & Clearing									
F- 6030201 Levee Foundations & Clear&Grub	159740.00	CY	556,207	55,621	48,946	66,077	14,537	741,388	4.64
TOTAL Levee Foundations & Clearing	5.71	MI	556,207	55,621	48,946	66,077	14,537	741,388	129954.16
F- 60303 Remove "J" Levee to onsite Ste	247700.00	CY	1,132,213	113,221	99,635	134,507	29,592	1,509,167	6.09
F- 60304 Erosion protection=Entreached									
F- 6030401 Clear Levee Fill Borrow Site	7.15	AC	15,931	1,593	1,402	1,893	416	21,235	2970.32
F- 6030402 Load Levee Fill at Borrow Site	65632.00	CY	216,473	21,647	19,050	25,717	5,658	288,545	4.40
F- 6030403 Haul Levee Fill from Borrow Site	24612.00	C/M	19,693	1,969	1,733	2,339	515	26,249	1.07
F- 6030404 DERRICK STONE MATERIAL	96690.00	TON	1,546,579	154,658	136,099	183,734	40,421	2,061,491	21.32
F- 6030405 HAUL DERRICK STONE 80K LB GVW	403.00	HRS	77,050	7,705	6,780	9,153	2,014	102,702	254.84
F- 6030406 PLACE DERRICK STONE FROM LEVEE	96690.00	TON	123,318	12,332	10,852	14,650	3,223	164,374	1.70
F- 6030407 Place Levee Fill	16408.00	CY	46,084	4,608	4,055	5,475	1,204	61,426	3.74
F- 6030408 Compact Levee Fill	16408.00	CY	23,302	2,330	2,051	2,768	609	31,059	1.89
TOTAL Erosion protection=Entreached	0.59	MI	2,068,428	206,843	182,022	245,729	54,060	2,757,082	4704918
F- 60305 Levee Material from onsite Ste	247700.00	CY	742,135	74,213	65,308	88,166	19,396	989,218	3.99
F- 60306 Erosion prot. Riprap 3'-2h on 1v									
F- 6030601 Erosion protection Riprap	26015.00	TON	283,791	28,379	24,974	33,714	7,417	378,276	14.54
F- 6030602 PLACE Erosion protection Riprap	26015.00	TON	37,375	3,737	3,289	4,440	977	49,818	1.91
TOTAL Erosion prot. Riprap 3'-2h on 1v	0.47	MI	321,166	32,117	28,263	38,155	8,394	428,094	905060.62
F- 60307 15 ft Crown Road									
F- 6030701 Patrol Road Agg. Frm Qry to site	16744.00	TON	549,339	54,934	48,342	65,261	14,358	732,234	43.73
F- 6030702 PLACE AGG.BASE FROM COMM.SOURCE	16744.00	TON	49,833	4,983	4,385	5,920	1,302	66,424	3.97
TOTAL 15 ft Crown Road	5.71	MI	599,172	59,917	52,727	71,182	15,660	798,658	139992.60

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                                                 QUANTITY UOM  TOTAL DIRECT  FIELD OH  HOME OFC    PROFIT      BOND   TOTAL COST UNIT COST
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F- 60308  Erosion Prodection HYDROSEEDIG

F- 6030801  HYDROSEEDING

F- 603080101  Native Grass Seed                    49.00 AC        212,563    21,256    18,706    25,252     5,556      283,332   5782.30
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL HYDROSEEDING                       2139375 SF        212,563    21,256    18,706    25,252     5,556      283,332      0.13
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Erosion Prodection HYDROSEEDIG        5.71 MI        212,563    21,256    18,706    25,252     5,556      283,332  49663.89


F- 60309  Fencing

F- 6030901  Fencing                             35745.60 LF        148,539    14,854    13,071    17,646     3,882      197,993      5.54
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Fencing                               6.77 MI        148,539    14,854    13,071    17,646     3,882      197,993  29245.66


F- 60310  Seepage Berm

F- 6031001  Haul Seepage Berm Material            144.00 HR         30,306     3,031     2,667     3,600       792       40,397    280.53
F- 6031003  Seepage Berm Mat.(Drain Rock)       89400.00 TON       930,466    93,047    81,881   110,539    24,319    1,240,252     13.87
F- 6031004  Place Seepage Berm Material           144.00 HR         49,783     4,978     4,381     5,914     1,301       66,357    460.81
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Seepage Berm                      44700.00 CY      1,010,555   101,056    88,929   120,054    26,412    1,347,005     30.13
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Fish & Wildlife Sancturaries          1.00 JOB     7,057,565   705,756   621,066   838,439   184,457    9,407,282   9407282


F- 673  Habitat & Feeding Facilities

F- 673 1  Mob & Demob                               1.00 JOB        36,000     3,600     3,168     4,277       941       47,986  47985.70
F- 67301  Cottonwood                              200.00 AC      1,455,000   145,500   128,040   172,854    38,028    1,939,422   9697.11
F- 67302  Riparian                                796.60 AC      4,500,790   450,079   396,070   534,694   117,633    5,999,265   7531.09
F- 67303  Grassland                                70.40 AC        190,080    19,008    16,727    22,582     4,968      253,364   3598.93
F- 67304  Savannah                                147.90 AC        761,685    76,169    67,028    90,488    19,907    1,015,277   6864.62
F- 67305  Scrub                                   261.20 AC      1,475,780   147,578   129,869   175,323    38,571    1,967,120   7531.09
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Habitat & Feeding Facilities          1.00 JOB     8,419,335   841,934   740,901 1,000,217   220,048   11,222,435  11222435
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Fish & Wildlife Fac.(Mitigation)      1.00 JOB    15,476,900 1,547,690 1,361,967 1,838,656   404,504   20,629,717  20629717


F-11  LEVEES

F-1101  Mob., Demob. and Preparatory Wo:

F-1101 1  Mob., Demob. and Preparatory Wo:          1.00 JOB        13,329     1,333     1,173     1,584       348       17,767  17767.18
                                                               ----------- --------- --------- --------- ---------  -----------
        TOTAL Mob., Demob. and Preparatory Wo:      1.00 JOB        13,329     1,333     1,173     1,584       348       17,767  17767.18
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	QUANTITY	UOM	TOTAL DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
F-1102 Levee Foundations & Clear&Grub									
F-110201 Levee Foundations & Clear&Grub	29820.00	CY	98,154	9,815	8,638	11,661	2,565	130,833	4.39
TOTAL Levee Foundations & Clear&Grub	1.07	MI	98,154	9,815	8,638	11,661	2,565	130,833	122848.20
F-1103 Erosion protecton = Riprap									
F-110301 EXCAVATION	186.00	CY	6,704	670	590	796	175	8,935	48.04
F-110302 Riprap - slope	224.00	CY	8,226	823	724	977	215	10,964	48.95
F-110303 Riprap - toe	67.00	CY	2,997	300	264	356	78	3,995	59.62
TOTAL Erosion protecton = Riprap	0.02	MI	17,926	1,793	1,578	2,130	469	23,894	1257605
F-1104 Increase in ER Levee Component	66000.00	CY	200,713	20,071	17,663	23,845	5,246	267,538	4.05
F-1105 Training Dike	28500.00	CY	83,631	8,363	7,359	9,935	2,186	111,474	3.91
F-1106 15 ft Crown Road									
F-110601 Patrol Road Agg. Frm Qry to site	3956.00	TON	91,726	9,173	8,072	10,897	2,397	122,265	30.91
F-110602 PLACE AGG.BASE FROM COMM.SOURCE	3956.00	TON	14,950	1,495	1,316	1,776	391	19,927	5.04
TOTAL 15 ft Crown Road	1.07	MI	106,676	10,668	9,387	12,673	2,788	142,192	133513.69
F-1107 Erosion Prodection Hydroseeding									
F-110702 HYDROSEEDING									
F-11070201 Native Grass Seed	10.00	AC	28,361	2,836	2,496	3,369	741	37,803	3780.30
TOTAL HYDROSEEDING	449856.00	SF	28,361	2,836	2,496	3,369	741	37,803	0.08
TOTAL Erosion Prodection Hydroseeding	1.07	MI	28,361	2,836	2,496	3,369	741	37,803	35495.82
TOTAL LEVEES	1.00	JOB	548,790	54,879	48,294	65,196	14,343	731,503	731502.52
TOTAL FEDERAL	1.00	JOB	16,025,690	1,602,569	1,410,261	1,903,852	418,847	21,361,219	21361219
N NON-FEDERAL									
N-02 RELOCATIONS									
N-0203 Local / Interior Drainage									
N-020301 Interior Drainage									
N-02030101 PUMPING FACILITY(3-1200GPM PUMS)									

		QUANTITY	UOM	TOTAL DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
N-0203010101	PUMPING FACILITY(3-1200GPM PUMS)	0.51	JOB	14,507	1,451	1,277	1,723	379	19,337	37983.25
	TOTAL PUMPING FACILITY(3-1200GPM PUMS)	0.51	JOB	14,507	1,451	1,277	1,723	379	19,337	37983.25
N-02030102	CONCRETE									
N-0203010201	Concrete Forming	344.53	SF	3,660	366	322	435	96	4,879	14.16
N-0203010202	Concrete	53.45	CY	17,430	1,743	1,534	2,071	456	23,232	434.69
N-0203010203	Curing	360.76	SF	742	74	65	88	19	988	2.74
N-0203010204	Darby	880.65	SF	1,024	102	90	122	27	1,364	1.55
N-0203010205	Float	880.65	SF	1,104	110	97	131	29	1,472	1.67
	TOTAL CONCRETE	53.45	CY	23,960	2,396	2,108	2,846	626	31,937	597.55
N-02030103	Reinforce Steel									
N-0203010301	Reinforce Steel	5599.70	LB	11,284	1,128	993	1,341	295	15,041	2.69
	TOTAL Reinforce Steel	5599.14	LB	11,284	1,128	993	1,341	295	15,041	2.69
N-02030105	GRATING									
N-0203010501	STEEL ACCESS PLATFORMS	3499.51	LBS	22,826	2,283	2,009	2,712	597	30,426	8.69
	TOTAL GRATING	139.98	SF	22,826	2,283	2,009	2,712	597	30,426	217.36
N-02030106	MISCELLANEOUS METALS									
N-02030106 1	MISCELLANEOUS FABRICATION	763.54	LBS	4,057	406	357	482	106	5,408	7.08
N-02030106 4	Prep & paint	25.33	SF	315	31	28	37	8	419	16.56
N-0203010650	TRANSPORT MISCELLANEOUS METALS	763.09	LBS	566	57	50	67	15	754	0.99
N-0203010660	INSTALL MISCELLANEOUS METALS	763.09	LBS	1,387	139	122	165	36	1,848	2.42
	TOTAL MISCELLANEOUS METALS	763.54	LBS	6,324	632	557	751	165	8,430	11.04
N-02030107	GEOCOMPOSIT DRAIN SYSTEM									
N-0203010701	Geosynthetic Wall Drain	3.93	SY	2,779	278	245	330	73	3,704	943.33
N-0203010702	18" DIA. PREFORATED PIPING	13.09	LF	9,160	916	806	1,088	239	12,210	932.93
N-0203010703	DRAIN ROCK	10.47	TON	889	89	78	106	23	1,184	113.12
	TOTAL GEOCOMPOSIT DRAIN SYSTEM	338.47	SF	12,828	1,283	1,129	1,524	335	17,098	50.52
N-02030108	ELECTRIC SERVICE TO PUMPS									

	QUANTITY	UOM	TOTAL DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
N-02030108 1 INSTALL TRANS.w/CONC PULL BOXES	0.51	JOB	5,524	552	486	656	144	7,363	14463.18
N-02030108 3 INST EL.CABLE & PULL BOXES	0.51	JOB	5,518	552	486	656	144	7,355	14446.68
TOTAL ELECTRIC SERVICE TO PUMPS	0.51	JOB	11,042	1,104	972	1,312	289	14,718	28909.85
TOTAL Interior Drainage	300.00	CFS	102,771	10,277	9,044	12,209	2,686	136,987	456.62
N-020302 Trailer Park Ditch & Surface D/C									
N-02030202 CONCRETE									
N-0203020201 Concrete Forming	588.00	SF	4,645	464	409	552	121	6,191	10.53
N-0203020202 Concrete	200.00	CY	32,031	3,203	2,819	3,805	837	42,695	213.47
N-0203020203 Curing	1350.00	SF	620	62	55	74	16	826	0.61
N-0203020204 Darby	695.25	SF	808	81	71	96	21	1,077	1.55
N-0203020205 Float	695.25	SF	872	87	77	104	23	1,162	1.67
TOTAL CONCRETE	200.00	CY	38,975	3,898	3,430	4,630	1,019	51,952	259.76
N-02030203 Reinforce Steel									
N-0203020301 Reinforce Steel	20000.00	LB	13,303	1,330	1,171	1,580	348	17,731	0.89
TOTAL Reinforce Steel	20000.00	LB	13,303	1,330	1,171	1,580	348	17,731	0.89
TOTAL Trailer Park Ditch & Surface D/C	1.00	JOB	52,278	5,228	4,600	6,211	1,366	69,683	69683.03
TOTAL Local / Interior Drainage	1.00	JOB	155,048	15,505	13,644	18,420	4,052	206,670	206669.55
N-0205 Road 23									
N-020507 Raise Road 23									
N-02050701 Patrol Road Agg. Frm Qry to site	1262.00	TON	49,014	4,901	4,313	5,823	1,281	65,332	51.77
N-02050702 PLACE AGG.BASE FROM COMM.SOURCE	1262.00	TON	4,983	498	439	592	130	6,642	5.26
TOTAL Raise Road 23	0.43	MI	53,997	5,400	4,752	6,415	1,411	71,974	167382.40
TOTAL Road 23	1.00	JOB	53,997	5,400	4,752	6,415	1,411	71,974	71974.43
N-0206 Road 203									
N-020607 Raise Road 203									
N-02060701 Patrol Road Agg. Frm Qry to site	2495.00	TON	82,163	8,216	7,230	9,761	2,147	109,517	43.89
N-02060702 PLACE AGG.BASE FROM COMM.SOURCE	2495.00	TON	7,475	747	658	888	195	9,964	3.99

	QUANTITY	UOM	TOTAL DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
TOTAL Raise Road 203	0.85	MI	89,638	8,964	7,888	10,649	2,343	119,481	140565.95
TOTAL Road 203	1.00	JOB	89,638	8,964	7,888	10,649	2,343	119,481	119481.06
N-0207 City Roads									
N-020707 Raise and Relocate									
N-02070701 Patrol Road Agg. Frm Qry to site	1233.00	TON	40,873	4,087	3,597	4,856	1,068	54,481	44.19
N-02070702 PLACE AGG.BASE FROM COMM.SOURCE	1233.00	TON	3,737	374	329	444	98	4,982	4.04
TOTAL Raise and Relocate	0.42	MI	44,611	4,461	3,926	5,300	1,166	59,463	141578.77
TOTAL City Roads	1.00	JOB	44,611	4,461	3,926	5,300	1,166	59,463	59463.08
TOTAL RELOCATIONS	1.00	JOB	343,293	34,329	30,210	40,783	8,972	457,588	457588.12
TOTAL NON-FEDERAL	1.00	JOB	343,293	34,329	30,210	40,783	8,972	457,588	457588.12
TOTAL Hamilton base estimate	1.00	EA	16,368,984	1,636,898	1,440,471	1,944,635	427,820	21,818,807	21818807
Contingency								34,971	
TOTAL INCL OWNER COSTS								21,853,778	

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                                                        QUANTITY UOM  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST UNIT COST
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F  FEDERAL

F- 6  Fish & Wildlife Fac.(Mitigation)

F- 603  Fish & Wildlife Sancturaries

F- 60301  Mob., Demob. and Preparatory Wo:

F- 60301 1  Mob., Demob. and Preparatory Wo:              1.00 JOB        0   133,294   133,294         0         0     266,587 266587.20
                                                                    ------- --------- --------- --------- ---------  ----------
        TOTAL Mob., Demob. and Preparatory Wo:            1.00 JOB        0   133,294   133,294         0         0     266,587 266587.20

F- 60302  Levee Foundations & Clearing

F- 6030201  Levee Foundations & Clear&Grub           159740.00 CY     4,760   290,138   266,069         0         0     556,207      3.48
                                                                    ------- --------- --------- --------- ---------  ----------
        TOTAL Levee Foundations & Clearing                5.71 MI     4,760   290,138   266,069         0         0     556,207  97494.67

F- 60303  Remove "J" Levee to onsite Ste             247700.00 CY    10,080   609,297   522,916         0         0   1,132,213      4.57

F- 60304  Erosion protection=Entreached

F- 6030401  Clear Levee Fill Borrow Site                  7.15 AC         0     8,245     7,686         0         0      15,931   2228.40
F- 6030402  Load Levee Fill at Borrow Site            65632.00 CY         0   104,417   112,056         0         0     216,473      3.30
F- 6030403  Haul Levee Fill from Borrow Site          24612.00 C/M        0    11,812     7,880         0         0      19,693      0.80
F- 6030404  DERRICK STONE MATERIAL                    96690.00 TON        0         0         0         0 1,546,579   1,546,579     16.00
F- 6030405  HAUL DERRICK STONE 80K LB GVW               403.00 HRS        0    46,216    30,833         0         0      77,050    191.19
F- 6030406  PLACE DERRICK STONE FROM LEVEE            96690.00 TON        0    73,969    49,349         0         0     123,318      1.28
F- 6030407  Place Levee Fill                          16408.00 CY         0    20,901    25,182         0         0      46,084      2.81
F- 6030408  Compact Levee Fill                        16408.00 CY         0    15,889     7,413         0         0      23,302      1.42
                                                                    ------- --------- --------- --------- ---------  ----------
        TOTAL Erosion protection=Entreached               0.59 MI         0   281,449   240,400         0 1,546,579   2,068,428   3529741

F- 60305  Levee Material from onsite Ste             247700.00 CY     8,060   463,675   278,460         0         0     742,135      3.00

F- 60306  Erosion prot. Riprap 3'-2h on 1v

F- 6030601  Erosion protection Riprap                 26015.00 TON    1,110    65,009    50,723   168,059         0     283,791     10.91
F- 6030602  PLACE Erosion protection Riprap           26015.00 TON      420    24,950    12,425         0         0      37,375      1.44
                                                                    ------- --------- --------- --------- ---------  ----------
        TOTAL Erosion prot. Riprap 3'-2h on 1v            0.47 MI     1,530    89,959    63,148   168,059         0     321,166 678997.80

F- 60307  15 ft Crown Road

F- 6030701  Patrol Road Agg. Frm Qry to site          16744.00 TON    2,880   172,959   136,008   240,372         0     549,339     32.81
F- 6030702  PLACE AGG.BASE FROM COMM.SOURCE           16744.00 TON      560    33,266    16,566         0         0      49,833      2.98
                                                                    ------- --------- --------- --------- ---------  ----------
        TOTAL 15 ft Crown Road                            5.71 MI     3,440   206,226   152,574   240,372         0     599,172 105025.75
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	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
F- 60308 Erosion Prodection HYDROSEEDIG									
F- 6030801 HYDROSEEDING									
F- 603080101 Native Grass Seed	49.00	AC	98	6,581	378	205,604	0	212,563	4338.01
TOTAL HYDROSEEDING	2139375	SF	98	6,581	378	205,604	0	212,563	0.10
TOTAL Erosion Prodection HYDROSEEDIG	5.71	MI	98	6,581	378	205,604	0	212,563	37259.02
F- 60309 Fencing									
F- 6030901 Fencing	35745.60	LF	80	4,587	263	143,689	0	148,539	4.16
TOTAL Fencing	6.77	MI	80	4,587	263	143,689	0	148,539	21940.79
F- 60310 Seepage Berm									
F- 6031001 Haul Seepage Berm Material	144.00	HR	288	19,307	10,999	0	0	30,306	210.46
F- 6031003 Seepage Berm Mat.(Drain Rock)	89400.00	TON	0	0	0	930,466	0	930,466	10.41
F- 6031004 Place Seepage Berm Material	144.00	HR	288	16,514	33,269	0	0	49,783	345.71
TOTAL Seepage Berm	44700.00	CY	576	35,821	44,268	930,466	0	1,010,555	22.61
TOTAL Fish & Wildlife Sancturaries	1.00	JOB	28,624	2,121,027	1,701,768	1,688,190	1,546,579	7,057,565	7057565
F- 673 Habitat & Feeding Facilities									
F- 673 1 Mob & Demob	1.00	JOB	0	0	0	0	36,000	36,000	36000.00
F- 67301 Cottonwood	200.00	AC	0	0	0	0	1,455,000	1,455,000	7275.00
F- 67302 Riparian	796.60	AC	0	0	0	0	4,500,790	4,500,790	5650.00
F- 67303 Grassland	70.40	AC	0	0	0	0	190,080	190,080	2700.00
F- 67304 Savannah	147.90	AC	0	0	0	0	761,685	761,685	5150.00
F- 67305 Scrub	261.20	AC	0	0	0	0	1,475,780	1,475,780	5650.00
TOTAL Habitat & Feeding Facilities	1.00	JOB	0	0	0	0	8,419,335	8,419,335	8419335
TOTAL Fish & Wildlife Fac.(Mitigation)	1.00	JOB	28,624	2,121,027	1,701,768	1,688,190	9,965,914	15,476,900	15476900
F-11 LEVEES									
F-1101 Mob., Demob. and Preparatory Wo:									
F-1101 1 Mob., Demob. and Preparatory Wo:	1.00	JOB	0	6,665	6,665	0	0	13,329	13329.36
TOTAL Mob., Demob. and Preparatory Wo:	1.00	JOB	0	6,665	6,665	0	0	13,329	13329.36

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
F-1102 Levee Foundations & Clear&Grub									
F-110201 Levee Foundations & Clear&Grub	29820.00	CY	840	51,201	46,953	0	0	98,154	3.29
TOTAL Levee Foundations & Clear&Grub	1.07	MI	840	51,201	46,953	0	0	98,154	92163.61
F-1103 Erosion protecton = Riprap									
F-110301 EXCAVATION	186.00	CY	54	3,260	3,444	0	0	6,704	36.04
F-110302 Riprap - slope	224.00	CY	34	1,875	1,206	5,145	0	8,226	36.72
F-110303 Riprap - toe	67.00	CY	16	875	583	1,539	0	2,997	44.73
TOTAL Erosion protecton = Riprap	0.02	MI	104	6,009	5,233	6,684	0	17,926	943484.54
F-1104 Increase in ER Levee Component	66000.00	CY	2,880	123,403	77,308	0	2	200,713	3.04
F-1105 Training Dike	28500.00	CY	1,200	51,418	32,212	0	1	83,631	2.93
F-1106 15 ft Crown Road									
F-110601 Patrol Road Agg. Frm Qry to site	3956.00	TON	444	26,004	20,289	45,433	0	91,726	23.19
F-110602 PLACE AGG.BASE FROM COMM.SOURCE	3956.00	TON	168	9,980	4,970	0	0	14,950	3.78
TOTAL 15 ft Crown Road	1.07	MI	612	35,984	25,259	45,433	0	106,676	100165.12
F-1107 Erosion Prodection Hydroseeding									
F-110702 HYDROSEEDING									
F-11070201 Native Grass Seed	10.00	AC	8	537	31	27,793	0	28,361	2836.07
TOTAL HYDROSEEDING	449856.00	SF	8	537	31	27,793	0	28,361	0.06
TOTAL Erosion Prodection Hydroseeding	1.07	MI	8	537	31	27,793	0	28,361	26629.80
TOTAL LEVEES	1.00	JOB	5,644	275,216	193,661	79,910	4	548,790	548790.43
TOTAL FEDERAL	1.00	JOB	34,268	2,396,243	1,895,429	1,768,100	9,965,918	16,025,690	16025690
N NON-FEDERAL									
N-02 RELOCATIONS									
N-0203 Local /. Interior Drainage									
N-020301 Interior Drainage									
N-02030101 PUMPING FACILITY(3-1200GPM PUMS)									

U.S. Army Corps of Engineers
PROJECT HAMBK6: Hamilton base estimate
HAM - CIT 001
** PROJECT DIRECT SUMMARY - Level 6 **

		QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
N-0203010101	PUMPING FACILITY(3-1200GPM PUMS)	0.51	JOB	70	3,740	312	10,455	0	14,507	28495.93
	TOTAL PUMPING FACILITY(3-1200GPM PUMS)	0.51	JOB	70	3,740	312	10,455	0	14,507	28495.93
N-02030102	CONCRETE									
N-0203010201	Concrete Forming	344.53	SF	51	2,502	565	594	0	3,660	10.62
N-0203010202	Concrete	53.45	CY	203	8,595	2,647	6,188	0	17,430	326.12
N-0203010203	Curing	360.76	SF	15	661	69	12	0	742	2.06
N-0203010204	Darby	880.65	SF	20	917	106	0	0	1,024	1.16
N-0203010205	Float	880.65	SF	20	917	187	0	0	1,104	1.25
	TOTAL CONCRETE	53.45	CY	309	13,592	3,574	6,793	0	23,960	448.30
N-02030103	Reinforce Steel									
N-0203010301	Reinforce Steel	5599.70	LB	101	7,130	2,704	1,450	0	11,284	2.02
	TOTAL Reinforce Steel	5599.14	LB	101	7,130	2,704	1,450	0	11,284	2.02
N-02030105	GRATING									
N-0203010501	STEEL ACCESS PLATFORMS	3499.51	LBS	91	6,112	3,047	3,896	9,772	22,826	6.52
	TOTAL GRATING	139.98	SF	91	6,112	3,047	3,896	9,772	22,826	163.07
N-02030106	MISCELLANEOUS METALS									
N-02030106 1	MISCELLANEOUS FABRICATION	763.54	LBS	25	1,491	392	2,174	0	4,057	5.31
N-02030106 4	Prep & paint	25.33	SF	7	311	3	0	0	315	12.42
N-0203010650	TRANSPORT MISCELLANEOUS METALS	763.09	LBS	5	279	287	0	0	566	0.74
N-0203010660	INSTALL MISCELLANEOUS METALS	763.09	LBS	18	1,133	253	0	0	1,387	1.82
	TOTAL MISCELLANEOUS METALS	763.54	LBS	54	3,215	935	2,174	0	6,324	8.28
N-02030107	GEOCOMPOSIT DRAIN SYSTEM									
N-0203010701	Geosynthetic Wall Drain	3.93	SY	41	2,479	272	27	0	2,779	707.71
N-0203010702	18" DIA. PREFORATED PIPING	13.09	LF	90	4,973	275	3,912	0	9,160	699.90
N-0203010703	DRAIN ROCK	10.47	TON	7	420	258	210	0	889	84.87
	TOTAL GEOCOMPOSIT DRAIN SYSTEM	338.47	SF	138	7,873	806	4,149	0	12,828	37.90
N-02030108	ELECTRIC SERVICE TO PUMPS									

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                                                   QUANTITY UOM  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER   TOTAL COST UNIT COST
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N-02030108 1  INSTALL TRANS.w/CONC PULL BOXES          0.51 JOB      43     2,250         0     3,274         0        5,524  10850.62
N-02030108 3  INST EL.CABLE & PULL BOXES               0.51 JOB      48     2,514       403     2,600         0        5,518  10838.24
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL ELECTRIC SERVICE TO PUMPS                0.51 JOB      91     4,764       403     5,875         0       11,042  21688.85
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL Interior Drainage                      300.00 CFS     855    46,425    11,781    34,793     9,772      102,771    342.57

N-020302  Trailer Park Ditch & Surface D/C

N-02030202  CONCRETE

N-0203020201  Concrete Forming                       588.00 SF       60     2,963       669     1,013         0        4,645      7.90
N-0203020202  Concrete                               200.00 CY      160     6,785     2,090    23,156         0       32,031    160.15
N-0203020203  Curing                                1350.00 SF       12       522        54        44         0          620      0.46
N-0203020204  Darby                                  695.25 SF       16       724        84         0         0          808      1.16
N-0203020205  Float                                  695.25 SF       16       724       148         0         0          872      1.25
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL CONCRETE                               200.00 CY      264    11,718     3,045    24,212         0       38,975    194.88

N-02030203  Reinforce Steel

N-0203020301  Reinforce Steel                      20000.00 LB       80     5,629     2,135     5,539         0       13,303      0.67
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL Reinforce Steel                      20000.00 LB       80     5,629     2,135     5,539         0       13,303      0.67

        TOTAL Trailer Park Ditch & Surface D/C         1.00 JOB     344    17,347     5,179    29,751         0       52,278  52277.85
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL Local / Interior Drainage                1.00 JOB   1,199    63,772    16,960    64,544     9,772      155,048 155048.37

N-0205  Road 23

N-020507  Raise  Road 23

N-02050701  Patrol Road Agg. Frm Qry to site        1262.00 TON     288    17,296    13,601    18,117         0       49,014     38.84
N-02050702  PLACE AGG.BASE FROM COMM.SOURCE         1262.00 TON      56     3,327     1,657         0         0        4,983      3.95
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL Raise  Road 23                           0.43 MI      344    20,623    15,257    18,117         0       53,997 125574.22
                                                                ------- --------- --------- --------- ---------  -----------
        TOTAL Road 23                                  1.00 JOB     344    20,623    15,257    18,117         0       53,997  53996.92

N-0206  Road 203

N-020607  Raise  Road 203

N-02060701  Patrol Road Agg. Frm Qry to site        2495.00 TON     432    25,944    20,401    35,818         0       82,163     32.93
N-02060702  PLACE AGG.BASE FROM COMM.SOURCE         2495.00 TON      84     4,990     2,485         0         0        7,475      3.00
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	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Raise Road 203	0.85	MI	516	30,934	22,886	35,818	0	89,638	105455.89
TOTAL Road 203	1.00	JOB	516	30,934	22,886	35,818	0	89,638	89637.50
N-0207 City Roads									
N-020707 Raise and Relocate									
N-02070701 Patrol Road Agg. Frm Qry to site	1233.00	TON	216	12,972	10,201	17,701	0	40,873	33.15
N-02070702 PLACE AGG.BASE FROM COMM.SOURCE	1233.00	TON	42	2,495	1,242	0	0	3,737	3.03
TOTAL Raise and Relocate	0.42	MI	258	15,467	11,443	17,701	0	44,611	106215.73
TOTAL City Roads	1.00	JOB	258	15,467	11,443	17,701	0	44,611	44610.61
TOTAL RELOCATIONS	1.00	JOB	2,317	130,796	66,546	136,180	9,772	343,293	343293.39
TOTAL NON-FEDERAL	1.00	JOB	2,317	130,796	66,546	136,180	9,772	343,293	343293.39
TOTAL Hamilton base estimate	1.00	EA	36,585	2,527,039	1,961,976	1,904,280	9,975,690	16,368,984	16368984
Prime Contractor's Field Overhead								1,636,898	
SUBTOTAL								18,005,882	
Prime's Home Office Expense								1,440,471	
SUBTOTAL								19,446,352	
Prime Contractor's Profit								1,944,635	
SUBTOTAL								21,390,988	
Prime Contractor's Bond								427,820	
TOTAL INCL INDIRECTS								21,818,807	
Contingency								34,971	
TOTAL INCL OWNER COSTS								21,853,778	

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------------------------------------------------------------------------- ** CONTRACT ** ------------------------------------------------------
                                                   QUANTITY UOM        UNIT         TOTAL                  ADJ UNIT        TOTAL
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F FEDERAL
F. 6 Fish & Wildlife Fac.(Mitigation)
F. 6.03 Fish & Wildlife Sancturaries
F. 6.03.01 Mob., Demob. and Preparatory Wo:
F. 6.03.01. 1 Mob., Demob. and Preparatory Wo:          1.00 JOB   355343.68      355,344                 344185.00      344,185
                                                                 -------------------------  ------------------------ ------------
F. 6.03.01 Mob., Demob. and Preparatory Wo:             1.00 JOB   355343.68      355,344                      0.00      344,185

F. 6.03.02 Levee Foundations & Clearing
F. 6.03.02.01 Levee Foundations & Clear&Grub       159740.00 CY         4.64      741,388                      4.65      742,791
                                                                 -------------------------  ------------------------ ------------
F. 6.03.02 Levee Foundations & Clearing                 5.71 MI    129954.16      741,388                      0.00      742,791

F. 6.03.03 Remove "J" Levee to onsite Ste
F. 6.03.03.00 <<< Not Identified >>>               247700.00 CY         6.09    1,509,167                      6.00    1,486,200
                                                                 -------------------------  ------------------------ ------------
F. 6.03.03 Remove "J" Levee to onsite Ste          247700.00 CY         6.09    1,509,167                      6.00    1,486,200

F. 6.03.04 Erosion protection=Entreached
F. 6.03.04.01 Clear Levee Fill Borrow Site              7.15 AC      2970.32       21,235                   2970.00       21,233
F. 6.03.04.02 Load Levee Fill at Borrow Site        65632.00 CY         4.40      288,545                      4.40      288,781
F. 6.03.04.03 Haul Levee Fill from Borrow Site      24612.00 C/M        1.07       26,249                      1.07       26,335
F. 6.03.04.04 DERRICK STONE MATERIAL                96690.00 TON       21.32    2,061,491                     21.32    2,061,431
F. 6.03.04.05 HAUL DERRICK STONE 80K LB GVW           403.00 HRS      254.84      102,702                    254.84      102,701
F. 6.03.04.06 PLACE DERRICK STONE FROM LEVEE        96690.00 TON        1.70      164,374                      1.70      164,373
F. 6.03.04.07 Place Levee Fill                      16408.00 CY         3.74       61,426                      3.74       61,366
F. 6.03.04.08 Compact Levee Fill                    16408.00 CY         1.89       31,059                      1.89       31,011
                                                                 -------------------------  ------------------------ ------------
F. 6.03.04 Erosion protection=Entreached                0.59 MI   4704918.19    2,757,082                      0.00    2,757,230

F. 6.03.05 Levee Material from onsite Ste
F. 6.03.05.00 <<< Not Identified >>>               247700.00 LS         3.99      989,218                      4.00      990,800
                                                                 -------------------------  ------------------------ ------------
F. 6.03.05 Levee Material from onsite Ste          247700.00 CY         3.99      989,218                      4.00      990,800

F. 6.03.06 Erosion prot. Riprap 3'-2h on 1v
F. 6.03.06.01 Erosion protection Riprap             26015.00 TON       14.54      378,276                     14.50      377,218
F. 6.03.06.02 PLACE Erosion protection Riprap       26015.00 TON        1.91       49,818                      2.00       52,030
                                                                 -------------------------  ------------------------ ------------
F. 6.03.06 Erosion prot. Riprap 3'-2h on 1v             0.47 MI    905060.62      428,094                      0.00      429,248

F. 6.03.07 15 ft Crown Road
F. 6.03.07.01 Patrol Road Agg. Frm Qry to site      16744.00 TON       43.73      732,234                     43.75      732,550
F. 6.03.07.02 PLACE AGG.BASE FROM COMM.SOURCE       16744.00 TON        3.97       66,424                      2.00       33,488
                                                                 -------------------------  ------------------------ ------------
F. 6.03.07 15 ft Crown Road                             5.71 MI    139992.60      798,658                      0.00      766,038

F. 6.03.08 Erosion Prodection HYDROSEEDIG
F. 6.03.08.01 HYDROSEEDING                        2139375.00 SF         0.13      283,332                      0.13      278,119
                                                                 -------------------------  ------------------------ ------------
F. 6.03.08 Erosion Prodection HYDROSEEDIG               5.71 MI     49663.89      283,332                      0.00      278,119
```

			** CONTRACT **			
	QUANTITY	UOM	UNIT	TOTAL	ADJ UNIT	TOTAL
F. 6.03.09 Fencing						
F. 6.03.09.01 Fencing	35745.60	LF	5.54	197,993	5.55	198,388
F. 6.03.09 Fencing	6.77	MI	29245.66	197,993	0.00	198,388
F. 6.03.10 Seepage Berm						
F. 6.03.10.01 Haul Seepage Berm Material	144.00	HR	280.53	40,397	280.00	40,320
F. 6.03.10.03 Seepage Berm Mat.(Drain Rock)	89400.00	TON	13.87	1,240,252	13.90	1,242,660
F. 6.03.10.04 Place Seepage Berm Material	144.00	HR	460.81	66,357	460.81	66,357
F. 6.03.10 Seepage Berm	44700.00	CY	30.13	1,347,005	30.00	1,349,337
F. 6.03 Fish & Wildlife Sancturaries	1.00	JOB	9407282.09	9,407,282	0.00	9,342,335
F. 6.73 Habitat & Feeding Facilities						
F. 6.73. 1 Mob & Demob						
F. 6.73. 1.00 <<< Not Identified >>>	1.00	LS	47985.70	47,986	48550.00	48,550
F. 6.73. 1 Mob & Demob	1.00	JOB	47985.70	47,986	48550.00	48,550
F. 6.73.01 Cottonwood						
F. 6.73.01.00 <<< Not Identified >>>	200.00	LS	9697.11	1,939,422	9700.00	1,940,000
F. 6.73.01 Cottonwood	200.00	AC	9697.11	1,939,422	9700.00	1,940,000
F. 6.73.02 Riparian						
F. 6.73.02.00 <<< Not Identified >>>	796.00	LS	7536.77	5,999,265	7500.00	5,970,000
F. 6.73.02 Riparian	796.60	AC	7531.09	5,999,265	7500.00	5,970,000
F. 6.73.03 Grassland						
F. 6.73.03.00 <<< Not Identified >>>	70.40	LS	3598.93	253,364	3600.00	253,440
F. 6.73.03 Grassland	70.40	AC	3598.93	253,364	3600.00	253,440
F. 6.73.04 Savannah						
F. 6.73.04.00 <<< Not Identified >>>	147.90	LS	6864.62	1,015,277	6900.00	1,020,510
F. 6.73.04 Savannah	147.90	AC	6864.62	1,015,277	6900.00	1,020,510
F. 6.73.05 Scrub						
F. 6.73.05.00 <<< Not Identified >>>	261.20	LS	7531.09	1,967,120	7500.00	1,959,000
F. 6.73.05 Scrub	261.20	AC	7531.09	1,967,120	7500.00	1,959,000
F. 6.73 Habitat & Feeding Facilities	1.00	JOB	11222434.72	11,222,435	0.00	11,191,500
F. 6 Fish & Wildlife Fac.(Mitigation)	1.00	JOB	20629716.81	20,629,717	0.00	20,533,835

			** CONTRACT **			
	QUANTITY	UOM	UNIT	TOTAL	ADJ UNIT	TOTAL
F.11 LEVEES						
F.11.01 Mob., Demob. and Preparatory Wo:						
F.11.01. 1 Mob., Demob. and Preparatory Wo:						
F.11.01. 1.00 <<< Not Identified >>>	1.00	EA	17767.18	17,767	28464.00	28,464
F.11.01. 1 Mob., Demob. and Preparatory Wo:	1.00	JOB	17767.18	17,767	28464.00	28,464
F.11.01 Mob., Demob. and Preparatory Wo:	1.00	JOB	17767.18	17,767	0.00	28,464
F.11.02 Levee Foundations & Clear&Grub						
F.11.02.01 Levee Foundations & Clear&Grub						
F.11.02.01.00 <<< Not Identified >>>	29820.00	CY	4.39	130,833	4.40	131,208
F.11.02.01 Levee Foundations & Clear&Grub	29820.00	CY	4.39	130,833	0.00	131,208
F.11.02 Levee Foundations & Clear&Grub	1.07	MI	122848.20	130,833	0.00	131,208
F.11.03 Erosion protecton = Riprap						
F.11.03.01 EXCAVATION						
F.11.03.01.00 <<< Not Identified >>>	186.00	CY	48.04	8,935	48.00	8,928
F.11.03.01 EXCAVATION	186.00	CY	48.04	8,935	49.00	8,928
F.11.03.02 Riprap - slope						
F.11.03.02.00 <<< Not Identified >>>	224.00	CY	48.95	10,964	49.00	10,976
F.11.03.02 Riprap - slope	224.00	CY	48.95	10,964	49.00	10,976
F.11.03.03 Riprap - toe						
F.11.03.03.00 <<< Not Identified >>>	67.00	CY	59.62	3,995	60.00	4,020
F.11.03.03 Riprap - toe	67.00	CY	59.62	3,995	60.00	4,020
F.11.03 Erosion protecton = Riprap	0.02	MI	1257604.52	23,894	0.00	23,924
F.11.04 Increase in ER Levee Component						
F.11.04.00 <<< Not Identified >>>						
F.11.04.00.00 <<< Not Identified >>>	66000.00	CY	4.05	267,538	4.00	264,000
F.11.04.00 <<< Not Identified >>>	66000.00	CY	4.05	267,538	4.00	264,000
F.11.04 Increase in ER Levee Component	66000.00	CY	4.05	267,538	0.00	264,000
F.11.05 Training Dike						
F.11.05.00 <<< Not Identified >>>						
F.11.05.00.00 <<< Not Identified >>>	28500.00	LS	3.91	111,474	4.00	114,000

			** CONTRACT **			
	QUANTITY	UOM	UNIT	TOTAL	ADJ UNIT	TOTAL
F.11.05.00 <<< Not Identified >>>	28500.00	CY	3.91	111,474	4.00	114,000
F.11.05 Training Dike	28500.00	CY	3.91	111,474	0.00	114,000
F.11.06 15 ft Crown Road						
F.11.06.01 Patrol Road Agg. Frm Qry to site						
F.11.06.01.00 <<< Not Identified >>>	3956.00	TON	30.91	122,265	31.00	122,636
F.11.06.01 Patrol Road Agg. Frm Qry to site	3956.00	TON	30.91	122,265	31.00	122,636
F.11.06.02 PLACE AGG.BASE FROM COMM.SOURCE						
F.11.06.02.00 <<< Not Identified >>>	3956.00	TON	5.04	19,927	5.00	19,780
F.11.06.02 PLACE AGG.BASE FROM COMM.SOURCE	3956.00	TON	5.04	19,927	5.00	19,780
F.11.06 15 ft Crown Road	1.07	MI	133513.69	142,192	0.00	142,416
F.11.07 Erosion Prodection Hydroseeding						
F.11.07.02 HYDROSEEDING						
F.11.07.02.01 Native Grass Seed	449856.00	SF	0.08	37,803	0.08	35,988
F.11.07.02 HYDROSEEDING	449856.00	SF	0.08	37,803	0.00	35,988
F.11.07 Erosion Prodection Hydroseeding	1.07	MI	35495.82	37,803	0.00	35,988
F.11 LEVEES	1.00	JOB	731502.52	731,503	0.00	740,000
F FEDERAL	1.00	JOB	21361219.32	21,361,219	0.00	21,273,836
N NON-FEDERAL						
N.02 RELOCATIONS						
N.02.03 Local / Interior Drainage						
N.02.03.01 Interior Drainage						
N.02.03.01.01 PUMPING FACILITY(3-1200GPM PUMS)	1.00	JOB	19337.27	19,337	19300.00	19,300
N.02.03.01.02 CONCRETE	53.00	CY	602.58	31,937	600.00	31,800
N.02.03.01.03 Reinforce Steel	5600.00	LB	2.69	15,041	2.75	15,400
N.02.03.01.05 GRATING	140.00	SF	217.33	30,426	220.00	30,800
N.02.03.01.06 MISCELLANEOUS METALS	760.00	LBS	11.09	8,430	11.00	8,360
N.02.03.01.07 GEOCOMPOSIT DRAIN SYSTEM	340.00	SF	50.29	17,098	50.50	17,170
N.02.03.01.08 ELECTRIC SERVICE TO PUMPS	1.00	JOB	14718.01	14,718	14700.00	14,700
N.02.03.01 Interior Drainage	300.00	CFS	456.62	136,987	400.00	137,530
N.02.03.02 Trailer Park Ditch & Surface D/C						

			** CONTRACT **			
	QUANTITY	UOM	UNIT	TOTAL	ADJ UNIT	TOTAL
N.02.03.02.02 CONCRETE	200.00	CY	259.76	51,952	260.00	52,000
N.02.03.02.03 Reinforce Steel	20000.00	LB	0.89	17,731	1.00	20,000
N.02.03.02 Trailer Park Ditch & Surface D/C	1.00	JOB	69683.03	69,683	80000.00	72,000
N.02.03 Local / Interior Drainage	1.00	JOB	206669.55	206,670	0.00	209,530
N.02.05 Road 23						
N.02.05.07 Raise Road 23						
N.02.05.07.01 Patrol Road Agg. Frm Qry to site	1262.00	TON	51.77	65,332	52.00	65,624
N.02.05.07.02 PLACE AGG.BASE FROM COMM.SOURCE	1262.00	TON	5.26	6,642	5.25	6,626
N.02.05.07 Raise Road 23	0.43	MI	167382.40	71,974	151200.00	72,250
N.02.05 Road 23	1.00	JOB	71974.43	71,974	0.00	72,250
N.02.06 Road 203						
N.02.06.07 Raise Road 203						
N.02.06.07.01 Patrol Road Agg. Frm Qry to site	2495.00	TON	43.89	109,517	44.00	109,780
N.02.06.07.02 PLACE AGG.BASE FROM COMM.SOURCE	2495.00	TON	3.99	9,964	4.00	9,980
N.02.06.07 Raise Road 203	0.85	MI	140565.95	119,481	147060.00	119,760
N.02.06 Road 203	1.00	JOB	119481.06	119,481	0.00	119,760
N.02.07 City Roads						
N.02.07.07 Raise and Relocate						
N.02.07.07.01 Patrol Road Agg. Frm Qry to site	1233.00	TON	44.19	54,481	44.00	54,252
N.02.07.07.02 PLACE AGG.BASE FROM COMM.SOURCE	1233.00	TON	4.04	4,982	4.00	4,932
N.02.07.07 Raise and Relocate	0.42	MI	141578.77	59,463	142856.00	59,184
N.02.07 City Roads	1.00	JOB	59463.08	59,463	0.00	59,184
N.02 RELOCATIONS	1.00	JOB	457588.12	457,588	0.00	460,724
N NON-FEDERAL	1.00	JOB	457588.12	457,588	0.00	460,724
Hamilton base estimate	1.00	EA	21818807.45	21,818,807	0.00	21,734,559

No errors detected...

* * * END OF ERROR REPORT * * *

Appendix C9.

STRUCTURAL
(Not Applicable)

Appendix C10.

HABITAT REVEGETATION REPORT

Hamilton City
Flood Damage Reduction and Ecosystem Restoration, California

Habitat Revegetation Report

Landscape Architectural Unit
Civil Design B Section

US ARMY CORPS OF ENGINEERS
Sacramento District

May 2004

Hamilton City, Flood Damage Reduction and Ecosystem Restoration Project, CA

Habitat Revegetation Report

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Hamilton City, Flood Damage Reduction and Ecosystem Restoration, CA
Habitat Revegetation Report

Revegetation Basis of Design

February 2004

1. Introduction

This report studies revegetation methods for the various restoration alternatives for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project (the "Project"). As such it addresses only one of the ecosystem restoration measures that is explained along with other measures in section 3.3 of the Feasibility report. The measure addressed is the restoration of native vegetation

This report provides a methodology for revegetation of all of the project alternatives. In general, for each of the alternatives all land on the waterside of the levee would be revegetated. This report is concerned with efforts to revegetate various types of native riparian habitats within the floodplain areas formed between the Project levee and the Sacramento River within the Project limits. The design concept consists of planting and establishing the various riparian habitats using established agricultural techniques tailored to the Sacramento River beginning in 1989. The specific types of riparian habitat to be established will be located based on hydrologic modeling, flooding frequency, soil properties, and depth to water table. The revegetation efforts and methods presented in this report describe the process to establish riparian habitats within the Hamilton City Project.

Therefore, this report looks at the technical requirements for determining and establishing appropriate vegetative habitat types. The requirements for each habitat type are considered and documented in this report. The level of detail used to assess the technical requirements is generalized to the two proposed major classes of habitat types, grassland and habitat types with woody vegetation. Since the level of detail for this feasibility study did not include site specific design and mapping, all proposed techniques and methods are general and will be adapted to site specific conditions in the next phase of the project, the Project Engineering Design (PED) Phase. Specific Site conditions that may require adjustment or change of implementation technique include but are not limited to: topology, previous land use, specific weed infestations in the various fields, Soil types and groundwater conditions. Quantities are established in this report which can be extended across the habitat acreages of the various alternatives. Refer to chapter 3 of the main report.

The selected alternative is a combined flood damage reduction and ecosystem restoration solution. An overall takeoff of quantities for the selected alternative is provided as well

2. References

Riparian Restoration Plan for the Pine Creek Unit, Upper Sacramento River Wildlife Area Sacramento River mile 194.5-197R Butte County, California; Prepared by Sacramento River Partners for the California Department of Fish and Game Wildlife Conservation Board. April 24, 2003

Preliminary plant design model: soil stratigraphy and elevation. The Nature Conservancy, Sacramento River Project. 2003.

2003 Site Assessments: Haleakala, RX Ranch, Sunset Ranch, and Deadman's Reach. The Nature Conservancy, Sacramento River Project. August 2002.

Woodson Bridge/Kopta Sough Restoration Project, Appendix A: Kopta Slough Restoration Design, September 23, 2003; CESPK-ED-E, Civil Design B

Field Notes and Observations, James Lee, CESPK-ED-D, September 2003 Field Visit.

EC 1165-2-201 Ecosystem Restoration in the Civil Works Program.

Donald Twiss, PE: Personal communication, RE: wave wash barriers.

3. Revegetation Goals & Objectives

3.1 The objectives for the revegetation design are:

a. Revegetate floodplain areas on the waterside of the Project levee and training dikes with various native riparian habitat types.
b. Maximize habitat diversity in the Project area by recreating a diverse mosaic of riparian habitat types as dictated by physical site conditions.
c. Create self sustaining riparian habitats based on site conditions.
d. Provide wave wash protection to levees and training dikes as necessary.
e. Provide vegetative erosion protection for the levees and training dikes as necessary.

3.2 To accomplish these revegetation goals, the following measures have been developed:

a. Maximize habitat diversity by planting differing subtypes of riparian forest, savannah, scrub or grassland to create mosaics of habitat types.
b. Establish container, or pole cutting plantings to self-sufficient state by irrigating for the three-year establishment phase.
c. Protect container or pole cutting plantings during establishment from rodent browse.
d. Protect container or pole cutting plantings from maintenance activities during the establishment phase.
e. Maximize habitat diversity by leaving small (2-10 acres) open areas with no woody

vegetation. These will provide edge effects, areas that will provide areas of different vegetative maturity and an opportunity to assess the effectiveness of revegetation of woody plant material by actively establishing native grasses and letting woody plants volunteer in smaller areas within the context of larger active revegetation projects. This may be limited to 10 acres total area.

f. Maximize habitat by protecting and preserving existing naturally occurring native vegetation where possible.
g. Maximize habitat by planting native grass and forbs in all habitat areas and actively managing during the establishment phase.
h. Maximize habitat by controlling invasive exotic weed species within Project limits during the establishment phase.

4. Design Criteria

4. 1 Site Description: Hamilton City is located along the right bank of the Sacramento River in Glenn County, California, about 85 miles north of Sacramento. The Project area lies roughly to the east of the Hamilton City between river miles 193 and 201. The areas to be revegetated in all alternatives consist of lands on the waterside (East) of all proposed levee alternatives. The Project area to be revegetated encompasses roughly 1500 acres.

4. 2 Existing Site Conditions and Analyses: Hydrologic modeling, soil types, flood frequency, and depth to groundwater are the primary factors affecting which habitat types are best suited for any given area. Both The Nature Conservancy (TNC) and the Sacramento River Partners have done extensive floodplain restoration along the Sacramento River in the Project area. Both organizations have noted specific relationships between soil types, flood frequency, and depth to groundwater and the habitat types these factors will support. Refer to Table 1 for a summary of these relationships. These factors will be measured and mapped during the Preconstruction, Engineering and Design (PED) phase of the Project to produce a revegetation design based on the above factors.

4.2.1 Soils/Sediment: The soils in the area are alluvial deposits. Some areas have deep continuous soil profiles consisting of various types of loamy soils; others have gravel or clay lenses deposited by the river in point bars and oxbow channels, respectively. These features can be abandoned by the river when the channel migrates or avulses and subsequently have sediment deposited during flooding. The discontinuity in soil textures vertically can have the effect of interrupting capillary ground moisture creating droughty areas, which typically support scrub or grassland areas as opposed to the riparian forest or savannah communities supported by deeper soils. This creates a complex mosaic of various soil types with differing strata that affect the depth to groundwater.

4.2.2 Groundwater: The groundwater table varies throughout the year and also varies based on distance to river and the permeability of soil substrates. The late summer and fall months are the months of lowest river levels, groundwater levels, and general soil moisture. Theses are the critical months during which plant stress is highest and has a great impact on what types of vegetation will survive. Typically, grasslands require less moisture, followed by Scrub, savannah, and riparian forest.

Table 1 – Site Condition – Physical Factor Design Key

Physical Factors					Habitat Recommendation			
Groundwater		Flood Frequency		Dominant Soil type	TNC recommendation (Plant community – Based on Holland Veg. Classification)	Broad Category (from EA-based on HEP)	River Partners Habitat Type(s)	
							Series	Tiles (dominant tile in bold)
Impenetrable soil Layer above groundwater	Yes →	**More than 6' of Soil?**	Yes →	Clay, Clay Loam	Valley grassland	Grassland	Purple/Nodding needle grass	
				Silty, Silt Loam	Upland Savanna	Savanna	Valley Oak	VO1; VO4; **EB2**
No (go down one level)		No (Riparian Scrub **EB2**, V01		Loam, Sandy Loam				
				Sand/Gravel	Riparian Scrub	Scrub	Mexican Elderberry	V01; VO4; **EB2**
Groundwater >20'	Yes →	Infrequently flooded?	Yes →	Clay, Clay Loam	Valley Oak	Savanna	Valley Oak,	**VO2-3**; EB1; SY1
				Silty, Silt Loam	Upland Savanna			
No (go down one level)		No (go down one level)		Loam, Sandy Loam				
				Sand/Gravel	Riparian Scrub	Scrub	Mexican Elderberry	**EB1**; VO3
Groundwater 9'-15'	Yes →	Occasionally flooded	Yes →	Clay, Clay Loam	Valley Oak	Savanna	Box Elder	**BE1**
				Silty, Silt Loam			Fremont Cottonwood	FC2-4; **VO3-4**; EV1; EB3; SY1
No (go down one level)				Loam, Sandy Loam				
				Sand/Gravel	Riparian Scrub	Scrub	Mexican Elderberry	**EB1**
Groundwater 6'-9'	Yes →	Occasionally flooded	Yes →	Clay, Clay Loam	Lower mixed forest	Riparian	Mixed Willow	**MW3**
				Silty, Silt Loam			Fremont Cottonwood	MW3; **FC1,2,4**; EV1; BE1; EB3
No (go down one level)				Loam, Sandy Loam			Fremont Cottonwood	**FC1,2 4**; EB3; MW1
				Sand/Gravel	River Scrub	Scrub	Mixed Willow	**FC1**; MW1
Groundwater <6'	Yes →	Frequently flooded	Yes →	Clay, Clay Loam	Cottonwood/Willow	Riparian	Mixed Willow	**MW3**
				Silty, Silt Loam			Fremont cottonwood	**FC1,2 4, BE1**
				Loam, Sandy Loam				
				Sand/Gravel	River Scrub	Scrub	Mixed Willow	**MW2**

Note: This Key was adapted from a key provided by The Nature Conservancy (TNC) for the UCSACE Woodson Bridge/Kopta Slough Feasibility Study

4.2.3 Flooding: Frequency and depth of flooding influences plant survival based on the ability of different plant species to survive certain durations of flood events. With the Project (Setback Levees) in place, the flood frequency ranges from about 1 to 15 years. Periodic flooding is important to establishing a number of the native species, which are adapted to seasonal flooding. Periodic flooding is also beneficial as it replenishes ground water providing higher ground water levels later into the growing season. Finally, periodic flooding is beneficial as it is a natural river function that can disturb areas, initiate cycles of vegetative succession contributing to habitat diversity, and restore natural topographic variation to previously laser-leveled fields.

4.2.4 Landform: The landform in the project area is generally flat. Nearly all areas have been under cultivation as orchards or row crops and have been leveled. Some remnants of river activity are present in abandoned channels and other subtle patterns of relief created by old river activity. These create areas with different depth to groundwater as well as areas that are more prone to flooding. Some limited grading may be done to recreate topography for drainage and flood damage control purposes. This work will require definition in the Project Engineering Design (PED) Phase.

4.2.5 Existing Vegetation: The project area to be revegetated currently is mostly occupied by orchards or row crops. Some areas have been long abandoned (more than 10 years) and are in a fallow state infested heavily with noxious invasive weeds. Small linear patches of native vegetation remain on edges of fields and along the banks of the river. Existing native vegetation in the areas to be restored will be retained and protected in place during restoration activities. This includes patches of grasses and forbs that can provide a seed source for nearby restored area. Existing orchards in the restoration areas will need to be cleared and grubbed.

Some of the existing orchard trees may be retained to provide temporary cover for various animal species before the newly planted native vegetation matures sufficiently to provide adequate cover. It is likely that retaining a small percentage of trees in scattered individual locations will suffice for this purpose These trees will likely slowly die in period of a few years after orchard irrigation and pest control practices are ended. To prolong the life of existing orchard trees remaining, they may receive limited irrigation during the three year irrigation period for the new native vegetation . After the orchard trees die they will provide valuable habitat as snags.

4.2.6 Threatened or Endangered Species: Revegetation activities shall be designed to avoid unacceptable impacts to State or Federally listed threatened or endangered species (e.g., Swainson's Hawk, Valley Elderberry Longhorn Beetle). Unavoidable impacts shall be fully mitigated in accordance with applicable laws. Elderberry plants (Sambucus mexicana) are currently included in the revegetation plan. No elderberry plants will be planted if a memorandum of understanding (MOU) regarding allowing take of VELB cannot be negotiated between the Department of Water Resources and the USFWS. If an agreement cannot be made, the species mixes will be adjusted.

4.2.7 Levee Construction: Careful consideration and protection of existing native vegetation will need to be specified and incorporated into construction documents and field guidance. Revegetation activities will need to be coordinated with levee, training dike and erosion protection construction.

4.3. Habitats: Four broad categories of riparian habitat types are planned for restoration, Riparian, Savannah, Scrub, and Grassland. These categories were developed for the purposes of evaluating the habitat outputs of the projects for this feasibility study. For the actual planting design, these broad habitat categories will be further broken down into subcategories to develop habitat types suited for their specific locations, soil, flooding, and depth to groundwater conditions. These habitat types may correspond roughly to Holland's habitat classification scheme or may correspond to the more specific CNPS 's (California Native Plant Society) vegetation classification system (Sawyer and Keeler-Wolf 1995). The basic approaches are outlined here and will be refined during the PED phase.

TNC and the USFWS have been using Holland's classification system since 1989 to restore 3,500 acres of the Sacramento River National Wildlife Refuge, with documented success for avian, mammal, and invertebrate targets as well as natural processes such as soil development.

The River Partners restoration plan classified the habitat types based on the CNPS 's (California Native Plant Society) vegetation classification system (Sawyer and Keeler-Wolf 1995). This methodology was developed by TNC beginning in 1989 and refined by cooperative work between the USFWS, Point Reyes Bird Observatory, and TNC since 1993, then adopted by the Partner's staff after they stopped working at TNC's Sacramento River Project. The River Partners have used this approach in their Riparian Restoration Plan for the Pine Creek Unit for the California Department of Fish and Game. This classification system classifies vegetation types based on the dominant plant found in each type. Their definition of dominance is not fixed but relates to percent cover or number of plants as applicable. The CNPS system further breaks down the vegetation types into sub-categories that they call "series". These contain associations of plant species. These associations are used by the SRP to add further complexity and diversity to support specific habitat objectives and have been named "tiles".

Refer to Table 2 for a breakdown of how the different methodologies relate to the four broad habitat categories used in the plan formulation process for measuring and assessing habitat outputs. Table 2 also outlines site physical characteristics, design characteristics and habitat benefits from the various vegetation series.

Approximate planting densities for the various habitat types are given in the chart. Where ranges are stated it is our goal to provide the maximum densities. However, as the habitat types to be provided have not yet been mapped based on soil and groundwater surveys, absolute costs of revegetation are currently based on projections of the habitat types to be created based on extrapolation from other areas. For this reason, if a greater percentage of more costly habitat types than are currently estimated are dictated by the soil and ground water conditions to be mapped in the PED phase, some leeway for reducing costs to fit within an authorized project must remain. Therefore, ranges, of planting densities are given.

Table 2. Rationale for vegetation series planting design

Broad Category	*Holland Classification*	*CNPS Series*	*Planting Location/ Physical Characteristics*	*Design Characteristics*	*Habitat Benefits*
Riparian Forest	Riparian Forest	California Sycamore	Soil: loams Water table: typically >15 feet Location near water bodies, or in areas that are likely to be less favorable to cottonwood trees	Creates a grove of sycamores in relatively slow growing tiles, or near the river Density: approx. 225-265 woody plants per acre + 140- 265 herbaceous plants per acre.	Sycamore trees provide nesting cavities and vegetative structure typically in a relatively short period.
	Great Valley Cottonwood Forest	Fremont Cottonwood	Soil: Sandy loams Water table: 8-15 feet	Large variety of woody species, Density: approx. 320-360 woody plants per acre + 180-360 herbaceous plants per acre	Favored by many neotropical migrants (common yellowthroat, yellow billed cuckoo). Because of rapid growth, potentially provides LWD (Large Woody Debris) and SRA (Shaded Riverine Aquatic habitat) in erosive areas or near the river.
	Great Valley Mixed Riparian Forest	Fremont Cottonwood (Box elder)	Soil: loams Water table: 8-15 feet	Creates a grove of low stature trees that fits into a patchy mosaic. Density: approx. 320-360 woody plants per acre + 180-360 herbaceous plants per acre	Shade tolerant box elder will provide additional structure, under the dominant cottonwoods.
	Great Valley Mixed Riparian Forest and Great Valley Willow Scrub	Mixed Willow	Soil: loams Water table: <12 feet	Composed of willow species only; inserted within Fremont cottonwood and Valley oak series, composing approximately 5% of these areas. Density: approx. 225-265 woody plants/acre + 140- 265 herbaceous plants per acre.	Favored by many neotropical migrants (i.e. Wilson's warbler, yellow breasted chat). Provides a dense screen, if a favorable site.
Scrub	Riparian Scrub	Mexican Elderberry (Coyote brush)	Soil: loams Water table: >12 feet	Composed of shrub species only; inserted within Fremont cottonwood and Valley oak series, composing approximately 10% of these areas. Density: approx. 225-265 woody plants/ acre + 140- 265 herbaceous plants per acre.	Dense thicket of shrubs; cover for quail and doves; nesting habitat favored by neotropical migrants (for example blackheaded grosbeaks), elderberry are critical habitat for valley elderberry longhorn beetles and along with coyote brush provide food for beneficial insects.
Savanna	Great Valley Oak Riparian Forest and Riparian Forest	Valley Oak	Soil: Silt and clay loams; stratified textural layers, extremely sandy areas will support savanna rather than woodland or forest. Water gable: >15 ft or with soil layers that will not permit root growth (pure sand or gravel)	Focus on drought-tolerant species. Density: approx. 175-200 woody plants/ acre +100-200 herbaceous plants per acre	Favored by many resident and migratory birds. Acorns will eventually provide a food source for a variety of species. Once established, cover species will compete against perennial pepperweed and star thistle and provide nesting substrate for ground nesters and neotropical migrants if vines can trellis on trees.

Notes: Table adapted from "Riparian Restoration Plan for the Pine Creek Unit" by Sacramento River Partners

Refer to Table 3 for a breakdown of the vegetative associations into "tiles". The Number of tiles or their usage may be simplified for practical application if necessary. Each tile type will be developed into a pre-planned layout showing the plant material layout for an area 10 plant locations wide by 10 plant locations long. Vegetation series will be mapped onto the project areas based on soil, flood frequency, depth to groundwater and flood impacts. All mapped vegetation series will be further divided into tiles, which will be determined by target percentages of various tiles for each series that will be developed during PED phase. Other deciding factors, such as proximity to river, levees, existing elderberry shrubs and professional judgment may also be used in determining specific tile location.

Table 3. Rationale for Vegetation Tiles

Broad Category	*Vegetation Series*	*Association or Tile Description*	*Rationale for inclusion*
Riparian	California Sycamore	SY1	Creates a grove of sycamores for cavity nesters (such as ringtails, owls, or wood ducks) close to the water, or to provide more rapid structure in areas that may be too dry to support cottonwood. Rapid growth may make these good candidates for large woody debris. Typically will be placed next to water bodies or embedded in valley oak series.
	Fremont Cottonwood	FC1	A mixture of newly recruited species (predominantly cottonwood and willow) similar to that found in the are south of Field 4, and additional species (found along the east border) that will provide more varied structure (box elder, Oregon ash, valley oak) or cover (rose, coyote brush, and blackberry).
		FC2	Composition in this association is more even than the above with fewer willows but more cottonwood. Most shaded area, should provide potential LWD in a short period. May attract yellow-billed cuckoos.
		FC3	This association could have been placed into other categories (more willows, 48%, and valley oak, 26%, are planned than cottonwood, 14%), but these areas will be initially domesticated by cottonwood. We believe that the areas planted to this series will eventually transition to valley oak, but the fast growing species will provide good habitat, before the transition is complete.
		FC4	Mixed riparian species with taller stature plants (for LWD or shaded riverine aquatic) and a more open understory, with far fewer willows, than FC4. Box elder will provide mid-canopy structure.
	Fremont Cottonwood (Box elder)	BE1	Intended to create a more patchy effect across the site. May create less shade for native herbaceous plants. Box elder can tolerate a variety of conditions.
	Mixed Willow	MW1	Mixed willow series dominated by arroyo willow, which is prevalent and growing well in several newly recruited areas in the area. Willows typically provide visual screens and increase wildlife cover, reduce flood velocities and capture debris or sediment. These associations will provide continuous habitat in newly recruited areas.
		MW2	As above, but with sandbar willow for areas with sandy soil and high seasonal water table or prone to high velocity flows.
		MW3	As above, but for areas with finer texture soil. Black willow typically grows in relatively dense patches, and this association mimics that effect. This association will typically reach greater heights than the other ones.
	Wild grape	EV1	Composition: Contains a relatively even mix of all species on the site.

Broad Category	*Vegetation Series*	*Association or Tile Description*	*Rationale for inclusion*
Scrub	Mexican Elderberry (Coyote brush)	EB1	Intended for dry areas of site, and will typically be embedded in other series (especially valley oak). High proportion of elderberry will provide habitat for Valley Elderberry Longhorn Beetle. In areas of good soil, will provide a shrubby thicket for bird cover. Elderberry and coyote brush create a light gap for native herbaceous plants. These shrubs typically have a high survivorship in areas of poor soil.
		EB2	As above, but with a high proportion of coyote brush and no willows. Intended for extremely dry areas.
Scrub, continued	Mexican Elderberry (Coyote brush), continued	EB3	As above, includes a wider variety of species. Includes some trees (for trellis support and shade) and climbing vines clematis, Dutchman's pipe vine, and poison oak, which can provide important sources of food and cover for neotropical birds. Pipe vine is important in the lifecycle of the pipe vine swallowtail butterfly. Intended for areas with better soil moisture than the other areas. Typically embedded in Fremont cottonwood series.
Savanna	Valley Oak	VO1	Excludes elderberry for areas near the levee. High percentages of low-statured plants (coyote brush, blackberry, mulefat, rose, willows).
		VO2	Excludes elderberry for areas near the levee.
		VO3	As above, but with a diverse species (including elderberry) to occupy a variety of conditions.
		VO4	As above, but for the most extreme dry areas of the site, contains elderberry.
Grassland		GR1	Creeping Wildrye Grasslands in lower more frequently flooded areas, emphasis on Leymus triticoides includes Leymus triticoides, Elymus trachycaulus, Elymus glaucus, Hordeum brachyantherum , Hordeum b. ssp californicum, Mulenbergia rigens, Grindelia spp. (Creeping wildrye Slender wheatgrass, California barley, meadow barley, Deer grass, Gum plant, forbes)
		GR2	Grasslands in upland, drier areas with sandy soils emphasis on pine bluegrass, needlegrasses, includes Poa secunda, Stipa spp, Leymus triticoides, Elymus glaucus, Hordeum californica, Bromus carinatus, Grindelia spp (Sandhill Bluegrass, Needlegrasses, Creeping wildrye, Blue wildrye, California barley, California Brome, Gum plant, forbes)
		GR3	Grasslands in upland drier areas with silty/clayey soils emphasis on needlegrasses, includes Stipa spp, Leymus triticoides, Elymus glaucus, Hordeum californicum, Grindelia camphorum (Needlegrasses, Creeping wildrye, Blue wildrye, California barley, Gum plant, forbes)
		GR4	Native Erosion control mix for reseeding habitat areas disturbed in construction. Includes California brome, Six weeks fescue, California barley, Blue wildrye, Creeping Wildrye, Needle grass, Pine blue grass, lupine spp, California poppy, Achillea millefolium, Gum plant
		GR5	Annual Non native Erosion control mix for non-habitat areas, such as levee slopes. Includes Blando brome, Zorro fescue, Rose clover, lupine spp, California poppy, Achillea millefolium, Sweet Alyssum, Gum plant) Forbes in native grass mixes may be seeded at end of 3-season establishment period, as selective herbicides will kill most non-grass species. Application will likely be no till overseeding.

Adapted from "Riparian Restoration Plan for the Pine Creek Unit" by Sacramento River Partners

4.4. Habitat Acreage: The projected with–project conditions shown below were determined using a model developed by The Nature Conservancy for projected riparian restoration communities for the RX Ranch reference site. For more information refer to the Ecosystêm Plan Formulation Methodology section of the report Appendix A.3

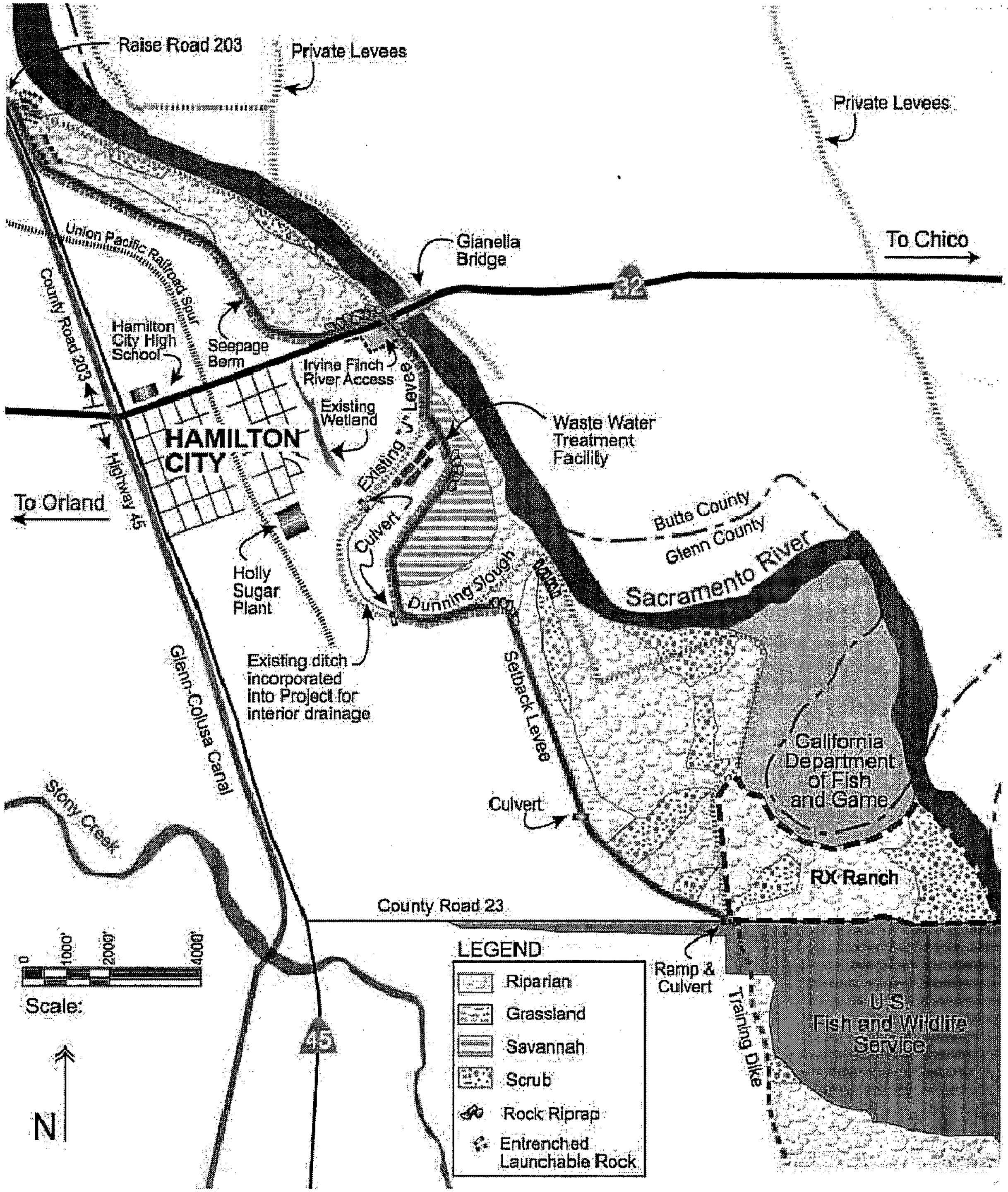


Figure 1 Preliminary Mapping of projected habitat areas

The following percentages of habitat types are projected over the Project area, these are subject to change based on actual soil conditions to be mapped during the PED phase.

Scrub	261.2 acres	18%
Riparian Forest	996.6 acres	73%
Grassland	70.4 acres	5%
Oak Savanna	147.9 acres	4%
TOTAL	1476.1 acres	100%

5. Implementation

5.1. Construction phasing and coordination: Revegetation activities will need to be coordinated with levee and training dike construction as well as erosion protection. There is a potential for the levee construction contractor(s) to be working in the same area at the same time as the revegetation contractor(s). To reduce conflicts between various contractors under different contracts with the government, implementation of revegetation should be phased to limit, as much as possible, ongoing revegetation adjacent to construction activities. It is preferable that removal of the existing J levee occurs after the revegetated areas behind them have been through at least one growing season.

Phasing of revegetation into several years will also provide some insurance that unfavorable weather or flooding does not impact as large an acreage in the vulnerable first year of establishment. In the second and third years, the more established plants can survive extended flooding much better. Phasing of revegetation into several sequential contracts may also be desirable so that lessons learned from early efforts may be applied to subsequent contracts. In any phasing scenario, the size of the revegetation areas must be sufficiently large to prevent undue damage from herbivores, and take advantage of economies of scale. To provide economies of scale, it is suggested that the minimum size for revegetation fields should be no less than 20 acres; the minimum size for contracts should be no less than 200 acres, unless specific conditions requiring smaller contracts or sites arise. In order to give contractors the flexibility to most efficiently utilize the resources available to them, it is anticipated that the scheduling in the contract will allow for flexibility for phasing the project. The contract will likely provide a fixed period of time (e.g., six years) within which the contractor shall install and establish for three years all areas within the contract. This should allow the contractor to phase the installation based on availability of materials, labor and equipment.

5.2. Preservation of Existing Vegetation: Existing native vegetation to be preserved shall be surrounded by protective fencing near flood control feature construction areas requiring vehicular access or access by mechanized construction equipment. Existing sensitive State or Federally listed threatened or endangered species and adjacent existing native plant communities located within the project limits or adjacent to access routes shall be surrounded during construction by protective fencing.

5.3 Erosion control The following erosion control measures are generalized, as site level planning is not being done for the feasibility phase of this project for restoration activities. During PED the corps will be adjusting the erosion control measures to minimize cost based on site specific drainage patterns and topology. Permanent erosion control vegetation in habitat areas will consist of native vegetation. Erosion control on levees and for disturbance from construction activities outside habitat areas will consist of exotic and/or native grasses best suited for the particular areas needing protection. Erosion control mix for engineered, compacted soils such as levee slopes may include Blando brome, Zorro fescue, Rose clover, lupine spp, California poppy, Achillea millefolium, Sweet Alyssum, and Gum plant. Various erosion control and weed suppression crops of winter wheat, beans, peas and oats may be grown in habitat areas for temporary erosion control and weed suppression.

5.3.1. Storm Water Runoff Erosion A storm water prevention plan (SWPPP) will be provided with the plans and specs that specifies minimum acceptable erosion and sedimentation best management practices (BMP's). The SWPPP also outlines the procedures for complying with NPDES (National Pollution Discharge Elimination System) pollution prevention requirements and permitting. The SWPPP shall comply with Corps of Engineers, Sacramento District Work instructions for Storm Water Pollution Prevention Plan (04-01-01) NPDES laws require all construction projects over one acre in size to comply with local NPDES permitting requirements. In California, this means that between Oct 1 and March 31 erosion and sediment control BMP's must be in place.

5.3.1.1 Best Management Practices For the majority of the largely flat site, Erosion controls BMP's will consist of seeding fast growing temporary vegetative cover in all areas. Permanent native vegetative cover will be no-till drill seeded into the temporary cover. Areas disturbed by construction with steeper topography that generate sheet flow will receive appropriate erosion control BMP's, such straw mulch, bonded fiber matrix hydromulch, and erosion control fabric etc. in addition to the vegetative cover. Areas disturbed by construction with topography that concentrates flow or conveys concentrated off site run-on will receive erosion BMP's, such straw mulch, bonded fiber matrix hydromulch, cobble dissipaters and erosion control fabric etc., in addition to the vegetative cover

Sedimentation control BMP's will consist of straw rolls, silt fences and/or sedimentation ponds, which will be implemented where necessary to prevent discharge of sediment-laden runoff into receiving waters. Additionally, vegetative buffer strips 50 feet in width will be used on the downslope edges of sites bordering receiving waters. These strips may be native grass established before soil disturbing activities or may be existing vegetation left in place permanently or temporarily until cover vegetation is established on the rest of the sites.

5.3.1.1 Rainwater Erosion on Proposed Levees Where rock is not present, erosion from rainfall runoff will need to be controlled by establishing erosion control grasses on the levees in areas. While grasses establish in the first season after seeding, erosion control will be provided by straw mulch with tackifier. Sufficient overburden of soil will need to be designed into the levees to allow ripping and cultivation of soil of the compacted levee surfaces to allow grasses to thrive. Native and non-native species may be used, as levees and training dikes are an artificially dry habitat with highly compacted soils. These harsh conditions require use of grasses adapted to drier conditions and poorer soil than the immediately surrounding area.

5.3.2. Wave Wash Erosion: Wave wash erosion on the river side of the proposed levee and training dikes will be a concern in areas where rock is not present. The projected habitat type for the majority of the project restoration areas will be riparian forest, which should provide sufficient attenuation from wave wash after about 5- 10 years of establishment. In the interim, the levees would be protected by erosion control vegetation. Establishing native grass on the levees would require a minimum of 24" of uncompacted soil on the levee to allow the grass to grow, as highly compacted levee surfaces are not conducive to native grass growth. Exotic annual and perennial grasses can be grown on compacted levee material though an overburden of 12" of cultivated soil will be beneficial in promoting a denser more effective stand of vegetation. Temporary straw mulch will be required to protect newly constructed levees from rain runoff until the erosion control vegetation is established.

5.4. Removal of Orchards: Removal of orchards constitutes an activity that disturbs soil requiring it to be coordinated with site prep and grass seeding activities. Existing orchards will be removed using bulldozers or other appropriate heavy equipment. The value of orchard wood for wood chips sent to cogeneration plants may help offset the cost of orchard removal Disposal of wood from cleared orchards into landfills should be discouraged. Depressions from removal of root wads will need to be graded to a level condition. After removal of orchards, site preparation and weed control will proceed.

5.5 Site Preparation/Weed Control: Site preparation and weed control are the two most important components of a successful restoration program. It is crucial that the specific steps and timing of the treatments respond to the actual field conditions and weather patterns. Unpredictable conditions necessitate the ability of the resident engineer to be able to respond to continually changing circumstances throughout each growing season and at each step of the implementation process. This will require the contract for implementation to be carefully structured so that rapid contract modifications are not required for the contractor to be able to respond to field and weather conditions.

The following two sub-sections detail site preparation and weed control steps for the two general categories of restoration communities: grasslands and tree/shrub dominated communities. These recommendations are preliminary and will be adapted in the PED phase to the latest and most effective native grassland restoration methods. Grassland restoration is still in it's infancy along the Sacramento River with recent projects indicating that a lengthy weed control program prior to seeding is a fundamental necessity for establishing native grasses. Recent regulations limiting spraying seasons certain types of herbicide have also impacted typical herbicide treatment programs used in the past.

5.5.1 Grassland Communities

For establishing grassland communities, site preparation methods include a number of steps and would require approximately two years to complete. Final site preparation will be field dependent and adjusted for the weeds and the previous land use on the particular field. The steps below are intended as a no-till drill seeding site preparation methodology. These prescriptions assume heavy weed infestations, fields with lighter weed infestations would require fewer applications of herbicide. Fields planted from clean crop cultivation may require less weed abatement and a different set of site preparation steps.

Weed control activities of sufficient duration and intensity are key to success. Eliminating the initial season of weed control is inadvisable. All herbicide applications must be permitted by the Glenn County Department of Agriculture.

step	item	Season	month
1	Remove orchard or row crops	1	April-August
2	level	1	April-August
3	disk	1	April-August
4	Seed cover crop	1	September/October
5	mow	2	March/April
6	Spray herbicide	2	April/May
7	Spray herbicide	2	December/January
8	No till Drill Native grass Seed	2	January
9	Spray w/ herbicide(s)	2	Feb-March
10	Spray w/ herbicide(s)	2	March- April
11	Mow	3	May
12	Spray w/ herbicide(s)	3	June/July
13	Spray w/ herbicide(s)	3	Feb-March
14	burn	3	May
15	Spray w/ herbicide(s)	4	December
18	No till drill seed forbs	4	December/January

5.5.2 Forest, Savanna, or Scrub Communities

For establishing communities dominated by trees and shrubs (forest, savanna, scrub), methods of site preparation include several steps. Final site preparation will be field dependent, adjusted for the weeds and the previous land use on the particular field. Establishing trees and shrubs in the first year followed by grass establishment in the second year allows for weed control efforts in year one to work towards the necessary weed control efforts needed for native grass establishment.

The following steps may be taken for establishing tree and shrub dominated communities:

step	item	Season	month
a	Grow container plants	0	prior year
1	Remove orchard or row crops	1	April-August
2	level	1	April-August
3	disk	1	April-August
4	install irrigation	1	April-August
5	plant deepot container plants	1	September

6	plant herbacious container plants	1	September
7	Seed cover crop	1	September/October
8	mow	2	February
9	Spray herbicide(s)	2	March
10	Spray herbicide(s)	2	April May
11	Spray herbicide(s)	2	December/January
12	No till Drill Native grass Seed	2	January
13	Spray w/ herbicide(s)	2	Feb-March
14	Mow	2	May
15	Spray w/ herbicide(s)	2	October
16	Spray w/ herbicide(s)	3	March
17	Mow	3	May
18	No till Drill forbs	3	October

5.6 Native Grass Seeding: Native grass mixes will be applied by no till drill seeding. Native grass mixes will be applied with mycorhizal inoculum applied at the same time the seed is drilled. Due to anticipated usage of selective herbicides, forbs, if used, may be overseeded by no till drill seeding at the end of the second or third year of maintenance Success of establishment of Forbs by overseeding is currently under investigation. If trials of forb overseeding are sufficiently successful, forbs may be overseeded in this project. If trials are not indicating success, limited amounts of forb seeding may be done to test potential methods for establishing forbs

5.6 Plant Material: All woody and herbaceous plant material to be propagated in containers or by cuttings shall be collected within 20 miles of the Project area to ensure local ecotypes are used. The seed will be collected the year preceding planting to allow sufficient propagation time for the specified container sizes. Woody and some herbaceous plant materials will be installed from containerized plants grown in containers specialized for revegetation planting ranging in sizes from 7 cu. inches (Super Stubby) in volume to 180 cu inches (Treepot 4) in volume. Willow and cottonwood species may be planted from pole cuttings collected in the project vicinity, or from containerized plantings. Plant containers shall be specialized revegetation containers with narrow proportions for deep rooting. Containerized plants will be grown from locally collected seeds, cuttings or root divisions. Collection of seed or cuttings shall be carried out in accordance with all applicable laws and with required permits. Containerized plantings will be fertilized with 20 grams of slow release fertilizer pellets or tablets. Refer to the following table for species and container types. Seed for Native grass seeding may be commercially grown from Sacramento Valley ecotypes, preferably collected from within 20 miles of the Project area.

Table 04: Preliminary Restoration Plant List

Botanical Name	*Common Name*	*Plant Type*	*Primary Habitat Category*	*Propagule type or container size*
Aristolochia californica	Dutchman's pipevine	Vine	Riparian	Treeband
Clematis ligusticifolia	Clematis	Vine	Riparian	Deepot 40
Vitus californica	California Grape	Vine	Riparian	Deepot 40
Acer Negundo	Box Elder	Tree	Riparian	Deepot 40
Alnus Rhombifolia	White Alder	Tree	Riparian	Deepot 40
Fraxinus latifolia	Oregon Ash	Tree	Riparian	Deepot 40
Platanus racemosa	California Sycamore	Tree	Riparian	Deepot 40
Populus fremontii	Fremont poplar	Tree	Riparian	Deepot 40/ cutting
Quercus lobata	Valley Oak	Tree	Savanna	Deepot 40
Salix goodingii	Black willow	Tree	Riparian	Deepot 40/ cutting
Salix lasiolepis	Arroyo willow	Tree	Riparian	Deepot 40/ cutting
Baccharis pilularis	Coyote Brush	Shrub	Savanna	Deepot 40
Baccharis salicifolia	Mule Fat	Shrub	Riparian	Deepot 40
Calycanthus occidentalis	Spicebush	Shrub	Riparian	Deepot 40
Rosa californica	California Rose	Shrub	Riparian	Deepot 40
Rubus ursinus	California Blackberry	Shrub	Savanna	Deepot 40
Salix exigua	Sandbar Willow	Shrub	Savanna	Deepot 40/ cutting
Sambucus mexicanas	Mexican elderberry	Shrub	Savanna	Deepot 40
Toxicodendron diversiloba diversilobium (optional)	Poison Oak	Shrub/Vine	Savanna	Treeband
Artemesia douglasii	Mugwort	Herbaceous perennial	Riparian	Treeband
Leymus triticoides	Creeping wildrye	Perennial Grass	Riparian	Super Stubby
Solidago canadensis	Goldenrod	Herbaceous perennial	Savanna	Super Stubby
Urtica holoserica	Hoary nettle	Herbaceous perennial	Riparian	Treeband
Muhlenbergia rigens	Deergrass	Herbaceous perennial	Riparian	Super Stubby
Carex barbarae	Santa Barbara Sedge	Perennial sedge	Riparian	Treeband
Plant species percentages per vegetation type classification or "tile" will be developed during PED phase.				

5.7. Plant Installation methods:

5.7.1. Planting Layout: Plants will be planted in regularly spaced rows to facilitate establishment irrigation and weed control. Adjustments to plant spacing, holding density constant, may be done to optimally accommodate weed control equipment such as mowers, herbicide spray booms, and various cultivation implements in the aisles between the rows of plants. Planting rows will undulate or curve slightly to minimize appearance of rows. Refer to the following chart for planting spacing at various densities. Actual spacing may vary dependant on equipment to be used.

density		sq. ft. per plant	Sq. spacing (in ft)	row X aisle spacing (in ft)	
360	ppa	121	11.0	10.1	12
265	ppa	164	12.8	11.0	15
220	ppa	198	14.1	13.2	15
200	ppa	218	14.8	14.5	15
175	ppa	249	15.8	16.6	15
150	ppa	290	17.0	14.5	20

5.7.2. Irrigation: Temporary irrigation for the planting installation and following three-year maintenance period will be provided. The goal of the irrigation is to increase plant survival rates, growth rates and encourage deep plant rooting. This requires frequent watering in the first season, followed by increasingly infrequent and deep watering in the second and third years. Irrigation in most locations will be by drip. Irrigation tubing and pipe will be removed from the site at the end of the establishment period. Flood or overhead irrigation systems are less effective for plant establishment, require larger amounts of water, and result in higher rates of weed growth. Many native species do not do well with flood irrigation, as they are not adapted to this watering regime in the summer months, resulting in repeated leaf senescence throughout the growing season. There fore re-use of existing overhead spray and flood irrigation systems in not feasible.

5.7.3. Irrigation water source: Irrigation water source will likely be provided from 18 existing wells. These wells currently provide irrigation water for nearly the entire area to be restored. The existing wells are currently sized for irrigating orchards and row crops by a combination of methods such as overhead spray, microspray, drip and flood. These methods generally require greater system capacity than drip irrigation. Therefore the existing wells will likely provide sufficient capacity.

5.7.4. Irrigation at each plant location: Each planting location will be provided with a minimum of at least one drip emitter. At each location, the main or large woody plant will be installed adjacent to the drip emitter(s). At selected plant locations secondary, herbaceous plant material may be installed at the outside of the emitters for a total of two plants at those planting locations.

5.7.5. Planting: Planting will be scheduled for fall. Planting may be delayed for one or two seasons after grass seeding if overall reduction of weed controls costs are anticipated. Costs of the different methods will be evaluated in PED phase.

Planting pits will be dug to the size of the planting stock and native soil will be used as backfill. Watering basins will not be required, however the contactor will be responsible for ensuring that required irrigation water is available to the plants' root zone. Weed control mulch mats will not be required. At a minimum, all plants will be provided with a browse guard to reduce above ground rodent damage and to provide protection from weed control herbicide spraying. Browse guards will be at a minimum milk cartons or equivalent protection. Milk carton (and tube type) browse guards also provide some protection from herbicide spray drift when the plant is very young. All plants shall be irrigated within several hours of installation to prevent undue planting stress and to ensure complete settling of back fill in planting hole. Contract specifications should provide a short-term guarantee (30 day) on plant survival to motivate contractor to install plants with adequate care. Pre-emergent herbicide may be applied immediately around plant to minimize need for weeding in the browse guards.

5.6. As-Builts:

As-built plans based on the contract documents shall be drawn to scale and show any deviations from the contract plans by the installation contractor. As built plans shall be created electronically using AutoCAD or Intergraph CADD software. Arcview GIS software may also be used. As builts shall include lists of plants as planted by zones and sub-zones, or tiles, and shall be prepared in a computerized spreadsheet. As-builts shall be used for maintenance records and monitoring work.

6. Establishment/Maintenance

An establishment and maintenance program will be a critical component of a successful revegetation program.

6.1. Regular Maintenance: The maintenance period for establishing the plants will be for 3 growing seasons after installation. Maintenance items will include: weed control, irrigating plants, planting upkeep, and some minor re-planting efforts. Monitoring and reporting of the project will be required for each year along with three yearly reports. Items to be included are:

6.1.1. Irrigation Program: The following schedule will form the basis of watering, to be adjusted to weather conditions during the establishment phase. It is important to note that irrigation schedules need to be adaptive to prevailing weather conditions and that the following are meant as guidelines.

1. First Season: Start irrigation in April (or when soil moisture levels require irrigation), with twice weekly watering of 2 gallons per watering. Beginning in June (the hot season) increase volume to 3 gallons per watering. At beginning of September (the end of the hot season), reduce watering frequency to reflect lower water needs (e.g., 1 day per week with volume of 6 gallons per irrigation). End irrigation after October 31

2. Second Season: Start irrigation in mid April (when soil moisture levels require irrigation), with weekly watering of 10 gallons per watering. Beginning in June increase

volume to 15 gallons per watering. At beginning of September, reduce watering frequency to every other week with volume of 30 gallons per irrigation. End irrigation after October 31.

3. Third Season: Start irrigation in mid April, with watering every other week of 30 gallons per watering. Beginning in June decrease frequency of watering to once every three weeks with a volume of 50 gallons per watering. At beginning of September, reduce watering frequency to once a month with volume of 100 gallons per irrigation. End irrigation after October 31.

Unusually hot, dry and windy weather may require additional irrigation. Maximum plant growth is achieved by limiting water stress on plants; however, deep infrequent watering should be the rule to supply adequate soil moisture in the desired deep root zone. Plant roots do not "seek" water; rather they grow and persist in areas that have adequate moisture, soil and oxygen. Therefore frequent shallow irrigation must be avoided. Also, plants respond to water stress with physiological changes that reduce water consumption, thus the plants should be slowly weaned from ample watering in the first season so that by the end of the maintenance period, the plants have hardened to conditions without irrigation. Extremely droughty conditions at the end of the maintenance period may require an additional season or two of irrigation.

6.1.2. Weed Control: During the establishment phase, a regular weed control program shall be implemented including the appropriate use of herbicides, mechanical, and hand weed control methods. The area immediately around each planting location will be kept free from weeds by herbicide application and by hand weeding.

Weeds in the aisles between the rows (the middles)and in the rows with the plant locations (the strips) will be controlled by mowing and by timed nonselective, pre-emergent and/or selective broadleaf herbicide applications in the first and second growing seasons. Timing is dependant on the growing conditions based on weather. Refer to section 5.5 for timing and and type of weed control measures needed for the various habitat types to be restored. The approximately 3-5 foot wide strips will be sprayed several times per year with non selective and/or pre-emergent herbicides. The approximately 8-12 foot wide middles will be sprayed several times per year with selective and/or pre-emergent herbicides

Alternate methods of weed control in conjunction with delayed planting will be evaluated during the PED phase for potential cost savings and improvement in habitat establishment.

Certain types of herbicides may be restricted in use due to proximity of sensitive crops such as cotton, grapes and pistachios. Also, endangered species restrictions for Valley Elderberry longhorn beetle could limit herbicide use in certain areas. The following measures as appropriate will be used in areas where herbicide application limitations apply:

1. Use herbicides registered for use near sensitive crops. Application procedures and equipment are also subject to regulations, which must be followed.
2. Use mowing to control weeds. Additional mowing may be needed, up to once a

month April through July.
3. Use Disking to control weeds. May be needed on regular basis April through July.
4. Delay seeding native grass seeds until the 3rd year of establishment, thereby allowing use of glyphosphate (Roundup) herbicide for weed control.
5. Utilize pre-emergent herbicides.

Pre- and post-seeding weed control is crucial. The timing of mowing and spraying are critical and usually occur in a very short time frame.

6.1.3. Replanting / Replacement: Mortality rates should be measured by planting area and by species. Replacement of plants will be required if mortality rates for any of the above are higher than 15 percent the first season, 25 percent the second season and 35 percent the third season. Replacement planting to original planting quantities will be required if the above mortality rates are exceeded. Species for replanting may be adjusted if mortality rates for individual species indicate they are not suited for certain areas. Past results indicate that an overall survival rate of 80% should be easily met for the entire Project area.

6.1.4. Monthly Maintenance Reports: Monthly records of maintenance activities and project conditions shall be kept. The monthly reports should include general weather and climate conditions, major events such as storms, fire, vandalism, herbivore browse, irrigation scheduling and quantity, weed growth and weed control activities and general description of plant performance. Monthly reports shall be submitted to the Corps on an ongoing monthly basis

6.1.4. Yearly Maintenance Reports: Compilation of monthly records of maintenance activities and project conditions will be required to be submitted to the Corps each December 1 in an annual, year-end report.

6.2. Monitoring: A simplified monitoring program shall be developed and implemented during the 3-year establishment period. All hand planted species in the irrigation rows should be monitored, as well as the grasslands to determine restoration establishment success. The monitoring program shall be developed and carried out by experienced biologists, and at a minimum consist of the following:

- Mortality rates
- Photographs (Permanent color photograph stations)
- Plant counts (by species and area)
- Yearly reports

7. Success Criteria

The following success criteria will be targeted for the end of the maintenance period:

- Minimum 65% survival of container plants per “tile” and per species.
- Minimum 85% survival of container plants overall.
- Control of exotic weed species. (Long-term establishment and regeneration of native plants not threatened by exotic weeds)

- Successful introduction of native grasses and herbaceous vegetation. This should be defined as patches of native grass and herbaceous perennials established over a minimum 15% of the site.

Success will be measured by annual plant survival counts during the 3 year plant establishment period.

8. Post Establishment Operations and Maintenance.

At the end of the three year establishment period, the Project will be turned over to the State for operations and maintenance for the life of the project. Infrastructure related to the restoration such as gates, locks, fences and maintenance access roads will be maintained in operational condition. Removal of trash and other unnatural debris will be encouraged.

In terms of vegetation management, post establishment operations and maintenance for the restoration aspects of the Project generally consist of benign neglect. Successful restoration is defined as sustained self-sufficiency of the native vegetation, therefore mowing, clearing, weeding and herbicide application will not be allowed unless called for as an adaptive management action to improve project performance or for Public Health and safety. Areas adjacent to farm fields may be maintained free of elderberries by removing elderberry plants periodically from restorarion areas within 100 ft of the flood control levee

Yearly reports will be submitted to the USACE Sacramento District Engineer, Environmental Resources Branch and Landscape Architecture Unit. These reports will contain the checklist from the annual spring inspection. The reports will also contain photographs from set photographic monitoring points. Additional monitoring, though useful and is encouraged, will be at the discretion of the State, local sponsor and stakeholders.

Grazing within strict limitations may be permitted to mimic natural herbivore browse. Generally 5-10 years after establishment, the site can be grazed intensely for short periods of time up to 3 times per decade. Grazing can be managed to help control exotic weeds by carefully timing grazing.

The following uses may be permitted
hiking
bird watching
hunting
fishing
camping within limited designated camp grounds should also be allowed.
Access to the river for a boating (designated boat ramp)

The following uses shall not be permitted:
mountain biking
off road vehicle use

9. Revegetation Quantities

The following tables outline quantities expected for the projected habitat types.

Table 5
Plant quantities

habitat type	woody ppa	herbaceous ppa	acres	total woody plants	total herbaceous plants
riparian	264	264	796.6	210,302	210,302
cottonwood	360	360	200	72,000	72,000
scrub	264	264	261.2	68,957	68,957
savannah	200	200	147.9	29,580	29,580
grassland	0	0	70.4	-	-
			1476.1	380,839	380,839
			30% cuttings	114,252	
			80% containers	266,587	
				50% treeband	190,420
				50% super cell	190,420

Table 6
Drip tubing quantities

item	Average Row Spacing	Length in feet of one side of square acre	no of rows at 15' oc square acre	total length of rows in square acre	total number of acres	total length of drip tubing required, in feet
drip tubing	15	209	14	2,904	1,400	4,065,198

End of Revegetation Report

****

APPENDIX D: Real Estate Plan

Hamilton City Flood Damage Reduction
And
Ecosystem Restoration, California

Feasibility Study

REAL ESTATE PLAN

1. General Project Description.

The project is located in Glenn County in the immediate vicinity of Hamilton City, California. The town of Hamilton City is in the northern part of California's central valley, approximately 85 miles northwest of Sacramento. Hamilton City is an unincorporated community of approximately 1,800 residents, and is essentially a small rural farming community surrounded by a largely agricultural region. The Hamilton City Flood Damage Reduction and Ecosystem Restoration California, Feasibility Study is part of the Sacramento and San Joaquin River Basins Comprehensive Study initiated in 1998. The Comprehensive Study was authorized in the 1998 Energy and Water Development Act, Public Law (PL) 105-62. The House Report 105-190, which accompanied the 1998 Act, called for "development and formulation of comprehensive plans for flood control and environmental restoration purposes" in the Sacramento and San Joaquin River Basing in California.

2. Real Estate Requirements.

The property rights necessary to support the construction, operation and maintenance of the project are considered to be standard estates as defined in ER 405-1-12, Chapters 5 and 12. The proposed alignment of the project consists of a lengthy levee that will be set back from the west bank of the Sacramento River. The new levee will begin near Road 7 and run south to a mile south of Road 23. The environmental features of the project will have large land requirements that impact all or portions of 21 parcels. Most of the parcels required for the project are owned by the Nature Conservancy who fully supports the project. The levees will require a flood protection levee easement, affecting 19 parcels and covering an area of 144.64 acres. The levee will encumber approximately 4 acres along the edge of land which are a part of a wildlife refuge managed by the US Fish and Wildlife Service. The refuge operations staff has been involved in the project development and are supportive of the project. For the areas where restoration is to occur, fee title will be required, affecting 15 parcels and covering an area of 1,469.92 acres. There is also a requirement for a one year temporary work area easement, affecting 17 parcels and covering an area of 27.96 acres. An existing levee, constructed by landowners in about 1904 and known as the "J" levee, provides some flood protection to the town and surrounding area. The property requirements are shown on the attached tract map.

3. Baseline Cost Estimate.

The baseline cost estimate was developed by a gross appraisal , prepared the Sacramento District Appraisal Branch in January 2004. The cost by feature is presented below:

(1) Fee Title Lands, 15 Parcels, 1,469.92 acres	= $ 8,292,768
(2) Flood Protection Levee Easements, 19 Parcels, 144.64 acres	= $ 799,496
(3) Temporary Work Area Easement 17 Parcels, 27.96 acres	= $ 73,575
Sub-Total	= $ 9,146,339
Contingencies: 25%	= $ 2,286,046
Severance: 10%	= $ 914,087
Total LERRD's	= $12,347,075

The administrative costs for the project were developed by the non-Federal Sponsor and the Corps in the Micro Computer Aided Cost Estimating System (MCACES). The table below represents the current estimated administrative costs used for the plan formulation:

Number of Owners	Non-Federal Administration Cost	Land Values	Total LERRD Cost
14	$999,790	$12,347,000	$13,346,790

4. PL 91-646 Relocation Assistance Benefits.

There are no residences or business affected by the project that would require relocation assistance.

5. Mineral Interests.

N/A

6. Facility/Utility Relocations.

County Road 203 will require raising 1.5 feet to tie into the new levee, and ramping the road over the levee. The affected road has been determined to be compensible and the relocation will be the responsibility of the non-Federal Sponsor. 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 a part of its LERRD responsibilities is preliminary only. The Government will make a final determination of the relocations necessary for the construction, operation and maintenance of the project after further analysis and completion and approval of Final Attorney's Opinion of Compensability for each of the impacted utilities and facilities.

7. HTRW.

No contamination has been identified.

8. Land Owners.

The landowners are supportive of the project.

9. Non-Federal Sponsor.

The non-Federal Sponsor will be the Reclamation Board, Department of Water Resources, State of California. The Reclamation Board has been the non-Federal Sponsor of many Federal projects and has sufficient staff and ability to fulfill the obligations of the non-Federal Sponsor.

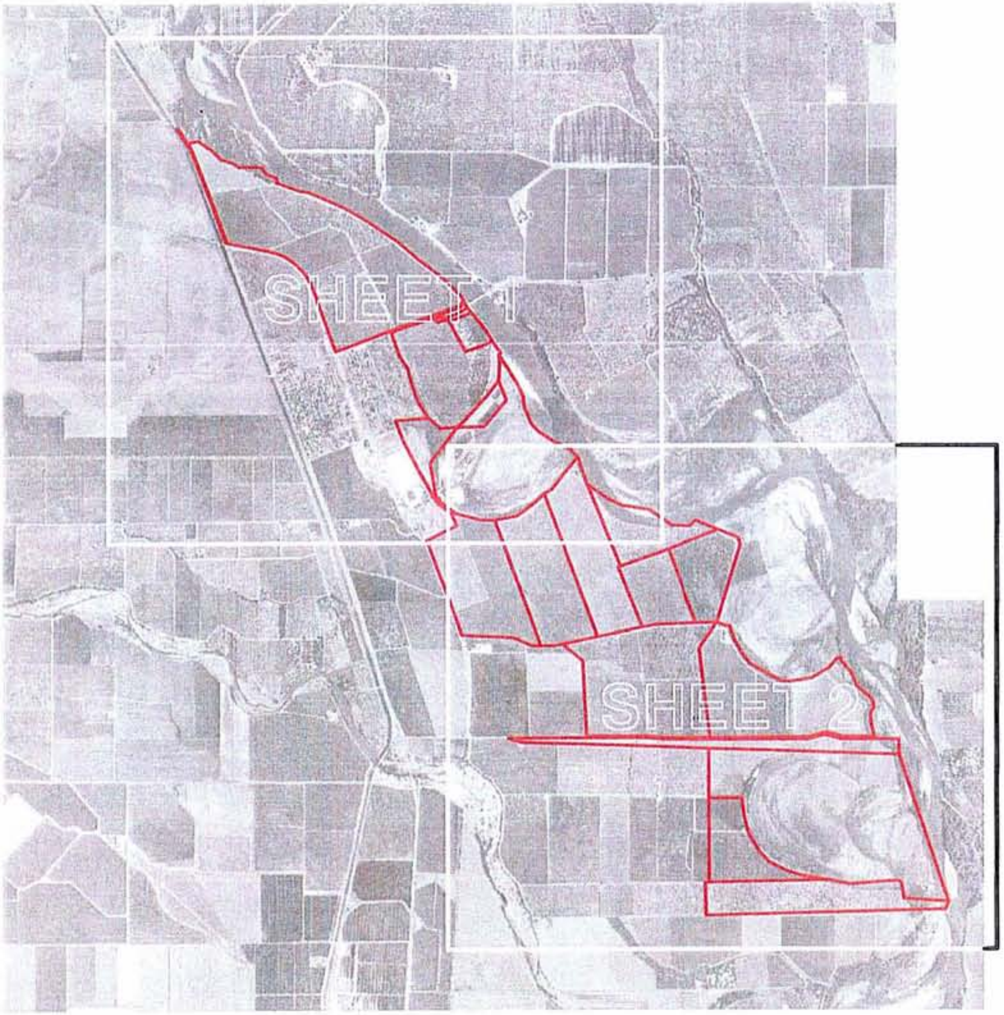
10. Real Estate Acquisition Schedule.

Next Page.

REAL ESTATE ACQUISITION SCHEDULE

	COE* START	COE* FINISH	NFS* START	NFS* FINISH
RECEIPT OF FINAL DRAWINGS FROM ENGINEERING/PM	March 2006	April 2006	N/A	N/A
EXECUTION OF PCA	Oct 2004	April 2006	Dec 2004	April 2006
FORMAL TRANSMITTAL OF FINAL ROW DRAWINGS & INSTRUCTIONS TO ACQUIRE LERRD	April 2006	April 2006	N/A	N/A
CONDUCT LANDOWNERS MEETINGS	N/A	N/A	April 2006	April 2006
PREPARE/REVIEW MAPPING AND LEGAL DESCRIPTIONS	N/A	N/A	April 2006	May 2006
OBTAIN/REVIEW TITLE EVIDENCE	N/A	N/A	April 2006	May 2006
OBTAIN/REVIEW TRACT APPRAISALS	N/A	N/A	May 2006	June 2006
CONDUCT NEGOTIATIONS	N/A	N/A	June 2006	Sept 2006
PERFORM CLOSINGS	N/A	N/A	June 2006	Sept 2006
PREPARE/REVIEW CONDEMNATIONS	N/A	N/A	July 2006	Sept 2006
OBTAIN POSSESSION	N/A	N/A	July 2006	Sept 2006
COMPLETE/REVIEW PL 91-646 BENIFIT ASSISTANCE	N/A	N/A	July 2006	Sept 2006
CONDUCT/REVIEW FACILITY AND UTILITY RELOCATIONS	N/A	N/A	April 2006	Sept 2006
CERTIFY ALL NECESSARY LERRD IS AVAILABLE FOR CONSTRUCTION	Sept 2006	Sept 2006	Sept 2006	Sept 2006
PREPARE AND SUBMIT CREDIT REQUESTS	N/A	N/A	Sept 2006	Sept 2007
REVIEW/APPROVE OR DENY CREDIT REQUESTS	Sept 2006	Sept 2007	N/A	N/A
ESTABLISH VALUE FOR CREDITABLE LERRD IN F&A COST ACCOUNTING SYSTEM	Sept 2006	Sept 2007	N/A	N/A

*COE - Corps of Engineers
NFS - Non-Federal Sponsor



CALIFORNIA
VICINITY MAP

DATUM: NORTH AMERICAN 1983
PROJECTION: STATE PLANE
ZONE: CALIFORNIA 2

NOTE: The data is only a representation of features on the earth compiled by computer program from raw data obtained from different sources and is not necessarily, in whole or in part, based upon any physical recording, study or survey, professional or otherwise, of the covered property. This information is not intended as a substitute for a field survey by a licensed professional or any other use or application that requires legal or engineering accuracy.

LEGEND

〰 PROPERTY LINE

PLOT
NOT TO SCALE

HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION

T.21 & 22N., R.1W., M.D.B.&M.
GLENN COUNTY, CA

US Army Corps
of Engineers
Sacramento District

Symbol	Description	Date	Approved

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

PREPARED BY:
REAL ESTATE DIVISION
CADASTRAL SECTION
1325 'J' STREET
SACRAMENTO, CA 95814-2922

Mapping Lead: C. HIDALGO		Date Approved:	Rev.
Drawn by: J. HENRIKSEN	Spec No.:	Assisted by: T. TUFTS	
Reviewed by: C. HIDALGO		Drawing Code:	
Project Manager: CRAIG GAPEN		File name: Hamilton City Master Plot date: 01/30/04 Plot scale: Not to Scale	

GLENN COUNTY CALIFORNIA
FLOOD DAMAGE REDUCTION AND
ECOSYSTEM RESTORATION PROJECT

HAMILTON CITY
REAL ESTATE MAPS

Sheet
reference
number:
Index

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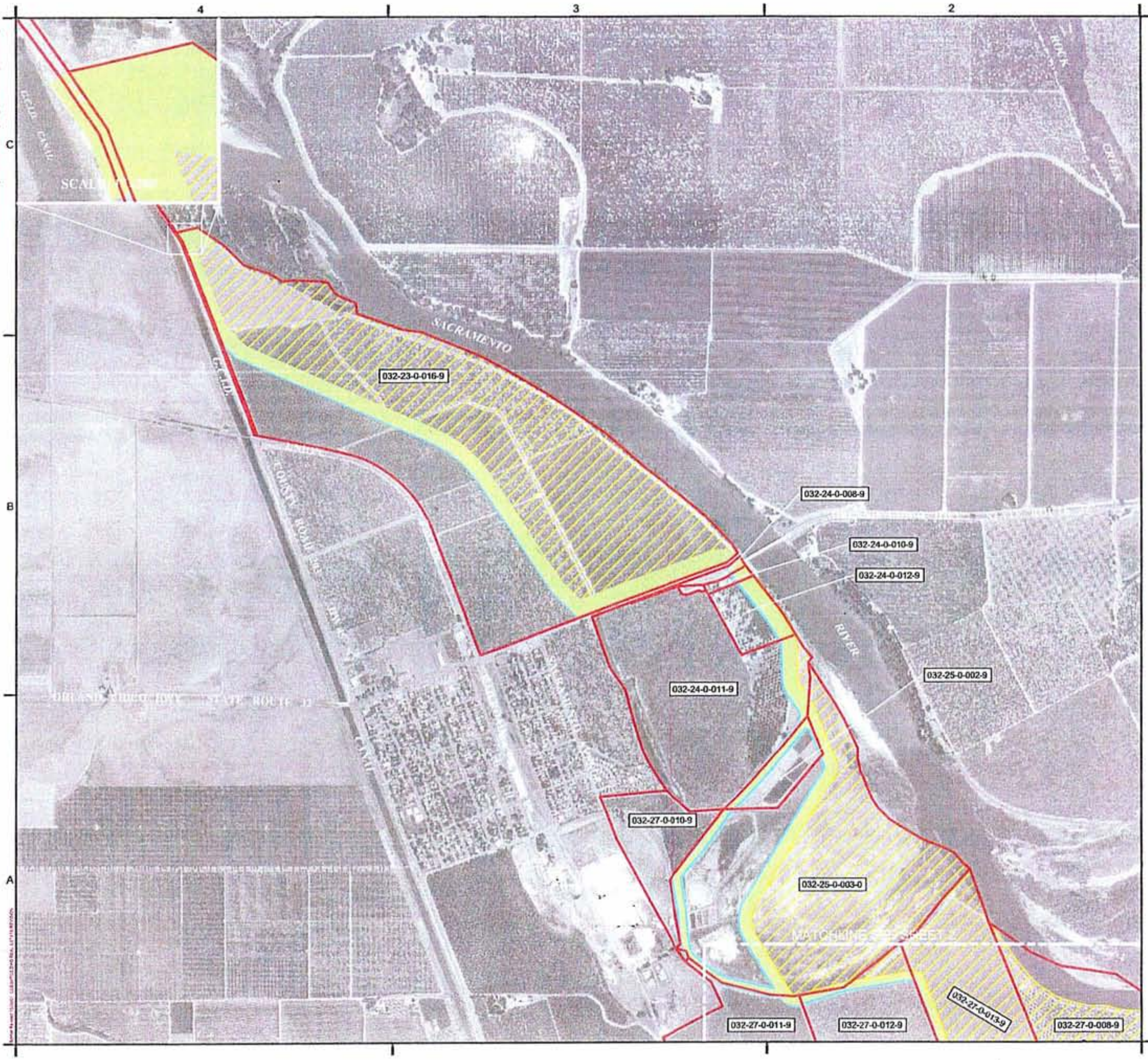

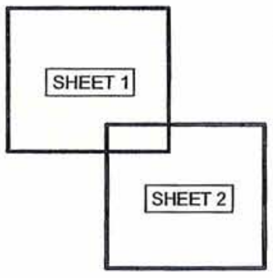

KEY PLAN

NO SCALE

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PROJECTION: STATE PLANE
ZONE: CALIFORNIA 2

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LEGEND

🟥	PROPERTY LINE
123-45-6-789-0	ASSESSORS PARCEL NUMBER
🟨	FLOOD PROTECTION LEVEE EASEMENT (FPLE)
▨	FEE TITLE
🟦	TEMPORARY WORK AREA EASEMENT (TWAE)

PLOT
NOT TO SCALE

HAMILTON CITY
FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION

T.21 & 22N., R.1W., M.D.B.& M.
GLENN COUNTY, CA

US Army Corps
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Reviewed by: C. HIDALGO
Assisted by: T. TUFTS

GLENN COUNTY CALIFORNIA
FLOOD DAMAGE REDUCTION AND
ECOSYSTEM RESTORATION PROJECT

HAMILTON CITY
REAL ESTATE MAPS

Sheet reference number:
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SHEET 1 OF 2

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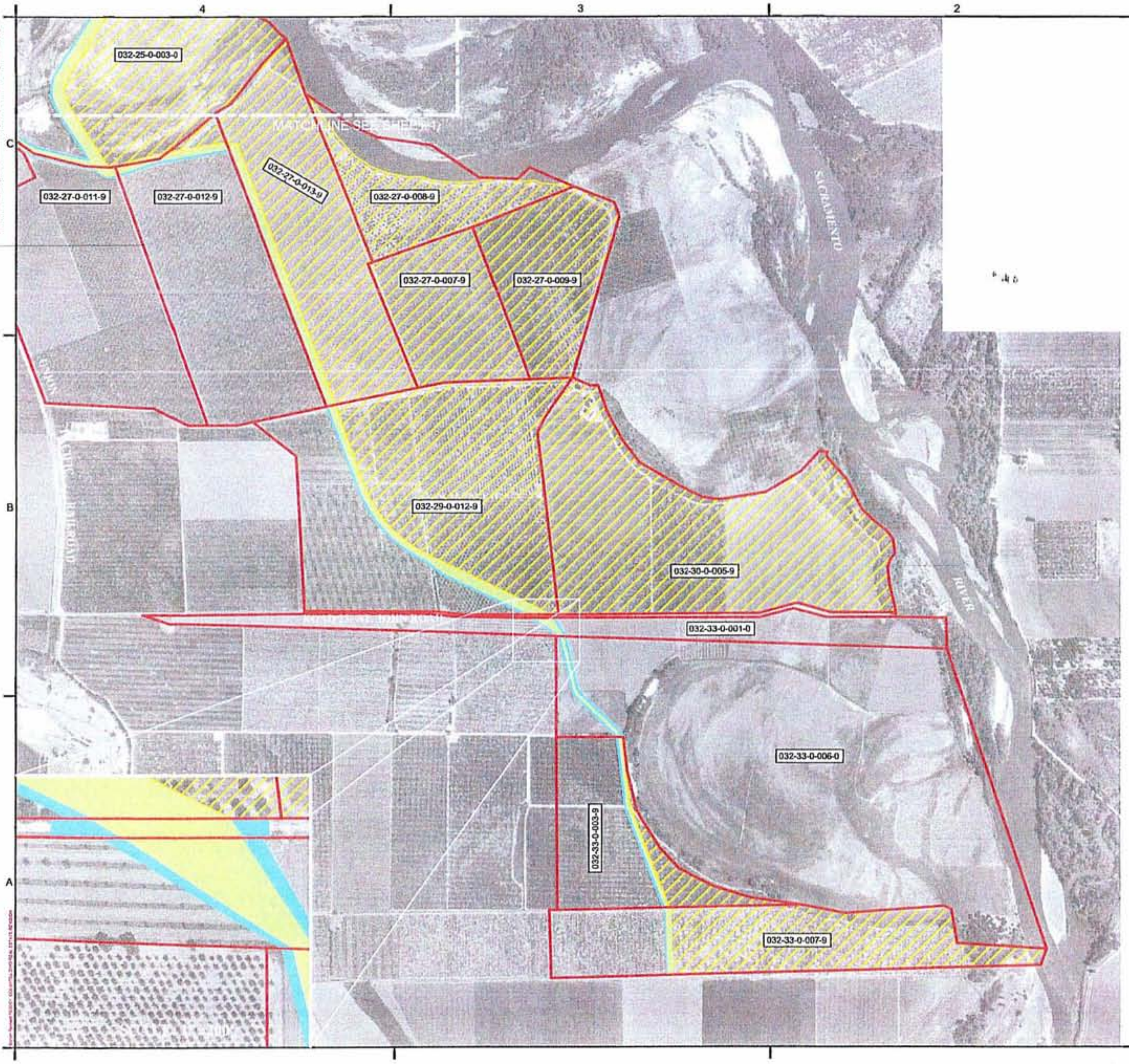

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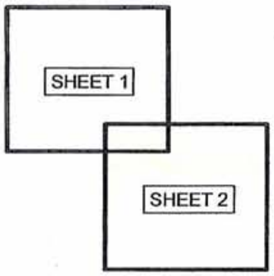

KEY PLAN

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PROJECTION: STATE PLANE
ZONE: CALIFORNIA 2

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HAMILTON CITY
FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION

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Spec No.:
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Reviewed by: C. HIDALGO
Drawing Code:
Project Manager: DAVE SHAKE
File name: Hamilton City Master
Plot date: 01/30/04
Plot scale: Not to Scale

GLENN COUNTY CALIFORNIA
FLOOD DAMAGE REDUCTION AND
ECOSYSTEM RESTORATION PROJECT

HAMILTON CITY
REAL ESTATE MAPS

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number:
2
SHEET 2 OF 2

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APPENDIX E: Economics

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APPENDIX E - ECONOMICS

HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION PROJECT

This economics appendix summarizes a revised flood damage analysis performed for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project. The first evaluation was conducted in October 2001 as part of Sacramento & San Joaquin River Basins Comprehensive Study. This appendix focuses upon the evaluation of without- and with-project flood damage and the benefits of alternative plans to reduce flood damage. Ecosystem restoration benefits, project costs and plan formulation are found in Chapter 3 (Alternative Plans) in the main report and Appendix A (Plan Formulation).

The economic evaluation was performed in accordance with ER 1105-2-100 (Planning Guidance Notebook) and ER 1105-2-101 (Risk-Based Analysis for Evaluation in Flood Damage Reduction Studies). The analysis was based on a 50-year period of analysis, October 2003 price levels and a Federal discount rate of 5 5/8%. The earliest the project could become operational is estimated to be the fall of 2008.

E.1 BACKGROUND

The U.S. Army Corps of Engineers and The Reclamation Board of the State of California are conducting a feasibility study to develop and evaluate potential alternative plans to reduce flood damages and restore the ecosystem along the Sacramento River near Hamilton City. The goal of the study is to identify a cost effective, technically feasible, and locally acceptable project that best meets the dual objectives of reducing flood damages and restoring the ecosystem and is in compliance with all Federal, State, and local laws and regulations. The study will culminate in completion of an integrated feasibility report and environmental impact statement / environmental impact report (EIS/EIR) documenting the study findings. The intent is to submit the report to Congress for authorization to implement the project. The costs to conduct the study and implement a project are shared between Federal, State, and local interests. State and/or local interests are responsible for operation and maintenance of the project, if implemented.

E.1.1 Study Area Description

Hamilton City is located in Glenn County, California, along the right (west) bank of the Sacramento River, about 85 miles north of the City of Sacramento. The study area includes Hamilton City and the surrounding rural area. The study area is bounded by the Sacramento River to the east and the Glenn Colusa Canal to the west and extends about two miles north and six miles south of Hamilton City. In 2000, Hamilton City had a population of about 1,900, up from about 1,810 in 1990 and about 1,340 in 1980 (CA Dept of Finance). Estimated 1999 Hamilton City per capita income is about $9,050 (US Census), much less than the 1999 Glenn County per capita income of about $18,015 or the California average of about $29,910 (CA Dept of Finance). Surrounding land use is agricultural with fruit and nut orchards being the primary crops.

An existing private levee, constructed by landowners in about 1904 and known as the "J" Levee, provides some flood protection to the town and surrounding area. The "J" Levee is not constructed to any formal engineering standards and is largely made of silty sand. It is extremely susceptible to erosion and floodfighting is often necessary to prevent flooding when river levels rise. Since the construction of Shasta Dam in 1945, flooding in Hamilton City due to problems with the "J" Levee has occurred once (1974) causing about $50,000 in damage and about $22,000 in levee repair costs (current year dollars).[1] In addition, extensive floodfighting has been necessary to avoid flooding in 1983, 1986, 1995, 1997, and 1998. Currently, the Sacramento River is actively eroding into the toe of the levee at the northern end of the study area. Glenn County has built a backup levee, about 1,000 feet in length, to protect the community in the event the toe erosion causes failure at the northern end of the "J" Levee.

Native habitat and natural river function in the study area have been altered by construction of the "J" Levee and conversion of the floodplain to agriculture and rural development. The "J" Levee and bank protection (typically with rock) constrain the river's ability to meander and overflow its banks to promote propagation and succession of native vegetation. Conversion of the floodplain to agriculture and rural development reduced the extent of native habitat to remnant patches along the river and in historic oxbows. These alterations to the ecosystem have greatly diminished the abundance, richness, and complexity of riparian, wetland, and floodplain habitat in the study area and the species dependent upon that habitat.

Regional location and study area maps are provided in Figures 1 and 2.

---

[1] *This damage was caused by inadequate levee maintenance that allowed floodwater to back up into orchards and the southeastern part of town rather than a failure of the levee itself. Although past reports do not indicate the estimated frequency of this event, they do indicate that the flow was 181,000 cfs, which equates to about a 7% event based upon the 2003 hydrologic analysis.*

Figure 1
Regional Location Map

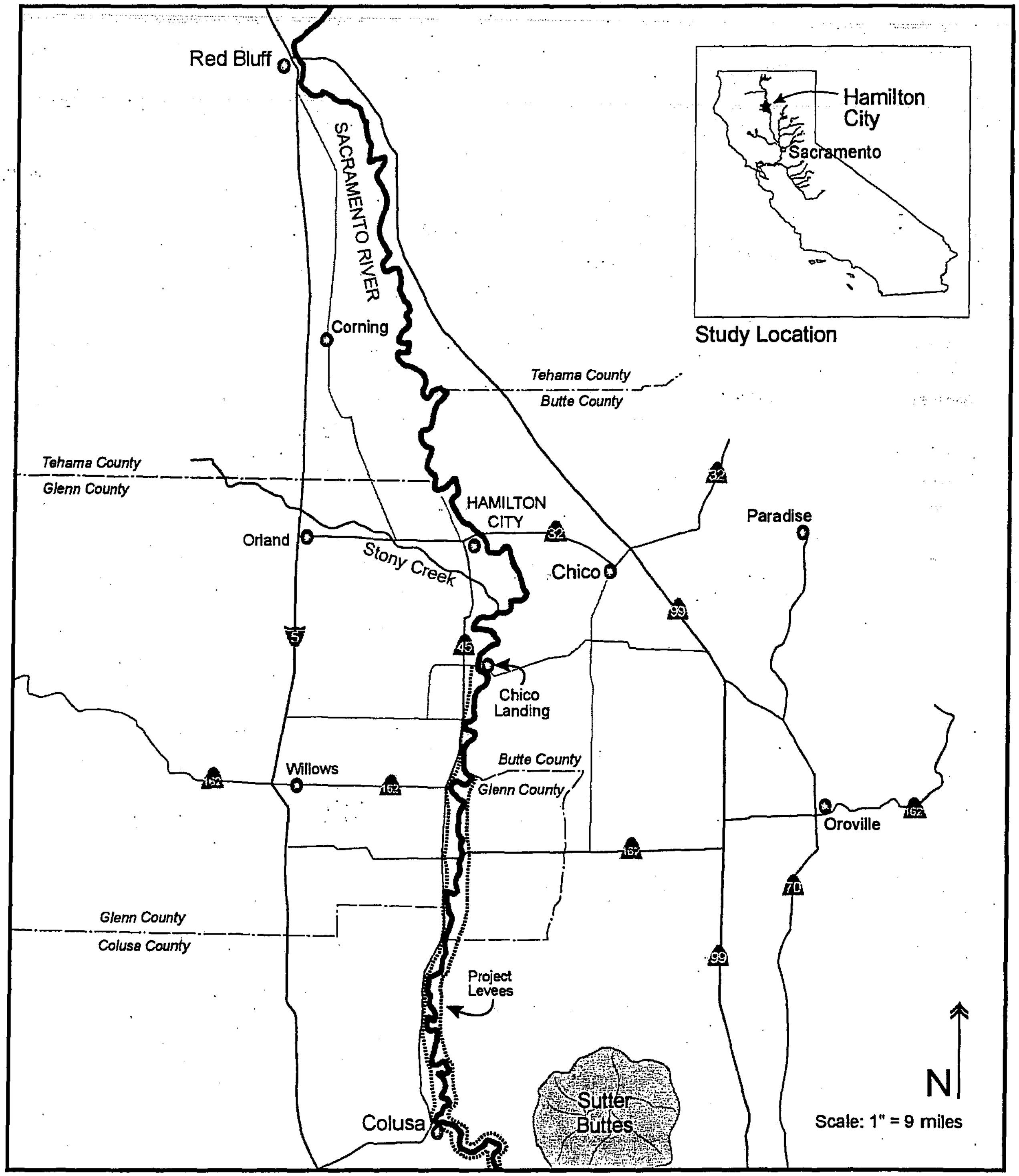
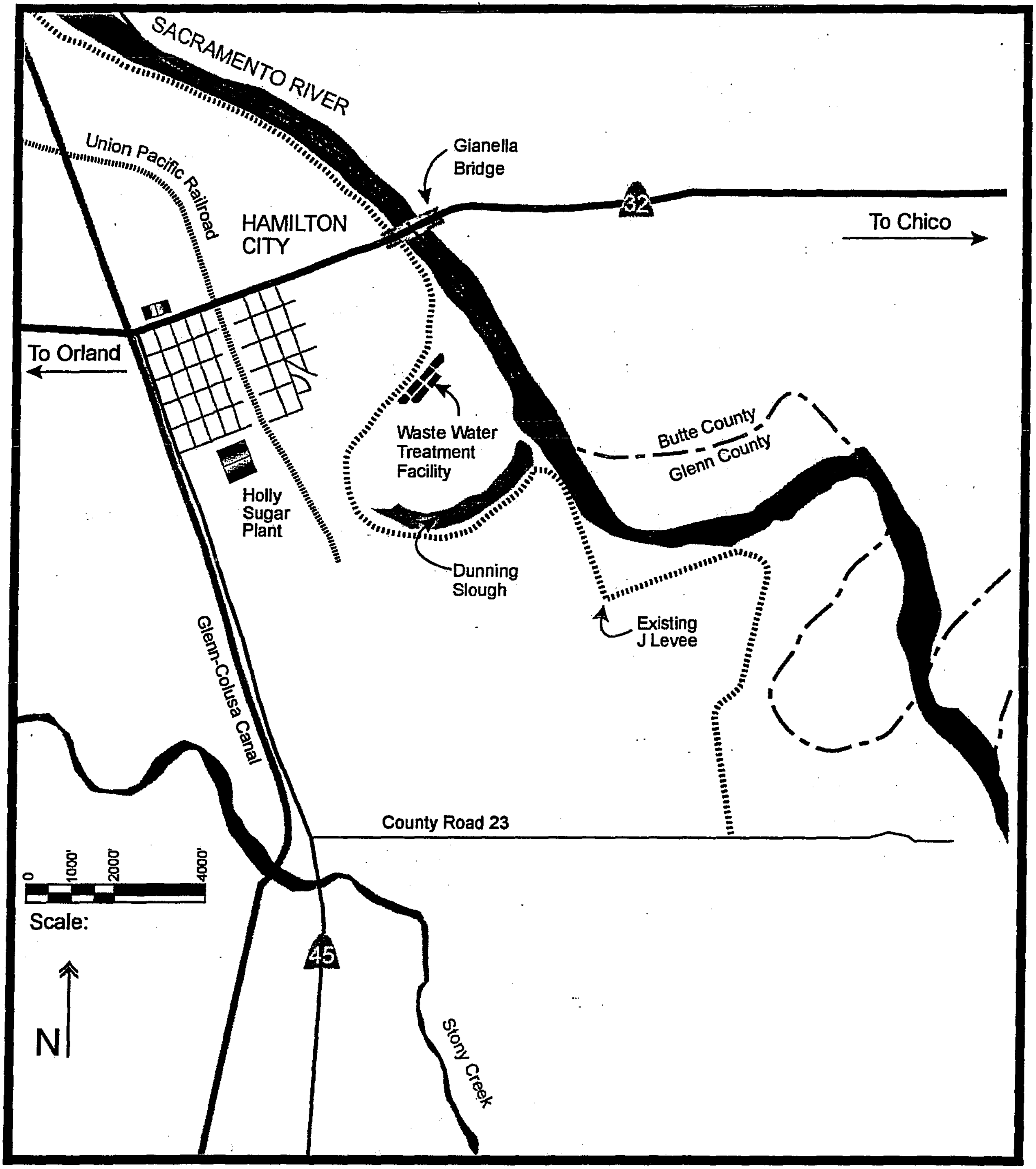


Figure 2
Study Area Map



E.1.2 Changes from the 2001 Economic Analysis

This revised 2003 economic analysis incorporates numerous significant changes to the original analysis that was conducted in 2001. These changes include:

- **Hydrology and Hydraulics (H&H)** —the H&H models were revised to be site-specific for the Study Area. Changes included: (1) an evaluation of local storm centerings, (2) a wider range of storm events and (3) different levee failure assumptions on the left (east) and right (west) banks of the Sacramento River. The original index point of 198.61 was moved downstream to 198.25 to avoid problems with water surface elevations (WSE) being unduly influenced by the nearby Gianella Bridge. Two additional index points were assigned downstream to more accurately define the site-specific hydraulic and geotechnical relationships.
- **Impact areas** — study areas are typically subdivided into impact areas (also known as damage reaches) to facilitate the flood damage analysis by taking into account differing flooding problems and land uses. In the 2001 economic analysis, only one impact area was used (Hamilton City) which incorporated the town itself and agricultural lands immediately north and south of town. However, for this revised analysis, three impact areas were identified to better account for differing flood problems - Northern (index point at river mile 198.25), Southern #1 (index point at river mile 197.25) and Southern #2 (index point at river mile 194.25), as shown in Figure 3. The economic impact areas were delineated based upon the 500-year, or 0.2% event (2003) hydrology. Although the town itself and agricultural areas immediately north and south of town are protected by the existing "J" Levee, further south, there is no levee and agricultural lands are directly threatened by higher-velocity overland flows from the river. Further complicating the flooding issue is the presence of backwater flooding, which can flow around the southern end of existing (and proposed) levees and flood agricultural lands to the north. The division into three impact areas also improves the analysis of crop flood damage compared to the original economic analysis.
- **Analysis zones** - The impact areas were further divided into analysis zones (A through L) to facilitate the flood damage analysis for different levee setback alternatives (Figure 3). The Northern impact area contains analysis zones F through L; Southern #1 contains D and E; and Southern #2 includes A, B and C. Conditions in a zone could remain unchanged (i.e., same as the future without-project condition), the zone could be protected by a new levee, the zone could be converted from agriculture to native habitat (eliminating most flood damage), or a flowage easement could be purchased within the zone to compensate for induced flooding (caused by breaching the existing "J" Levee).

Changes in technical models and assumptions are summarized in Table 1.

Figure 3
Economic Analysis Impact Areas and Analysis Zones

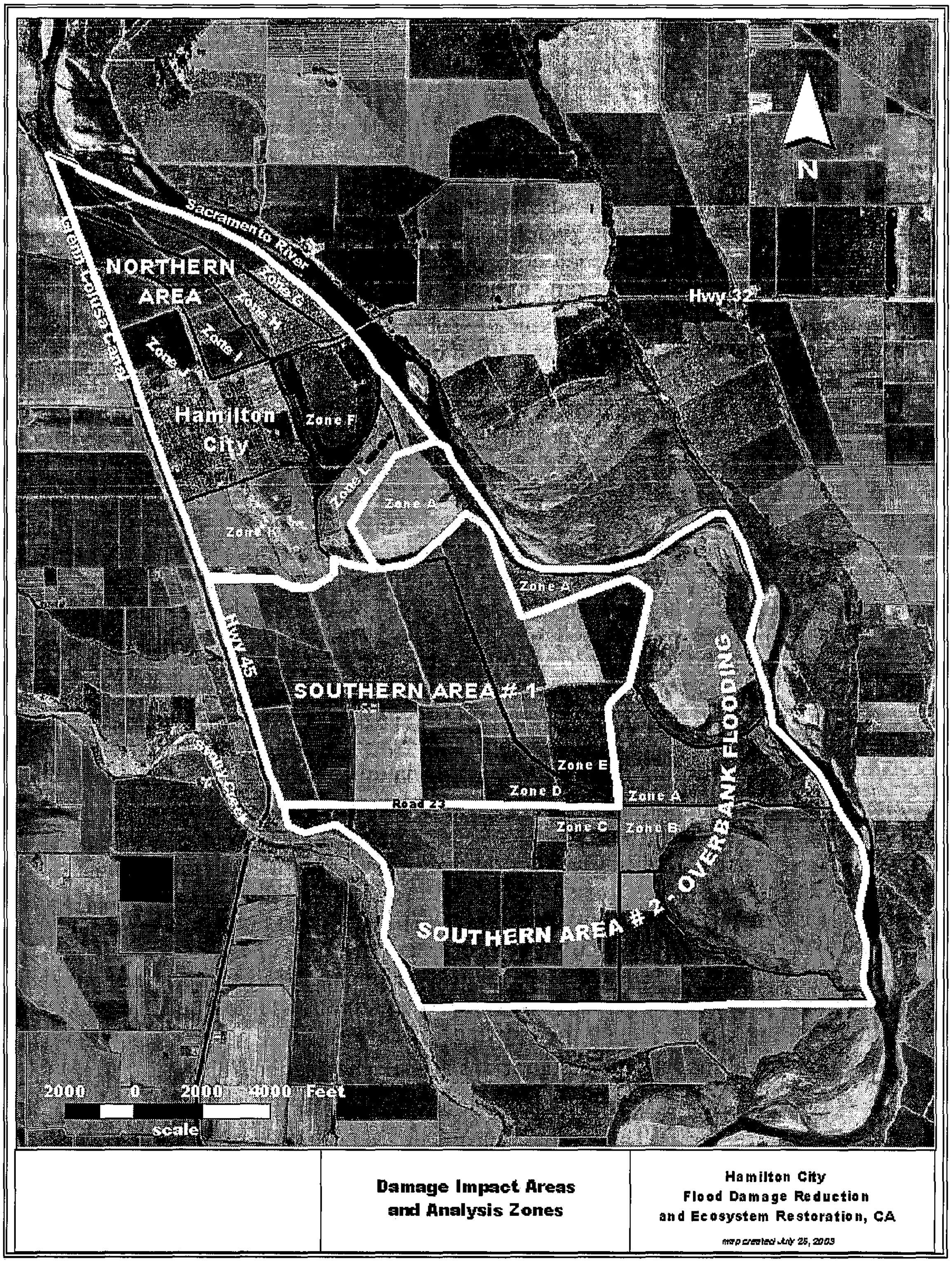


Table 1
Comparison of Technical Studies Models and Assumptions
2001 and 2003 Economic Analyses

Technical Study	Original Analysis (October 2001)	Revised Analysis (July 2003)
Hydrology & Hydraulics		
Model	HEC-RAS (steady state)	HEC-RAS (steady state)
Storm Centering Assumptions	Comp Study	Revised Comp Study to be more site specific
Levee Failure Assumptions		
In-Channel Flows	Left (east) bank—no levees	Left (east) bank—levees
	Right (west) bank—no levees	Right (west) bank—levees
Floodplain Delineations	Left (east) bank—no levees	Left (east) bank—levees
	Right (west) bank—no levees	Right (west) bank—no levees
Floodplain Maps	2%, 1%, 0.5%, 0.2% and 0.1% chance events	50%, 10%, 4%, 2%, 1%, 0.5%, 0.2% and 0.1% chance events
Index Points	River Mile 198.61 (1997 Comprehensive Study)	River Miles 198.25, 197.25 and 194.25 (1997 Comprehensive Study)
Backwater Flooding	Not analyzed	Analyzed
Geotechnical		
Levee Failure Assumptions	Top of levee, probable non-failure point, probable failure point identified at index points (TOL, PNP, PFP)	Top of levee, probable non-failure point, probable failure point identified at index points (TOL, PNP, PFP)
Economics		
Model	Hydrologic Engineering Center's Flood Damage Reduction Analysis (FDA)	Hydrologic Engineering Center's Flood Damage Reduction Analysis (FDA)
Impact Areas	Hamilton City (entire area)	Hamilton City (includes northern agricultural areas)
		Northern (Hamilton City and agricultural area to north)

Table 1
Comparison of Technical Studies Models and Assumptions
2001 and 2003 Economic Analyses

Technical Study	Original Analysis (October 2001)	Revised Analysis (July 2003)
		Southern #1 (southern agricultural area protected by "J" Levee)
		Southern #2 (southern agricultural area not protected by "J" Levee)
Analysis Zones	None	Impact areas divided into analysis zones to account for differences in areas protected by alternative setback levee alignments
FDA Adjustments (F3 to F4)	None	Add stage-damage curves for 10%, 4% chance events (2003 H&H)
		Translate frequencies from 2001 H&H to 2003 H&H for 2%, 1%, 0.5%, 0.2% chance events
		Translate stages from 2001 index point to 2003 Hamilton City index point (RM 198.61 to 198.25)
FDA Model Outputs	Expected Annual Damage Project Performance Statistics	Expected Annual Damage Project Performance Statistics

E.2 FLOOD DAMAGE REDUCTION ANALYSIS METHODS

A primary objective in flood damage reduction studies is to determine the expected annual damage (EAD) along a river reach taking into account all possible flood scenarios and to compare changes in the damage resulting from various alternative plans over the study period. Expected annual damage is approximately equivalent to an average annual damage estimate, taking into account all possible storm events that might occur, from very frequent to very infrequent. The determination of EAD in a flood management study must take into account interrelated hydrologic, hydraulic, geotechnical and economic information. Specifically, EAD is determined by combining the discharge-frequency, stage-discharge (or stage frequency), and stage-damage functions and integrating the resulting damage-frequency function. Stage refers to water surface elevation. Uncertainties are present for each of these functions and are carried forth into the EAD computation. In addition, for many studies (including the Hamilton City), most of the rivers have levees. Adding levees to channels keeps more flowing water from breaking out into adjacent land area. However, as the volume of water behind the levee rises, the probability of levee failure increases. Thus, the derivation of geotechnical levee probability of failure curves becomes very critical to the analysis. Once levees have failed and water enters the floodplain, then stages in the floodplain (which inundate structures and crops) become more critical to the EAD computation than stages in the river channel.

E.2.1 Risk Analysis

Risk involves exposure to a chance of injury or loss. The fact that risk inherently involves chance leads directly to a need to describe and plan for uncertainty. Corps policy has long been to acknowledge risk and uncertainty in anticipating floods and their impacts and to plan accordingly.[2] Historically that planning relied on analysis of the expected long-term performance of flood-damage reduction measures, application of safety factors and freeboard, designing for worse case scenarios, and other indirect solutions (such as engineering judgment) to compensate for uncertainty. These indirect approaches were necessary because of the lack of technical knowledge of the complex interaction of uncertainties in estimating hydrologic, hydraulic, geotechnical and economic factors due to the complexities of the mathematics required for doing otherwise. However, with advances in statistical hydrology and the availability of computerized analysis tools (such as HEC-FDA), it is now possible to improve the evaluation of uncertainties in the hydrologic, hydraulic, geotechnical and economic functions. Through this risk analysis, and with careful communication of the results, the public can be better informed about what to expect from flood-damage reduction projects and thus can make more informed decisions.

The determination of EAD for a flood reduction study must take into account complex and uncertain hydrologic, hydraulic, geotechnical, and economic information:

- **Hydrologic** - The discharge-frequency function describes the probability of floods equal to or greater than some discharge Q,
- **Hydraulics** - The stage-discharge function describes how high (stage) the

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[2] *In a flood damage reduction study, risk is defined is the probability of failure during a flood event. Uncertainty is the measure of the imprecision of knowledge of variables in a project plan.*

flow of water in a river channel might be for given volumes of flow discharge,

- **Geotechnical** - The geotechnical levee failure function describes the levee failure probabilities vs. stages in channel with resultant stages in the floodplain, and
- **Economics** - The stage-damage function describes the amount of damage that might occur given certain floodplain stages.

Figure 4 illustrates the conceptual risk approach for Corps' flood damage analyses. To find the damage for any given flood frequency, the discharge for that frequency is first located in the discharge-frequency panel (panel #1), then the river channel stage associated with that discharge value is determined in the stage-discharge panel (panel #2). As mentioned above, the study area contains the "J" Levee located along the west bank of the Sacramento River. Levees typically fail before the water reaches the top (panel #3).[3] Once levees have failed and water enters the floodplain, then stages (water depths) in the floodplain inundate structures and crops and cause damage (panel #4, left side).[4] By plotting this damage and repeating for process many times, the damage-frequency curve is determined (panel #4, right side).[5] EAD is then computed by finding the area under the flood damage-frequency curve by integration for both without and with-project conditions. Reductions in EAD attributable to projects are flood reduction benefits. Uncertainties are present for each of the functions discussed above and these are carried forth from one panel to the next, ultimately accumulating in the EAD. These uncertainties are shown in Figure 4 as "error bands" located above and below the hydrologic, hydraulic and economics curves.[6]

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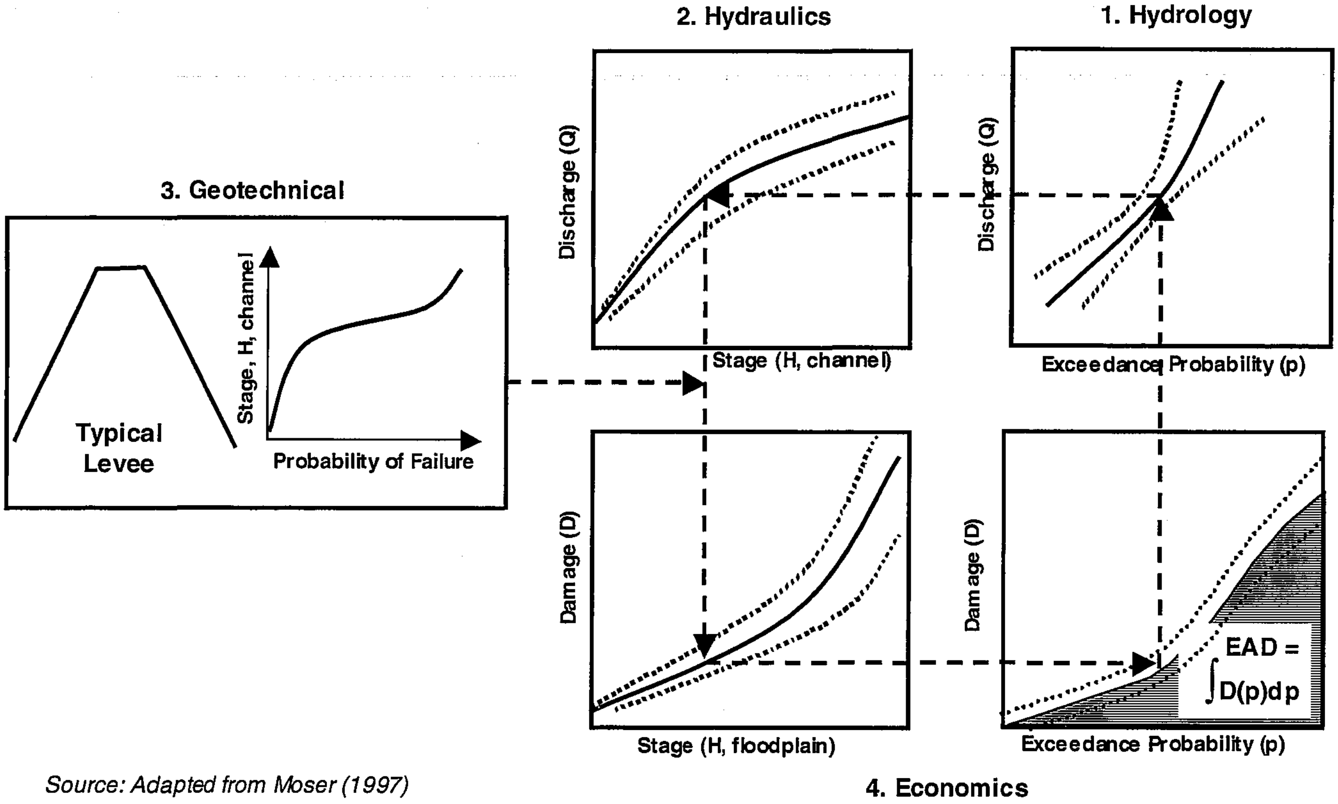
[3] *Project levees are levees that are part of a Federal flood control project. They include levees built by the Corps as well as levees built by others and brought up to the Corps design standards applicable at the time of incorporation into the federal project. The maintenance of project levees is usually the responsibility of the local sponsors. Non-project levees (such as the "J" Levee) are not part of a federal flood control project and are built and maintained by individuals and agencies other than the Corps.*

[4] *For reaches without levees, the stage in the channel and overbank areas is used to determine damage.*

[5] *The HEC-FDA model, described in section E.2.2, uses Monte Carlo analysis to repeat this "sampling" process thousands of times. Mathematically, FDA computes EAD in a different manner than illustrated by this figure.*

[6] *Uncertainty in the geotechnical levee probability of failure curves are multitude in character and the resultant curve used in the analysis reflects how well that levee can be expected to perform during random periods of high flows for a particular reach length. Typically the greater the length of the levee reach, the less reliably that reach will perform during a flood event.*

Figure 4
Conceptual Risk Approach for Estimating Flood Damage



Source: Adapted from Moser (1997)

Some of the important uncertainties specific to the Hamilton City Flood Damage Reduction and Ecosystem Restoration Study include:

- **Hydrologic** - Uncertainty factors include hydrologic data record lengths that are often short or do not exist, precipitation-runoff computational methods that are not precisely known, and imprecise knowledge of the effectiveness of flow regulation.[7] Using the graphical method, FDA automatically assigned error bands based upon the input frequency-discharge curve and the hydrologic periods of record (80 years). The resulting curves are shown in

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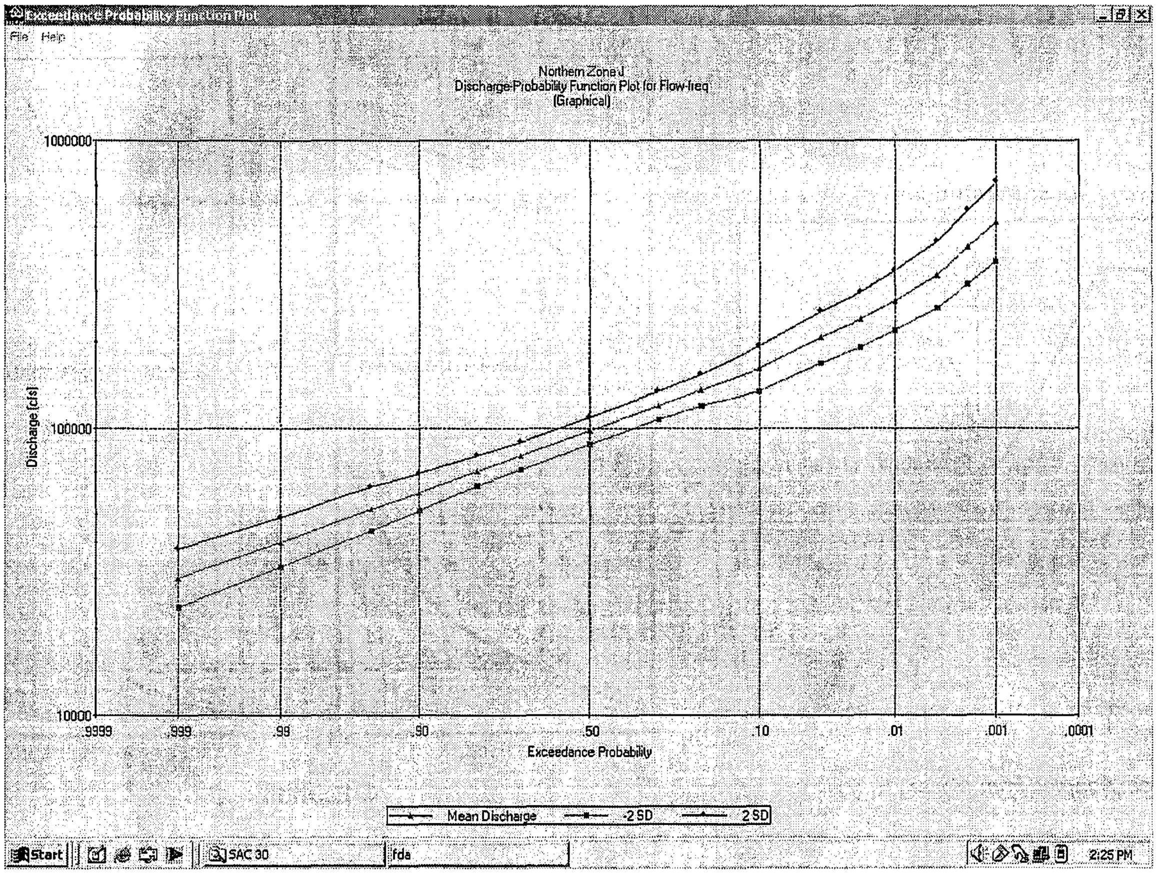
[7] *The hydrologic data record lengths (period of record) are the number of years of a systematic record of peak discharges at a stream gage. This parameter directly influences the uncertainty associated with the frequency-discharge function shown in Figure 5 and consequently the project performance statistics. In general, a longer period of record implies less uncertainty associated with this function. For the Hamilton City Study, the hydrologic period of record is 80 years.*

Figure 5
Frequency-Discharge Curve and Uncertainties
Sacramento River
River Mile 198.25

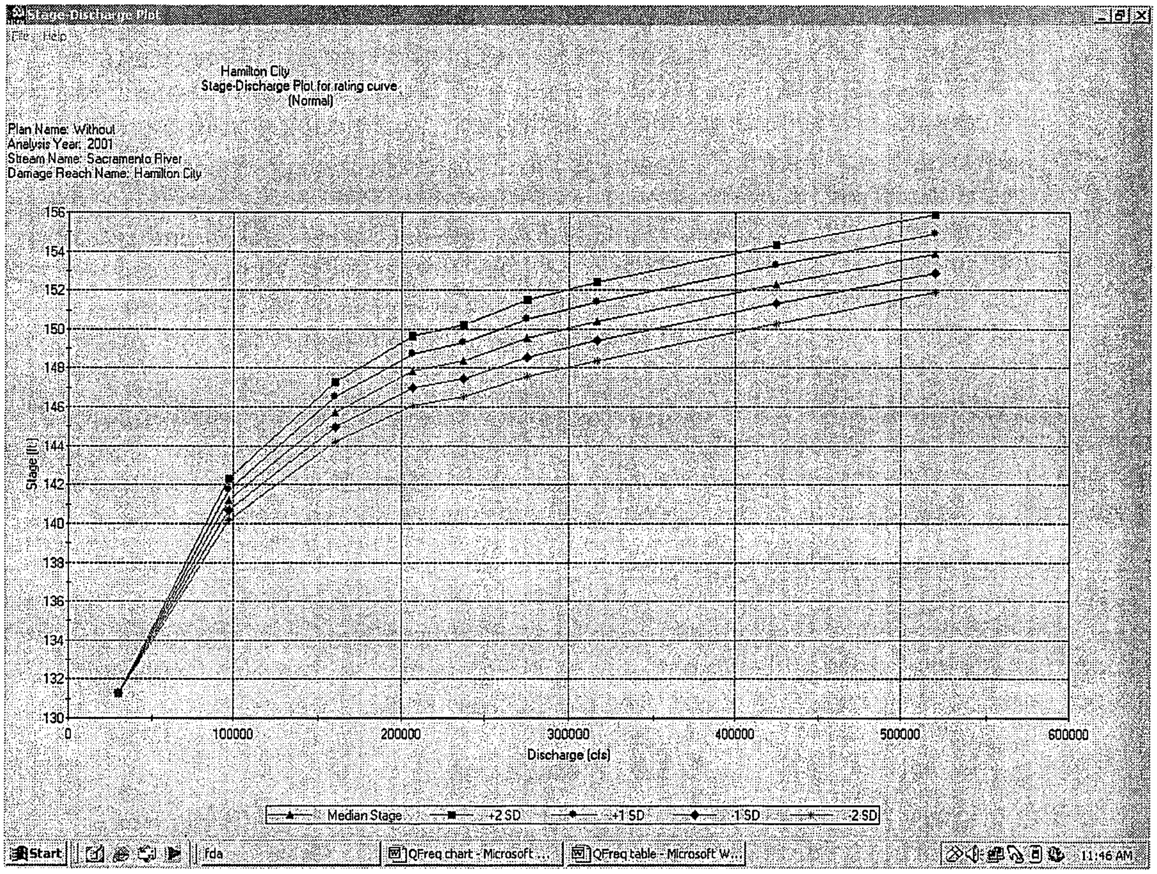


- **Hydraulics** - Uncertainty arising from the use of simplified models to describe complex hydraulic phenomena, including the lack of detailed geometric data, misalignments of hydraulic structures, material variability, and from errors in estimating slope and roughness factors. FDA automatically assigned error bands to the stage-discharge curve, as illustrated in Figure 6. FDA assigns these bands based upon an assumed error distribution (normal for this study) and constant errors above a calculated (or user specified) stage.
- **Geotechnical** - Uncertainty in the geotechnical performance of flood control structures during loading from random events such as flood flows and earthquakes affect levee performance. Other uncertainties may include geotechnical parameters such as soil and permeability values used in analysis, mathematical simplifications in the analysis models, frequency and magnitude of physical changes or failure events, and the uncertainty of unseen features such as rodent burrows, cracks within the levee, or other defects. Although geotechnical uncertainties are present, the current

version of FDA does not assign error bands around the levee failure curves.

- **Economics** - Uncertainty concerning land uses, depth/damage relationships, structure/content values, structure locations, first floor elevations, floodwater velocity, the amount of debris and mud, flood duration, and warning time and response of floodplain inhabitants. Specific uncertainties for key economic variables are presented below in the section, Stage-Damage Curves.

Figure 6
Stage-Discharge Curve and Uncertainties
Sacramento River
River Mile 198.25



Hamilton City
Stage-Discharge Plot for rating curve
(Normal)

Plan Name: Without
Analysis Year: 2001
Stream Name: Sacramento River
Damage Reach Name: Hamilton City

E.2.2 HEC-FDA Model Development

The Hydrologic Engineering Center's Flood Damage Reduction Analysis (FDA) program was used to estimate equivalent annual damages. The program utilizes risk analysis to integrate hydrologic, hydraulic, and economic and geotechnical relationships. Engineering provided discharge-probability, stage-discharge, and levee failure curves that were combined with the frequency/stage-damage functions generated from the @RISK analysis described further below.

The development of the FDA files for the study area was complicated by (1) different types of flooding (overland vs backwater) and (2) several alternative levee setback alignments:

- **Types of flooding:** To the north of Hamilton City, the existing "J" Levee is subject to levee failure caused by high flows in the Sacramento River, as well as continuing erosion throughout the year. Levee failure in this area threatens croplands to the west of the levee as well as the town itself. Directly east of Hamilton City, the "J" Levee is very susceptible to failure, which would cause overland flooding of the town itself. Immediately south of town, the agricultural areas receive some protection from the "J" Levee, which extends south to County Road 23. However, this protection is limited to flows directly originating from the river to the east. These southern lands are still subject to backwater flooding, which creeps around the southern end of the "J" Levee. Further south of County Road 23, the agricultural lands are not protected by levees and they are consequently subject to frequent, and sometimes high-velocity, overland flooding from the river.
- **Alternatives:** In order to address these different types of flood threats (and to also address the ecosystem restoration objective of the project), different levee setbacks have been identified for the Northern, Central and Southern #2 impact areas. These setbacks can be "mixed and matched" from north to south resulting in numerous permutations of alternatives, which are described in more detail in Chapter 3 of the main report and the "With-project" section below.

Because of these complexities, the impact areas were further subdivided into analysis zones whose boundaries followed the alternative levee alignments. A separate FDA file was created for each analysis zone so that different plans (levee protection, buyout, etc.) could be analyzed. The analysis zones were shown in Figure 3.

E.3 WITHOUT-PROJECT CONDITIONS

A critical step in the economic analysis is the identification of the without-project conditions, which includes not only existing conditions, but also future without-project conditions expected to occur over the 50-year analysis period.

E.3.1 Floodplains

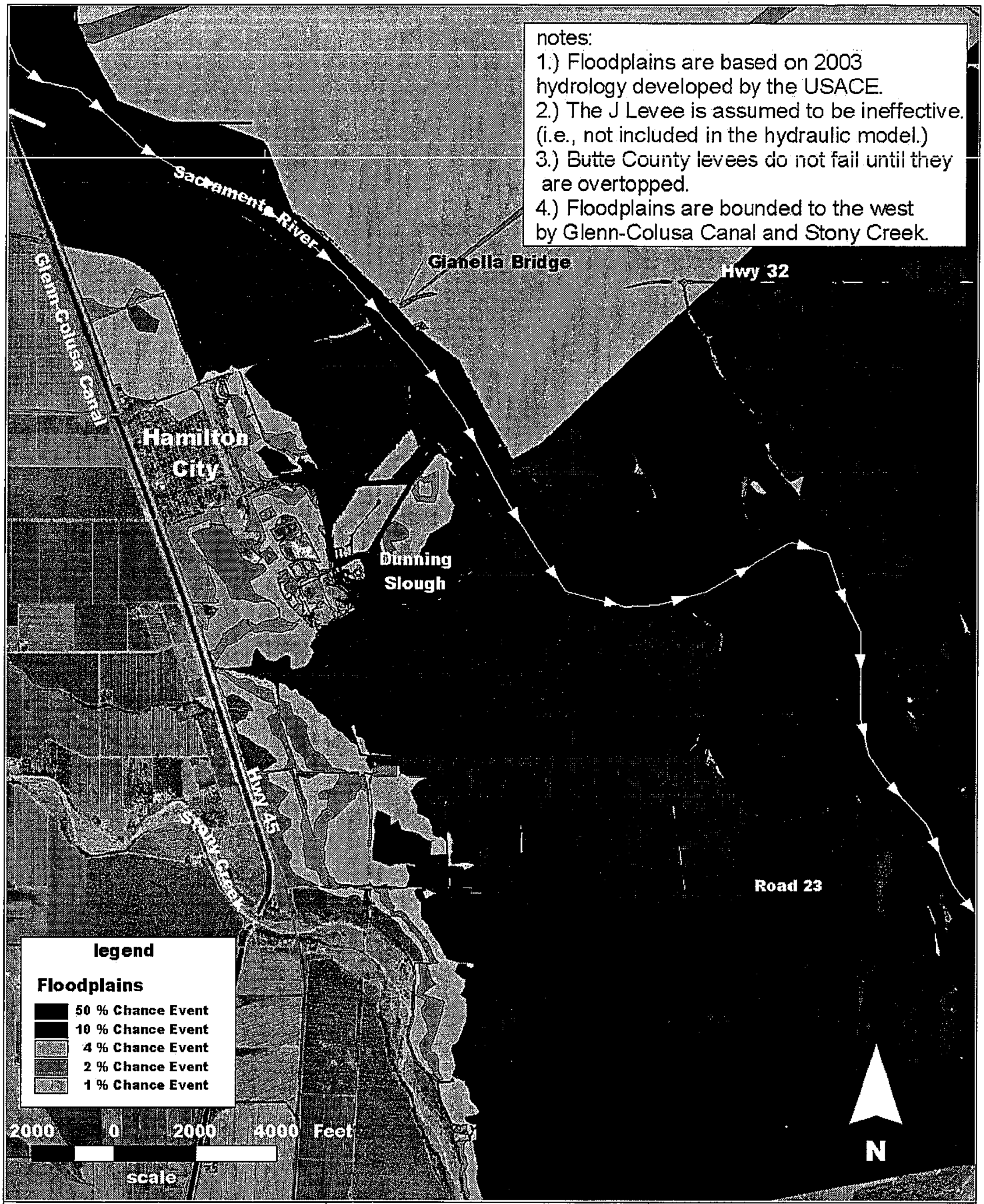
The primary risk (highest probability) of flooding to Hamilton City is from upstream unregulated tributary streams along the Sacramento River between Shasta Dam and Hamilton City. Runoff from these streams can cause the Sacramento River water level to rise and break through or overtop the "J" Levee. Extremely large storm events in the upper Sacramento River watershed result in high release flows from Shasta Dam, which could cause flooding in the Hamilton City area. Similarly, large storm events in the Stony Creek watershed can result in high release flows from Black Butte Dam, causing flooding in the Hamilton City area. In both cases, however, the probability of flooding due to dam releases is relatively low compared to the risk from the unregulated tributaries. The community relies on the "J" Levee to contain flows in the Sacramento River. The "J" Levee does not meet Corps or any other levee construction standards and could fail at river levels well below the top of the levee.

The Hamilton City study area is subject to both overbank and backwater flooding. Overbank flooding originates from the right (west) bank of the Sacramento River and directly threatens the existing "J" Levee and the community and farmlands landside of that levee. However, the southern end of the "J" Levee (near County Road 23) does not tie into high ground, therefore floodwater can creep around the end of the levee and flood lands to the north, although usually with reduced velocities. To perform the economic analysis, existing condition floodplain maps were generated that show both types of flooding problems in the study area.

- **Overbank Flooding.** Utilizing the 2003 hydrologic and hydraulic (H&H) information, floodplain maps were generated for the 50%, 10%, 4%, 2%, 1%, 0.5% and 0.2% chance events (Figures 7 and 8). As an example, a 50% event has a 1 in 2 probability of occurring in any given year. Key assumptions that were used to develop these floodplain maps include:
    - The "J" Levee is assumed to be ineffective (i.e., removed from the hydraulic model).
    - Across the Sacramento River, the Butte County levees are assumed not to fail until they are overtopped.
- **Backwater Flooding.** Backwater flooding occurs when floodwater creeps around the southern end of the "J" Levee and fills in low-lying lands to the north (primarily analysis zone E and the eastern portion of analysis zone D). However, backwater flooding can reach as far north as the southern edge of Dunning Slough (analysis zone A). Backwater flooding typically occurs more frequently than flooding from levee failures, and it usually does not occur with the higher flood velocities associated with levee failure flooding (which can flow quickly through narrow breaks in levees), so damage tends to be less. Figure 9 shows the estimated backwater floodplains from water flowing around the southern end of the existing "J" Levee. If the "J" Levee were to be extended further south (as in some of the alternatives), backwater flooding would still be present although the floodplains would shift southward. Figure 10 illustrates the differences in levee failure vs. backwater flooding. Areas subject to levee failure flooding include I and II, with water originating from the river breaching the "J" Levee. In contrast, backwater flooding flows around the southern edge of the "J" Levee (through area III) and up into area II. Total flood damage should then be computed for areas I + II + III. But, these cannot be simply added together. Using Figure 10 as an example, adding damage in areas flooded by levee failures (I and II) to areas flooded by backwater flooding (II and III) double the counts of damage occurring in area II.

  Another complication is that the extents of the two types of floodplains (levee failure and backwater) may not always match (for example, as shown in Figure 10). Sometimes the extent of the backwater flooding may occur entirely within the extent of the levee failure floodplain, sometimes just the opposite, or they may overlap unevenly. To avoid expending significant amounts of time and resources studying the backwater flooding issue, a simplifying assumption was made that one of the floodplains (levee failure or backwater) is always contained within the other. Given this assumption, damage estimates from the levee failure and backwater flooding scenarios were computed separately using FDA, and the larger estimate of the two was taken as the damage estimate for that analysis zone. @RISK frequency/stage-damage curves and FDA files were developed separately for backwater and levee failure floodplains within an analysis zone.

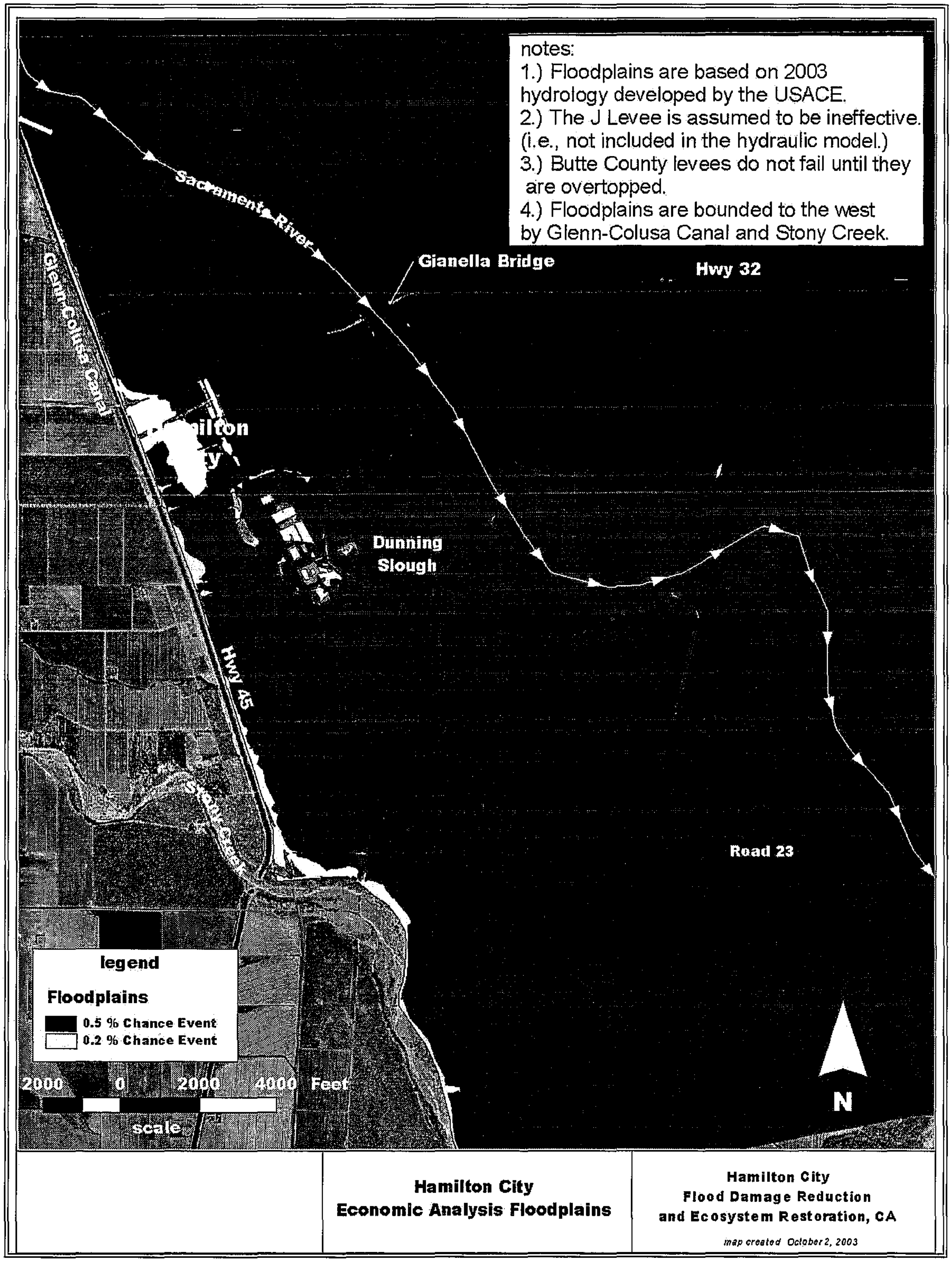
Figure 7
Hamilton City Economic Analysis Floodplains



notes:
1.) Floodplains are based on 2003 hydrology developed by the USACE.
2.) The J Levee is assumed to be ineffective. (i.e., not included in the hydraulic model.)
3.) Butte County levees do not fail until they are overtopped.
4.) Floodplains are bounded to the west by Glenn-Colusa Canal and Stony Creek.

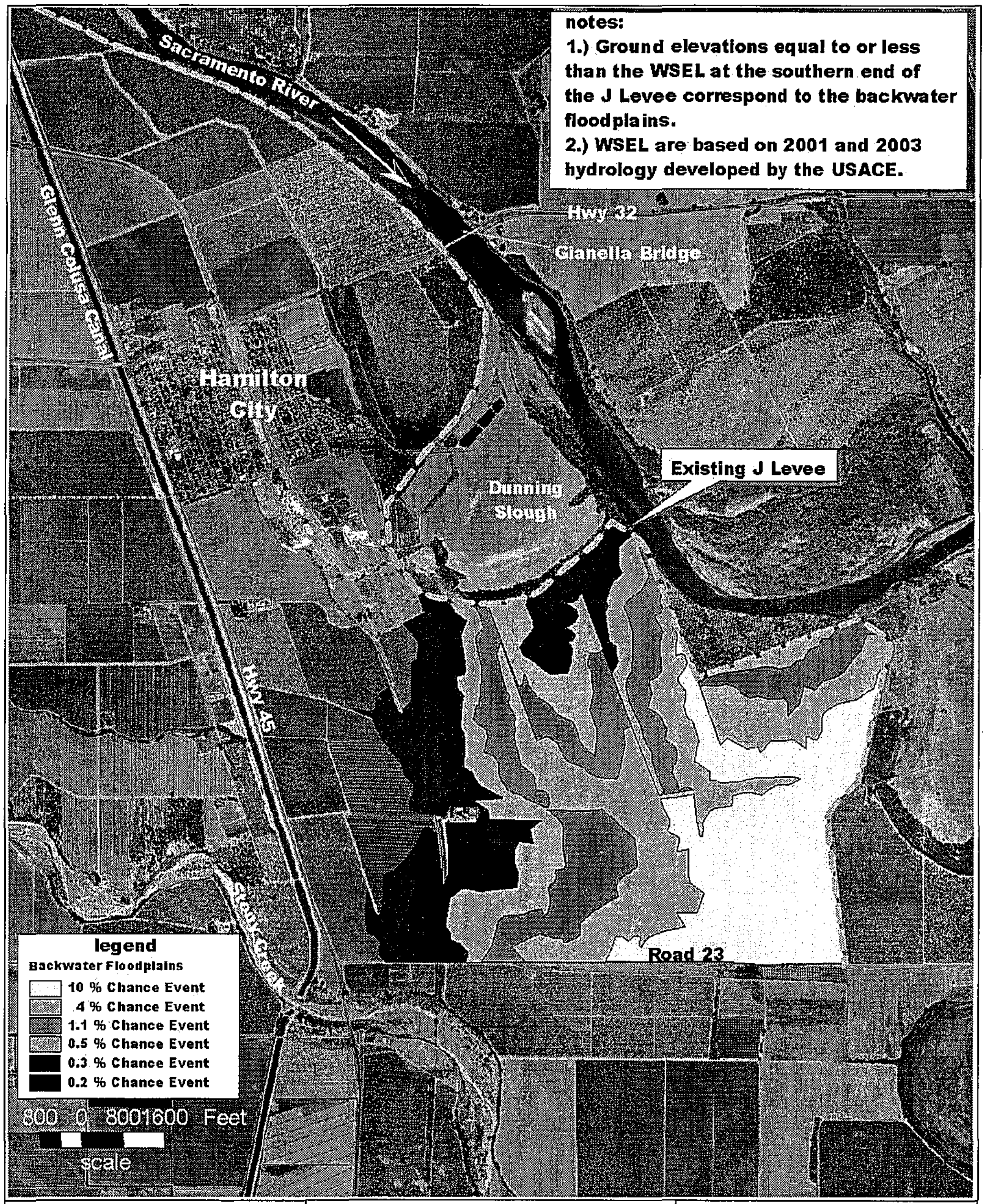
	Hamilton City **Economic Analysis Floodplains**	**Hamilton City** **Flood Damage Reduction** **and Ecosystem Restoration, CA** *map created October 2, 2003*

Figure 8
Hamilton City Economic Analysis Floodplains



notes:
1.) Floodplains are based on 2003 hydrology developed by the USACE.
2.) The J Levee is assumed to be ineffective. (i.e., not included in the hydraulic model.)
3.) Butte County levees do not fail until they are overtopped.
4.) Floodplains are bounded to the west by Glenn-Colusa Canal and Stony Creek.

Figure 9
Hamilton City Economic Analysis
Backwater Flooding
(Without Project)



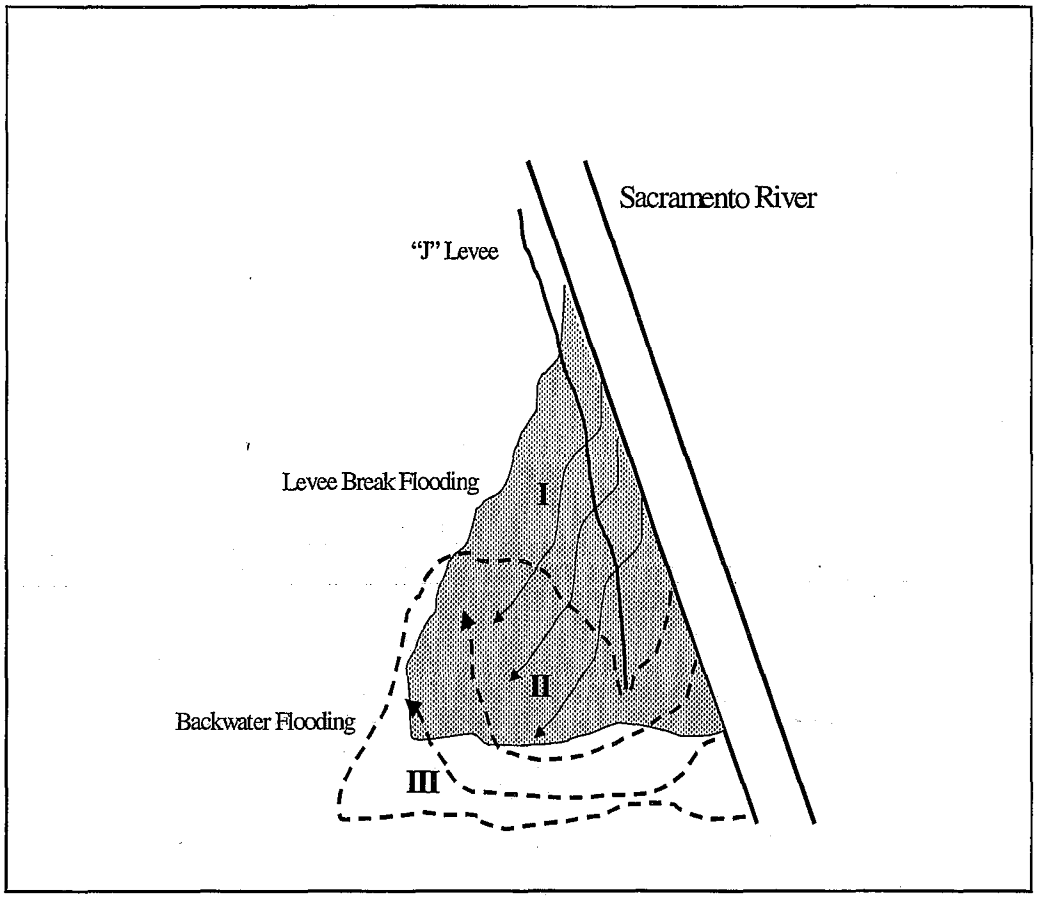
notes:
1.) Ground elevations equal to or less than the WSEL at the southern end of the J Levee correspond to the backwater floodplains.
2.) WSEL are based on 2001 and 2003 hydrology developed by the USACE.

**Hamilton City Economic Analysis
Backwater Floodplains**

**Hamilton City
Flood Damage Reduction
and Ecosystem Restoration, CA**
map created July 28, 2003

Note—This figure only shows backwater flooding flowing north from the southern end of the "J" Levee. Flows contributing to this backwater flooding (south of the "J" Levee) are not shown.

Figure 10
Levee Break Flooding vs. Backwater Flooding



Changes in future hydrologic and hydraulic conditions could affect the floodplains and thus the flood damage analysis; however, these changes have not been modeled (nor are there plans to do so because such an analysis would be highly speculative and could significantly affect the study schedule and cost). However, it should be remembered that hydrologic, hydraulic and geomorphic processes along the river do not remain constant over time, and changes in any of these factors (such as sedimentation) could potentially affect future flood damage.

E.3.2 Damage Categories

For analysis purposes, potential flood damage was classified into different categories:

- **Residential** - includes single family and multi-family units, houses, apartments, duplexes, mobile and manufactured homes. Damage includes physical damage to the structure, clean-up, damage to contents including household items and personal property, and clean-up.
- **Commercial** - includes retail stores, restaurants, service stations and light-repair garages. Damage was computed for both structure and contents including equipment, furniture, supplies and merchandise.
- **Public** - includes schools, churches, libraries and government service buildings such as the fire station and post office. Also included are the wastewater treatment ponds located in economic analysis zone L. Damage is comprised of losses to the building and its contents.
- **Agricultural/Industrial** - this category includes the agricultural production facilities, distribution and storage structures, including warehouses and processing plants. Damage was estimated for structures, equipment and inventories. Because many of the facilities are currently idle, including the largest processing plant in the area, content damages were limited to active units.
- **Emergency Costs** - additional costs incurred during flood emergencies for evacuation, temporary housing, medical supplies, food, clothing and re-occupation. Estimates were based on the number of people displaced, number of days evacuated or occupying temporary housing, and average daily costs (based on averages from other area flood studies.)
- **Auto** - damage to trucks and automobiles. Damages were determined as a percentage loss based on depth of flooding. Most vehicles begin to take measurable damages once water exceeds one-foot in depth.
- **Roads** - damage in the form of clean up, increased maintenance and repair. Estimates were a function of road miles inundated and average depth of flooding for the area surrounding the road.
- **Crop Damage** - includes the loss of cumulative cultivation costs incurred prior to flooding, the current net value of the crop affected by the flood event, the depreciated value of perennial crops lost as a direct result of flooding, and clean up costs.

E.3.3 Structure Flood Damage

Glenn County parcel maps were compared with floodplain maps to identify structures subject to flooding.[8] The area subject to flooding can be seen in the floodplain maps (Figures 7 and 8). Assessor's data was gathered using a CD-based database for Glenn County, including land use, structure type, assessed improvement value, and physical features. Field inspections were performed to determine foundation heights and to verify database physical characteristics. Adjustments were made to include public structures and those parcels that had changed land use or were not found in the database.

- **Structure Inventory.** The number of parcels with structures and the number of units are displayed by land use in Table 2. Based on this analysis, there are about 618 structured parcels within the largest floodplain (0.2% event, 2001 H&H) and nearly 690 residential units (including mobile homes). The residential structures include the new 116 units of the Pallisades subdivision located in the eastern part of Hamilton City. In the 2001 analysis, these were considered as "future growth", but since almost 80 have been completed (with the remainder to be finished by summer of 2004) they are considered to be "existing conditions" for the 2003 analysis.

Table 2 - Structure Inventory (1)

Land Use Type	Number of Parcels	Number of Units
Residential - Single Family (2)	464	464
Residential- Multi-Family	17	91
Residential- Mobile Home	94	135
Commercial	19	19
Public/Semi-Public	15	15
Agricultural/Industrial	9	9
Total	618	733

(1) All of these parcels are located within the Northern impact area with the exception of one agricultural production parcel, which is located in the Southern #1 impact area.
(2) Includes Pallisades subdivision (116 units).

- **Value of Damageable Property.** Value of damageable property includes both structure and content values, but does not include land values or crop value improvements. All structural values were based on adjusted assessed improvement values to represent depreciated replacement values. The first adjustment was made to account for California's Proposition 13, which allows for assessed values to be capped at an annual increase of two percent. Assessed values were adjusted (actual factor ranged from 5% to 99% depending on the recording date and structure type) based on sales recorded date and then compared to increases found in Marshall & Swift Valuation Service (Marshall & Swift). The next adjustment was based upon a sample of structures and determining improvement value using the square foot method. Values per square foot were taken from Marshall & Swift. Square footage was

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[8] *Floodplain maps were used to identify structures and crops that are subject to damage. They are not the same as FEMA or other regulatory floodplain maps.*

gathered from the database and depreciation was determined based on a visual field inspection. For the structure sample, values were determined as a function of square footage multiplied by dollars per square foot multiplied by percent of remaining life of the structure (100% minus percent depreciation.). This sample was then compared to the adjusted assessed values to see if they were reasonable and to estimate standard deviations used in the risk analysis, which is described below. This second adjustment was minor, with residential values increased by 4% and standard deviations from 10% to 15% of the mean structure value. Content values were estimated as a percentage of structure value. These percentages were determined based on land use and were taken from the 1992 Yuba River surveys conducted for the USACE Sacramento District.[9]

For residential and public, content percentages were set at fifty percent. Commercial contents values ranged from 50% to 130%. Agricultural industrial warehouses are typically set at 100%, however, several buildings in Hamilton City are currently vacant or without contents. For those structures that do not have current redevelopment plans, contents were set at zero. Table 3 displays values by land use category under existing conditions.

Table 3
Value of Damageable Property
Existing Conditions
(Millions of Dollars; October 2003 Price Levels)

Land Use Category	Structure Value	Content Value	Total Value of Damageable Property
Residential (1)	33	17	50
Commercial	2	2	4
Public/ Semi Public	8	3	10
Agricultural/Industrial	6	2	8
Total	48	24	72

(1) Includes Pallisades subdivision.

- **Structure/Contents Depth-Damage Curves.** For most structural damage categories, dollar damage increases as depth of flooding increases. To evaluate potential losses, structural and contents depth - damage curves were entered into the @RISK models described below. For residential structure and content damage, the generic depth-damage relationships developed by the Institute of Water Resources (IWR) were used, as found in Economic Guidance Memorandum (EGM 01-03). These relationships are particularly relevant to this study as the nearby 1997 Arboga/Yuba County surveys were part of data compiled for the IWR study. For the commercial, public and agricultural/industrial sectors, the curves were the same

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[9] *Foster Associates, "Property Valuation For Portions of The Yuba River City Floodplain," August 20, 1992.*

relationships used in Modesto Pilot Study of the Sacramento-San Joaquin Comprehensive Study. These curves were originally taken from the Tennessee Valley Authority and have been verified and utilized in many Sacramento District studies. Separate curves were used for one-story vs. two-story structures and contents. For commercial structures, "S-shaped" and "U-shaped" curves were used.[10] Automobile depth-damage curves came from the 1983 Soil Conservation Service study for the Lower Silver Creek Watershed. Residential and auto damage depth-damage curves are shown in Tables 4 and 5.

Table 4
IWR Residential Structural and Contents Depth-Damage Curves
(One Story Residence)

Depth (feet)	Structural Depth-Damage		Content Depth-Damage[1]	
	Mean of Damage	Standard Deviation of Damage	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	0%	3.0%
-1	2.5%	2.7%	2.4%	2.1%
0	13,4%	2.0%	8.1%	1.5%
1	23.3%	1.6%	13.3%	1.2%
2	32.1%	1.6%	17.9%	1.2%
3	40.1%	1.8%	22.0%	1.4%
4	47.1%	1.9%	25.7%	1.5%
5	53.2%	2.0%	28.8%	1.6%
6	58.6%	2.1%	31.5%	1.6%
7	63.2%	2.2%	33.8%	1.7%
8	67.2%	2.3%	35.7%	1.8%
9	70.5%	2.4%	37.2%	1.9%
10	73.2%	2.7%	38.4%	2.1%
11	75.4%	3.0%	39.2%	2.3%
12	77.2%	3.3%	39.7%	2.6%
13	78.5%	3.7%	40.0%	2.9%
14	79.5%	4.1%	39.9%	3.2%
15	80.2%	4.5%	39.6%	3.5%
16	80.7%	4.9%	39.1%	3.8%

(1) Expressed as a percent of structural value.

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[10] *S- and U-shaped commercial depth-damage curves were developed to reflect differences in types of inventory and how merchandise is stored (close to the floor or raised on shelves or other furniture). The U-shaped curves have greater damages at the lower depths than the S shaped curves (one looks sort of like an upside down U and the other sort of like an S).*

Table 5
Automobile Depth-Damage Curve (1)

Flood Depth	Percent Car Damage	Comments
0 - 0.9	0	Water not inside car
1.00 - 1.16	12.5	Water in floor of car
1.17 - 1.59	20.8	Water in seats of car, transmission, differential
1.60 - 2.00	45.8	Water in engine compartment and electrical equipment
> 2.00	80	Water in dash board instruments

(1) Source: 1983 Soil Conservation Service Study, Lower Silver Creek Watershed

- **Stage-Damage Curves.** To calculate stage-damage curves with uncertainty, a program called @RISK by Palisade Corporation was used. @RISK is an add-on program for MS-EXCEL, which incorporates Monte Carlo Simulation. The model uses variables with probability distributions to account for uncertainty. Computationally, @RISK outputs are frequency-damage curves that are then manually converted into stage-damage curves for entry into FDA. Economic variables and their associated uncertainty used in the damage template include:
    - Structure value (10% coefficient of variation)[11]
    - Contents value (10% coefficient of variation)
    - Foundation height (0.6 foot standard error)
    - Percent damage (5% coefficient of variation)

For the original 2001 analysis, stage-damage (with uncertainty) was estimated for the 2%, 1%, 0.5% and 0.2% chance events by damage category. These were then linked to the corresponding stages at the index point used in the rating curve (discharge/stage) at river mile 198.61 based on river miles developed for the Comprehensive Study's hydraulics models. However, there have been several significant changes that have affected the original stage-damage curves, including:

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(11) *The coefficient of variation measures variability in relation to the mean and is used to compare the relative dispersion in another type of data. The coefficient is equal to the standard deviation divided by the mean, multiplied by 100 to produce a percentage.*

- Revised hydrologic and hydraulic modeling: The 2001 H&H modeling efforts were revised to reflect site-specific information as well as adding more event frequencies (50%, 10%, and 4%). This improves the economic analysis by establishing when significant damage begins. However, it also creates complications in using stage-damage curves developed using different H&H modeling outputs because specific events in the 2001 analysis may no longer be those same event frequencies in the 2003 analysis. For example, a 1 in 100 (1%) year event in the 2001 analysis is now considered to be a 1 in 192 year event (about 0.5%) based upon the 2003 H&H modeling runs. Other events are also affected as shown in Table 6. In general, most events are now considered to occur less frequently based upon the 2003 H&H modeling. This is handled within FDA by inputting the 2001 stage-damage curves, but also inputting the 2003 discharge/probability and discharge/stage relationships, which essentially reassigns the 2003 frequencies to the 2001 stage-damage curves. Because more frequent events were analyzed in the 2003 H&H (50%, 10% and 25% chance events), floodplains were developed for those events and new stage-damage estimates were developed and added to the existing stage-damage curves. The results are stage-damage curves that reflect new information for the more frequent events and reassigned probabilities for events greater than the 2% chance event (2001 H&H).

Table 6
Comparison of 2001 and 2003 Event Frequencies
Sacramento River

2001 H&H	2003 H&H
NA	50% (1 in 2)
NA	10% (1 in 10)
NA	4% (1 in 25)
2% (1 in 50)	1.1% (1 in 88)
1% (1 in 100)	0.5% (1 in 192)
0.5% (1 in 200)	0.3% (1 in 370)
0.2% (1 in 500)	0.2% (1 in 520)
0.1% (1 in 1000)	0.1% (1 in 900)

NA—not evaluated

- Revised impact areas and index points: With more information concerning flooding patterns in the study area, two additional impact areas (Southern #1 and Southern #2, see Figure 3) were added to the 2001 Hamilton City (now called Northern) impact area. This necessitated the identification of two new index points (river mile 197.25 and river mile 194.25) and the linking of stage-damage curves to those index points. Nearly all of the damage in these two new impact areas is agricultural. The crop stage-damage curves were developed using the 2001 floodplains (and reassigning probabilities for events greater than 2%) plus adding new stage-damage information for the 50%, 10% and 4% chance events. In addition to the new index points, the index point in the Northern impact area was moved downstream (from river mile 198.61 to river mile 198.25) to avoid problems with water surface elevations being unduly influenced by the close proximity of the Gianella Bridge at river mile 198.61. This necessitated yet another adjustment in the stage-damage curves for this impact area to translate stages from the 2001 index point to the new index point.

The revised stage-damage curves are shown in Tables 7, 8, and 9 for the three impact areas. These stage-damage curves represent the damage caused by overland flows originating from levee failures and/or bank over-topping. They do not reflect backwater flooding into the southern impact areas. Although not shown, a separate set of backwater flooding stage-damage curves were also developed.

Table 7
Northern Impact Area (1)
Stage - Damage Curves (Existing Conditions) (2)
(Thousands of Dollars; October 2003 Price Levels)

Stage (ft)	Exceedance Years H&H Study		Stage-Damage Curves ($1,000)									
	2001	2003	Residential	Commercial	Mobile Homes	Public	Autos	Roads	Emergency Costs	Ag Industrial	Crops	Total
145.73	-----	10	0	0	0	0	0	0	0	0	223	223
147.85	-----	25	663	70	9	143	27	9	115	0	464	1,358
149.08	50	88	3,188	277	292	1,165	531	116	433	198	528	6,525
150.26	100	192	5,034	681	577	1,519	759	189	617	405	581	10,158
151.12	200	370	12,052	1119	881	2,836	1,409	268	1,685	863	607	21,517
152.42	500	520	16,643	2,065	1,336	3,900	2,007	351	2,166	1,101	611	29,908

(1) Includes analysis zones F, G, H, I, J, K and L.

(2) These stage damage curves reflect damage caused by overland flows from the river caused either by levee failures or water over top of bank, but do not include backwater-flooding effects.

Table 8
Southern #1 Impact Area (1)
Stage - Damage Curves (Existing Conditions) (2)
(Thousands of Dollars; October 2003 Price Levels)

Stage (ft)	Exceedance Years H&H Study		Stage-Damage Curves ($1,000)									
	2001	2003	Residential	Commercial	Mobile Homes	Public	Autos	Roads	Emergency Costs	Ag Industrial	Crops	Total
143.18	-----	10	0	0	0	0	0	0	0	0	752	752
144.87	-----	25	0	0	0	0	0	1	0	0	879	880
146.69	50	88	0	0	0	0	0	21	0	186	978	1,185
147.48	100	192	0	0	0	0	0	28	0	481	1,012	1,521
148.17	200	370	0	0	0	0	0	34	0	584	1,018	1,635
149.32	500	520	0	0	0	0	0	34	0	704	1,018	1,755

(1) Includes analysis zones D and E.

(2) These stage damage curves reflect damage caused by overland flows from the river caused either by levee failures or water over top of bank, but do not include backwater-flooding effects.

Table 9
Southern #2 Impact Area (1)
Stage - Damage Curves (Existing Conditions) (2)
(Thousands of Dollars; October 2003 Price Levels)

Stage (ft)	Exceedance Years H&H Study		Stage-Damage Curves ($1,000)								
	2001	2003	Residential	Commercial	Mobile Homes	Public	Autos	Roads	Emergency Costs	Ag Industrial	Crops
132.34	-----	2	0	0	0	0	0	0	0	0	498
135.40	-----	10	0	0	0	0	0	0	0	0	819
136.98	-----	25	0	0	0	0	0	1	0	0	880
138.53	50	88	0	0	0	0	0	21	0	0	918
139.70	100	184	0	0	0	0	0	28	0	0	929
140.79	200	330	0	0	0	0	0	34	0	0	940
142.16	500	520	0	0	0	0	0	34	0	0	945

(1) Includes analysis zones A, B and C.

(2) These stage damage curves reflect damage caused by overland flows from the river caused either by levee failures or water over top of bank, but do not include backwater-flooding effects.

E.3.4 Crop Flood Damage

The current land use for the study area was obtained from 1998 California Department of Water Resource's county land use files. Because these files are in a Geographic Information System (GIS) format, they were used to summarize the agricultural land area inundated for each flood event. For analytical purposes, five crops were selected as being representative of all crops grown within the study area: plums, prunes, almonds and walnuts (fruit and nut crops) and wheat (field crop). These five crops comprise the majority of all the rural acreage within the study area.

Crop damage includes losses directly caused by the flooding of agricultural land. Crop damage can occur during every stage of plant development as well as during periods of land preparation prior to the actual planting of the crop. It includes reduction in yield and quality resulting from plantings delayed by early floods or partially destroyed by floods of short duration, and losses incurred in replanting crops completely or partially destroyed by flooding. Both the loss of original expenses incurred in raising such crops, and the loss of income, which would have been received from their sale, contribute to flood damage. This study only estimates damage that accrues directly to the farm producer, or farmer, and not to the secondary processors within the region. Crop damage information has been obtained from interviews with cooperative extension agents and farmers that have been conducted over the past several years.

For this study, agricultural damage due to flooding for each acre was computed by adding the following types of costs:

- **Loss of the cumulative production (variable) costs incurred prior to flooding:** Production costs are incurred periodically throughout the crop year and include field preparation, chemical and fertilizer application, hired labor, planting, weed and pest control, harvesting, etc. These costs are computed on a monthly basis to determine the cumulative amount of production costs that are expended (and thus lost).
- **Loss of the crop net income affected by the flood event:** Crop net income is determined by subtracting the direct production (variable) costs from gross income. Loss of crop net income is a significant part of agricultural damage.
- **Loss of perennial crop depreciated value as a direct result of flooding:** Damage caused by long-term duration flooding may result in permanent loss of perennial crops (for example, permanent reductions in crop yields). 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.
- **Cost of activities associated with land clean up and rehabilitation resulting from flooding:** Erosion and deposition of debris and sediment may be caused by floods of any duration or time of year. Additionally, drainage and irrigation ditches may become clogged with silt and debris. Clean up and rehabilitation of farm acreage is accounted for in the computation of agricultural flood damages.

A significant difference between the 2001 and the 2003 analysis is improved crop flood damage estimates. Agriculture is the major industry within the study area, particularly orchards that are considered a long-term investment. Historically, orchards have been planted and grown in the surrounding area and it is expected that the current land use will continue.

Tables 10 and 11 present estimated existing conditions of crop acres and annual gross crop income.

Table 10
Crop Acres
Existing Conditions

Crops	Northern	Southern #1	Southern #2	Total
Almonds	452	387	550	1,389
Prunes	195	68	423	686
Plums	0	804	149	953
Walnuts	192	401	267	863
Grain	0	0	90	90
Total	839	1,660	1,478	3,977

Source: CA Department of Water Resources, Glenn County land use survey.

Table 11
Gross Crop Income
Existing Conditions
(Thousands of Dollars; October 2003 Price Levels)

Crops	Northern	Southern #1 & #2	Total
Almonds	781	1,628	2,409
Prunes/Plums	325	2,043	2,368
Walnuts	301	1,048	1,349
Grain	0	19	19
Total	1,407	4,738	6,145

The season of the year that the flood occurs greatly impacts the amount of flood damage to a crop. If flooding occurs early, producers may be able to re-prepare the field, plant and realize a return on their 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 flood damage, in any particular month was provided by the hydrology staff for the study area and indicates 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.

During the course of the study, it became apparent that landowners in the extreme southern part of the study area (Southern #2 impact area) were concerned about flood flows leaving the Sacramento River and flowing south through lands unprotected by the "J" Levee (in Figure 3, these flows originate in analysis zone A and flow south through analysis zones B and C). These flows occur frequently because there is no levee protection, and they can also occur with high velocities causing significant damage. Based upon information submitted by a major landowner in the area concerning the extent and magnitude of damage occurred during past events, the crop frequency-damage curves for these analysis zones were adjusted to reflect this type of flooding.[12]

E.3.5 Levee Failure Assumptions

A critical input into FDA is the levee failure assumptions, which typically include three points on a levee failure curve: the top of levee (or top of bank if no levee is present), the probable failure point (85% chance of failure at this water surface elevation), and the probable non-failure point (15% chance of failure at this water surface elevation). Table 12 shows the without-project "J" Levee failure curves for the three impact areas (Southern #2 does not have a levee) as well as the curve used in the 2001 analysis at RM 198.61. Although not used in FDA, levee toe information is also shown for informational purposes (except for the 2001 curve).

Table 12
"J" Levee Failure Curves
(Without-Project)

Levee Failure Curve	2001 H&H	2003 H&H		
	Hamilton City (RM 198.61)	Northern (RM 198.25)	Southern #1 (RM 197.25)	Southern #2 (RM 194.25)
TOL/TOB (1)	151.0	149.2	145.3	133.9
PFP (2)	149.0	146.8	144.3	-----
PNP (3)	144.0	144.3	140.8	-----
TOE (4)	-----	142.4	137.0	-----

(1) Top of levee/top of bank (Southern #2).
(2) Probable failure point (85% chance of failure).
(3) Probable non-failure point (15% chance of failure).
(4) Toe of levee.

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[12] *Computationally, this adjustment was done by increasing the duration time of floodwaters upon the acres at risk from this type of flooding. Although in reality duration times may not be longer with this type of flooding, mathematically it yields a higher damage estimate that approximates a more involved procedure of individually adjusting frequency-damage curves for these affected acreages.*

E.3.6 Equivalent Annual Damages

Tables 2 and 3 show existing structural inventories and associated structural and contents values. Future development within the floodplain is limited based on many factors including available space and demand. For the 2001 and 2003 analyses, future growth is limited to those development project sites specifically planned or under current construction. In the 2001 analysis, this future growth was comprised of 116 single-family homes in the Pallisades sub-division and a middle school located just east of Sacramento Avenue and south of CA Highway 32. Many of the homes, which range from 1,100 to 1,500 square feet, have already been completed, with the remainder (about 40) to be completed in 2004. Thus, for this analysis, these homes are now considered as existing condition. However, the middle school is still considered to be future conditions since it most likely will not be completed until 2010. Existing crop acreages are shown in Table 10. Table 11 shows annual gross crop income. These were assumed to remain constant over the analysis period based upon historical trends in the study area.

FDA was run for a base year of 2001 and future year 2010 conditions. Equivalent annual damages were estimated in the program using a 50-year period of analysis, October 2003 price levels, and a discount rate of 5 5/8%. Equivalent annual damage is the damage value associated with the without-or-with-project condition over the analysis period considering changes in hydrology, hydraulics, and flood damage conditions in the study area. Expected annual damage is computed for each analysis year and discounted to present worth, which is then annualized to obtain the equivalent annual damage value. Rather than compute the expected annual damage for each year, it is computed for the base year and most likely future year (2001 and 2010, respectively, for Hamilton City). Values in between these two years are interpolated, and values in later years are assumed to be equal to the most likely future year. For the 2003 analysis, the only difference between the base year and most likely future year is the assumed construction of a middle school in Hamilton City.

Equivalent annual damage over the period of analysis is displayed for the without-project condition in Table 13. For comparison purposes, the EAD estimates developed from the 2001 analysis are also shown. As shown in Table 13, the current EAD estimates are considerably higher than the 2001 estimates. The primary reasons for this are:

- The size of the 2003 study area incorporates the area of analysis zones B and C (see Figure 3) which were not included in the 2001 analysis, and
- The 2003 analysis uses a more detailed analysis of crop flood damage than what was used in 2001

Table 13
Without-Project
Equivalent Annual Damage
(Values in $1,000, October 2003 Prices)

Damage Category	2003 Analysis				2001 Analysis
	Northern	Southern #1	Southern #2	Total	
Residential	215	-	-	215	*214*
Commercial	22	-	-	22	*23*
Public	69	-	-	69	*65*
Ag/Industrial	18	10	-	27	*22*
Roads	6	1	1	7	*11*
Autos	26	-	-	26	*27*
Emergency Costs	27	-	-	27	*27*
Crops	55	129	189	373	*22*
Total	438	140	190	768	*411*

Note: numbers may not add due to rounding

E.3.7 Project Performance

Table 14 presents the without-project (existing levee) project performance statistics for the three impact areas. The three indicators of project performance estimated by FDA include expected annual exceedance probability, long-term risk, and conditional non-exceedance probability.

- **Expected annual exceedance probability (AEP).** Expected AEP is a key element in defining the performance of a plan. It is the probability that a specific capacity or target stage will be exceeded in a given year.[13] For example, in Table 14, the Northern impact area expected annual exceedance probability is estimated to be 0.116, indicating that there is about a 12 percent chance of a damaging flood event along that particular river reach in any given year. If levees are located along the river reach (which is the case for the Northern and Southern #1 impact areas), the chance of their failure is also taken into account. Table 14 shows that AEP values increase for the southern impact areas. The 2001 AEP values are also shown for comparison purposes.
- **Long-term risk.** Long-term risk is the probability of a target stage being exceeded during a specified period. FDA estimates long-term risk for 10-, 25- and 50- year periods. For example, for the Northern impact area, the long-term risk for a 25-year period is estimated to be 0.9542, indicating that there is about a 95 percent chance that there will be one or more events that exceed a specified target stage during that time frame. These values also increase for the southern impact areas due to less reliable levees (in Southern #1) or no levees at all (Southern #2).

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[13] *Target stage is the maximum stage possible before any significant flood damage is incurred.*

Conditional non-exceedance probability. This is the probability that a specified event will be contained by a project. If levees are involved, this statistic includes both the chance of levee overtopping as well as the chance of failure at lower stages. For example, in the Northern impact area, the conditional non-exceedance probability is 0.024 for a 2% (i.e., 1 in 50-year) event. This indicates that there is about a 2 percent chance that the target stage will not be exceeded for that particular flood event. Thus, while the expected annual exceedance and long-term risk probabilities measure the susceptibility of areas to flooding, conditional non-exceedance probability measures their ability to survive specified flood events. FDA generates conditional non-exceedance probabilities for the 10%, 4%, 2%, 1%, 0.4%, and 0.2% events.

For long-time residents of Hamilton City, this 12 percent chance of flooding annually in the Northern impact area may seem exaggerated because the town has not suffered major flooding in the last 50 years or so, even though severe flood events have occurred (most recently in 1997). The reason the town has not flooded is because of floodfighting—significant local, state and federal resources are typically used to combat flood events in Hamilton City so that the levee has not failed. If these events were not flood fought, then the chance of failure would have been greater, as is indicated by the FDA AEP results. There is no established way of incorporating floodfighting into a FDA analysis because of the uncertainties of these efforts actually being successful. However, the Study Team has developed an approach to incorporate floodfighting into the analysis and the results of this analysis are presented below.[14]

The long-term risk and conditional non-exceedance statistics are also subject to the distortions caused by the inability to incorporate floodfighting into the analysis. The long-term risk statistics are probably exaggerated because the levee curve input into FDA does not account for human efforts to protect it, thus greater long-term risk probabilities of failure will be obtained. Conversely, the conditional non-exceedance values are probably under-estimated by unknown amounts due to the use of levee curves that do not reflect human efforts to protect the levee during storm events.

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[14] *This is described in the draft paper "Incorporating Floodfighting Into the Hamilton City HEC-FDA Analysis" (July 2003) included in Appendix A.*

Table 14
Project Performance Statistics
Without-Project

Impact Area	Annual Exceedance Probability (Expected)	Long Term Risk (Years)			Conditional Non-Exceedance Probability by Events					
		10	25	50	10% (1 in 10 years)	4% (1 in 25 years)	2% (1 in 50 years)	1% (1 in 100 years)	0.40% (1 in 250 years)	0.20% (1 in 500 years)
Northern	0.1160 (12%)	0.7086 (71%)	0.9542 (95%)	0.9979 (100%)	0.4805 (48%)	0.0881 (9%)	0.0240 (2%)	0.0054 (0.5%)	0.0005 (0.05%)	0.0001 (0.01%)
Southern #1 (1)	0.1500 (15%)	0.8039 (80%)	0.9830 (98%)	0.9997 (100%)	0.3957 (40%)	0.0700 (7%)	0.0158 (6%)	0.0032 (0.3%)	0.0000 (0.0%)	0.0000 (0.0%)
Southern #2 (2)	0.2370 (24%)	0.9335 (93%)	0.9989 (100%)	1.0000 (100%)	0.0650 (7%)	0.0033 (0.3%)	0.0004 (0.04%)	0.0000 (0%)	0.0000 (0%)	0.0000 (0%)
2001 Analysis	0.1170 (12%)	0.7134 (71%)	0.9560 (96%)	0.9981 (100%)	0.5631 (56%)	0.2795 (28%)	0.1250 (13%)	0.0492 (5%)	0.0134 (1%)	0.0049 (0.5%)

(1) For Southern #1 impact area, these statistics reflect the risk only of levee failure/overtopping. The risk of backwater flooding is higher.
(2) For Southern #2, these statistics reflect the risk of overbank flooding because no levee is present.

E.3.8 FDA Floodfighting Adjustments

As mentioned above, floodfighting is a critical part of flood management within Hamilton City and it does affect the flood damage analysis. It was determined that floodfighting costs should be incorporated into the flood damage reduction analysis. Floodfighting costs would be very significant for the without and future-without-project conditions, but may also be present (although hopefully in lesser amounts) in the future with-project conditions. The comparison of floodfighting costs between the without and with-project conditions would be important for the flood damage reduction analysis.[15] However, to be consistent, these costs cannot be included until the flood damage analysis (using the FDA program) is also adjusted to reflect the benefits of floodfighting (i.e., reduced flood damage).

A proposed method for incorporating floodfighting into FDA is discussed in Appendix A: Plan Formulation. This method relies upon modifying the levee failure curves that are developed by geotechnical specialists and input into FDA. These curves typically have three points: the probable non-failure point (PNP), the probable failure point (PFP), and the top of levee (TOL). The PNP is the water surface elevation at which there is about a 15% chance of levee failure and the PFP is the water surface elevation with about an 85% chance of levee failure. These curves are based upon the physical characteristics of levees and they do not reflect any floodfighting actions taken to protect levees. Table 15 shows the "without floodfight" levee failure curves currently input into FDA for the Northern and Southern #1 impact areas. The Southern #2 impact area is not protected by the "J" Levee.

To adjust the FDA analysis for floodfighting requires that the levee failure curves be modified to reflect social actions taken to protect the levee (patrolling, sandbagging, plastic sheathing, boil repairs, etc.). These curves were adjusted as follows:

- **Northern Impact Area (Index Point River Mile 198.25):** The maximum river stage at the Hamilton City gage (just upstream of the Gianella Bridge) in 1997 was 147.92 (National Geodetic Vertical Datum). This was the highest recorded stage in the past 20 years. The estimated stage at the Northern impact area index point for the 1997 event was 147.5. Thus, the without-project PFP of 146.8 should be changed to 147.5 since the levee seemed able to withstand this type of event—with floodfighting. The PNP was increased an equivalent distance (0.7 feet) from 144.3 to 145.0, since it is reasonable to assume floodfighting would be at least as effective at a lower river stage. In addition to raising the PNP and PFP values, it was also decided to add another point on the levee failure curve for input into FDA. This point was one-half foot less than the top of levee (148.70) and it was assigned a probability of failure of 0.99.
- **Southern #1 Impact Area (Index Point River Mile 197.25):** The same logic

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[15] It should be noted that even though the FDA model is being adjusted to account for it, floodfighting is not really a reliable flood management strategy. The "J" Levee did not perform well in 1986 and 1998, and the inhabitants of Hamilton City narrowly escaped disaster. People were displaced temporarily. What were left were a scoured/eroded levee with thousands of sand bags and visqueen holding the remains of the levee together.

was followed as within the Northern impact area, except the PFP and PNPs were only be increased by half the amount (about 0.3 feet) to reflect to reflect that floodfighting for the potential mode of levee failure for these levees is problematic. The additional point (0.99 probability of failure) was added about one-quarter of a foot less than the top of levee.

These curves are for *existing conditions.* Continued deterioration of the "J" Levee can be expected over time, which would ideally be accounted for by lowering the PFP and PNPs (without and with floodfighting). Within FDA, this adjustment would occur by inputting these "deteriorated" levee curves at some future year (say 2030). Unfortunately, FDA does not allow for analysis years to be changed once they have been entered, thus this adjustment cannot be made. As a consequence, increases in future flood damage caused by the use of "deteriorated" levee failure curves will not be included in the flood damage reduction analysis.

FDA was run again incorporating the without-project, floodfight-revised, levee failure curves. The results of these runs are shown in Tables 16 (equivalent annual damage) and 17 (project performance statistics). The without-project equivalent annual damage was reduced from $768,000 (Table 13) to $726,000 for the entire study area. This implies that floodfighting efforts on the "J" Levee reduce annual flood damage by about $42,000. The equivalent annual damage and project performance statistics shown in Tables 16 and 17 will be considered the "without-project" conditions which will be compared to "with-project" conditions (discussed below).

Table 15
Northern and Southern #1 Levee Failure Curves
Without and With Floodfighting

Levee Failure Curve	Northern		Southern #1	
	Without Floodfight	With Floodfight	Without Floodfight	With Floodfight
Top of Levee (TOL)	149.2	149.2	145.3	145.3
Additional point (0.99 probable failure)	-----	148.7	-----	145.1
Probable Failure Point (PFP)	146.8	147.5	144.3	144.6
Probable Non-Failure Point (PNP)	144.3	145.0	140.8	141.1
Toe of Levee	142.4	142.2	137.0	137.0

Table 16
Without-Project
With Floodfighting
Equivalent Annual Damage
(Values in $1,000, October 2003 Prices)

Damage Category	2003 Analysis				2001 Analysis
	Northern	Southern #1	Southern #2	Total	
Residential	210	-	-	211	*214*
Commercial	21	-	-	21	*23*
Public	54	-	-	54	*65*
Ag/Industrial	18	10	-	27	*22*
Roads	6	1	1	7	*11*
Autos	26	-	-	26	*27*
Emergency Costs	26	-	-	26	*27*
Crops	45	119	189	353	*22*
Total	406	130	189	726	*411*

At first glance, the equivalent annual flood damage estimate of $726,000 presented in Table 16 for the study area may not seem to correspond with historical flood damaging events, especially for the community of Hamilton City (Northern impact area). As pointed out in Section E.1.1, there has been only one occasion (1974) of flood damage within the community of Hamilton City, causing about $55,000 in damage plus $22,000 in levee repair costs. No other significant flood damage has occurred within the community, although there has been more frequent agricultural damage in the southern agricultural lands caused by backwater flooding and overland flows from the Sacramento River. The primary reason for the avoidance of significant flood damage in the community itself has been the reliance upon significant floodfighting efforts, which occurred in 1983, 1986, 1995, 1997, and 1998. Although floodfighting has so far proved relatively effective in avoiding significant flood damage[16], continual deterioration of the "J" Levee makes it much more unlikely that floodfighting will reliably protect the community of Hamilton City in the future.

Floodfighting is expensive, and unfortunately, good records of expenses for flood events are not available. However, based upon available historical information in the study area, future floodfighting costs have been estimated based upon three weather condition scenarios in the study area over the 50-year planning period: mostly dry years, average weather conditions, and mostly wet years. These costs are summarized in Table 18 and described in more detail in Appendix A: Plan Formulation.

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[16] *Even with floodfighting, the community did not go completely unscathed by flood events. The residents were often temporarily displaced, and after each event the levee was left in a further degraded condition, with thousands of sand bags and visqueen holding the remains of the levee together. Significant federal, state and local resources were employed in the floodfighting efforts.*

Table 17
Northern and Southern #1 Impact Areas Project Performance Statistics
Floodfighting vs. No Floodfighting
Without Project

Impact Area	Annual Exceedance Probability (Expected)	Long Term Risk (Years)			Conditional Non-Exceedance Probability by Events					
		10	25	50	10% (1 in 10 years)	4% (1 in 25 years)	2% (1 in 50 years)	1% (1 in 100 years)	0.40% (1 in 250 years)	0.20% (1 in 500 years)
Northern (No Floodfighting)	0.1160 (12%)	0.7086 (71%)	0.9542 (95%)	0.9979 (100%)	0.4805 (48%)	0.0881 (9%)	0.0240 (2%)	0.0054 (0.5%)	0.0005 (0.05%)	0.0001 (0.01%)
Northern (With Floodfighting)	0.0860 (9%)	0.5929 (59%)	0.8942 (89%)	0.9888 (99%)	0.6628 (66%)	0.2157 (22%)	0.0956 (10%)	0.0349 (3%)	0.0057 (0.5%)	0.0006 (0.06%)
Southern #1 (No Floodfighting)	0.1500 (15%)	0.8039 (80%)	0.9830 (98%)	0.9997 (100%)	0.3957 (40%)	0.0700 (7%)	0.0158 (2%)	0.0032 (0.3%)	0.0000 (0.0%)	0.0000 (0.0%)
Southern #1 (With Floodfighting)	0.1310 (13%)	0.7548 (75%)	0.9702 (97%)	0.9991 (100%)	0.4643 (46%)	0.1317 (13%)	0.0447 (4%)	0.0117 (1%)	0.0025 (0.3%)	0.0002 (0.02%)

Table 18
Estimated Floodfight Costs (1)

Floodfight Activity	Mostly Dry Years		Average Weather		Mostly Wet Years	
	# of Events	Cost	# of Events	Cost	# of Events	Cost
Rock Revetment Floodfights	3	$3,000,000	4	$4,000,000	6	$6,000,000
Events with Floodfight Crews	6	$360,000	13	$780,000	20	$1,200,000
Associated Floodfighting Costs	-----	$450,000	-----	$975,000	-----	$1,500,000
Environmental Mitigation	-----	$360,000	-----	$530,000	-----	$800,000
Total Costs	-----	$4,170,000	-----	$6,285,000	-----	$9,500,000
Annualized Costs (2)	-----	$73,100	-----	$114,200	-----	$153,900

(1) Source: Appendix A: Plan Formulation
(2) Over 50 years; 5 5/8 interest rate.

Not surprisingly, regardless of the assumptions concerning weather conditions, all of the annualized floodfighting costs exceed the estimated annual damage reduced from floodfight activities (about $42,000).

E.4 WITH-PROJECT CONDITIONS

The objectives of the Hamilton City project are to improve ecosystem conditions along the Sacramento River and to reduce flood damage in the community of Hamilton City and surrounding agricultural areas. The benefits and costs of any proposed projects are determined by comparing "without project" vs. estimated "with-project" conditions.

E.4.1 Description of Alternatives

For the Hamilton City study area, several flood damage reduction and ecosystem restoration management measures were investigated and preliminary combined alternatives were identified which are summarized below. More detailed information can be found in Chapter 3 of the feasibility report.

- **No Action Alternative:** The Corps is required to consider the option of "No Action" as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the No Action plan, which is synonymous with the "Without-Project Condition," it is assumed that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. The No Action Alternative provides a base against which all other alternatives are measured and ensures that any action taken is more in the public interest than doing nothing.
- **Alternative #1:** Alternative 1 consists of constructing a levee about 6.6 miles long and about 6 feet high, set back roughly 500 to 7,600 feet from the river, and removal of most of the existing "J" levee. The alignment continues south of County Road 23 for about a mile as a training levee because it does not tie into high ground. Alternative 1 is shown in Figure 11.
- **Alternative #2:** Alternative 2 consists of constructing a setback levee about 3.8 miles long and setback roughly 1,300 to 2,700 feet from the river, breaching the existing "J" levee in several locations, and actively restoring about 1,400 acres of native habitat. Alternative 2 is shown in Figure 12.
- **Alternative #3:** Alternative 3 consists of This alternative consists of constructing a setback levee about 3.3 miles long and setback roughly 1,300 to 2,700 feet from the river, breaching the existing "J" levee in several locations, and actively restoring about 1,600 acres of native habitat. Alternative 3 is shown in Figure 13.
- **Alternative #4:** Alternative 4 consists of constructing a levee about 4.1 miles long, about 6 feet high, set back roughly 500 to 2,700 feet from the river, removing most of the existing "J" levee, and actively restoring about 1,100 acres of native habitat. Alternative 4 is shown in Figure 14.
- **Alternative #5.** Alternative 5 consists of This alternative plan consists of actively restoring about 1,600 acres of native vegetation, constructing a setback levee about 5.3 miles long, and about 6 feet high, and removing most of the existing "J" levee. The alignment continues south of County Road 23 for about a mile as a training levee because it does not tie into high ground. Alternative 5 is shown in

Figure 15.

- **Alternative #6.** Alternative 6 consists of actively restoring about 1,500 acres of native vegetation, constructing a setback levee about 5.7 miles long, and about 6 feet high, and removal of most of the existing "J" levee. The alignment continues south of County Road 23 for about a mile as a training levee because it does not tie into high ground. Alternative 6 is shown in Figure 16.
- **Alternative #7:** Alternative 7 does not include a setback levee and thus does not provide flood damage reduction benefits. All project lands, approximately 1,600 acres, would be restored but the "J" Levee would not be breached. Several of the areas to be restored would be located behind the existing J levee and would not be hydrologically connected to the river. Because of this, the value of the habitat in this alternative would be significantly lower in these areas because they are disconnected from the river and are not periodically subjected to flooding. Alternative 7 is shown in Figure 17.

Depending upon the alternative setback levee locations, individual analysis zones could be (i) located on the landside of the levee, thus lands would receive protection from it; (ii) located on the waterside of the levee, thus lands would be restored for ecosystem purposes; (iii) located to the south of the levee and may incur additional flooding, resulting in the need for flood easements to be purchased; or (iv) in some instances, not be affected by an alternative. Understanding how the analysis zones are affected by particular levee alignments was crucial for the FDA analysis.

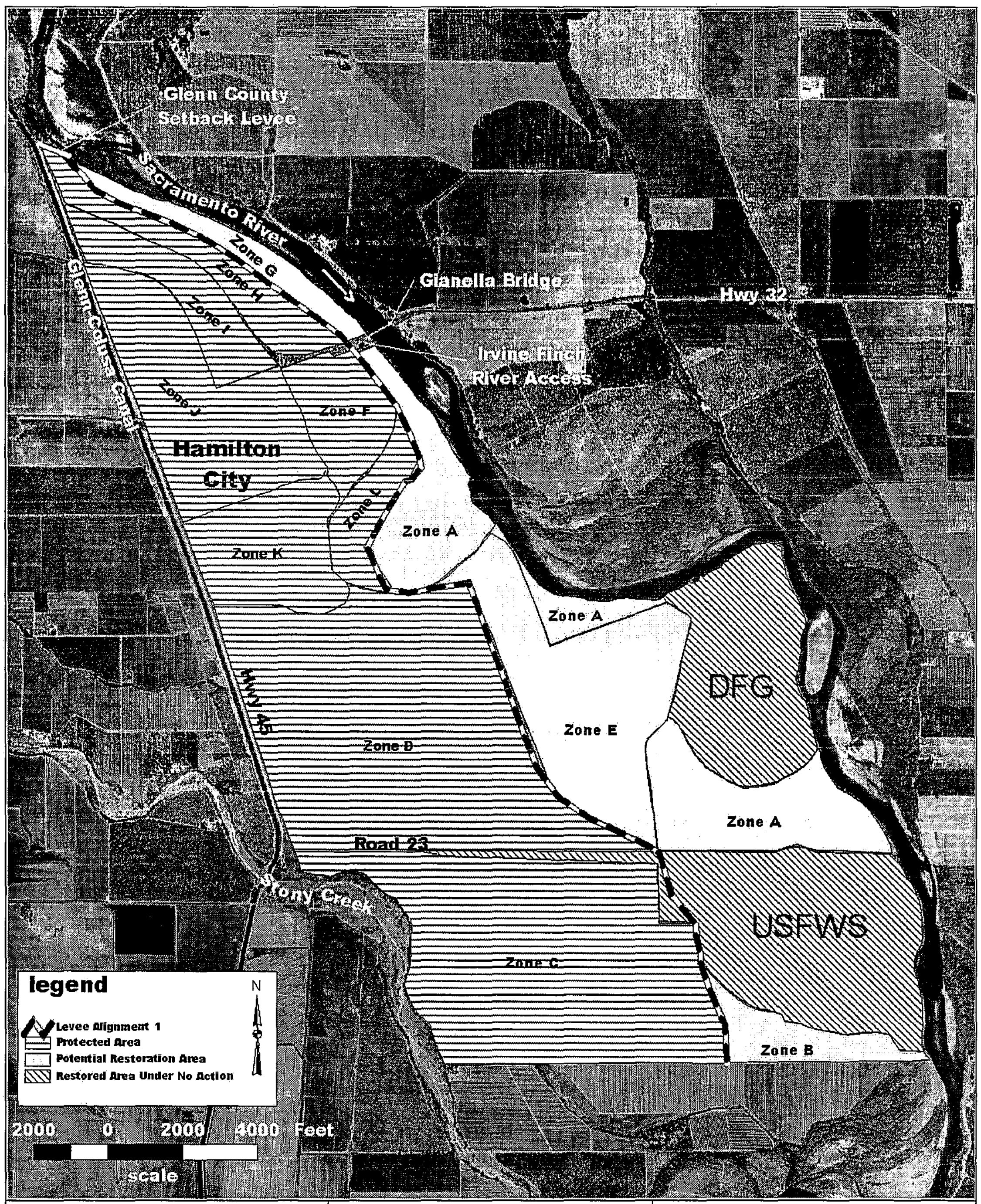
Table 19 summarizes how the alternatives affect the different analysis zones. The alternative levee setback alignments and areas protected, restored etc. are shown in Figures 11 - 17.

Table 19
Summary of Plans and Effects Upon Analysis Zones

Plan	No Change	Zones with Additional Protection (1)	Zones Restored	Zones with Easements
No Action	A - L	None	None	None
Alternative 1	None	C,D,F,H,I,J,K,L	A,B,E,G	None
Alternative 2	B,C,L	I,J,K	A,E,F,G,H	D
Alternative 3	B,C,L	J	A,E,F,G,H,I	D,K
Alternative 4	B,C	F,H,I,J,K,L	A,E,G	D
Alternative 5	L	D,I,J,K	A,B,E,F,G,H	None
Alternative 6	None	C,D,F,I,J,K,L	A,B,E,G,H	None
Alternative 7	B,C,D,J,K	None	A,E,F,G,H,I	None

(1) Analysis zones C & D still subject to some backwater flooding.

Figure 11
Alternative 1



Potential Restoration and Protection Zones - Alternative 1 -

Hamilton City
Flood Damage Reduction
and Ecosystem Restoration, CA

map created December 10, 2003

Figure 12
Alternative 2

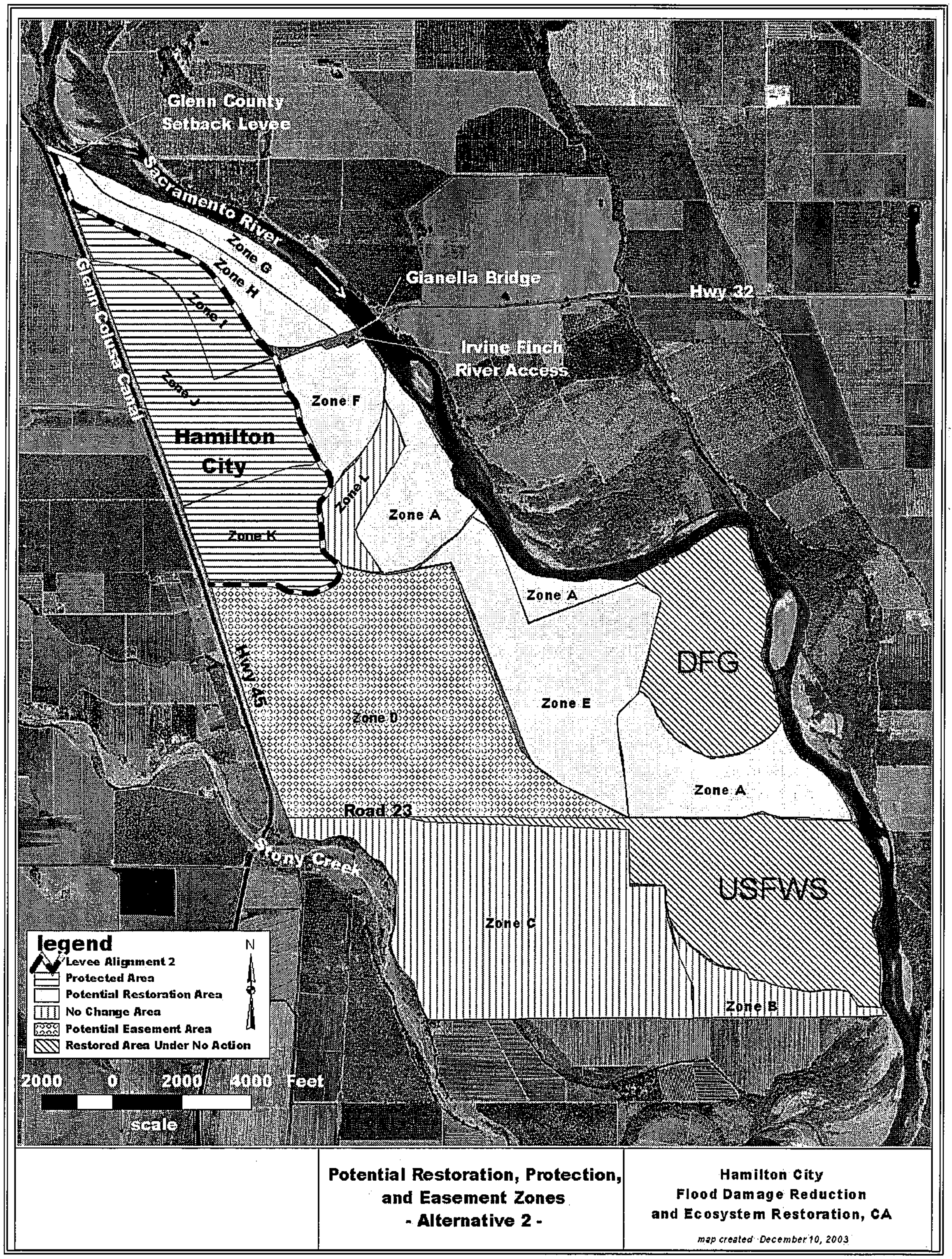


Figure 13
Alternative 3

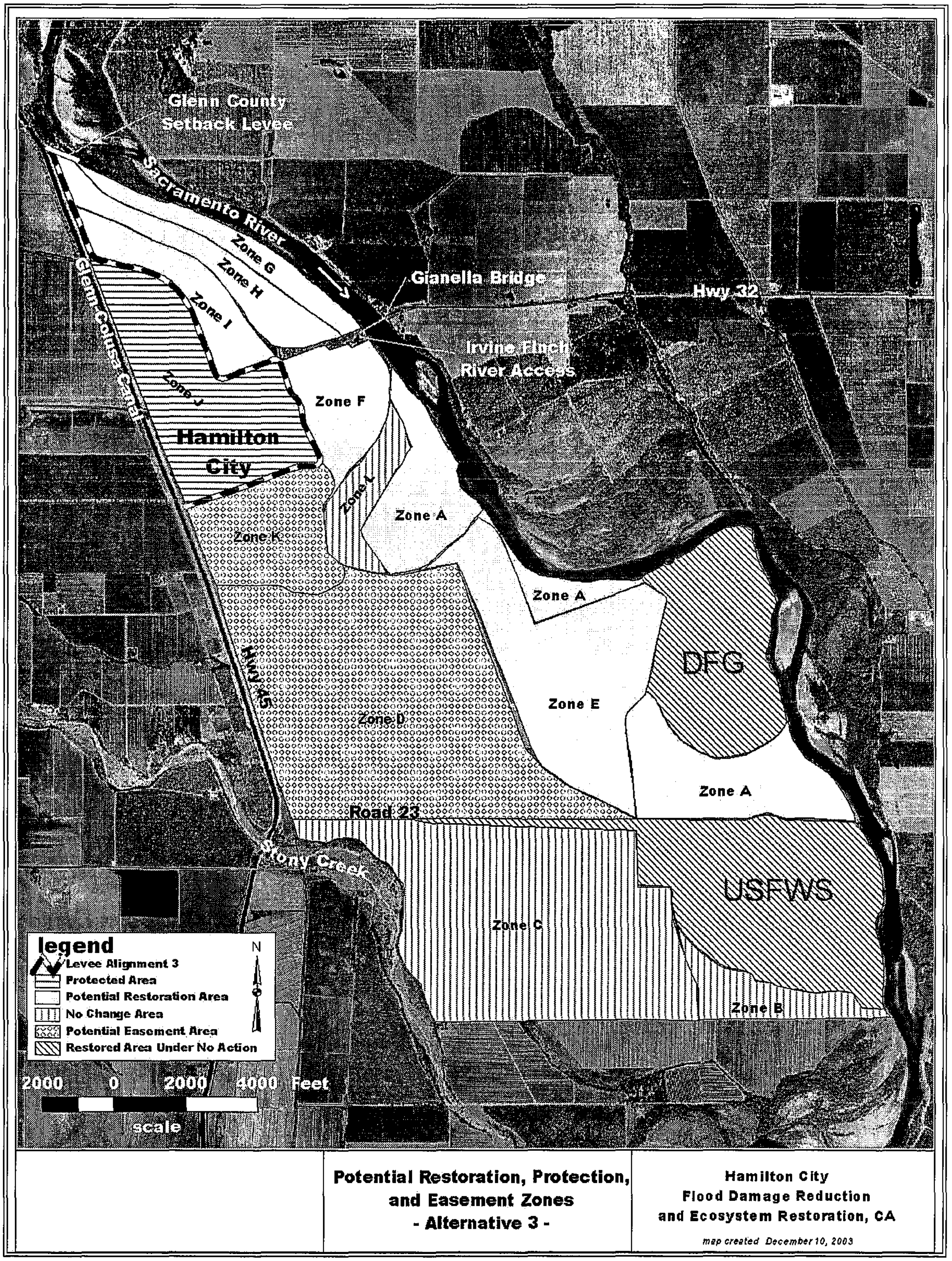
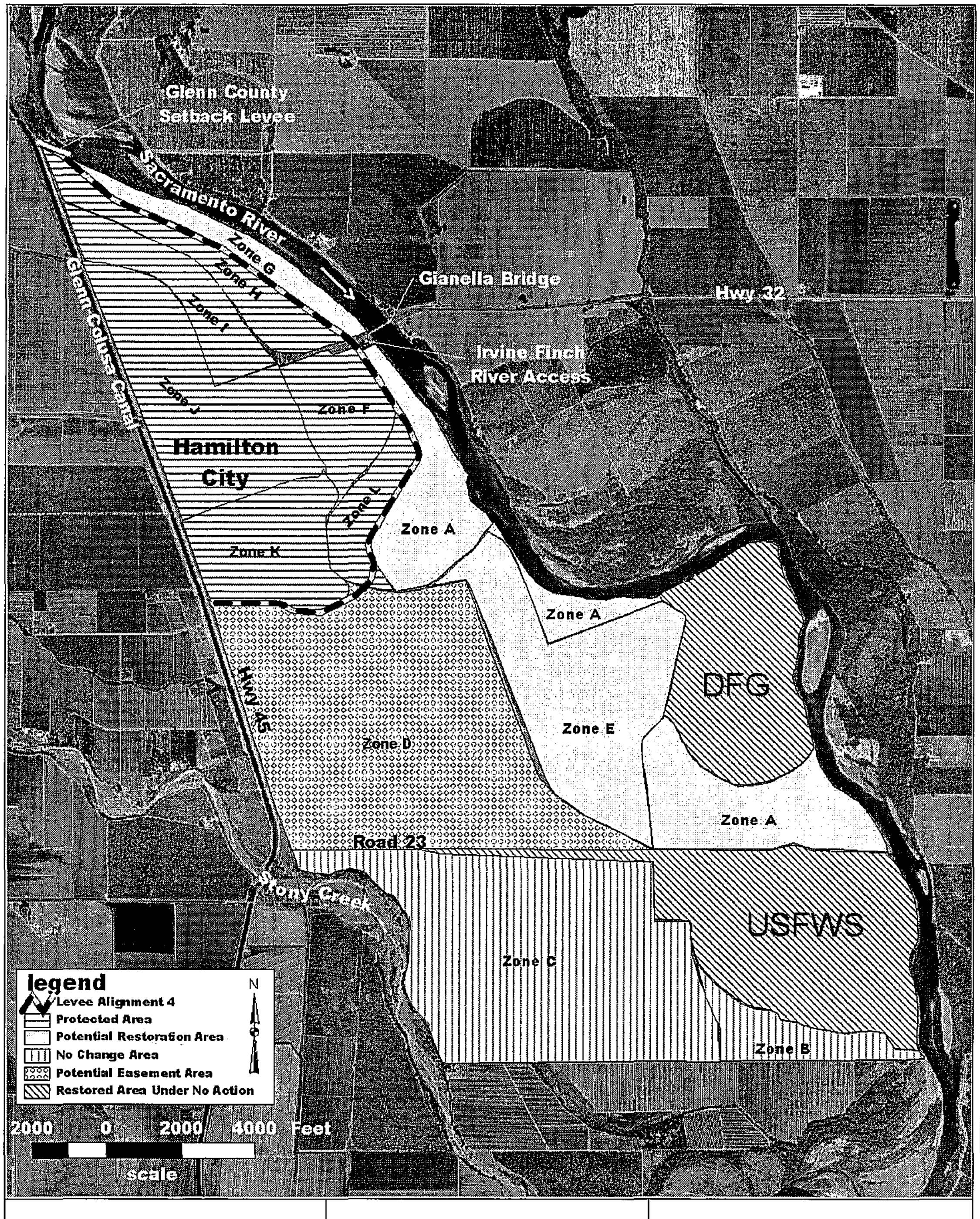


Figure 14
Alternative 4



Potential Restoration, Protection, and Easement Zones
- Alternative 4 -

Hamilton City
Flood Damage Reduction
and Ecosystem Restoration, CA

map created December 10, 2003

Figure 15
Alternative 5

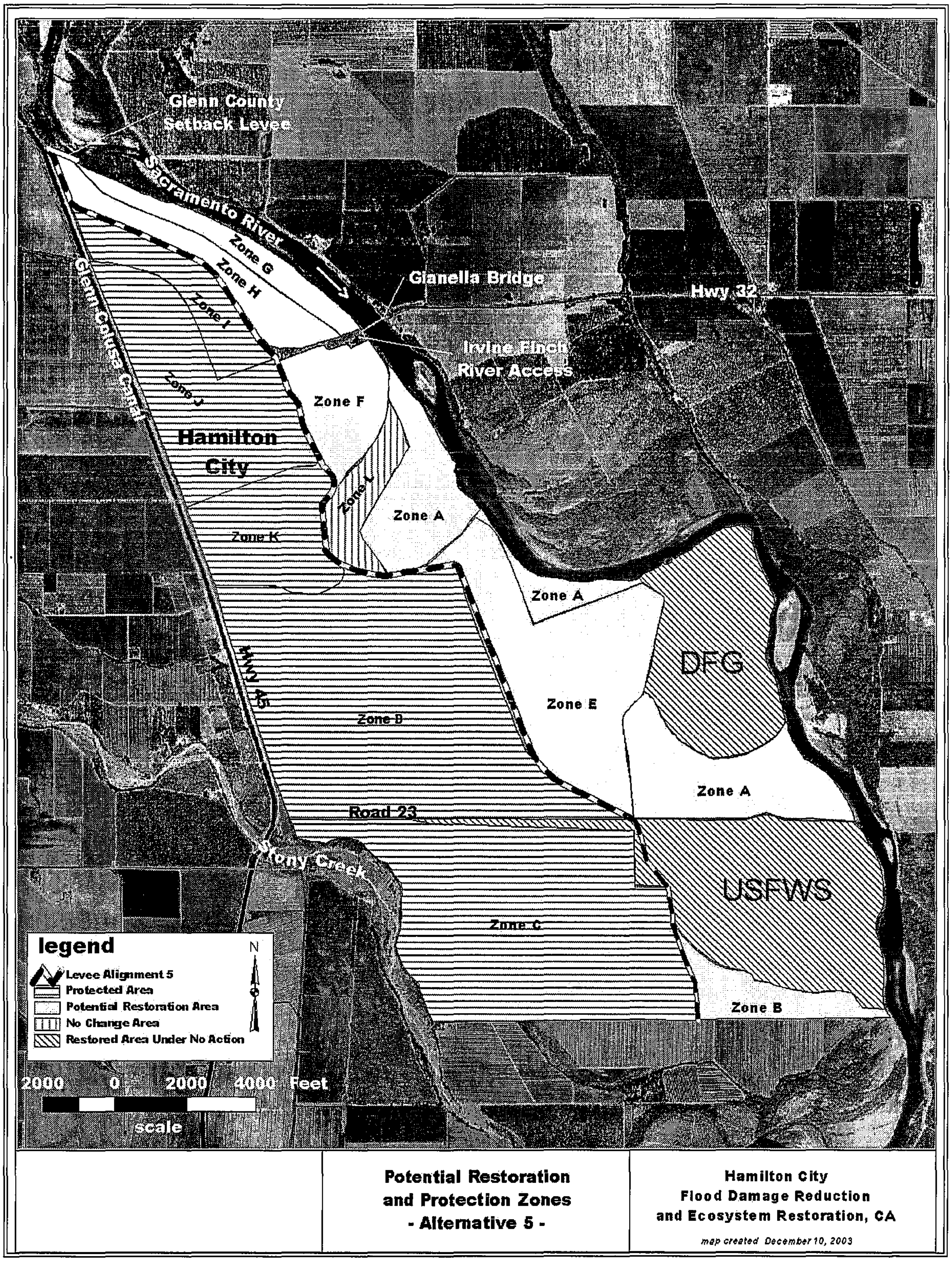
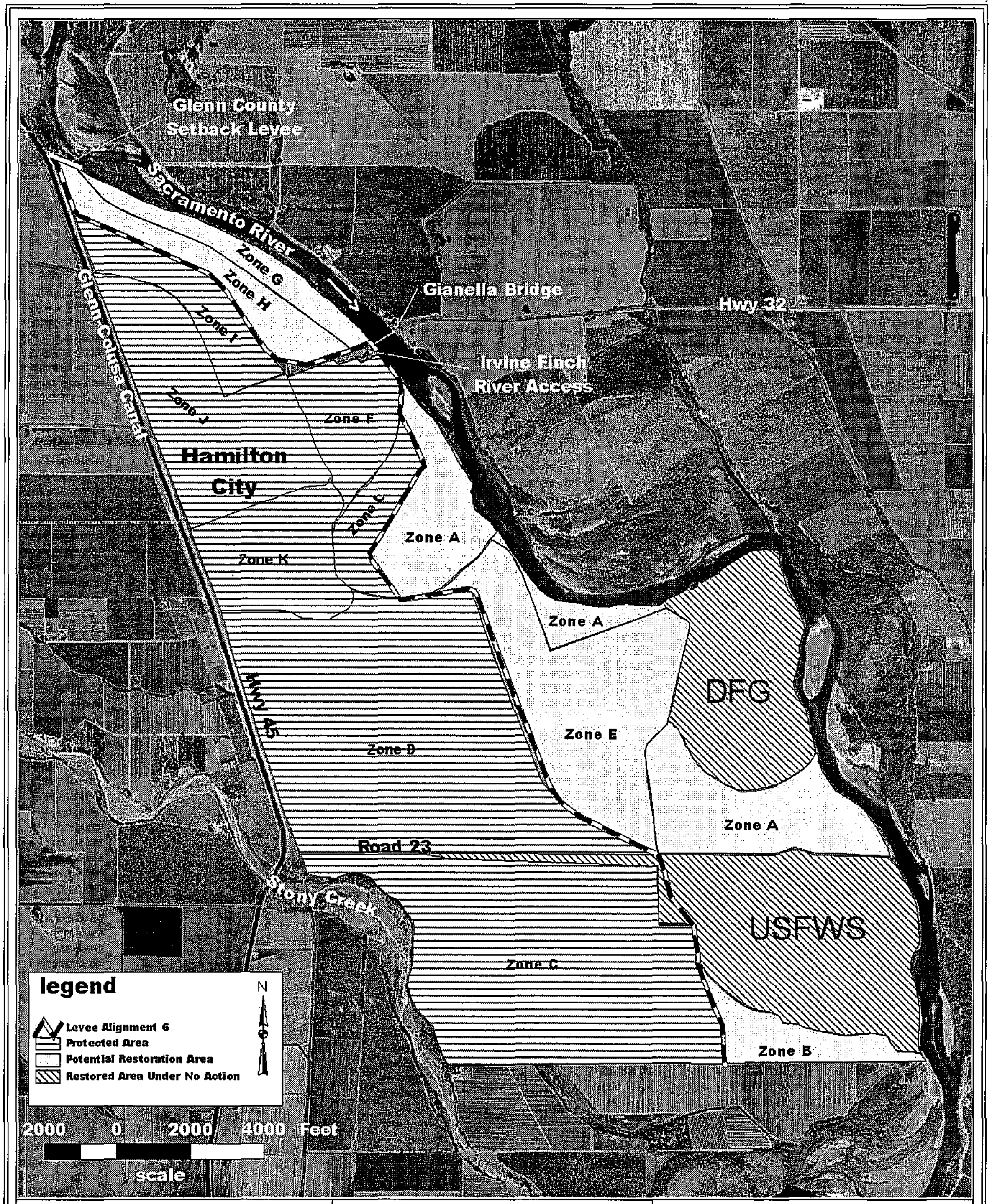
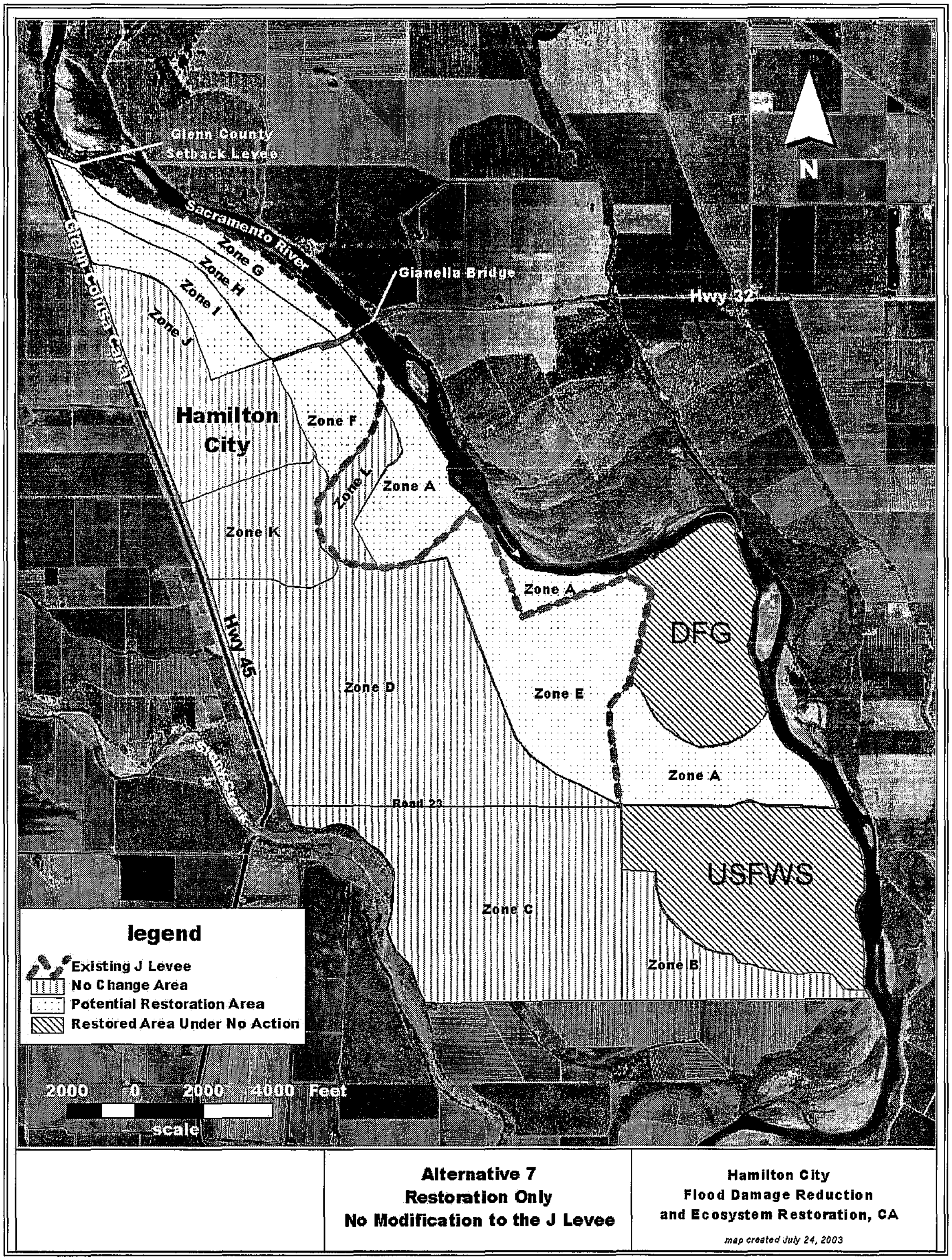


Figure 16
Alternative 6



	Potential Restoration and Protection Zones - Alternative 6 -	**Hamilton City Flood Damage Reduction and Ecosystem Restoration, CA** *map created. December 10, 2003*

Figure 17
Alternative 7



E.4.2 Levee Failure Assumptions

In addition to the location of the alternative levee setbacks, the other key assumption involves the height of the new levee. Will it be as high as (and stronger than) the existing (but poorly functioning) levee, or shorter (and stronger) than the existing levee? It has been determined that the height of the new replacement levee should be the same as the existing "J" Levee, which is about the same as the 100-year water surface elevation [17]. Table 20 summarizes the with-project levee failure assumptions. For a new levee, the PNP and PFP are assumed to be equal to the TOL.

Table 20
Levee Failure Curves
With-Project (1)

Levee Failure Curve	2003 H&H		
	Northern (RM 198.25)	Southern #1 (RM 197.25)	Southern #2 (RM 194.25)
TOL (2)	149.2	147.1	138.9
PFP (3)	149.2	147.1	138.9
PNP (4)	149.2	147.1	138.9
TOE (5)	142.4	137.0	133.9

(1) TOL was set to the height of the existing "J" Levee.
(2) Top of levee.
(3) Probable failure point (85% chance of failure).
(4) Probable non-failure point (15% chance of failure).
(5) Toe of levee.

E.4.3 Equivalent Annual Damage

Table 21 summarizes the total equivalent annual damage estimates for the without- and with-project conditions for all alternatives in all three impact areas (assuming floodfighting). Tables 22-24 summarize the alternatives' equivalent annual damage estimates for the without- and with-project conditions for each impact area. Because the various levee alternatives include increased protection to agricultural lands landside of the levee as well as conversion of some agricultural lands to native vegetation on the waterside of the levee, the EAD reductions are actually comprised of two components: damage reduction to existing crops because of improved levee protection and damage reduction resulting from taking lands out of production and therefore removing them from the flood threat. An advantage of creating FDA files for individual analysis zones is that it allows for these two components to be identified, as shown in Tables 21-24 and Figure 18. All of the alternative plans have significant amounts of damage reduction due to improved levee protection as well as removing lands from production. However, lands that will be protected by new setback levees will still be subject to some residual risk of flooding from levee failure. In comparison,

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[17] *Because a setback levee will be essentially "mitigation" for breaching the existing "J" Levee in order to accomplish ecosystem restoration, it was determined that the height of any setback levee should be the same as the "J" Levee. This height was chosen because the existing "J" Levee historically has passed flood events of this magnitude—albeit with significant floodfighting efforts.*

lands that are removed from production will not only have no residual agricultural flood damage, but they will also have additional ecosystem restoration (and possibly recreation) benefits. Chapter 3 (Plan Formulation) brings together all of the benefit and cost information for the alternatives.

E.4.4 Project Performance

Table 25 presents the with-project project performance statistics for the three impact areas. Project performance statistics were actually computed for each analysis zone, but because analysis zones within the same impact area had the same index point (i.e., the same H&H data), the project performance statistics for all analysis zones within an impact area are the same. The statistics in Table 25 can be compared with the without-project statistics in Table 17 (with floodfighting). Generally, with-project annual exceedance and long-term risk statistics should be lower than the without-project condition, and conditional non-exceedance values should be higher than the without-project condition.

Figure 18
Alternative Plans Damage Reduction: Restoration vs. Protection
All Impact Areas
TOL = 100 Year WSE
(Thousands of Dollars; October 2003 Price Levels)

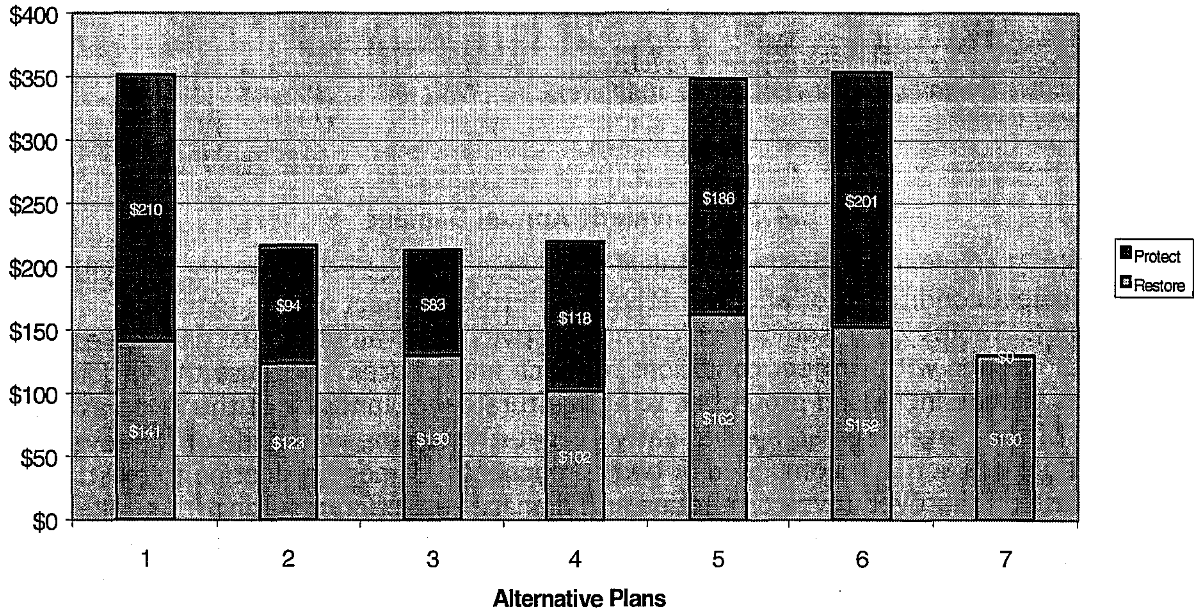

Table 21
Comparison of Alternative Plans' Equivalent Annual Damage and Damage Reduced by Project Purpose
All Impact Areas
(Thousands of Dollars; October 2003 Price Levels)(1)(2)

Plans	Equivalent Annual Damage			Damage Reduced[3]		
	Without Project	With-Project	Damage Reduced	Restore	Protect	Total
No Action	726	726	0	0	0	0
Alternative 1	726	375	351	141	210	351
Alternative 2	726	509	217	123	94	217
Alternative 3	726	513	213	130	83	213
Alternative 4	726	506	220	102	118	220
Alternative 5	726	378	348	162	186	348
Alternative 6	726	373	354	152	202	354
Alternative 7	720	596	130	130	0	130

(1) TOL for plans was set equal to the existing height of the "J" Levee (approximately 100 Yr water surface elevation (WSE) for all impact areas, including extension south of County Road 23.
(2) 5 5/8 interest rate; 50-year analysis period.
(3) Reduction in damage due to either land being restored or lands protected from new setback levee.

Table 22
Comparison of Alternative Plans' Equivalent Annual Damage and Damage Reduced by Project Purpose
Northern Impact Area
(Thousands of Dollars; October 2003 Price Levels) (1)(2)

Plan	Equivalent Annual Damage			Damage Reduced[3]		
	Without Project	With-Project	Damage Reduced	Restore	Protect	Total
No Action	407	407	0	0	0	0
Alternative 1	407	280	127	9	118	127
Alternative 2	407	283	124	30	94	124
Alternative 3	407	287	120	37	83	120
Alternative 4	407	280	127	9	118	127
Alternative 5	407	283	124	30	94	124
Alternative 6	407	278	129	21	109	129
Alternative 7	407	370	37	37	0	37

(1) TOL for plans was set equal to the existing height of the "J" Levee (approximately 100 Yr WSE).
(2) 5 5/8 interest rate; 50-year analysis period.
(3) Reduction in damage due to either land being restored or lands protected from new setback levee.

Table 23
Comparison of Alternative Plans' Equivalent Annual Damage and Damage Reduced by Project Purpose
Southern #1 Impact Area
(Thousands of Dollars; October 2003 Price Levels) (1)(2)

Plan	Equivalent Annual Damage			Damage Reduced[3]		
	Without Project	With-Project	Damage Reduced	Restore	Protect	Total
No Action	130	124	0	0	0	0
Alternative 1	130	17	113	46	67	113
Alternative 2	130	84	46	46	0	46
Alternative 3	130	84	46	46	0	46
Alternative 4	130	84	46	46	0	46
Alternative 5	130	17	113	46	67	113
Alternative 6	130	17	113	46	67	113
Alternative 7	130	84	46	46	0	46

(1) TOL for plans was set equal to the existing height of the "J" Levee (approximately 100 Yr WSE).
(2) 5 5/8 interest rate; 50-year analysis period.
(3) Reduction in damage due to either land being restored or lands protected from new setback levee.

Table 24
Comparison of Alternative Plans' Equivalent Annual Damage and Damage Reduced by Project Purpose
Southern #2 Impact Area
(Thousands of Dollars; October 2003 Price Levels) (1)(2)

Plan	Equivalent Annual Damage			Damage Reduced[3]		
	Without Project	With-Project	Damage Reduced (3)	Restore	Protect	Total
No Action	189	189	0	0	0	0
Alternative 1	189	78	111	86	25	111
Alternative 2	189	143	47	47	-	47
Alternative 3	189	143	47	47	0	47
Alternative 4	189	143	47	47	0	47
Alternative 5	189	78	111	86	25	111
Alternative 6	189	78	111	86	25	111
Alternative 7	189	143	47	47	0	47

(1) TOL for plans was set equal to the existing height of the "J" Levee (approximately 100 Yr WSE).
(2) 5 5/8 interest rate; 50-year analysis period.
(3) Reduction in damage due to either land being restored or lands protected from new setback levee.

Table 25
Project Performance Statistics
With-Project (1)
TOL = 100 Year WSE

Impact Area	**Annual Exceedance Probability (Expected)**	**Long Term Risk (Years)**			**Conditional Non-Exceedance Probability by Events**					
		10	**25**	**50**	**10% (1 in 10 years)**	**4% (1 in 25 years)**	**2% (1 in 50 years)**	**1% (1 in 100 years)**	**0.40% (1 in 250 years)**	**0.20% (1 in 500 years)**
Northern	0.0170 (2%)	0.1570 (16%)	0.3476 (35%)	0.5744 (57%)	0.9991 (100%)	0.9099 (91%)	0.7213 (72%)	0.4290 (43%)	0.1256 (13%)	0.0207 (2%)
Southern #1(2)	0.0130 (1%)	0.1200 (12%)	0.2735 (27%)	0.4722 (47%)	0.9994 (100%)	0.9632 (96%)	0.8101 (81%)	0.5283 (53%)	0.1991 (20%)	0.0585 (6%)
Southern #2 (2)	0.0140 (1%)	0.1318 (13%)	0.2976 (30%)	0.5067 (51%)	0.9998 (100%)	0.9448 (94%)	0.7848 (78%)	0.5052 (51%)	0.1621 (16%)	0.0279 (3%)

(1) Reflects risk of levee failure only and does not include risk of backwater flooding.

(2) Statistics for these impact areas are for analysis zones located behind levees; analysis zones restored on the water side of the levees will have a greater risk of flooding.

E.4.5 Backwater Flood Damage Analysis

Backwater flooding occurs when floodwater creeps around the southern end of the existing "J" Levee and fills in low-lying (primarily agricultural) lands to the north in the Southern impact area #1. Although not protected by the existing "J" Levee, the Southern impact area #2 is also subject to backwater flooding from lands further to the south. Backwater flooding can reach as far north as the southern edge of Dunning Slough (on the *landside* of the "J" Levee) and it typically occurs more frequently than flooding from levee failures. However, backwater flooding does not usually occur with the higher flood velocities associated with levee failure flooding (which can flow quickly through narrow breaks in levees), so damage tends to be less. Figure 9 shows the estimated existing backwater floodplains from water flowing around the southern end of the existing "J" Levee. If the "J" Levee were to be extended further south (as in some of the alternatives), backwater flooding would still be present although the floodplains would shift southward.

Figure 10 illustrates the differences in levee failure vs. backwater flooding. Areas subject to levee failure flooding include I and II, with water originating from the river breaching the "J" Levee. In contrast, backwater flooding flows around the southern edge of the "J" Levee (through area III) and up into area II. Total flood damage should then be computed for areas I + II + III. But, these cannot be simply added together. Using Figure 10 as an example, adding damage in areas flooded by levee failures (I and II) to areas flooded by backwater flooding (II and III) double counts damage occurring in area II.

The extents of the two types of floodplains (levee failure and backwater) may not always match (for example, as shown in Figure 10). Sometimes the extent of the backwater flooding may occur entirely within the extent of the levee failure floodplain, sometimes just the opposite, or they may overlap unevenly. To avoid expending significant amounts of time and resources studying the backwater flooding issue, a simplifying assumption was made that one of the floodplains (levee failure or backwater) is always contained within the other. Given this assumption, damage estimates from the levee failure and backwater flooding scenarios were computed separately using FDA, and the larger estimate of the two was taken as the damage estimate for that analysis zone.

Table 26 illustrates this analysis for economic analysis zones C and D.[18] For economic analysis zone D, without-project equivalent annual damage is estimated to be about $84,000. This damage results from the potential failure of the southern portion of the existing "J" Levee. This zone is also subject to backwater flooding as water creeps north around the southern end of the existing "J" Levee, causing an equivalent annual damage estimated to be about $21,000. With-project levee failure equivalent annual damage is estimated to be about $17,000 (for the 100-year water surface elevation levee height) compared to backwater equivalent annual flood damage of about $3,000. Because the potential levee failure damage is greater than the backwater flood damage for the without- and with-project conditions, the reduction in damage is computed by taking the difference between the levee failure damage and ignoring backwater flood damage. Thus, for the 100-year WSE levee height, the annual reduction in damage (i.e., benefit) of the proposed levee height is about $67,000.

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[18] *Economic analysis zone D is located within the Southern #1 impact area and zone C is located within the Southern #2 impact area. Other economic analysis zones are located within these impact areas, however they are located to the east of the proposed levee alignment. Thus they will be restored and will have no remaining "with-project" residual flood damage. See Figures 3 and 16.*

The analysis is different for economic analysis zone C. This zone is located south of County Road 23, which is below the southern extent of the existing "J" Levee. Existing without-project equivalent annual damage resulting from levee failure flooding is estimated to be about $103,000. This zone is also subject to backwater flooding from water coming north from lands located to the south; this equivalent annual damage is estimated to be about $78,000. Although a levee extension into this zone (with a height equal to the 100-year WSE) will reduce potential levee failure equivalent annual flood damage to about $8,000, this reduction in damage cannot be achieved because of the continued presence of backwater flooding. Thus, the maximum benefit that could be achieved is about $25,000—the difference between levee failure and backwater flood damage. This benefit can be achieved with a relatively low-height levee (at about the 5 year-WSE). Levee heights above this would not appear to gain additional economic benefits.

An interesting observation concerns the reduction in with-project backwater flood damage in economic analysis zone D. The existing "J" Levee terminates at the southern end of this impact area (at County Road 23), which allows the backwater flooding to flow around this southern end and back north into the impact area. With the proposed levee extension south of County Road 23, this backwater flooding still occurs, but the extent and magnitude of the flooding is reduced as the backwater floodplain is shifted to the south. Figure 19 shows the "with-project" backwater floodplains, which can be compared to Figure 9, which shows the "without-project" backwater floodplains. The floodplains in Figure 19 have shifted to the south compared to the floodplains in Figure 9.

Thus, the backwater equivalent annual flood damage in economic analysis zone D is reduced from about $21,000 to about $3,000 (or a benefit of $18,000) with the levee extension. When this benefit ($18,000) is combined with the reduction in "overbank" damage in economic analysis zone C from the levee extension (about $25,000), the total equivalent annual damage reduction from the levee extension is obtained—about $43,000.

Table 26
Backwater Flood Damage Analysis
Economic Analysis Zones D and C
(Thousands of Dollars; October 2003 Price Levels)

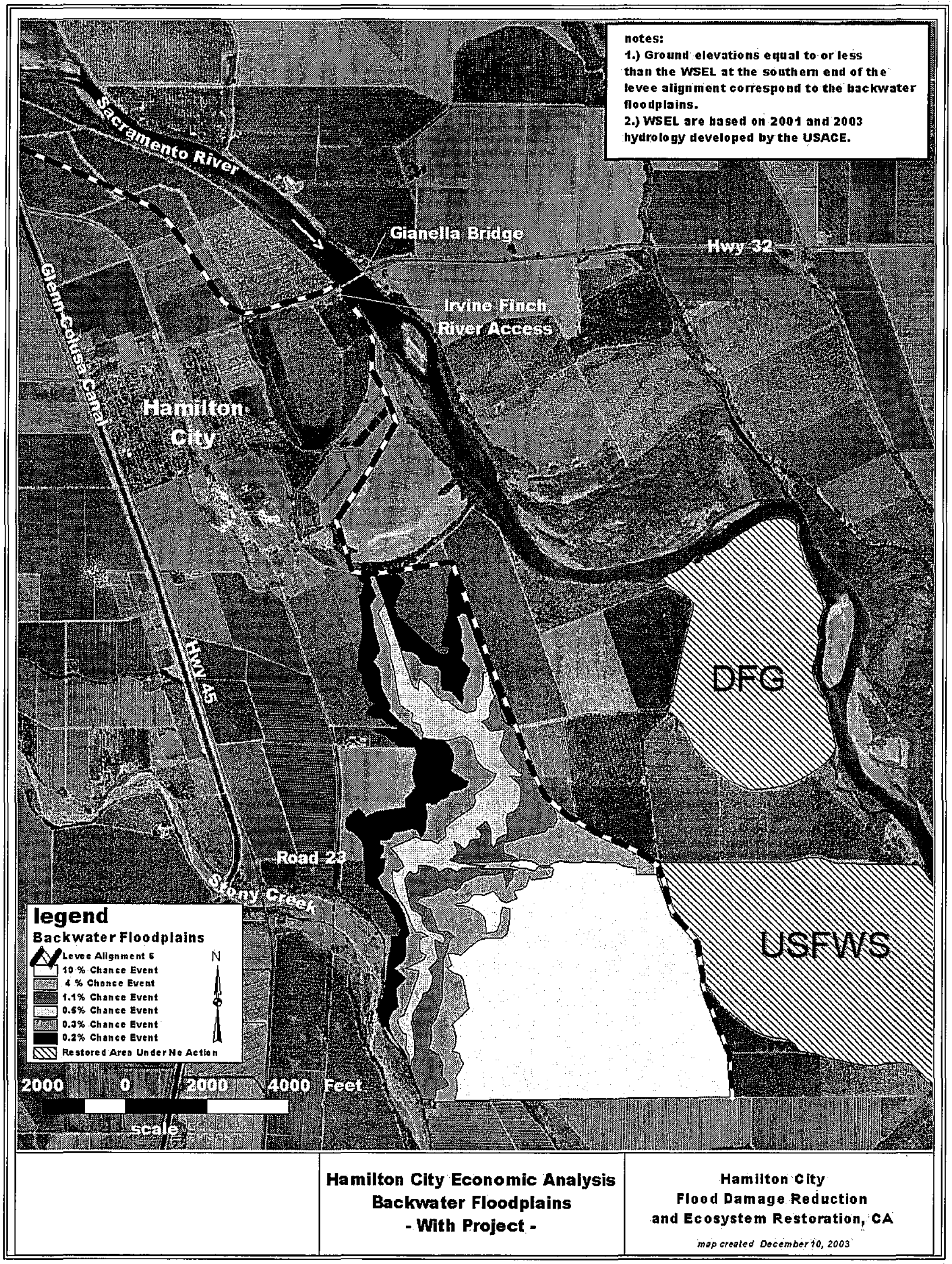
Economic Analysis Zone D (Southern #1 Impact Area)

WSE	W/O Project		With-Project		Damage Reduction
	Levee Failure	Backwater	Levee Failure	Backwater	
200	84	21	10	3	74
100	84	21	17	3	67
50	84	21	25	3	59
25	84	21	37	3	47

Economic Analysis Zone C (Southern #2 Impact Area)

WSE	W/O Project		With-Project		Damage Reduction
	Overbank	Backwater	Levee Failure	Backwater	
100	103	78	8	78	25
50	103	78	13	78	25
25	103	78	23	78	25
10	103	78	52	78	25
5	103	78	72	78	25

Figure 19
Hamilton City Economic Analysis Floodplains
Backwater Flooding
With-Project



notes:
1.) Ground elevations equal to or less than the WSEL at the southern end of the levee alignment correspond to the backwater floodplains.
2.) WSEL are based on 2001 and 2003 hydrology developed by the USACE.

E.4.6 Identification of the Final Array of Alternatives

Although the Hamilton City project will address flood damage reduction and ecosystem restoration purposes, recent Corps guidance[19] requires that:

- Plans first be formulated that address the *primary* purpose of the study,
- After the primary purpose has been identified, develop the NER (National Ecosystem Restoration) or NED (National Economic Development) combined plan, and then
- Formulate plans that address other problems and opportunities as well as the primary purpose.

For Hamilton City, the primary purpose has been identified as ecosystem restoration (NER). All of the alternatives discussed previously (with the exception of the No Action alternative) have ecosystem restoration as their primary purpose. Through the plan formulation process described in Chapter 3, the final array of combined NER/FDR alternatives that will be evaluated further (in addition to No Action) include Alternative 1, Alternative 5, and Alternative 6. These alternatives combine both flood damage reduction and ecosystem restoration objectives.

A setback levee is required for some ecosystem restoration-only plans to avoid induced flooding of lands outside of the project site caused by the intentional breaching of the "J" Levee. Therefore, it was necessary to determine at what elevation this replacement levee should be built. One procedure that could be used by the Corps would be to set the elevation of a replacement levee such that the annual exceedance (i.e. failure) probability for the replacement levee should be about the same as the existing levee. If this "risk and uncertainty" approach were to be followed, the elevation of the replacement levee would be considerably less than the existing "J" Levee. However, because of significant floodfighting efforts, the existing "J" Levee has the **possibility** of passing large events, a possibility which would not exist if a lower replacement levee were constructed. In addition, there are social and legal considerations (for example, obtaining State Reclamation Board approval) that would make a lower replacement levee unacceptable and unimplementable. Thus, as discussed in Chapter 3, it has been determined that the elevation of any setback levee for an ecosystem restoration-only plan should be the same elevation as the "J" Levee, which is close to the 100-year water surface elevation. This determination is consistent with previous Corps practice and received HQUSACE and SPD concurrence during the AFB conference. Figure 20 illustrates these concepts.

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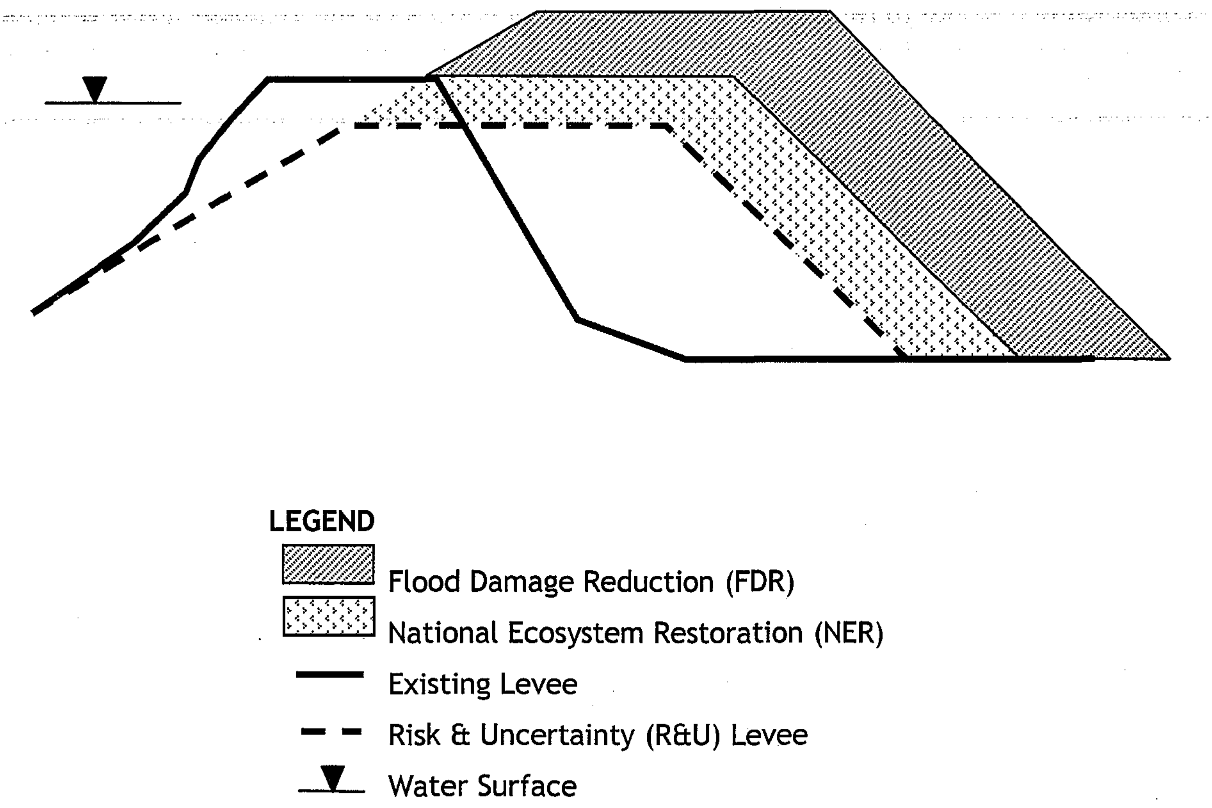
[19] *EC 1105-2-404, "Planning Civil Works Projects Under The Environmental Operating Principles", 1 May 2003.*

Figure 20
Hamilton City NER Levee Elevation Analysis



1 Note: The R&U Levee (Replacement) will meet the performance of the existing levee but is susceptible to overtopping at lesser flows than the existing levee. The NER levee meets Reclamation Board requirements. The NER levee is also based on social and political considerations that have to be included for project implementation. The FDR Levee provides the NER requirements and provides protection from higher flows thereby negating too-typical flood fighting efforts.

E.4.7 Levee Elevations and Incremental Flood Damage Reduction Benefits

Given this recommended NER levee elevation, the question remains if it would be economically feasible to raise any selected setback levee above the 100-year water surface elevation in order to provide additional flood damage reduction (FDR) benefits. Thus, for the final array alternatives, FDA was run incorporating the 200-, 320-, and 500-year water surface elevations plus the estimated FEMA certification levee elevation shown in Table 27 (assuming that PNP = PFP = top of levee).[20] Levee elevations greater than the 100-year water surface elevation were not analyzed for the Southern #2 impact area levee extension because they would protect primarily agricultural lands.

Table 27
Northern and Southern #1 Impact Areas
Levee Elevations (Feet)

Impact Area	Water Surface Elevations								
	River Mile	10 Yr WSE	25 Yr WSE	50 Yr WSE	100 Yr WSE	200 Yr WSE	320 Yr WSE	FEMA Cert	500 Yr WSE
Northern	198.25	145.7	147.9	148.4	149.5 (1)	150.4	150.8	151.2	152.3
Southern #1	197.25	143.2	144.9	145.9	147.1	147.9	148.0	148.8	149.1
Southern #2	194.25	135.4	136.98 (3)	137.9	138.9	N.A (2)	N.A (2)	N.A (2)	N.A (2)

(1) Within FDA, TOL was set equal to 149.2, which is the top of the "J" Levee at that river mile.
(2) Not analyzed above the 100 year WSE.
(3) 20 year WSE.

The results of this incremental FDR benefit analysis are shown in Tables 28-30 for the final array alternatives. In the section "Average Annual Benefits", these tables present:

- Residual flood damage remaining for the different setback levee heights;
- Flood damage reduction (compared to the without-project condition) for each of the levee heights;
- Avoided floodfight costs (assuming average weather conditions);
- Total annual FDR benefits, which are the sum of flood damage reduction and the avoided floodfight costs; and
- Incremental FDR benefits between successive levee height increases.

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[20] *FEMA and the Corps have agreed to criteria for certifying that a levee would be able to pass a 100-year (1% chance) flood event. Although the criteria vary somewhat depending upon local circumstances, they basically state that a levee must have at least a 90 percent chance of passing the 100-year (1%) flood event. This flood event is a critical threshold for the National Flood Insurance Program, because development within the 100-year (1% chance) floodplain is subject to NFIP development regulations and flood insurance requirements. It should be pointed out that in order to achieve the 90 percent confidence of passing the 100-year flood event, the levee usually must be designed at an elevation greater than the 100-year flood event because we can not predict with certainty exactly where the 100-year water surface elevation is likely to be.*

Under "Average Annual Costs", these tables present:

- Total levee first costs, which are the estimated construction costs for the different levee heights;
- Total FDR levee first costs, which are the construction costs allocated to the FDR purpose (primarily increased levee volume costs above the NER plan plus rock erosion protection costs);
- Annualized total levee and FDR-allocated first costs; and
- Incremental FDR costs between successive levee height increases.

The tables also show the average annual FDR net benefits (which are the difference between annualized FDR benefits and costs), incremental FDR net benefits, FDR benefit/cost ratios and two key project performance statistics for the Northern impact area, which includes the community of Hamilton City. Figures 21- 29 graphs the B/C ratios, FDR net benefits, and annual net benefits vs. annual FDR costs. For Alternatives 1, 5 and 6, net benefits decrease for levee heights above the 320-year water surface elevation.

Since the evaluation of the preliminary combined plans, initial hydraulic runs have been completed which suggest potential hydraulic impacts on the left bank (east side) of the Sacramento River if levee elevations in the Southern #1 and #2 impact areas are too high. Consequently, the final array alternatives were reevaluated using decreasing levee elevations for the three impact areas: Northern, 320-year water surface elevation; Southern #1, 100-year water surface elevation; and Southern #2, 20-year water surface elevation (training levee). The resulting without- and with-project flood damage reduction benefits for the final array alternatives are shown in Table 31. The selection of the recommended combined plan (Alternative 6) is discussed in Chapter 3, which takes into account ecosystem restoration benefits and costs, flood damage reduction benefits and costs, and potential hydraulic impacts across the Sacramento River. The project performance statistics for the without project condition and the recommended plan (Alternative 6) are summarized in Tables 32 and 33.

Table 28
Alternative 1 FDR Levee Elevation Analysis
(Thousands of Dollars; October 2003 Price Levels)

Benefits and Costs	Without Project (1)	100 Yr WSE NER Only (2)	Combined NER + FDR Plans			
			100 Yr WSE With Train. Levee (3)	200 Yr WSE With Train. Levee (3)	320 Yr WSE With Train. Levee (3)	500 Yr WSE With Train. Levee (3)
Levee Elevations (FT)						
Northern Impact Area	149.2	149.2	149.2	150.4	150.8	152.3
Southern #1 Impact Area	145.3	147.1	147.1	147.9	148	149.1
Southern #2 Impact Area	133.9 Bank	138.9	138.9	138.9 (4)	138.9 (4)	138.9 (4)
Average Annual Benefits						
Residual Flood Damage	$726	$418	$375	$285	$257	$164
Flood Damage Reduction	-----	$308	$351	$441	$469	$562
Avoided Floodfight Costs (5)	-----	$114	$114	$114	$114	$114
Annual FDR Benefits	-----	$422	$465	$555	$583	$676
Incremental Annual FDR Benefits	-----	$0	$43	$90	$28	$93
Average Annual Costs						
Total Project First Costs (6)	-----	$42,006	$42,006	$42,154	$42,343	$44,273
Total FDR First Costs	-----	$0	$685	$834	$1,024	$2,956
Annual Project Costs (7)	-----	$2,525	$2,525	$2,533	$2,545	$2,661
Annual FDR Costs (7)	-----	$0	$41	$50	$62	$178
Incremental Annual FDR Costs	-----	$0	$0	$9	$11	$116
Average Annual FDR Net Benefits (7)	-----	$422	$424	$505	$521	$498
Incremental Annual FDR Net Benefits	-----	$0	$2	$81	$17	-$23
FDR Benefit/Cost Ratio	-----	-----	11.30	11.07	9.47	3.81

Project Performance Statistics						
90% Confidence of Passing *x* Event						
Northern Impact Area	< 10 yr	26 yr	26 yr	59 yr	75 yr	190 yr
Southern #1 Impact Area	< 10 yr	35 yr	35 yr	58 yr	62 yr	146 yr
Southern #2 Impact Area	< 10 yr	37 yr	37 yr	NA	NA	NA
Annual Exceedance Probability						
Northern Impact Area	0.0860	0.0170	0.0170	0.0070	0.0050	0.0010
Southern #1 Impact Area	0.1310	0.0130	0.0130	0.0070	0.0060	0.0030
Southern #2 Impact Area	0.2370	0.0140	0.0140	NA	NA	NA

(1) Assumes floodfighting except for the Southern #2 impact area which has no existing levee
(2) Assumed mitigation levee elevation (NER Plan); no training levee
(3) Includes training levee south of County Road 23 (Southern #2 Impact Area)
(4) Not analyzed above the 100 WSE
(5) Assuming average weather conditions
(6) Excludes cultural resource preservation.
(7) 5 5/8 interest rate; 50 yrs

Table 29
Alternative 5 FDR Levee Elevation Analysis
(Thousands of Dollars; October 2003 Price Levels)

Benefits and Costs	Without Project (1)	100 Yr WSE NER Only (2)	Combined NER + FDR Plans			
			100 Yr WSE With Train. Levee (3)	200 Yr WSE With Train. Levee (3)	320 Yr WSE With Train. Levee (3)	500 Yr WSE With Train. Levee (3)
Levee Elevations (FT)						
Northern Impact Area	149.2	149.2	149.2	150.4	150.8	152.3
Southern #1 Impact Area	145.3	147.1	147.1	147.9	148	149.1
Southern #2 Impact Area	133.9 Bank	138.9	138.9	138.9 (4)	138.9 (4)	138.9 (4)
Average Annual Benefits						
Residual Flood Damage	$726	$421	$378	$292	$265	$174
Flood Damage Reduction	-----	$305	$348	$434	$461	$552
Avoided Floodfight Costs (5)	-----	$114	$114	$114	$114	$114
Annual FDR Benefits	-----	$419	$462	$548	$575	$666
Incremental Annual FDR Benefits	-----	$0	$43	$86	$27	$91
Average Annual Costs						
Total Project First Costs (6)	-----	$49,035	$49,035	$49,343	$49,545	$51,486
Total FDR First Costs	-----	$0	$685	$994	$1,197	$3,138
Annual Project Costs (7)	-----	$2,947	$2,947	$2,966	$2,978	$3,094
Annual FDR Costs (7)	-----	$0	$41	$60	$72	$189
Incremental Annual FDR Costs	-----	$0	$0	$19	$12	$117
Average Annual FDR Net Benefits (7)	-----	$419	$421	$488	$503	$477
Incremental Annual FDR Net Benefits	-----	$0	$2	$67	$15	-$26
FDR Benefit/Cost Ratio	-----	-----	11.22	9.17	7.99	3.53

Project Performance Statistics						
90% Confidence of Passing *x* Event						
Northern Impact Area	< 10 yr	25 yr	26 yr	59 yr	75 yr	190 yr
Southern #1 Impact Area	< 10 yr	35 yr	35 yr	58 yr	62 yr	146 yr
Southern #2 Impact Area	< 10 yr	37 yr	37 yr	NA	NA	NA
Annual Exceedance Probability						
Northern Impact Area	0.0860	0.0170	0.0170	0.0070	0.0050	0.0010
Southern #1 Impact Area	0.1310	0.0130	0.0130	0.0070	0.0060	0.0030
Southern #2 Impact Area	0.2370	0.0140	0.0140	NA	NA	NA

(1) Assumes floodfighting
(2) Assumed mitigation levee elevation (NER Plan); no training levee
(3) Includes training levee south of County Road 23 (Southern #2 Impact Area)
(4) Not analyzed above the 100 WSE
(5) Assuming average weather conditions
(6) Excludes cultural resource preservation.
(7) 5 5/8 interest rate; 50 yrs

Table 30
Alternative 6 Levee Elevation Analysis
(Thousands of Dollars; October 2003 Price Levels)

Benefits and Costs	Without Project (1)	100 Yr WSE NER Only (2)	Combined NER + FDR Plans			
			100 Yr WSE With Train. Levee (3)	200 Yr WSE With Train. Levee (3)	320 Yr WSE With Train. Levee (3)	500 Yr WSE With Train. Levee (3)
Levee Elevations (FT)						
Northern Impact Area	149.2	149.2	149.2	150.4	150.8	152.3
Southern #1 Impact Area	145.3	147.1	147.1	147.9	148	149.1
Southern #2 Impact Area	133.9 Bank	138.9	138.9	138.9 (4)	138.9 (4)	138.9 (4)
Average Annual Benefits						
Residual Flood Damage	$726	$416	$373	$294	$256	$164
Flood Damage Reduction	-----	$310	$353	$432	$470	$562
Avoided Floodfight Costs (5)	-----	$114	$114	$114	$114	$114
Annual FDR Benefits	-----	$424	$467	$546	$584	$676
Incremental Annual FDR Benefits	-----	$0	$43	$79	$38	$92
Average Annual Costs						
Total Project First Costs (6)	-----	$43,191	$43,191	$43,419	$43,615	$45,610
Total FDR First Costs	-----	$0	$685	$912	$1,109	$3,106
Annual Project Costs (7)	-----	$2,596	$2,596	$2,609	$2,621	$2,741
Annual FDR Costs (7)	-----	$0	$41	$55	$67	$187
Incremental Annual FDR Costs	-----	$0	$0	$14	$12	$120
Average Annual FDR Net Benefits (7)	-----	$424	$426	$491	$517	$489
Incremental Annual FDR Net Benefits	-----	$0	$2	$65	$26	-$28
FDR Benefit/Cost Ratio	-----	-----	11.34	9.96	8.76	3.62

Project Performance Statistics						
90% Confidence of Passing *x* Event						
Northern Impact Area	< 10 yr	26 yr	26 yr	59 yr	75 yr	190 yr
Southern #1 Impact Area	< 10 yr	35 yr	35 yr	58 yr	62 yr	146 yr
Southern #2 Impact Area	< 10 yr	37 yr	37 yr	NA	NA	NA
Annual Exceedance Probability						
Northern Impact Area	0.0860	0.0170	0.0170	0.0070	0.0050	0.0010
Southern #1 Impact Area	0.1310	0.0130	0.0130	0.0070	0.0060	0.0030
Southern #2 Impact Area	0.2370	0.0140	0.0140	NA	NA	NA

(1) Assumes floodfighting except for the Southern #2 impact area which has no existing levee

(2) Assumed mitigation levee elevation (NER Plan); no training levee.

(3) Includes training levee south of County Road 23 (Southern #2 Impact Area)

(4) Not analyzed above the 100 WSE

(5) Assuming average weather conditions

(6) Excludes cultural resource preservation.

(7) 5 5/8 interest rate; 50 yrs

Figure 21
Alternative 1 FDR Levee Elevation Analysis
B/C Ratios

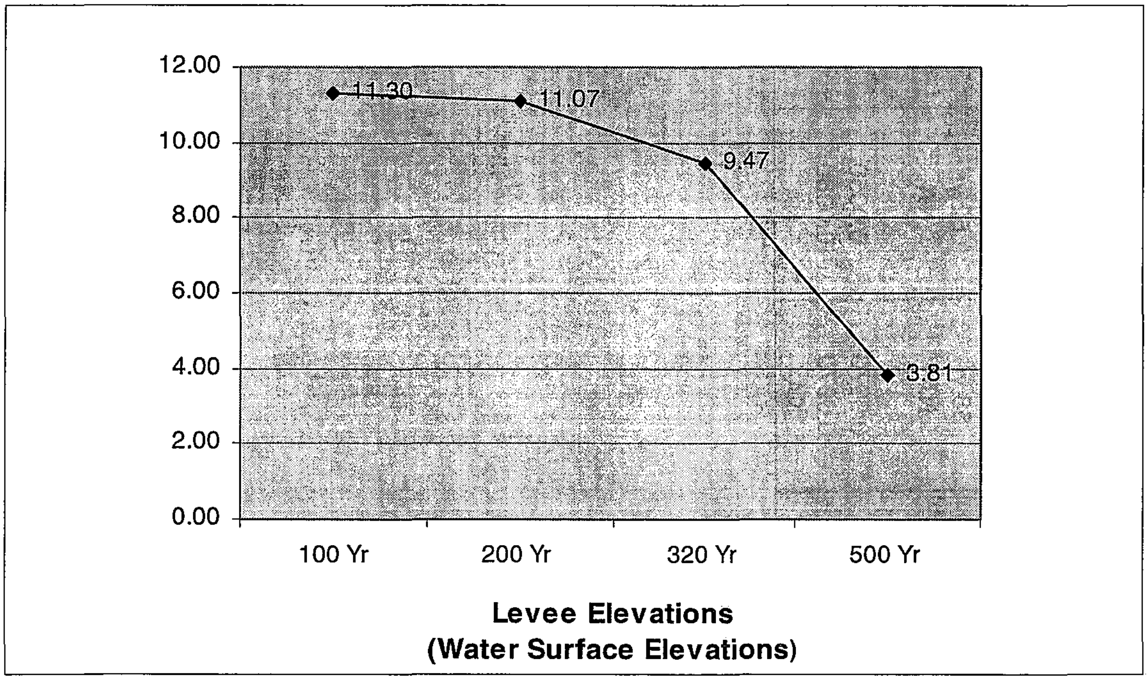

Figure 22
Alternative 1 FDR Levee Elevation Analysis
Annual Net Benefits
(Thousands of Dollars; October 2003 Price Levels)

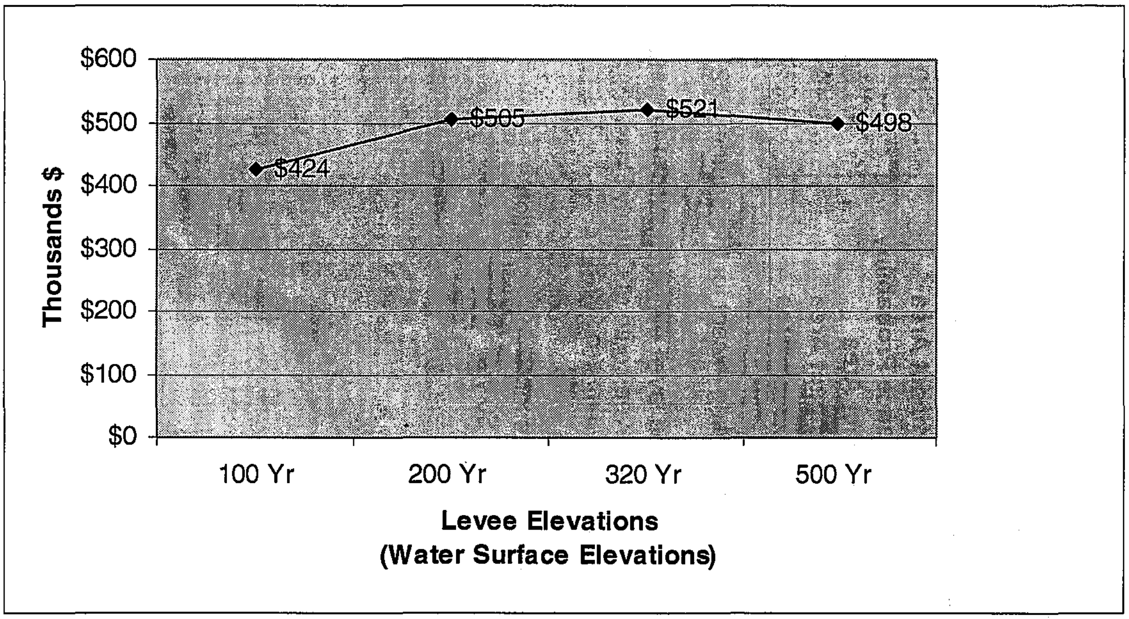

Figure 23
Alternative 1 FDR Levee Elevation Analysis
Annual FDR Benefits vs. FDR Costs
(Thousands of Dollars; October 2003 Price Levels)

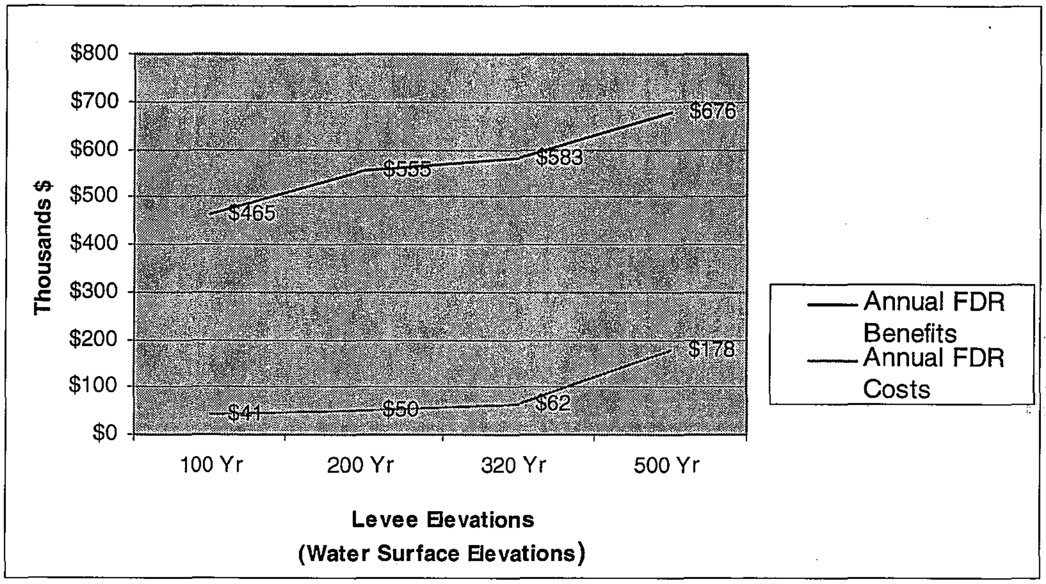

Figure 24
Alternative 5 FDR Levee Elevation Analysis
B/C Ratios

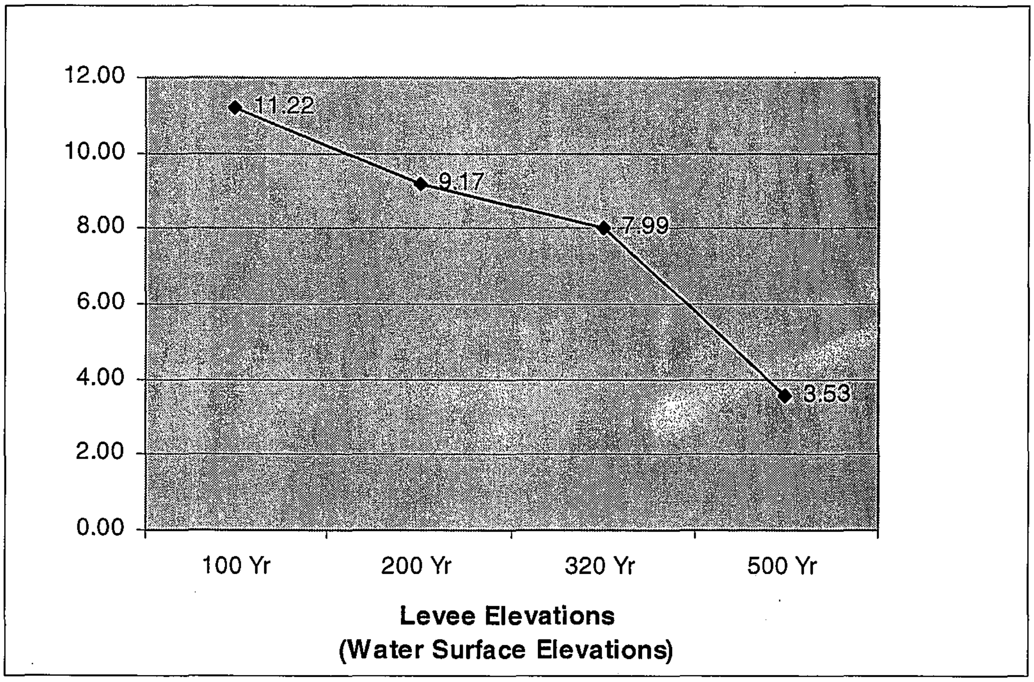

Figure 25
Alternative 5 FDR Levee Elevation Analysis
Annual Net Benefits
(Thousands of Dollars; October 2003 Price Levels)

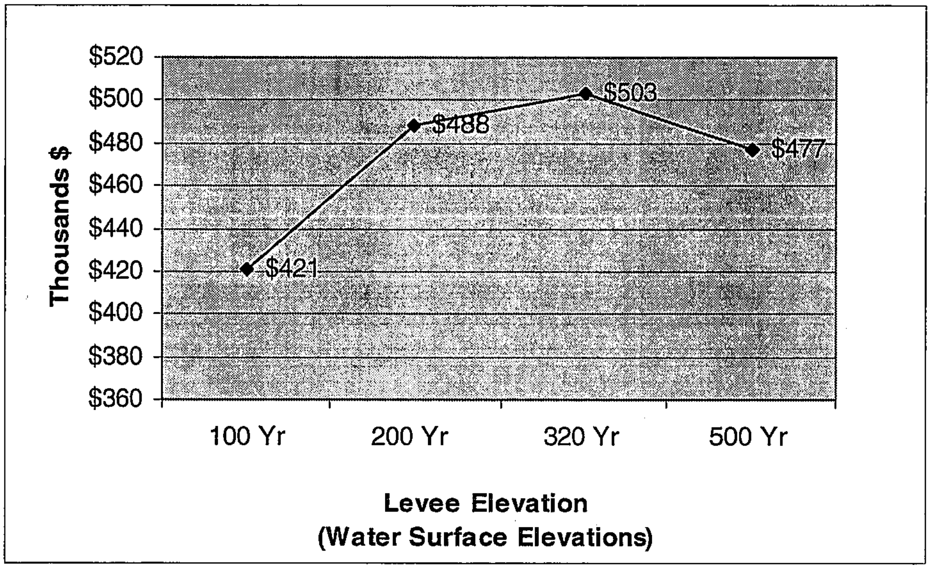

Figure 26
Alternative 5 FDR Levee Elevation Analysis
Annual FDR Benefits vs. FDR Costs
(Thousands of Dollars; October 2003 Price Levels)

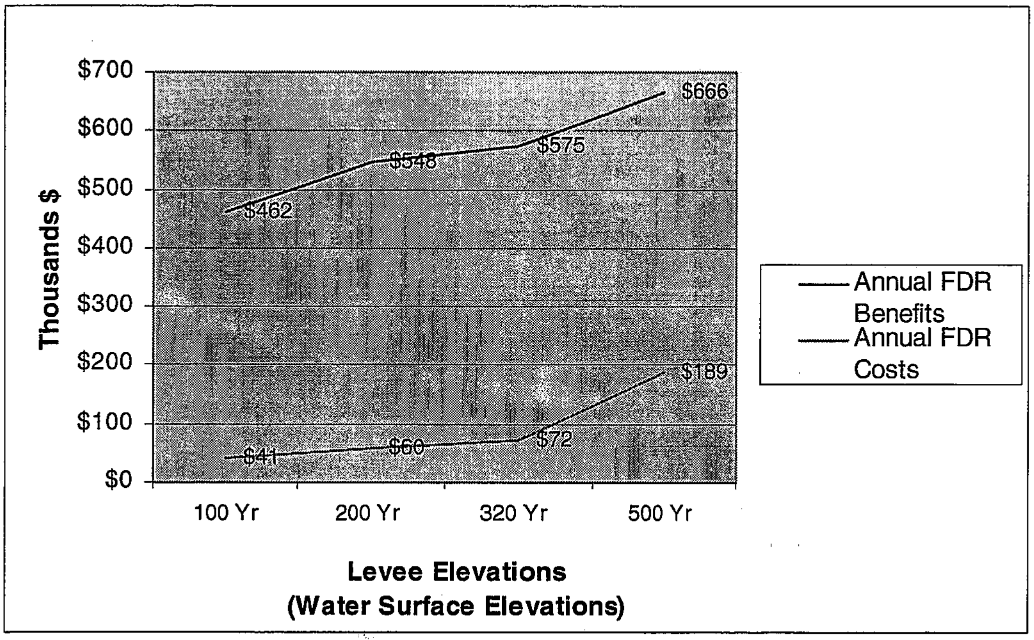

Figure 27
Alternative 6 FDR Levee Elevation Analysis
B/C Ratios

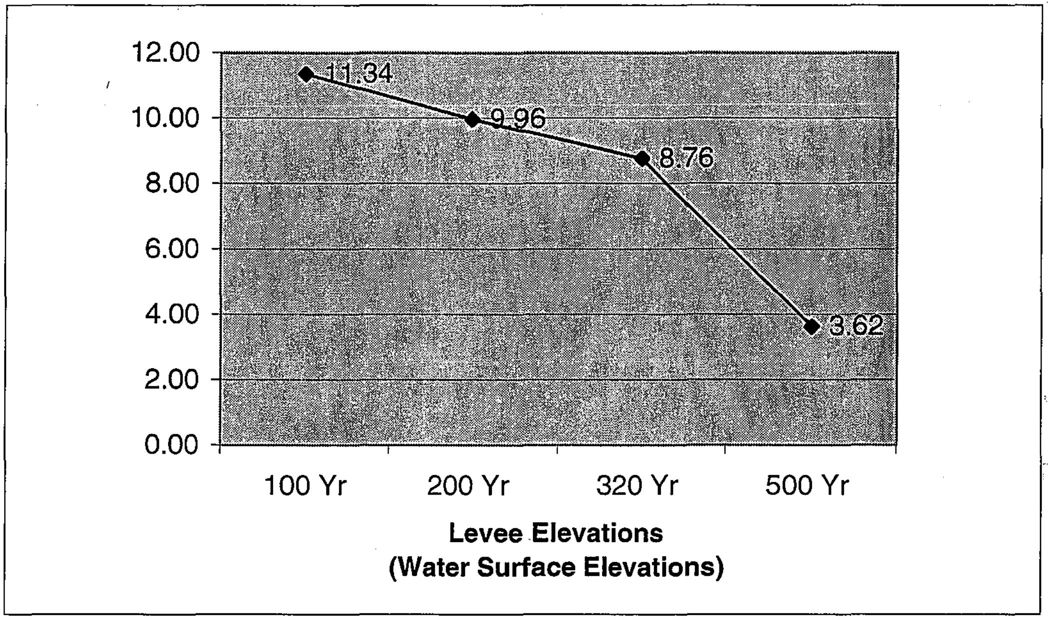

Figure 28
Alternative 6 FDR Levee Elevation Analysis
Annual Net Benefits
(Thousands of Dollars; October 2003 Price Levels)

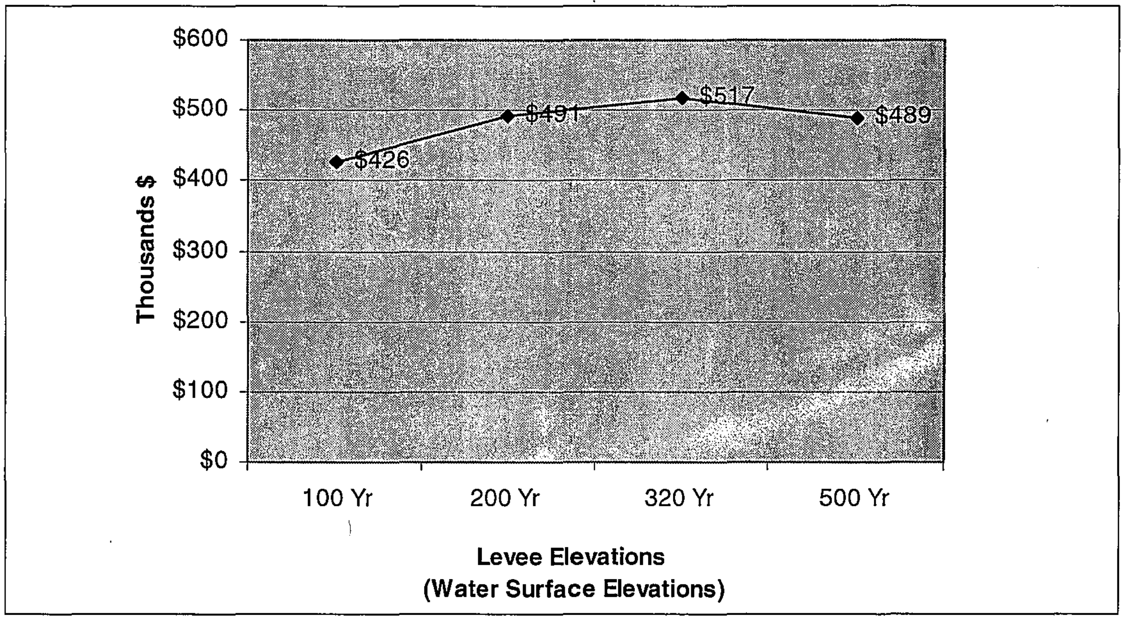

Figure 29
Alternative 6 FDR Levee Elevation Analysis
Annual FDR Benefits vs. FDR Costs
(Thousands of Dollars; October 2003 Price Levels)

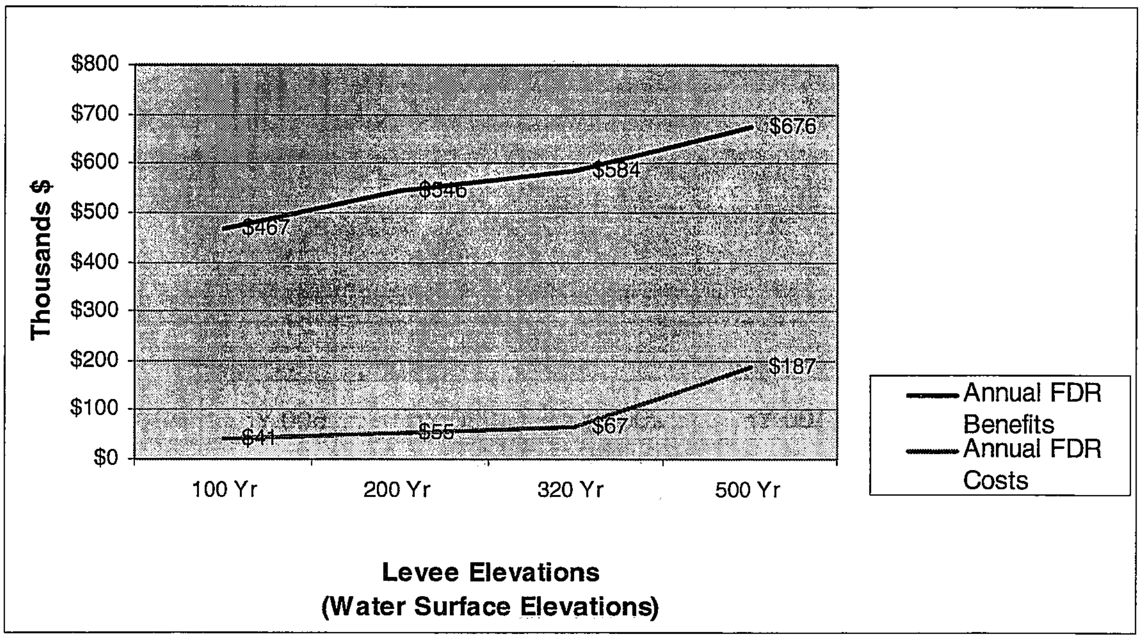

Table 31
Final Array Alternatives
Annual FDR Benefits with Decreasing Levee Elevations
(Thousands of Dollars; October 2003 Price Levels)

Plans	Equivalent Annual Damage			Avoided Floodfight Costs	Total FDR Benefits
	Without Project (1)	With Project (2)	Damage Reduced		
No Action	726	726	0	0	0
Alternative 1 (2)	726	264	462	114	576
Alternative 5 (2)	726	272	454	114	568
Alternative 6 (2)	726	263	463	114	577

(1) Includes floodfighting.
(2) TOL =

Northern	320 Yr WSEL
Southern #1	100 Yr WSEL
Southern #2	20 Yr WSEL

Table 32
Project Performance Statistics
Without Project
(With Floodfighting)

Impact Area	Annual Exceedance Probability (Expected)	Long Term Risk (Years)			Conditional Non-Exceedance Probability by Events					
		10	25	50	10% (1 in 10 years)	4% (1 in 25 years)	2% (1 in 50 years)	1% (1 in 100 years)	0.40% (1 in 250 years)	0.20% (1 in 500 years)
Northern	0.0860 (9%)	0.5929 (59%)	0.8942 (89%)	0.9888 (99%)	0.6628 (66%)	0.2157 (22%)	0.0956 (10%)	0.0349 (3%)	0.0057 (0.5%)	0.0006 (0.06%)
Southern #1	0.1310 (13%)	0.7548 (75%)	0.9702 (97%)	0.9991 (100%)	0.4643 (46%)	0.1317 (13%)	0.0447 (4%)	0.0117 (1%)	0.0025 (0.3%)	0.0002 (0.02%)
Southern #2	0.2370 (24%)	0.9335 (93%)	0.9989 (100%)	1.0000 (100%)	0.0663 (7%)	0.0025 (0.3%)	0.0006 (0.1%)	0.0001 (0.0%)	0.0000 (0.0%)	0.0000 (0.0%)

Table 33
Project Performance Statistics
With Project

Impact Area	Annual Exceedance Probability (Expected)	Long Term Risk (Years)			Conditional Non-Exceedance Probability by Events					
		10	25	50	10% (1 in 10 years)	4% (1 in 25 years)	2% (1 in 50 years)	1% (1 in 100 years)	0.40% (1 in 250 years)	0.20% (1 in 500 years)
Northern (1)	0.0050 (1%)	0.0492 (5%)	0.1184 (12%)	0.2228 (22%)	1.0000 (100%)	0.9957 (100%)	0.9624 (96%)	0.8368 (84%)	0.4914 (49%)	0.1661 (17%)
Southern #1 (2)	0.0130 (1%)	0.1200 (12%)	0.2735 (27%)	0.4722 (47%)	0.9994 (100%)	0.9632 (96%)	0.8101 (81%)	0.5283 (53%)	0.1991 (20%)	0.0585 (6%)
Southern #2 (3)	0.0490 (5%)	0.3944 (39%)	0.7145 (71%)	09185 (92%)	0.9309 (93%)	0.4554 (46%)	0.2012 (20%)	0.0618 (6%)	0.0073 (1%)	0.0007 (0.1%)

(1) TOL = 320 year WSE
(2) TOL = 100 year WSE
(3) TOL = 20 year WSE

E.5 CONCLUSIONS

The objectives of the Hamilton City project are to improve ecosystem conditions along the Sacramento River and to reduce flood damage in the community of Hamilton City and surrounding agricultural areas. This appendix summarizes the flood damage analysis of without- and with-project conditions. The Study Team evaluated seven combined alternatives consisting of flood damage reduction and ecosystem restoration measures (in addition to the no action alternative). All seven alternatives include a new levee setback (of different lengths) to replace the existing "J" levee. Because the primary purpose of the project has been identified as ecosystem restoration, it was determined that any new replacement "mitigation" setback levee should have an elevation similar to the existing "J" levee, or about the same as the 100-year water surface elevation. South of Hamilton City, the new setback levee may be built to shorter elevations, because it will be protecting primarily agricultural lands.

For the entire study area, the estimated without-project condition equivalent annual damage is about $726,000 (October 2003 price levels). Of this total, about $313,000 is damage to structures and contents. The without-project damage estimate assumes extensive floodfighting of the existing "J" levee, which reduces flood damage. It also includes allowances for backwater flooding which creeps around the southern end of the "J" levee and floods lands to the north (on the landside of the levee). All seven combined alternatives result in equivalent annual damage reductions ranging from $130,000 to $354,000 (with levee elevations set approximately to the100-year water surface elevation). The largest flood damage reduction is for Alternative 6. Of the total flood damage reduction for this alternative, about $202,000 is attributable to improved protection for lands that are to the west (landside) of the new setback levee, compared to about $152,000 which results from taking lands out of production because of restoration activities on the waterside of the new setback levee.

An incremental flood damage reduction analysis was conducted to determine if it would be economically feasible to raise the setback levee above the 100-year water surface elevation. Based upon this analysis, the net benefits of increasing levee elevations for Alternative 6 (the recommended plan) and the other final array alternatives increase up to the water surface elevation that may be sufficient to acquire FEMA certification (i.e., protection from the 1%, or 1 in 100, chance event). However, a hydraulic analysis is currently being conducted to show the maximum elevation to which the levee can be raised without causing any negative hydraulic impacts on the east bank of the Sacramento River or further downstream. Preliminary results from this hydraulic analysis indicate that it is at least possible to raise the levee up to the 320-year water surface elevation in the Northern impact area (which includes the community of Hamilton City), which would not be sufficient to acquire FEMA certification. To avoid negative hydraulic impacts, levee elevations in the Southern #1 and Southern #2 impact areas would need to be lower, possibly at the 100-yr and 20-yr water surface elevations, respectively.

APPENDIX F:
Letter of Intent
and
Comments and Responses

LETTER OF INTENT AND COMMENTS AND RESPONSES

This appendix includes the Letter of Intent from the non-Federal Sponsor indicating their willingness to cost share in the next phase of the project, Preconstruction, Engineering and Design (PED). It also includes the public and agency comments the study team received during the formal comment period between April 9th, 2004 and May 24th, 2004. Comments were received via letters, fax and email. A public workshop was held in Hamilton City on May 6th, 2004 and the written and oral comments received at that time are also included in this appendix.

STATE OF CALIFORNIA – THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, Governor

THE RECLAMATION BOARD
3310 El Camino Avenue, LL40
SACRAMENTO, CA 95821
(916) 574-0609 FAX: (916) 5790682
Permits: (916) 574-0653 FAX: (916) 5740681

AUG 05 2004

Colonel Ronald N. Light
District Engineer
Sacramento District
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Dear Colonel Light:

This letter is to express The Reclamation Board's (Board) intent to become the nonfederal sponsor for preconstruction, engineering, and design for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project as described in the final Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Report, dated July 2004. The Board took action on this project at its July 19, 2004 regularly scheduled public meeting. Board Resolution No. 04-14, which details the action taken, is attached.

Please note that this letter of intent is not an obligation of future unappropriated State funds by the State Legislature. We look forward to working with the U.S. Army Corps of Engineers and Glenn County on this project.

If you have any questions, you may contact me at (916) 574-0609, or your staff may contact Gary Lemon, Project Engineer for the Department of Water Resources' Division of Flood Management, at (916) 574-0358.

Sincerely,

Peter D. Rabbon
General Manager

Attachment

STATE OF CALIFORNIA
THE RESOURCES AGENCY
THE RECLAMATION BOARD

RESOLUTION NO. 04-14

HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION FEASIBILITY STUDY

WHEREAS, the U.S. Army Corps of Engineers (Corps) and the State of California (State) entered into a Feasibility Cost-Sharing Agreement (FCSA) on February 20, 1998 for the Sacramento and San Joaquin River Basins' Comprehensive Study (Comprehensive Study) to evaluate the flood management system in the Central Valley; and

WHEREAS, the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study, California, was identified as an initial project element of the Comprehensive Study; and

WHEREAS, on December 20, 2002, the Board, as lead agency under the California Environmental Quality Act (CEQA), filed a Notice of Preparation with the State Clearinghouse for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study, California; and

WHEREAS, the Hamilton City Flood Damage Reduction and Ecosystem Restoration Feasibility Study, California, identified six alternatives to increase flood protection for Hamilton City and the surrounding area; and

WHEREAS, the Corps released the Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report (FR/EIS/EIR) on April 9, 2004 for public and agency review; and

WHEREAS, the Board submitted the draft EIR to the State Clearinghouse for agency review on April 9, 2004; and

WHEREAS, all comments that were received during the 45-day review period were responded to and incorporated into the final Hamilton City Flood Damage Reduction and Ecosystem Restoration FR/EIS/EIR as appropriate; and

WHEREAS, following the alternative evaluation and public review, the sponsor tentatively selected a levee setback plan that would increase the level of flood protection for Hamilton City and the surrounding area; and

WHEREAS, prior to implementation of the selected plan, the Board must certify the EIR and adopt findings.

NOW, THEREFORE BE IT RESOLVED, that The Reclamation Board certifies that:

1. The Hamilton City Flood Damage Reduction and Ecosystem Restoration Final EIS/EIR, completed by the Corps and the Board in June 2004 as a joint National Environmental Policy Act/CEQA document, has been prepared according to CEQA guidelines; and

2. The final EIR was presented to the Board and the Board has reviewed and considered the information contained in the final EIR; and

3. The final EIR reflects the Board's independent judgment and analysis.

NOW, THEREFORE, BE IT FURTHER RESOLVED, that The Reclamation Board:

1. Finds that the Project could have a significant adverse effect on the following resources: water quality, air quality, special status species, and transportation, but that changes and alterations have been required in, or incorporated into, the Project which avoid or substantially lessen the significant effect as identified in the final EIR.

Water Quality - The removal of the J-Levee could have a significant but temporary effect to water quality. The use of Best Management Practices (BMP) to prevent sediment runoff from entering the Sacramento River will reduce this impact to a less-than-significant level.

Air Quality - Fugitive dust and emissions from equipment used during construction could have a significant temporary effect on air quality. The use of BMP to reduce fugitive dust and emissions during construction will reduce this impact to a less than significant level.

Special Status Species - Several species listed under the California Endangered Species Act may experience temporary disturbance or displacement during construction. These species are Yellow-billed cuckoo, Swainson's hawk and bank swallow. Surveys will be conducted prior to each construction season to determine the presence of these birds and the location of any nests. Specific avoidance and minimization of impact measures, as determined by the Department of Fish and Game, will be required to ensure there is no adverse impact or take of these species. These measures will reduce the impact to listed birds to a less than significant level.

Anadromous fish may be subject to short-term exposure to increased turbidity in the Sacramento River during construction. The project will implement BMP to avoid or limit runoff from reaching the River. The implementation of BMP will reduce this impact to anadromous fish to a less-than-significant level.

Transportation - Construction activities could generate temporary additional traffic and potential disruption to traffic due to detours. Increased traffic could adversely affect safety and roadway conditions. The implementation of an access management plan prior to the initiation of construction will reduce impacts to traffic to a less than significant level.

2. Approves the Project.

Dated: July 16, 2004

By: ORIGINAL SIGNED BY
Betsy A. Marchand
President

By: ORIGINAL SIGNED BY
William H. Edgar
Secretary

Approved as to Legal form
And Sufficiency

ORIGINAL SIGNED BY
Scott Morgan
Counsel

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Northern Central Valley Office
500 Main Street
Chico, CA 95928-5614

tel [530] 897.6370
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nature.org

May 12, 2004

RE: Comments to the Hamilton City Draft EIR/EIS and Feasibility Study

Ms. Erin Taylor
U.S. Army Corps of Engineers,
Sacramento District
Environmental Resources Branch
1325 J Street
Sacramento, CA 95814-2922

Dear Ms. Taylor,

The Nature Conservancy applauds the Army Corps of Engineers, and the State Reclamation Board as the non-federal sponsor of the project, for completing the Draft Feasibility Study and EIR/EIS. The Hamilton City Ecosystem Restoration and Flood Damage Reduction Project provides an excellent opportunity to form new partnerships and serve multiple Sacramento River stakeholders and other interests. We feel the team struck a good balance among diverse goals with the preferred plan. We are very supportive of the project and look forward to implementation. Our comments are limited to revegetation aspects of the project.

Consistent with CALFED Ecosystem Restoration Program principles, we have used a long-term (10 yr.) monitoring program, conducted by the Point Reyes Bird Observatory (PRBO), as a primary component of our adaptive management feedback loop. We use information generated by our research partners to guide restoration implementation. Over the years, PRBO supplied numerous recommendations, which we then incorporated into implementation practice to maximize wildlife benefit and ecosystem function within restoration sites. One of PRBO's first recommendations suggested denser restoration plantings better serving our migratory bird conservation targets. In addition, we continue to investigate wildlife and habitat relationships, and further quantify vegetation characteristics with researches at California State University Chico and elsewhere. These researchers quantified an average density of 323 plants per acre for existing riparian forest from 9 sites. Six of these research sites are within the project area.

1-1 As a result of the adaptive management feedback loop and continuing research, we now plant densities ranging from 200-360 plants per acre, depending on vegetation community. We recommend you increase the planting density per acre of the project area to the ranges specified above in order to more closely meet the needs of conservation targets and mimic ecosystem function.

1-2 Secondly, the plan includes "passive restoration" areas where no revegetation activities would occur. We suggest limiting this application to a maximum of 10 acres because exotic vegetation has significantly altered conditions on the Sacramento River floodplain. This exotic vegetation precludes natural recruitment of native vegetation in most cases.

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1-3 Lastly, the plan identifies seeding of native forbs. Again, due to altered floodplain conditions, we suggest a small scale pilot application of seeded native forbs prior to implementation over large acreages.

Sincerely,

Mike Roberts
Project Manager/Hydrology
The Nature Conservancy

Public Workshop Comment Card

Hamiton City Flood Damage Reduction And Ecosystem Restoration, California

Sacramento and San Joaquin River Basins
Comprehensive Study

Name: Sharon Wallace

1-1 Are there clear references in the EIR/EIS document to "Cumulative impacts" - particularly as they relate to the relationship of flood control projects proposed or planned for the eastside of the Sacramento River?

2-2 This eastside stretch of the river has also been the focus of several studies, as well, and your own flood event prediction maps already include that area (Keefer Slough, Pine and Rock Creeks, etc) for modelling purposes, as I understand it.

U.S. Department of Homeland Security
1111 Broadway, Suite 1200
Oakland, CA 94607-4052

FEMA

May 10, 2004

U.S. Army Corps of Engineers, Sacramento District
Attn: Ms. Erin Taylor
Environmental Resources Branch
1325 J Street
Sacramento, California 95814-2922

Dear Ms. Taylor:

This is in response to the draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, California.

3-1 Please review the current effective Flood Insurance Rate Maps (FIRMs) for Glenn County dated September 3, 1980. Please note that Glenn County is a participant in the National Flood Insurance Program (NFIP). The minimum, basic NFIP floodplain management building requirements are described in the Code of Federal Regulations #44, Sections 59 through 65.

A summary of these NFIP floodplain management building requirements are as follows:

- All buildings constructed within a riverine floodplain, (i.e., Flood Zones A, AO, AH, AE, and A1 through A30 as delineated on the FIRM), must be elevated so that the lowest floor is at or above the Base Flood Elevation level in accordance with the effective Flood Insurance Rate Map.

- If the area of construction is located within a Regulatory Floodway as delineated on the FIRM, any ***development,*** must not increase base flood elevation levels. **The term *development* means any man-made change to improved or unimproved real estate, including but not limited to buildings, other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, and storage of equipment or materials.** A hydrologic and hydraulic analysis must be performed *prior* to the start of development, and must demonstrate that the development would not cause any rise in base flood levels. No rise in permitted within regulatory floodways.

- All buildings constructed within a coastal high hazard area, (any of the "V" Flood Zones as delineated on the FIRM), must be elevated on pilings and columns, so that the lowest horizontal structural member, (excluding the pilings and columns), is elevated to or above the base flood elevation level. In addition, the posts and pilings foundation and the structure attached thereto, is anchored to resist flotation, collapse and lateral movement due to the effects of wind and water loads acting simultaneously on all building components.

- Upon completion of any development that changes existing Special Flood Hazard Areas, the NFIP directs all participating communities to submit the appropriate hydrologic and hydraulic data to FEMA for a FIRM revision. In accordance with CFR44, Section 65.3, as soon as practicable, but not later than six months after such data becomes available, a community shall notify FEMA of the changes by submitting technical for a flood map revision. To obtain copies of FEMA's Flood Map Revision Application Packages, please refer to the FEMA website at http://www.fema.gov/mit/tsd/dl_mt-2.htm

Please Note:

Many NFIP participating communities have adopted floodplain management building requirements, which are more restrictive than the minimum federal standards describe in CFR #44. Please contact the local community's floodplain manager for more information on local floodplain management building requirements. The Glenn County floodplain manager can be reached by calling Dan Gardner at 916-934-6545

If you have any questions or concerns, please do not hesitate to call Anna Davis of my staff at 510-627-7029.

Sincerely,

Michael Shore
Branch Chief
Community Mitigation Programs

cc:
Dan Gardner, Glenn County Building Inspector

Sandro Amaglio, FEMA Region IX Environmental Officer

From: Taylor, Erin A SPK
Sent: Tuesday, May 25, 2004 8:14 AM
To: Compstudy SPK
Subject: FW: Comments From John Merz on Hamilton City draft FR/EIS/EIR

-----Original Message-----
From: John Merz [mailto:jmerz@inreach.com]
Sent: Monday, May 24, 2004 2:52 PM
To: Taylor, Erin A SPK
Subject: Comments on Hamilton City draft FR/EIS/EIR

Erin,

The Trust would like to make the following comments on the Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report (Draft FR/EIS/EIR) for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Pproject (Project):

4-1

1). The statement is made (Summary-3) that the training dike would "...reduce damages from scouring flows." How would it do that? I would suggest that having some native vegetation on the landward side of the dike might help achieve this objective.

4-2

2). The description of where the setback levee will begin (first paragraph, Summary-4) is unclear to me and is not helped by the diagram in Figure S-1. Please provide a more detailed visual of this element of the Project.

4-3

3). How was the training dike alignment determined? Is it tied to topography or parcel boundaries? At any rate, I believe that the alignment should be further to the west (basically, heading due south from its beginning).

4-4

4). Please provide details concerning the BMPs that would be implemented as mitigation for temporary effects to Special Status Species (Summary-9).

4-5

5). When will the Project and related environmental review come up before the state sponsor? And who is the state sponsor, by the way? (Put another way, who is responsible for CEQA compliance?).

The Trust looks forward to your response to our comments and asks to be kept informed of any and all future activity concerning the Project.

Sincerely,

John Merz
President
Sacramento River Preservation Trust
PO Box 5366
Chico, CA 95927
530-345-1865 (Phone)
530-899-5105 (Fax)
jmerz@sacrivertrust.org

State of California

Memorandum

To: Ms. Annalena Bronson
The Reclamation Board
3310 El Camino Ave., LL-40
Sacramento, CA 95821

Date: May 24, 2004

Place: Sacramento

Phone: (916) 6574956

From: **Department of Food and Agriculture** Kenneth E. Trott, Acting Director
Office of Agricultural and Environmental Stewardship

Subject: Draft Feasibility Study and Draft Environmental Impact Report/Study (DEIR/S) for the Hamilton City Ecosystem Restoration and Flood Control Project - SCH 2002122043

The California Department of Food and Agriculture (Department) has reviewed the DEIR/S for the Hamilton City Ecosystem Restoration and Flood Control Project. The Department is responsible for protecting and promoting California agriculture and the resources upon which agriculture depends. The Department is also a member of the California Bay Delta Authority, where, consistent with the CALFED Record of Decision (ROD), supports a balanced implementation of the CALFED program. One way that the Department supports this goal is through its staff support of the Bay-Delta Public Advisory Committee's Working Landscape Subcommittee. The Subcommittee's work plan identifies actions that seek to integrate agricultural land conservation into CALFED projects. Also, the Department routinely reviews CEQA and NEPA documents for their impacts on agricultural resources. Based on these responsibilities and authorities, we offer the following comments on the Hamilton City project.

The proposed project would increase the flood protection and restore wildlife habitat near Hamilton City, along the Sacramento River in Glenn County. The project would include a nearly 6-mile setback levee and convert approximately 1,300 to 1,600 acres of Prime, Statewide Important and Unique Farmlands to habitat. The Department previously commented on the administrative draft and has met with lead agency staff to review these comments. The following comments reflect outstanding concerns of the Department with the DEIR/S.

For the sake of time and space, we refer you to our February 2004 comments (attached) on the administrative draft of the DEIR/S for greater detail on issues raised in the following comments.

Site Description

Page 4-24 of the DEIR/S describes the agricultural setting of the project site. We repeat our
February 2004 recommendation that this section include an Important Farmland Series map for
5-1 this part of Glenn County to depict the kind, extent and location of agricultural land in the project
site and vicinity. This map would complement the existing map of Williamson Act lands, figure
5-2 4-2. In addition, the section should include a table showing acreage of various agricultural land
categories according to the California Department of Conservation's Important Farmland Series
5-3 definitions. Finally, this section should include definitions of agricultural land used by CEQA, as
well as the definition of each category of farmland within the project site (e.g., Prime Farmland).

Significant Environmental Impact: Loss of Agricultural Land

5-4

The Department disagrees with the DEIR/S' conclusion that the adverse environmental impact on agricultural land is "less than significant." (Table 5.1) The DEIR/S incorrectly defines the threshold of significance as the conversion of agricultural lands to uses that would "cause serious degradation of the quality of soils or and/or result in expenditures of substantial development costs that would likely preclude the practicality of future conversion back to agriculture." The DEIR/S also incorrectly states that the project is in compliance with the CALFED ROD.

The CEQA Guidelines state that the loss of agricultural land to a non-agricultural use is a potentially significant environmental impact. This general threshold is based on the California Department of Conservation's Important Farmland Series definitions, which include a combination of both agricultural use and soil quality. The CEQA threshold makes no reference to soil quality degradation or cost to reclaim the converted lands back to agriculture uses. This is an invented threshold that, if it has any applicability in CEQA at all, would be most suitable in the "Geology and Soils" section of CEQA Guidelines, Appendix G.

In fact, this project would result in the conversion of 1,300 to 1,600 acres of Prime, Statewide Important, and Unique Farmland (the CEQA definition of "agricultural land") to non-agricultural uses. This meets the broad test of significance. Appendix G also provides as an optional test of significance, the California Land Evaluation and Site Assessment model developed by the California Department of Conservation. In our February 2004 comments, we recommended that the California LESA model be used to determine the significance of the project's impacts on agricultural land. Indeed, early administrative drafts of the DEIR/S used both federal and state versions of LESA. Both models rendered determinations that the project's impact on agricultural resources is significant. We continue to recommend that the lead agencies work with the Department of Conservation to apply the LESA model to the determination of the project's significance with respect to adverse impacts on agricultural resources.

One of the reasons given by the lead agencies for not using LESA was that it did not account for the benefits of either flood protection provided by the project to other agricultural lands, or to the habitat improvements of the project. This is not a valid argument for discounting the use of LESA. CEQA provides for the analysis of project impacts on biological resources as well as on hydrological impacts in other sections of Appendix G. These sections are where the positive and adverse impacts of the project on habitat and flooding should be addressed, not in the agricultural resources section. The agricultural resources section of Appendix G is limited to assessing the significance of the project-caused loss of agricultural land resources, and the LESA model is the suggested tool for doing so.

Further, the DEIR/S is an information disclosure document to be used by the lead agency in supporting its decision on project approval. It is the job of the lead agency to weigh and balance the over-all benefits of the project against its adverse impacts; i.e., its impacts on agricultural resources versus its benefits for flood protection and habitat restoration. This is not the job of LESA. Its stated purpose is to assess the project impacts on agricultural resources.

The project, without mitigation measures to address the adverse impacts of the project on agricultural resources, would not be consistent with the CALFED ROD. The ROD commits CALFED to mitigating the adverse impacts of its projects on agricultural land, where feasible, using any number of 31 mitigation measures. However, we did not see that the DEIR/S included measures that would mitigate the loss of agricultural land posed by the project.

Prime, Statewide Important and Unique Farmland?

5-5 The DEIR/S, in its conclusion that the project will not have a significant impact on agricultural land, states that current flooding conditions render the farmland at the project site as less than Prime, Statewide Important or Unique Farmland in quality. If this argument is to have any merit, such impairment of the agricultural use of the land should be reflected on the Department of Conservation's Important Farmland Series maps for Glenn County. If the Department's maps are inaccurate and need to be corrected, this should be taken up with the Department and rectified prior to concluding that the subject agricultural lands are not subject to the CEQA thresholds of Appendix G.

Alternatives

5-6 The DEIR/S does not include a "working landscape" alternative; i.e., an alternative that explores a 1,300-acre project site that integrates economic uses, such as floodplain compatible agriculture, with habitat restoration and flood protection. This would be consistent with state policy. The Department of Water Resources administers the Floodplain Corridor Protection Program, with administers grants for floodplain projects that seek to integrate floodplain protection with continuing agricultural uses and habitat restoration. We recommend that the final EIR/S include a working landscape alternative.

Cumulative Impacts

5-7 The DEIR/S does not present an adequate treatment of the cumulative impact of the project on agricultural resources. The document should include a review of past flood and habitat restoration projects that have occurred along the Sacramento River corridor that have converted agricultural land to non-agricultural uses. The Farmland Mapping and Monitoring Program has been tracking agricultural land conversion for 20 years. This period of time would, therefore, be a practical bracket for analyzing the retrospective component of the project's cumulative impacts. Similarly, other flood control and habitat projects along the Sacramento River that have been proposed, and that are concurrently under review for approval, should be included in this analysis.

5-8 Also, for the sake of documenting cumulative impacts of the project, past and foreseeable conversion of agricultural land by urbanization in the vicinity of the project should be characterized, based on past urbanization trends, Department of Finance projections and land use planning policies.

Growth Inducing Impacts

5-9 The DEIR/S notes that the proposed levee would provide less than the 100-year level of protection under FEMA standards. The document then concludes that the project would not be growth-inducing because it "would not alter the regulation of land use in the floodplain pursuant to the National Flood Insurance Program." This conclusion needs to be better documented. It would seem that any improvement in flood protection over the existing protection could have growth-inducing impacts since the final land use approval authority is Hamilton City, the

National Flood Insurance Program notwithstanding. We recommend that the final EIR/S discuss local land use policies that would affect the development potential of agricultural lands around the City, and how those policies would prevent increased flood protection from having growth-inducing impacts on adjacent agricultural land.

5-10 Finally, for the uninitiated, we recommend that how the level of flood protection influences land development under FEMA regulations, be elaborated upon in the final EIR/S.

Indirect Impacts

5-11 In our May 2004 comment letter on the project, we recommended that the potential indirect impacts of the project on adjacent farmlands be discussed and, as necessary, mitigated. As detailed in the May comment, examples of such impacts could include depredation of crops from wildlife drawn to the project, limitation on agricultural practices due to the proximity of protected wildlife habitat, spread of weeds from the retired lands of the project site, seepage, etc.

Mitigation Measures

5-12 One of the mitigation measures of the CALFED ROD, and one that this Department has routinely recommended be considered in other projects' CEQA documents, is the use of agricultural land conservation easements. We recommend that this mitigation measure, as well as the use of working landscape elements (see Alternatives, above), be considered as at least partial mitigation of the project's direct, growth-inducing and cumulative impacts on agricultural land.

The CALFED ROD lists 30 other measures that should be considered in mitigating CALFED project impacts on agricultural land. In our February 2004 comment letter, we listed nine measures from the list of 31 that we specifically recommended for your consideration in the DEIR/S. We continue to recommend that at least these measures be discussed and considered in the final EIR/S.

In conclusion, the Department supports the kind of locally supported, multi-purpose projects that the Hamilton City project represents. However, at the same time, California continues to lose a significant acreage of agricultural land every year to a combination of urbanization, public land acquisition and land retirements related to water transfers and drainage impairment. We believe that an adequately prepared DEIR/S that accurately documents the agricultural impacts of the project, agricultural friendly alternatives, and mitigation measures, can provide the basis for a project that not only serves the purposes of flood protection and habitat conservation, but also agricultural resources.

Thank you for the opportunity to comment on the DEIR/S. If you have questions concerning our comments, please contact me at (916) 657-4956.

Attachment

cc: Ms. Erin Taylor
U.S. Army Engineer District, Sacramento

Bill Duckworth, Agricultural Commissioner
Glenn County

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF FOOD AND AGRICULTURE
Office of Agriculture and Environmental Stewardship
1220 N Street, Room A-400
Sacramento, California 95814
Telephone: (916) 657-4956
Facsimile: (916) 657-5017

February 5, 2004

Ms. Sara M. Schultz
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814

Dear Ms. Schultz:

Subject: Administration Draft Feasibility Study and Draft Environmental Impact Report/Study (DEIR/S) for the Hamilton City Ecosystem Restoration and Flood Control Project

The California Department of Food and Agriculture (Department) has reviewed the Administrative DEIR/S. The Department's mission is to protect and promote California agriculture, including the natural resources upon which agriculture depends. From this perspective we offer the following suggestions for your continuing refinement of the DEIR/S.

The project will fund riparian and floodplain ecosystem restoration along the Sacramento River in the immediate proximity of Hamilton City, Glenn County. To mitigate the impacts of habitat restoration on flood protection, the project will include the construction of flood protection structures along the River as it passes Hamilton City. The project, depending on the alternative finally selected, will result in the loss of from 1,000 to 1,600 acres of largely Prime, Statewide Important and Unique Farmlands.

<u>Growth-inducing Impacts</u>
The DEIR/S acknowledges that the enhanced flood protection afforded Hamilton City by the project will encourage growth in the Hamilton City community by eliminating a constraint to growth; i.e. flooding. This is consistent with other statements within the DEIR/S where it is recognized that population growth in the region will continue to result in the conversion of agricultural and other rural lands to urban uses, and where it is also noted that the project will have "beneficial effects on the development potential of the area." (pages 4-40 and 5-33) The DEIR/S further references the pressures on Glenn County to encourage economic development through land use planning policies that foster growth. (page 5-26)

We recommend that the DEIR/S elaborate on the growth-inducing impacts of the project on surrounding agricultural land by including state and local growth projections, general plan designations and references to studies or reports that document the growth potential and/or projections for Hamilton City and environs. Also, maps and acreage tables showing agricultural lands (and their Farmland Mapping and Monitoring category) that would receive enhanced flood protected from the project, and thus be more vulnerable to urbanization, should be included to help the reader to grasp the nature of the growth-inducing impacts posed to agricultural land by the project.

Mr. Pete Rabbon spoke on this project at the Bay-Delta Public Advisory Committee's Working Landscape Subcommittee meeting this morning. In his comments, he stated that the height of the proposed levees will be high enough so that farmlands on the protected side of the levee will experience less flooding, but not so high that urban land uses can be permitted. We did not see this aspect of the project discussed as part of the growth-inducing impact section of the DEIR/S. This design feature/mitigation should be brought forth in the document, along with a discussion of the degree of protection against urbanization that will be afforded, legally, physically and geographically.

Cumulative Impacts

The DEIR/S concludes that the project will have a significant cumulative impact on agricultural land resources. However, the DEIR/S then discounts the significance of the impact by stating that "the conversion of agricultural lands to habitat attributed to this project is primarily occurring on lands with diminishing long-term productivity", and "this project will contribute to higher long-term productivity on agricultural lands on the landside of the new levee." Without documentation that the lands in the project area have inherent constraints to their productivity, the value of this farmland should not be discounted; the Department of Conservation's Farmland Mapping and Monitoring Program currently classifies these lands as dominantly Prime, Statewide Important and Unique Farmland. Also, the heightened flood protection for other farmlands is not germane to the documentation of the cumulative impacts of farmland conversion, particularly when the heightened protection may also make these lands more vulnerable to urbanization. The relevant fact is that this project potentially contributes to the ongoing loss of Important Farmland by urbanization and public land acquisitions.

We recommend that if there are inherent problems with the agricultural use of the lands proposed for conversion by this project, these problems be documented and compared with those of surrounding lands of similar quality. Documentation could include crop yields, farming costs and interviews with local and regional agricultural experts, such as the county agricultural commissioner.

The cumulative impact analysis, itself, is limited to a few lines that are focused on state level cumulative impacts (i.e., one million acres of agricultural land in the Central Valley). This analysis should be expanded to focus down on the Sacramento Valley region and, more specifically, the Hamilton City area. The acreage of agricultural land converted to non-agricultural uses over the past twenty years that the Department of

Conservation's Farmland Mapping and Monitoring Program has been in existence should be documented according to cause and farmland classification. In addition, the state Williamson Act program has documented Williamson Act contract terminations over the past 20 years, including terminations by public acquisition. This data could also be used to characterize past cumulative impacts. Finally, we recommend that habitat restoration and floodplain protection projects that have removed land from agricultural use over the past 10 to 20 years be documented.

In addition to documenting the retrospective component of the cumulative impact analysis, we recommend that the DEIR/S document other projects now in progress, as well as projects on the foreseeable horizon, which could contribute to the ongoing loss of agriculturally productive lands in the Sacramento Valley and project vicinity.

Indirect Impacts
We did not see reference to the potential impacts of the project on adjacent lands. Increased wildlife habitat and flooding on the project lands could create adverse impacts on the agricultural use of adjacent lands. For example, with improved habitat, depredation of crops on adjacent fields by wildlife could increase. Improved habitat could also attracted Threatened and Endangered species to adjacent farmlands, jeopardizing farming practices there with Endangered Species Act restrictions.

Further, unless closely managed for disease and weeds, the restored lands could serve as a weed and disease bank, increasing the cost of disease and weed control on adjacent agricultural lands.

Other indirect impacts could include trespass and vandalism from increased public use of the wildlife areas created, and the possibility of changed hydrologic conditions on adjacent agricultural lands that render the soils too wet to work.

Mitigation Measures
The DEIR/S states on page 5-28 that if the impact analysis shows "a significant effect, an appropriate level of mitigation would be identified." On page 5-31, the California Land Evaluation and Site Assessment (LESA) analysis assigns the level of agricultural land impact as 78, twice the significance threshold of 39. Indeed, the DEIR/S concludes that the project will have a significant impact on agricultural land and land uses.

However, the DEIR/S does not consider mitigation measures for the loss of agricultural land and land uses. The document, on page 5-31, dismisses the impacts on agriculture, by stating that "[a]lthough a significant and unavoidable effect to farmland conversion has been identified, the benefits of the project continue to provide a compelling argument for its implementation." This rationale should be part of a statement of overriding considerations, if one is later adopted, but not used to avoid the analysis of appropriate mitigation measures for an identified significant environmental impact. Therefore, we recommend that the public DEIR/S include a consideration of a reasonable range of mitigation measures that would lessen, compensate for, or avoid the significant impacts of the project on agricultural lands.

The CALFED Bay-Delta Program Record of Decision (ROD) stipulates that mitigation measures be considered and adopted, where appropriate, to mitigate Program impacts on agricultural land and water resources. The ROD lists 31 measures that should be considered for mitigating agricultural land and water use impacts. Following are a few selected mitigation measures extracted from the ROD that we specifically recommend for your consideration.

"1. Site and align Program features to avoid or minimize effects on agriculture.

2. Examine structural and nonstructural alternatives to achieve project goals in order to avoid effects on agricultural land.

6. Support the testing and application of alternative crops to idled farmland (for example, agroforestry or energy crops).

8. Support the California Farmland Conservancy Program in acquiring easements on agricultural land in order to prevent its conversion to urbanized uses and increase farm viability. Focus on lands in proximity to where any conversion effect takes place.

12. Use Farmer-initiated and developed restoration and conservation projects as a means of reaching Program goals.

14. Obtain easements on existing agricultural land for minor changes in agricultural practices (such as flooding rice fields after harvest) that would increase the value of agricultural crop(s) to wildlife.

15. Include provisions in floodplain restoration efforts for compatible agricultural practices.

19. Develop buffers and other tangible support for remaining agricultural lands.

25. When it appears that land within an agricultural preserve may be acquired from a willing seller by a State CALFED agency for a public improvement...advise the Director of Conservation and the local governing body responsible for the administration of the preserve of the proposal."

Two mitigation measures or alternatives that we specifically recommend for your consideration are measures that combine several of the above ROD measures. One would be a project alternative that relied on a "working landscape" approach to restoration where less flood-prone lands continue to be used for wildlife friendly farming operations. Under this alternative, restoration would occur on lands adjacent to the river channel and on marginal agricultural lands, while the higher, better agricultural lands are restricted by agricultural land conservation easements to limit agricultural uses and practices to those that do not impair flood water flows and are more accommodating to wildlife, such as pasture and hay operations.

A second mitigation measure that we encourage for your consideration is the use of agricultural land conservation easements to protect agricultural lands adjacent to the project and within the areas of enhanced flood protection near Hamilton City. An acre-for-acre protection of agricultural lands surrounding the project for each acre converted by the project could lessen the cumulative and growth-inducing impacts of the project. This measure could also enhance the sustainability of the remaining agricultural lands, partially compensating for the direct conversion impacts caused by the project. The creation of buffers by the application of agricultural land conservation easements could also mitigate the indirect impacts of the project on adjacent lands. While the purchase of agricultural land conservation easements will add costs to the project, the acquisition of up to 1,600 acres of agricultural easements at an estimated $1,500 per easement would amount to $2.4 million, or about five percent of the project's estimated cost.

<u>Other Comments</u>

1. An environmental document under CEQA or NEPA should be conducted and presented in an objective fashion. However, the DEIR/S often includes text that conveys an advocacy tone. An example is the discussion on why the project should proceed regardless of its impacts on agriculture (page 5-31). Another example is on page 5-4 where the project is referred to in the first person, using the term "our." In addition, the text includes unsupported statements that come across as advocacy rather than as objectivity. For example, "the effort...is already improving the health of local wildlife..." and "improvements in water quality as a result of restoration efforts have positive effects all the way down the Sacramento River to the Bay-Delta." Such claims may be true, but should be stated more objectively and documented with supporting data and observations.

2. The DEIR/S notes that the project area includes Williamson Act contracted lands. On page 4-40, it is stated that "less and less land would be re-contracted under the Williamson Act." The basis for this statement should be provided. Do trends in enrollment support this prediction?

   On pages 5-28 and 29, references are made to Williamson Act contracts being impacted by the project, but the fate of these contracts is not made clear. The

DEIR/S should describe whether the contracts will be terminated of their own accord, terminated by public acquisition, or cancelled. Also, consistent with the ROD mitigations, the Department of Conservation should be notified of any change in contract status as a result of this project.

3. Chapter four describes the agricultural character of the project site in narrative. We recommend that the agricultural acreage within the project site and on lands within the sphere of influence of Hamilton City, be shown on maps and tables, using, where available, the Department of Conservation's Farmland Mapping and Monitoring Program data and maps. This classification scheme should also be used in discussing project impacts on agricultural land.

   Also, on page 4-28, a reference is made to Williamson Act Prime and Unique agriculture. It seems that this reference is mixing two different definitions. The Williamson Act's lands are defined as Prime Agricultural Land and Open Space of Statewide Significance (often referred to as Non-Prime Agricultural Land). The Farmland Mapping and Monitoring Program uses a classification that relies on a completely different set of criteria to categorize lands as Prime Farmland, Farmland of Statewide Importance, Unique Farmland and Locally Important Farmland. There is no Williamson Act Unique agricultural land. This should be clarified and the two systems (three, including the USDA Land Capability Classification system) consistently used within the document.

4. We commend you on the use of the California version of the Land Evaluation and Site Assessment (LESA) analytical model. It was originally developed by the USDA to quantify the significance of the impacts of federally funded projects on agricultural lands. These projects can include airports, sewer treatment plants, highways and habitat acquisitions. The California version was developed to better apply to California conditions and is now an optional impact analysis tool in CEQA. CEQA offers the tool for the analysis of project conversions of agricultural land to non-agricultural uses. The Act's Guidelines do not distinguish between urban non-agricultural uses, or other, less intensive uses, as long as the conversion occurs to an assumed irreversible non-agricultural use. LESA is intended to document these impacts.

   The model rates lands according to its inherent physical and chemical characteristics. For example, land subject to frequent flooding will be assigned to lower land capability classes and score lower on the Land Evaluation side of the model. The model also rates the land use and policy setting of the subject lands. For example, the model gives a lower rating to farmland in close proximity to non-agricultural uses that could pose land use conflicts. Similarly, the model gives a higher rating to agricultural lands in close proximity to other agricultural lands that are protected for agricultural uses.

Also, because of our State's diversity, the California LESA model is intended to be modified by lead agencies, as necessary, to better account for unique local agricultural and land use conditions. For example, the statewide model gives additional points when the subject site is adjacent to other protected agricultural and open space lands. However, if an adjacent open space use is one that could impair the continuing agricultural use of the project site (e.g. an aggregate mine, off-highway vehicle park, or a wildlife refuge), it may be appropriate to modify the "SA" side of the LESA equation to account for the incompatible land use. As long as the modification is an attempt to better document the true agricultural value of the land in question, adaptation of the model is appropriate.

The California LESA tool, as well as the federal version of it, are referred to in the DEIR/S as two different methods of evaluating agricultural land impacts. This is not quite the case. The California LESA is an improved (for California) derivative of the federal LESA. The California LESA was developed to be more applicable to California's agricultural setting, while the federal LESA is a generic version, developed for national application with a Midwestern bias. While federal agencies are required to use the federal LESA in evaluating federal projects, the California LESA is more appropriate for this analysis. We recommend that this difference in the two systems be clarified and that deference be given to the California model. If the federal LESA is to be used at all, to be consistent, its score should also be shown in Chapter 5.

5. On page 5-5, a reference is made to "SCS." While the Technical Release cited was issued when this USDA agency was still named the Soil Conservation Service, it has since been renamed the Natural Resources Conservation Service. To avoid confusion, this clarification should be made.

6. On page 5-26, The Nature Conservancy September 2002 draft socioeconomic assessment study is cited to document socio-economic impacts of the project. Another germane study that should be reviewed is one funded by the U.S. Fish and Wildlife Service, "The Economic Impact on Glenn County of Public Land Acquisition and Habitat Restoration Activities in the Sacramento River Conservation Area", by Ronald G. Adams and David E. Gallo, dated June 15, 2001.

7. On page 5-39, the statement is made that project alternatives would "decrease dispersal of pesticides due to flooding of agricultural areas." The current problem of pesticide dispersal into California waters from the project site should be documented and the expected decrease due to the project, quantified.

8. On page 5-41, we recommend that the project's cumulative impacts on agricultural workers and third party economic interests also be addressed. This could be conducted along with the expanded cumulative agricultural land conversion impact analysis recommended previously in this letter.

Thank you for the opportunity to comment on the administrative DEIR/S. I hope that our comments and recommendations are useful to you as you prepare the document for its public release. If we can provide additional information and advice, or answer questions on our comments, please call me at (916) 651-9445.

Sincerely,

Kenneth E. Trott, Staff Environmental Scientist
Office of Agriculture and Environmental Stewardship

cc: William R. Duckworth, Agricultural Commissioner
Glenn County

Steve Shaffer, Director
Agricultural and Environmental Stewardship

KT:cm

State of California • The Resources Agency
Arnold Schwarzenegger, *Governor*

DEPARTMENT OF PARKS AND RECREATION
Ruth Coleman, *Director*

Northern Buttes District
400 Glen Drive
Oroville, California 95966-9222
(530) 538-2200

May 20, 2004

Ms. Erin Taylor
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, CA 95814-2922

Dear Ms. Taylor:

Subject: Hamilton City Flood Damage Reduction and Ecosystem Restoration, California (Draft FR/EIS/EIR), March 2004, SCH #2002122048

The following comments relate to the March 2004 report mentioned above; bold text is from your draft report.

6-1

1. Summary Page 4, **"Some modification of the existing boat ramp may be required"**. Some modification of the boat ramp and associated facilities will be required. (As delineated in alternative 6, raising the levee and covering the existing park landscaping and parking area with a levee will require the replacement of impacted parking and associated landscaping. The project may require replacement of the existing boat ramp, roads, and associated structures depending upon final levee design.)

6-2

2. Page 8-9, **"Federal Water Project Recreation Act"**. There are opportunities for this project to enhance recreation. The project could add additional parking and camping on lands adjacent to Irvine Finch River Access. The opportunity exists for cost sharing of these recreation enhancements adjacent to the Irvine Finch River Access owned and operated by the State of California, Department of Parks and Recreation. Up to 250 additional day use and boat parking spaces, and a campground (with 50 family campsites and 3 group campsites) could be developed on adjacent lands impacted by the project.

6-3

3. Page 5-45, "Mitigation measures" ..."**These effects shall be minimized through...redirection to the nearest comparable facility within the proposed project effected area**". Unfortunately, no comparable facilities exist for launching boats in the Sacramento River in the vicinity of Chico. The nearest comparable ramp downstream is Ord Bend (river mile184), and upstream the next ramp is at Woodson Bridge (river mile 218). The Woodson Bridge ramp is frequently closed due to silt build-up. The next comparable ramp upstream is Red Bluff (river mile 243). The two nearby ramps are Scotty's and Pine Creek. Both of these ramps are severely restricted. The ramp at Scotty's Boat Landing is substandard and without parking. The ramp at Pine Creek is substandard with very limited parking and a very shallow channel to the river.

6-4

The recreation mitigation suggested in the report "**Provide notice and signage to redirect use**" is insufficient. We suggest that every effort be made to keep the existing boat ramp and parking at Irvine Finch open to boaters during the salmon fishing season (fall and winter), and limit any boat ramp closures to short periods during other times of the year. Temporary river access, temporary boat launching and temporary parking should be maintained during the construction period. The boat ramp is extremely busy during the fall salmon fishing season. During the prime fishing season, it would be inexcusable to close the ramp, or severely limit parking.

Thank you for allowing us to comment on your draft report.

Roger Calloway
for
Robert Foster
District Superintendent

Cc: Tom Wyant, Natural Resource Division
Woody Elliott, Northern Buttes District
Roger Calloway, Northern Buttes District
Steve Feazel, Northern Buttes District
Ken Walters, Northern Buttes District

FAX: State Clearinghouse (916) 323-3018

From: Bundy, Burt [bundy@water.ca.gov]
Sent: Monday, May 24, 2004 3:09 PM
To: Compstudy
Subject: Hamilton City Draft FR/EIS/EIR Comments and Questions

2440 Main Street
Red Bluff, Ca. 96080
T.530-528.7411 F.530.528.7422

www.sacramentoriver.ca.gov

U.S. Army Corps of Engineers, Sacramento District

May 24, 2004

ATTN: Hamilton City Project
Environmental Resources Branch
1325 J Street
Sacramento, California 95814-2922

Regarding: The Draft Feasibility Report and Environmental Impact Statement/Environmental Impact Report (Draft FR/EIS/EIR) for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, California

The Sacramento River Conservation Area Forum is a non-profit organization that represents many different interests along the Sacramento River. Out Mission States:

> *"The Sacramento River Conservation Area Forum brings communities, individuals, organizations and agencies together along the Sacramento River from Keswick to Verona to make resource management and restoration efforts more effective and sensitive to the needs of local communities. The Forum supports restoration done well, and serves as a forum for sharing, a facilitator of solutions, and a partner for projects that protect both the natural values of the Sacramento River and the communities it runs through."*

1 Members of our group have played an active role in coordinating discussion about the Hamilton City Project. Both our Technical Advisory Committee and Board have been briefed on the project. The Board has accepted the TAC recommendation that the Hamilton City Project meets the principles and guidelines outlined in our Handbook, and the information presented in the Draft FR/EIS/EIR is accurate and acceptable.

The SRCAF looks forward in continuing our participation with the COE and State Reclamation Board planning process on Hamilton City.

If we may be of any assistance in this process, please let us know.

Burt Bundy, Manager
Sacramento River Conservation Area Forum
2440 Main Street
Red Bluff. California 96080

Phone (530) 528-7411
Fax (530) 528-7422
e-mail bundy@water.ca.gov
Website www.sacramentoriver.ca.gov

PUBLIC WORKSHOP MEETING FOR THE HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION FEASIBILITY STUDY

HAMILTON UNION HIGH SCHOOL
HAMILTON CITY, CALIFORNIA
THURSDAY, MAY 6th, 2004
8:00 P.M.
PUBLIC COMMENTS

Reported by: Sheryl Dirks, CSR#3513

(PUBLIC COMMENTS)

MS. GRIVEY: Actually two comments. My first
comment is that I want the people who are here paying
attention and making decisions to pay attention to the fact
that this community has a very low median and mean income
and 1.8 million dollars, if I understood him correctly, is a
8-1 lot of money to share among a thousand households; and then,
another, I don't know, $100,000 a year, $145,000 a year to
share among a thousand households is a lot of money. So I'm
all for the levee. I want it to go forward, but I want us
to keep that in mind. We're not a very rich community. So
that's the first thing I want people listening and paying
attention, making decisions to pay attention to.

The second comment I want to make as I understand
that the dirt, some of the dirt is going to be removed from
the Glenn-Colusa Irrigation Canal which is that huge mound
of dirt that goes along Highway 45 and that makes sense to
me. It's a lot of dirt and it's a great place to take it
from; but if you guys go in there and you just remove the
dirt like they sometimes do willy-nilly, haphazardly, not
paying attention to what's going on, there is habitat,
8-2 coyotes, birds, all sorts of habitat that lives in that
canal on those ditches, banks. There is homes on the --
8-3 along the ditch bank. It serves as a sound breaker for the
8-4 homes there. It also serves as a flood control for Colusa

Canal in the winter when it floods.

I want you to when you think about taking this dirt away whoever's job that is, I want you to think about we need to do this with a plan and to think about how it's going to impact the people that live there and the rest of the community and leave it so it looks nice because right now they go in there and remove the dirt, they track it everywhere and it looks horrible; and I would really like it to be left for pride for our community. Those are the two comments that I have.

8-5

Mr. BUNGARZ: Thank you, Susan. You might want to get together with some of the planners on that second question. They may be able to give you some answers on that.

Anyone else that wanted to say anything that has a card? Wow, we must be doing something right.

The planning team has agreed now the main reason for this, obviously, was to let you give your input into the draft plan which that input will go into the final plan both written and oral; and, again, if you want to do it in writing, these cards are out on the desk.

The planning team has agreed that if you have any questions, they would try to answer them for you now. Question-and-answer period.

MR. BENTON: This might be a little silly but, further questions or this presentation brought up something you didn't get answered and you want to get answered by the public feel free to do it. This Corps group and the Department of Water Resources has worked together with this community I think stronger than I've seen work for a long time, and I don't know how often we're going to be able to see them again. I would like to give them a big hand. Thank you very much.

MS. SAPP: Juanita Sapp. I'm following up on Barbara Bass' comment about the riparian area out here. I think that when they write this proposal up that something in it should be worded in a way that the local district will have access to the land as park area, the riparian area. If we are going to be asked to pay for this through the levee district because if I understand correctly, it includes the levee district -- I mean, the levee and the riparian area we're going to be asked to pay for this on an annual maintenance, we should have access to it.

9-1

(end of comments)

California Regional Water Quality Control Board

Central Valley Region

Terry Tamminen
Secretary for Environmental Protection

Redding Office
415 Knollcrest Drive, Suite 100, Redding, California 96002
Phone (530) 224-4845 • FAX (530) 224-4857
http://www.swrcb.ca.gov/rwqcb5

Arnold Schwarzenegger
Governor

7 May 2004

Annalena Bronson
The Reclamation Board
2210 El Camino Avenue, LL-40
Sacramento, CA 95821

COMMENTS ON DRAFT FEASIBILITY REPORT/EIS/EIR FOR HAMILTON CITY FLOOD DAMAGE REDUCTION AND ECOSYSTEM RESTORATION PROJECT, SCH #2002122043, GLENN COUNTY

Based on our review of a Draft Feasibility Report/Environmental Impact Statement/Environmental Impact Report (March 2004) for the project *Hamilton City Flood Damage Reduction and Ecosystem Restoration*, we have the following comments.

10-1 <u>Wetlands and/or stream course alteration</u> – The project proponent may need to apply for a Clean Water Act Section 404 permit (§404 permit) from the U.S. Army Corps of Engineers. A §404 permit is required for activities involving a discharge of dredged or fill material to waters of the United States. "Waters of the United States" include wetlands, riparian zones, streambeds, rivers, lakes and oceans. The Army Corps of Engineers Butte County contact for §404 permits is Ms. Laura Whitney, (916) 557-7455.

② 10-2 Projects requiring a §404 permit also require a water quality certification (pursuant to Section 401 of the Clean Water Act) verifying that the project does not violate State water quality standards. A water quality certification is required for any project that impacts water of the State (such as streams and wetlands). Activities that fall under the water quality certification process include, but are not limited to: stream crossings, the modification of stream banks or stream courses, and the filling or modification of wetlands. A water quality certification must be obtained prior to construction. Failure to obtain a water quality certification, when required, may result in enforcement action. The Regional Board Contact for water quality certifications is Scott A. Zaitz, who can be reached at the letterhead address or by telephoning (530) 224-4784.

3 <u>Isolated wetlands not covered by the federal Clean Water Act</u>
-3 Wetlands not covered by the Clean Water Act are known as "isolated wetlands." Should the U.S. Army Corps of Engineers determine that isolated wetlands exist at the project site and should the project impact or have potential to impact the isolated wetlands, a Report of Waste Discharge and filing fee must be submitted prior to commencing the construction activity. The Regional Board will consider the provided information and either issue or waive Waste Discharge Requirements. Failure to obtain waste discharge requirements or a waiver thereof, when required, may result in enforcement action. Report of Waste Discharge application forms are available by calling our office at (530) 224-4845.

4
10-4

Construction storm water - A Construction Activities Storm Water Permit is required for storm water discharges associated with a construction activity where clearing, grading, and excavation result in a land disturbance of one acre or more. Storm water discharges from construction activity that results in a land disturbance of less than one acre, but which is part of a larger common plan development of one acre or more, also requires a construction storm water permit. A construction storm water permit, if required, must be obtained prior to construction. Failure to obtain a construction storm water permit, when required, may result in enforcement action. Construction storm water permits can be obtained from Scott A. Zaitz (see above contact information) with the Redding office of the Regional Board.

5
10-5

Dewatering Alternative 1: discharge to storm drains or waters of the United States - A dewatering permit, *General Order for Dewatering and Other Low Threat Discharges to Surface Waters*, may be required for construction activities. This general NPDES (National Pollutant Discharge Elimination System) permit covers the discharge to waters of the United States of clean or relatively pollutant-free wastewater that poses little or no threat to water quality. The following categories are covered by the dewatering permit: well development water; construction dewatering; pump/well testing; pipeline/tank pressure testing; pipeline/tank flushing or dewatering; condensate discharges; water supply system discharges; miscellaneous dewatering/low threat discharges. The dewatering permit applies only to direct discharges to waters of the United States. Failure to obtain a dewatering permit, when required, may result in enforcement action. An application form and a copy of the permit are available at this office.

6
0-6

Dewatering Alternative 2: discharges to land - Construction dewatering discharges that are contained on land (i.e., will not enter waters of the United States) are allowed under a general waiver adopted under Regional Board Resolution No. R5-2003-0008, provided the following conditions are met: (1) the dewatering discharge is of a quality as good as or better than underlying groundwater; and (2) there is a low risk of nuisance. Examples of dewatering discharges to land include a terminal basin, irrigation (with no return to waters of the United States), and dust control. You may request written confirmation from this office that the waiver is applicable.

If you have any questions, please contact me at (530) 224-3249 or the letterhead address.

Ray Bruun, P.E.
Associate Engineer
Shasta-Cascade Watershed

KB: rcb

cc: State Clearinghouse, Sacramento

Taylor, Erin A SPK

From: Kurt Keilman [kurtkeilman@sbcglobal.net]
Sent: Tuesday, April 13, 2004 12:12 PM
To: Compstudy
Subject: Draft FR/EIS?EIR Hamilton City

Hope you don't mind that I am sending in a few comments. Several people have told me that the Ham City report was an excellent document and having worked on Ham City when I was at the Corps, I couldn't resist a quick read.

Well, I was impressed- told the "story" better than many of the traditional Corps documents. Having said that, I can't help but ask a few questions. Again, hope you don't mind me still being a nosy economist even on my time off.

Hamilton City Flood Damage Reduction and Ecosystem Restoration, California
Draft Feasibility Report/EIR/EIS March 2004

General Comment on the Report:

1 Overall the document is an excellent example of how to formulate a project for the combined purposes of both ecosystem restoration and flood damage reduction. And I believe the report presents that the Alternative 6 is the NER plan that is most cost effective and that adding the flood damage reduction increment where Average Levee Height=7.5 feet for the Combined Alternative 6 (given the restriction on project performance where conditional non-exceedance probabilities are not allowed to be greater than 90% for the 1/75 event or less than 90% for the 1/125 event) optimizes incremental net benefits. Based on the report, the Combined Alternative 6 is the best NED-NER plan. But I do have a few technical concerns regarding findings in the report.

Concerns:

11-2 1) Table 3-16: Alternative 3 is <u>**incorrectly identified**</u> as the least cost single purpose (ecosystem restoration plan). The problem is two-fold. First, it is not the least cost of any of the alternatives providing at least 888 AAHU. The least cost would be the NER plan Alt 6 (which is different from the Combined Alternative 6 in magnitude of flood damage reduction). In fact Alt 3 is the highest cost of any of the alternatives identified. Second, it is not a single purpose plan. Based on the estimates in Table 3-7, Alt 3 provides $327,000 in flood damage reduction benefits (or 56% as much flood damage reduction as the Combined Alternative 6 which was selected as the combined flood damage reduction and ecosystem restoration plan).

If there cannot be any plans (single purpose) formulated that provide 888 AAHU and $0 flood damage reduction that are less costly than the NER plan at 2,556,600 (see table 3-17) I would suggest that you use the NER plan as the least cost single purpose plan in Table 3-16. It is the least cost plan identified with similar ecosystem restoration outputs to the combined plan.

REVISED USING THE LOWER COST NER PLAN INSTEAD OF THE HIGHER COST ALT 3

TABLE 3-16. PRELIMINARY COST ALLOCATION
Combined Alternative 6
Tentatively Recommended Plan
(Flood Damage Reduction and Ecosystem Restoration)

	Annual Costs ($1,000)
Total Project Cost (a+b+c)	2623
a) FDR Separable Costs	67
b) ER Separable Costs	1736
c) Joint Costs	820

Annual Costs and Benefits ($1,000)

	FDR	ER	Total
d) Average Annual Benefits	584	888 AAHU	
e) Least Cost Alternative Plan (single purpose)	919 (alt 1)	2557 (alt 6)	
f) Limited Benefits (lesser of d and e)	584	2557	
g) Separable Costs (a and b)	67	1736	
Remaining Benefits	517	821	1338
h) Percentage of Remaining Benefits	38.6%	61.4%	
i) Allocated Joint Costs (cxh)	317	503	
j) Total Allocated Costs (i+a and i+b)	384	2239	

The FDR would still be feasible but with a lower net benefit and BC ratio of 1.5 to 1.

11-3
11-4
2) It appears that the only risk-based measure of with project performance was limited to defining the event that meets a Conditional Non-Exceedance Probability (CNP or as described in the report as reliability) of 90%. Why were Annual Exceedance Probabilities (AEP) and Long Term Risk excluded from the with project reporting? Was HEC-FDA used in the analysis? Can this information be found in any appendices and if so can you reference these sources in the Main Report?

Again, I think it is a great report and combined multi-purpose plans providing win-win situations for many stakeholders are the direction all water resources need to pursue.

Kurt Keilman

State of California **THE RESOURCES AGENCY OF CALIFORNIA**

Memorandum

To: Project Coordinator
Resources Agency

Date: May 20, 2004

Ms. Annalena Bronson
The Reclamation Board
3310 El Camino Ave., LL-40
Sacramento, CA 95821

Ms. Erin Taylor
U.S. Army Engineer District
1325 J Street
Sacramento, CA 95814-2922

From: Dennis J. O'Bryant
Acting Assistant Director
Department of Conservation – Division of Land Resource Protection

Subject: Draft Environmental Impact Report/Statement (DEIR/S) for the Hamilton City Flood Damage Reduction and Ecosystem Restoration, Glenn County
SCH #2002122048

The Department of Conservation's Division of Land Resource Protection (Division) monitors farmland conversion on a statewide basis and administers the California Land Conservation (Williamson) Act, California Farmland Conservancy Program, and other agricultural land conservation programs. The proposed project presents many important advantages that include structural and nonstructural flood protection to the region, combined with riverine and riparian habitat restoration on approximately 1500 acres.

Division staff met with state and federal lead agency representatives on several occasions so that our concerns are addressed within the scope of the environmental documentation. As this project is to receive funding through the California Bay-Delta Authority (formerly known as CALFED), we would like to commend the lead agencies in largely incorporating the mitigation measures that are identified in the CALFED's EIS/R Record of Decision (Section 7.1 Agricultural Land and Water Use) as intrinsic parts of the project. These mitigation measures are substantially identified in Chapters 5 and 9 of the document. We acknowledge the necessity for the proposed project, as well as the potential benefits the proposed project offers that includes protection of valuable farmland in the area surrounding and downstream of the project site.

We respectfully offer the following comments and ask that they be addressed in the FEIR/S's response to comments:

The DEIR/S contains mitigation measures that have already been incorporated
into the proposed project and are discussed in Chapters 5 and 9. We fully support and
recognize those measures that have been implemented thus far in the project. The
document mentions that an adjacent 157-acre parcel of land currently owned by The
12-1 Nature Conservancy may be under consideration for a permanent agricultural
easement. Please do not hesitate to contact the Division of Land Resource Protection
as we may be of assistance in the establishment of such an easement.

Even with implementation of the mitigation measures, there remains a net loss of
approximately 1500 acres of agricultural lands, which, as the agency in California state
12-2 government statutorily charged with monitoring farmland conversion, we consider to be
a significant environmental impact. The majority of these lands are currently under
12-3 Williamson Act contract and within a Farmland Security Zone. Please contact the
Division and the County for information regarding contract termination requirements.
As replacement of land is not possible, even with the mitigation measures, the lead
12-4 agencies may wish to consider adopting a statement of overriding considerations at the
time of certifying the environmental document.

Section 8.1.5 discusses the Farmland Protection Policy Act. The Act requires a
federal agency to consider the effects of its action and programs on the nation's
farmlands. This federal rating system (Farmland Conversion Impact Rating) is
essentially the federal Land Evaluation and Site Assessment (personal communication
with Phil Hogan, NRCS, May 19, 2004), and is the system upon which the Department's
Land Evaluation and Site Assessment (LESA) model was based. The NRCS conducted
an analysis for determining the Farmland Conversion Impact Rating for this project,
which resulted in a score that requires higher levels of consideration for protection
(please refer to the following website for a brief explanation of the federal system:
http://www.nrcs.usda.gov/programs/fppa). The state LESA model was developed to
provide state agencies with an optional methodology to assess the environmental
impacts of agricultural land conversions. As with the Farmland Conversion Impact
Rating, LESA is a framework for combining multiple factors into an integrated
assessment of the importance of a particular site for continued agricultural use. Such
factors as soil quality, agricultural productivity, development pressure and measures of
other public values are combined into a single score that allows units of government
and non-government to identify and protect agricultural resources and plan their
projects accordingly. The document provides a discussion in the Summary that
12-5 concludes that the use of the use of the LESA model is inappropriate for this project.
The rationale provided in the discussion emphasizes that soil quality is the primary
factor to consider, when it is just *one* of the factors. The discussion also appears to be

inconsistent with the federal rating system. Regardless of whether or not an agency opts to utilize the model, if the reasons for not using it are included in the document, it is important that the rationale be appropriately and correctly reflected. The document is correct in stating that there may be disagreement among agencies, and we look forward to working towards resolution so that important projects such as this may proceed smoothly.

Thank you for the opportunity to review this document. We recognize that this project is well-supported locally, and that when implemented, the project will provide a greater degree of protection to the surrounding agricultural lands, provide valuable habitat and allow the river's natural processes to return.

Please do not hesitate to contact if we can be of assistance. If you have any questions regarding these comments, please contact Jeannie Blakeslee at (916) 323-4943.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

May 24, 2004

Erin Taylor
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

Subject: Draft Environmental Impact Statement (DEIS) for the Hamilton City Flood Damage Reduction and Ecosystem Restoration project (CEQ#040161)

Dear Ms. Taylor:

The Environmental Protection Agency (EPA) has reviewed the above referenced document pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Section 309 of the Clean Air Act, as well our authorities under the Clean Water Act Section 404.

The Army Corps of Engineers proposes to increase flood protection and enhance ecosystem values along the Sacramento River in Hamilton City by constructing a setback levee, removing part of the existing "J" levee, and restoring native vegetation on project lands.

3-1 EPA supports the goals and objectives of the Hamilton City project. In our review of the document, we found that the DEIS sufficiently addresses the environmental impacts of the proposed alternative. EPA has rated this document *"Lack of Objections"* (LO). Please refer to the attached "Summary of Rating Definitions" for further details on EPA's rating system. Our rating reflects our overall view of the adequacy of the document.

We appreciate the opportunity to review this DEIS. Please send 2 copies of the Final EIS to the address above (Mail Code: CMD-2) when it is available. If you have any questions, please feel free to contact me or Shanna Draheim, the lead reviewer for this project. Shanna can be reached at 415-972-3851 or *draheim.shanna@epa.gov*.

Sincerely,

Lisa B Hanf

Lisa Hanf, Manager
Environmental Review Office

Attachments: Summary of EPA Rating Definitions

Printed on Recycled Paper

This rating system was developed as a means to summarize EPA's level of concern with a proposed action. The ratings are a combination of alphabetical categories for evaluation of the environmental impacts of the proposal and numerical categories for evaluation of the adequacy of the EIS.

ENVIRONMENTAL IMPACT OF THE ACTION

"LO" (Lack of Objections)

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

"EC" (Environmental Concerns)

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

"EO" (Environmental Objections)

The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

"EU" (Environmentally Unsatisfactory)

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potentially unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

ADEQUACY OF THE IMPACT STATEMENT

Category 1" (Adequate)

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

"Category 2" (Insufficient Information)

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analysed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

"Category 3" (Inadequate)

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analysed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From EPA Manual 1640, "Policy and Procedures for the Review of Federal Actions Impacting the Environment."

Public Comments and Responses on Draft FR/EIS/EIR

Commentors:

1. The Nature Conservancy
2. Ms. Sharon Wallace, area resident
3. FEMA, Community Mitigation Programs
4. Sacramento River Preservation Trust
5. California Department of Food and Agriculture
6. California Department of Parks and Recreation
7. Sacramento River Conservation Area Forum
8. Ms. Susan Grivey, area resident
9. Ms. Juanita Sapp, area resident
10. California Regional Water Quality Control Board
11. Mr. Kurt Keilman, public
12. California Department of Conservation
13. U.S. Environmental Protection Agency

Comment #

1-1 **... These researchers quantified an average density of 323 plants per acre for existing riparian forest from 9 sites. Six of these research sites are within the project area.**
As a result of the adaptive management feedback loop and continuing research, we now plant densities ranging from 200-360 plants per acre, depending on vegetation community. We recommend you increase the planting density per acre of the project area to the ranges specified above in order to more closely meet the needs of conservation targets and mimic ecosystem function.

Response: Planting densities (refer to page 6 and 7 of the revegetation report of the engineering appendix - Appendix C10: Habitat Revegetation Report) have been adjusted to the 200-360 plants per acre range as recommended by TNC.

1-2 **The plan includes "passive restoration" areas where no revegetation activities would occur. We suggest limiting this application to a maximum of 10 acres because exotic vegetation has significantly altered conditions on the Sacramento River floodplain. This exotic vegetation precludes natural recruitment of native vegetation in most cases.**

Response: The following text has been added to page 3, paragraph 3.2 e. of the revegetation report (Appendix C10): "This may be limited to 10 acres or less total area."

These areas are largely intended to provide more edge habitat. Additionally, these areas are not intended for completely passive restoration, rather, native grass would be restored in these areas, leaving native woody vegetation to establish passively with less competition with weedy exotic species. USACE would like to further evaluate this feature with the input of TNC and other learned parties during the detailed design phase of the project. It is the Corps' intention to implement this only to the extent that it maximizes habitat. If the value of this feature is unknown, USACE will implement less than 10 acres total to allow evaluation of the habitat value and potential for reduced costs for restoration arising from this type of feature. If the value of this feature is considered to be negative, this feature would not be implemented.

1-3 **The plan identifies seeding of native forbs. Again, due to altered floodplain conditions, perhaps this application should be tested on a small scale before implementation over large acreages.**

Response: The following text has been added to page 16 paragraph 5.6: "Success of establishment of Forbs by over-seeding is currently under investigation. If trials of forb over-seeding are sufficiently successful, forbs may be over-seeded in this project. If trials are not indicating success, limited amounts of forb seeding may be done to test potential methods for establishing forbs."

The Corps agrees that implementation of native forb over-seeding over the entire area should only be done if reasonable success can be expected. Also, This project is likely to be phased over a number of years allowing for adaptive implementation of forb over-seeding based on lessons learned from the early phases. As some of the groups doing restoration in the floodplain of the Sacramento River are experimenting with seeding forbs, and the implementation date of this project could be several years into the future, we believe that successful methods to over-seed forbs may be demonstrated prior to project implementation. We would like to leave open the possibility of large-scale implementation of forbs seeding if reasonable success can be expected.

2-1 **Are there clear references in the EIR/EIS document to "cumulative Impacts" - particularly as they relate to the relationship of flood control projects proposed or planned for the eastside of the Sacramento River?**

Response: As required by both NEPA and CEQA, cumulative impacts are addressed in the EIR/EIS. This discussion is located in Chapter 5, Section 5.5, "Cumulative Effects." Cumulative impacts should consider past, present, and reasonably foreseeable future actions. In accordance with the Water Resource Council's Principles and Guidelines, the future actions considered are only those proposed or planned projects that have been approved or funded for the "with and without-project future condition." The projects you reference have not been approved or funded.

2-2 **The eastside stretch of the river has also been the focus of several studies, as well, and your own flood event prediction maps already include that area (Keifer Slough, Pine Creek, and Rock Creek, etc...) for modeling purposes...**

Response: The Hydrology Study includes the Sacramento River Valley from the headwaters upstream of Lake Shasta down to the Sacramento River at Hamilton City, and includes contributions from Sacramento Valley "eastside tributaries" and "Westside tributaries." See Appendix C2, "Hydrology Office Report."

The Hydraulics model extended from RM 212 downstream to RM 191. The model extended approximately to the town of Nord on the east and the Glenn Colusa Canal on the west. See Appendix C3, "Hydraulic Design Document Report" Figure 1 to see an approximate extent of the model.

3-1 **Please review FIRM maps for Glenn County.**

Response: Comment noted. The study team considered National Flood Insurance Program (NFIP) requirements in the document.

4-1 **The statement is made (Summary-3) that the training dike would "...reduce damages from scouring flows." How would it do that? I would suggest that having some native vegetation on the landward side of the dike might help achieve this objective.**

Response: The training dike was designed to allow floodwaters to flow around to the landside of the structure from the south. Backwater begins to form behind the training dike as flood levels rise. Backwater is essentially free standing water that has ponded behind the levee with little to no velocity. As flood levels rise, overflow over the training dike plunges into the free standing backwater acting as an energy dissipater that reduces the velocity of the water therefore reducing the scouring flows behind the training dike. Native grasses would be planted on the training dike to reduce erosion from scouring and also serve as a buffer between the restoration area and adjacent agricultural lands. It is described on page 9-13.

4-2 **The description of where the setback levee will begin (first paragraph, Summary-4) is unclear to me and is not helped by the diagram in Figure S-1. Please provide a more detailed visual of this element of the Project.**

Response: The project maps (Figure S-1 and Figure 9-1) have been modified to include the area where the setback levee would cross County Road 203 at the northern end of the project.

4-3 **How was the training dike alignment determined? Is it tied to topography or parcel boundaries? At any rate, I believe that the alignment should be further to the west (basically, heading due south from its beginning).**

Response: The training dike was developed to reduce backwater flooding to the community of Hamilton City and reduce the frequency and velocity of flooding to adjacent agricultural lands. Various alignments and heights were analyzed to identify the alternative that maximized the benefits of reduced flood damages without causing negative hydraulic effects to neighboring landowners.

4-4 **Please provide details concerning the BMPs that would be implemented as mitigation for temporary effects to Special Status Species (Summary-9).**

Response: Each Special Status Species has it's own set of specific mitigation measures. These measures are described in Chapter 5, Section 5.3.8. The USFWS and NOAA Fisheries are completing their Biological Opinions, on which any more specific BMP's or mitigation measures will be based.

4-5 **When will the Project and related environmental review come up before the state sponsor? And who is the state sponsor, by the way? (Put another way, who is responsible for CEQA compliance?).**

Response: The Reclamation Board is the non-federal sponsor responsible for the EIR. The State Environmental Specialist is responsible for CEQA compliance. The public comment period for the document (both EIS and EIR) closed on May 24th. The Reclamation Board is scheduled to vote to certify the EIR as being prepared according to the provisions of the California Environmental Quality Act on July 16, 2004.

5-1 **Page 4-24 of the DEIR/S describes the agricultural setting of the project site. We repeat our February 2004 recommendation that this section include an Important Farmland Series map for this part of Glenn County to depict the kind, extent and location of agricultural land in the project site and vicinity. This map would complement the existing map of Williamson Act lands, figure 4-2.**

Response: A map from the Department of Conservation indicating the Important Farmland Series for the study area has been added to the document in Chapter 4.

5-2 **In addition, the section should include a table showing acreage of various agricultural land categories according to the California Department of Conservation's Important Farmland Series definitions.**

Response: Acreages of agricultural land categories occurring in the study area have been added to the corresponding text.

5-3 Finally, this section should include definitions of agricultural land used by CEQA, as well as the definition of each category of farmland within the project site (e.g., Prime Farmland).

Response: The definitions of farmland mapping categories in the study area as defined by the Department of Conservation have been included in Chapter 4.

5-4 The Department disagrees with the DEIR/S' conclusion that the adverse environmental impact on agricultural land is "less than significant." (Table 5.1) The DEIR/S incorrectly defines the threshold of significance as the conversion of agricultural lands to uses that would "cause serious degradation of the quality of soils or and/or result in expenditures of substantial development costs that would likely preclude the practicality of future conversion back to agriculture." The DEIR/S also incorrectly states that the project is in compliance with the CALFED ROD.

The CEQA Guidelines state that the loss of agricultural land to a non-agricultural use is a potentially significant environmental impact. This general threshold is based on the California Department of Conservation's Important Farmland Series definitions, which include a combination of both agricultural use and soil quality. The CEQA threshold makes no reference to soil quality degradation or cost to reclaim the converted lands back to agriculture uses...

In fact, this project would result in the conversion of 1,300 to 1,600 acres of Prime, Statewide Important, and Unique Farmland (the CEQA definition of "agricultural land") to non-agricultural uses. This meets the broad test of significance. Appendix G also provides as an optional test of significance, the California Land Evaluation and Site Assessment model developed by the California Department of Conservation. In our February 2004 comments, we recommended that the California LESA model be used to determine the significance of the project's impacts on agricultural land. Indeed, early administrative drafts of the DEIR/S used both federal and state versions of LESA. Both models rendered determinations that the project's impact on agricultural resources is significant. We continue to recommend that the lead agencies work with the Department of Conservation to apply the LESA model to the determination of the project's significance with respect to adverse impacts on agricultural resources.

One of the reasons given by the lead agencies for not using LESA was that it did not account for the benefits of either flood protection provided by the project to other agricultural lands, or to the habitat improvements of the project. This is not a valid argument for discounting the use of LESA. CEQA provides for the analysis of project impacts on biological resources as well as on hydrological impacts in other sections of Appendix G. These sections are where the positive

and adverse impacts of the project on habitat and flooding should be addressed, not in the agricultural resources section. The agricultural resources section of Appendix G is limited to assessing the significance of the project-caused loss of agricultural land resources, and the LESA model is the suggested tool for doing so.

Further, the DEIR/S is an information disclosure document to be used by the lead agency in supporting its decision on project approval. It is the job of the lead agency to weigh and balance the over-all benefits of the project against its adverse impacts; i.e., its impacts on agricultural resources versus its benefits for flood protection and habitat restoration. This is not the job of LESA. Its stated purpose is to assess the project impacts on agricultural resources.

The project, without mitigation measures to address the adverse impacts of the project on agricultural resources, would not be consistent with the CALFED ROD. The ROD commits CALFED to mitigating the adverse impacts of its projects on agricultural land, where feasible, using any number of 31 mitigation measures. However, we did not see that the DEIR/S included measures that would mitigate the loss of agricultural land posed by the project.

Response: The Department of Food and Agriculture's conclusion is based on the assumption that a project, which changes land from a commercial agricultural use to a non-commercial use, creates a per se potentially significant impact within the meaning of CEQA. As explained below, this is a novel legal extension of the California Environmental Quality Act that the lead agency declines to follow.

CEQA requires the disclosure of impacts to the physical environment. In 1993, CEQA was amended to authorize inclusion in the CEQA Guidelines Appendix G of an "optional" methodology for assessing whether an agricultural land conversion could result in a significant effect on the environment. (CEQA, § 21095; "CEQA Guidelines," California Code of Regulations, Title 14, § 150000-15387.) Appendix G is a "checklist" of "sample questions" which aid lead agencies in determining whether a project has the potential to cause significant environmental effects. Importantly, the Appendix G checklist for agricultural resources does not ask a lead agency to determine whether a project will have a potentially significant effect to "agriculture" but "whether potential impacts to agricultural resources are *significant environmental effects.*" A 'significant effect on the environment" is defined as a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, etc.

An economic or social change by itself is not considered a significant effect on the environment. (CEQA Guidelines, section 15382.) The CEQA Guidelines section on "economic and social effects" states that "[e]conomic or social effects of a project shall not be treated as significant effects on the environment.

An EIR may trace a chain of cause and effect from a proposed decision on a project through anticipated economic or social changes resulting from the project to physical changes caused in turn by the economic or social changes. The intermediate economic or social changes need not be analyzed in any detail greater than necessary to trace the chain of cause and effect. The focus of the analysis shall be on the physical change." (CEQA Guidelines, § 15131(a).)

In this case, the change from agricultural use to restored riparian and native grasslands would have a direct positive effect on the physical environment. The loss of agricultural use of the land is an economic and social impact to the agricultural industry that shall not be treated as significant effects on the environment. (CEQA Guidelines Section 15131(a).) The economic or social consequences of the Project would not result in an adverse impact to the physical environment. Therefore, The Reclamation Board concludes that the loss of agricultural use of approximately 1500 acres and the conversion of this land to native vegetation is not a significant adverse impact to the environment within the meaning of CEQA.

Here, the Department of Food and Agriculture's reliance on the Land Evaluation and Site Assessment Model (LESA) to support a finding of significance is misplaced. Again, Appendix G states that "in determining whether there are significant *environmental effects* lead agencies *may* refer to the [LESA] model prepared by the California Dept. of Conservation as an *optional* model to use in assessing impacts on agriculture and farmland." (Emphasis added.)

It is important to note that the LESA Model does not analyze whether there will be potentially adverse significant effects on the environment. It assumes there will be a potentially adverse impact and then rates the impact based on soil criteria, project size, water availability, and surrounding land use information. As such, the LESA model may be useful for determining the level of impact of projects, which are traditionally assumed to create adverse physical impacts (loss of open space, paving of permeable surfaces leading to run-off and potential impairment of water quality, growth-inducing impacts, etc.) such as land development projects. In such an instance the use of LESA is consistent with CEQA and appropriate because land speculation leading to growth is the type of intermediary economic and social "chain of cause and effect" which the CEQA Guidelines acknowledge can create additional adverse physical effects to flora, fauna, etc.

A review of the "LESA" model itself demonstrates that it was, in fact, designed to evaluate the significance of land development type effects. Step 1 of the model includes determining whether the land is "committed" to a nonagricultural use by a "Tentative subdivision map," "Tentative or final parcel map," "Recorded development agreement," or "Other decisions by a local government which are analogous to items #1-3 above and which exhibit an element of permanence" and refers to the "future *development* of the land in question." (*California Agricultural*

Land Evaluation and Site Assessment Model, Instruction Manual, at pgs. 26-27 (California Department of Conservation, Office of Land Conservation, 1997) (Emphasis added).)

Thereafter, the "site assessment" step of the Model requires that lead agencies identify "Protected Resources." A project will be rated as more potentially significant (i.e. have a higher "point rating" in that category) if it is located next to "protected resources." The Model defines "protected resources" as lands "with long term use restrictions that are compatible with or supportive of agricultural uses of land" and defines compatible lands to include "[l]ands with agricultural, wildlife habitat, open space, or other natural resource easements that restrict the conversion of such land to urban or industrial uses." (LESA Model Instruction Manual, p. 28.) Nevertheless, the staff of the Dept. of Conservation encouraged the project proponents to apply the LESA Model experimentally to the Hamilton City habitat restoration project. As a direct result, the lead agency discovered that a model which assumes potentially adverse physical impacts (i.e. land development impacts), and then evaluates the level of those impacts by incorporating economic factors was an improper tool for analyzing a project which, conversely, is designed to create and improve the health of what is defined by the Model itself as "Protected Resources."

When the legislature made the LESA Model an "optional methodology" under CEQA, it was rejecting a "per se" conclusion that all farmland conversion projects would cause potentially significant *environmental* effects. And, in fact, there is not one single judicial decision that can be cited to support the proposition that habitat projects on agricultural land cause per se potentially significant impacts that must be mitigated within the meaning of CEQA. Consistent with the above response, the only judicial decisions requiring mitigation for agricultural land conversions are traditional land development or construction projects.

The lead agency has examined the potential adverse physical impacts of this project and determined they are less than significant. In reaching its conclusions the Department of Food and Agriculture is stating that the project is a physical activity, which it claims will be "adverse" to commercial agriculture by taking land out of production. However, in considering the social and economic concerns raised by the Department of Food and Agriculture the agency finds they are not the intermediary economic and social effects which create a "chain of cause and effect" from one environmentally damaging physical impact to another but are economic and social considerations centered on the perceived value of using land for commercial agriculture versus restoration and preservation. Therefore, the agency declines to adopt the experimental LESA Model findings as an accurate indicator of the significance of potential environmental effects associated with this project. As detailed above, this decision is based on existing law, substantial evidence, and agency expertise.

5-5 **The DEIR/S, in its conclusion that the project will not have a significant impact on agricultural land, states that current flooding conditions render the farmland at the project site as less than Prime, Statewide Important or Unique Farmland in quality. If this argument is to have any merit, such impairment of the agricultural use of the land should be reflected on the Department of Conservation's Important Farmland Series maps for Glenn County. If the Department's maps are inaccurate and need to be corrected, this should be taken up with the Department and rectified prior to concluding that the subject agricultural lands are not subject to the CEQA thresholds of Appendix G.**

Response: The conclusion in Chapter 5 of the report does not state that flooding conditions on farmlands in the study area should cause these farmlands to be categorized any differently than they are currently. However, one could draw that conclusion from the arguments provided. Regardless, the categorization of farmlands is not a key consideration in the conclusion that the effects on farmlands are not significant.

5-6 **The DEIR/S does not include a "working landscape" alternative; i.e., an alternative that explores a 1,300-acre project site that integrates economic uses, such as floodplain compatible agriculture, with habitat restoration and flood protection. This would be consistent with state policy. The Department of Water Resources administers the Floodplain Corridor Protection Program, which administers grants for floodplain projects that seek to integrate floodplain protection with continuing agricultural uses and habitat restoration. We recommend that the final EIR/S include a working landscape alternative.**

Response: The Corps of Engineers has specific missions to reduce damages from flooding and to restore ecosystems of the nation. In order to maximize potential benefits, the alternative formulation methodology included restoring all lands waterside of a setback levee. Reducing the amount of habitat restoration associated with the alternative plans would reduce the ecosystem restoration accomplishments of the alternatives and, in our judgment, would render them unjustified. The project contributes to the region's agricultural productivity by providing increased and more reliable flood protection to agricultural lands landside of the recommended setback levee.

The DWR Floodplain Protection Corridor Program is for local governments and non-profit organizations to implement non-structural flood management projects that include wildlife enhancement and/or agricultural land preservation, and grants are not to exceed $5 million. In the project area, a non-structural flood management project could not adequately address either the flood management or the restoration objectives of the project.

5-7 **The DEIR/S does not present an adequate treatment of the cumulative impact of the project on agricultural resources. The document should include a review of past flood and habitat restoration projects that have occurred along the Sacramento River corridor that have converted agricultural land to non-agricultural uses. The Farmland Mapping and Monitoring Program has been tracking agricultural land conversion for 20 years. This period of time would, therefore, be a practical bracket for analyzing the retrospective component of the project's cumulative impacts. Similarly, other flood control and habitat projects along the Sacramento River that have been proposed, and that are concurrently under review for approval, should be included in this analysis.**

Response: The Cumulative Impact analysis includes consideration of past, present and reasonably foreseeable future actions (NEPA) and foreseeable probable future projects (CEQA). The Draft EIS/EIR Chapter 5, Section 5.5 Cumulative Effects, describes the projects that have been implemented in the study area. The flood protection projects in the study area have protected farmlands. Recent farmland conversion statistics from Department of Conservation were used for the analysis. The analysis also characterizes the proposed conversion of agriculture in the context of Glenn County (conversion of between 0.29 and 0.35 percent of farmland in Glenn County). For purposes of the cumulative effect analysis, reasonably foreseeable and foreseeable probable future projects are defined as being projects that are authorized or funded for implementation. To consider projects in the planning stage is speculative and the burden of disclosing cumulative impacts will be on each of those projects, if they are authorized or funded.

5-8 **Also, for the sake of documenting cumulative impacts of the project, past and foreseeable conversion of agricultural land by urbanization in the vicinity of the project should be characterized, based on past urbanization trends, Department of Finance projections and land use planning policies.**

Response: Between 1998 and 2000, 137 acres of prime farmlands and 223 acres of other important farmland were converted to urban uses in Glenn County. The Draft EIS/EIR, Chapter 4, Figure 4-4 shows the existing urban limit line for Hamilton City. Prime farmland currently occurs within this boundary. How much of this prime farmland will be converted for urban use in the future and when it would be converted will depend upon many factors. However, it is reasonable to assume that much of it will be converted at some point in time. If land currently zoned for urban development is to be converted to urban uses, those projects would need to comply with environmental laws to evaluate potential effects. The proposed project would not affect growth trends within the existing urban limits. Nevertheless, future urban growth of Hamilton City would contribute to the cumulative effects on agricultural lands. This information has been added to the "Cumulative Effects" section of the EIS/EIR.

5-9 **Growth Inducing Effects. The DEIR/S notes that the proposed levee would provide less than the 100-year level of protection under FEMA standards. The document then concludes that the project would not be growth inducing because it "would not alter the regulation of land use in the floodplain pursuant to the National Flood Insurance Program." This conclusion needs to be better documented. It would seem that any improvement in flood protection over the existing protection could have growth-inducing impacts since the final land use approval authority is Hamilton City, the National Flood Insurance Program notwithstanding. We recommend that the final EIR/S discuss local land use policies that would affect the development potential of agricultural lands around the City, and how those policies would prevent increased flood protection from having growth-inducing impacts on adjacent agricultural land.**

Response: Much of the undeveloped area within the urban growth limits of Hamilton City is outside of the limits of the FEMA 100-year floodplain (Figure 4-3, Urban Limit Line: Hamilton City Area, is now Figure 4-4 and has been modified to include the FEMA Floodplain Boundary). Thus, the City has adequate room for growth regardless of whether they can get additional flood protection. One of the most recent developments within Hamilton City occurred in an area near the eastern boundary of the City, within the 100-year floodplain, but included the requirement to place structures on pads that raised the structures out of the floodplain. This kind of development is indicative that the growth of the City is not seriously constrained by the limits of the 100-year floodplain. Since areas within the FEMA 100-year floodplain can be developed under existing conditions, and since most of the undeveloped areas are currently outside of this floodplain, it is reasonable to conclude that the increased level of flood protection provided by the proposed project would have little to no effect on growth.

Of the land that is currently zoned for urban development, lands north of Highway 32 that are bound on the west by the railroad spur and on the east by the recommended setback levee are currently in agricultural production and are classified as prime farmland. That land is currently owned by TNC but is not planned for restoration as part of the recommended project. It is uncertain at this time what TNC will do with that parcel of land. The future of that land is not dependent upon a project, although construction of a setback levee would provide it with improved flood protection.

Lands west of the Glenn-Colusa Canal that are zoned for urban development are not benefited by the recommended project and would consequently not be affected by the improved protection from flooding that would be realized east of the canal.

Lands to the south of the existing urban development are largely outside of the FEMA 100-year floodplain. Therefore, the project would not increase the development potential of these lands.

This information has been added to the report in Chapter 5, Growth-Inducing Effects.

5-10 ...we recommend that how the level of flood protection influences land development under FEMA regulations, be elaborated upon in the final EIR/S.

Response: The 100-year flood, which is the standard used by most Federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. Glenn County, including the unincorporated area of Hamilton City, participates in the NFIP. Existing structures on lands that are within the FEMA regulated 100-year floodplain must pay flood insurance. New structures on lands that are within the FEMA regulated 100-year floodplain must be raised to or above the 100-year floodplain elevation. The Reclamation Board has adopted a Designated Floodway for Glenn County that includes the 100-year floodplain. The Board has jurisdiction over the area within the designated floodway boundaries and regulates encroachments through its encroachment permit process. The Board's designated floodway and the FEMA 100-year regulatory floodway would be similar but may not be identical. The proposed levee would be located on the waterside of the western limit of the designated floodway. As the project will not provide 100-year protection, the designated floodway boundaries will not be affected by the project and the Board will continue to regulate encroachments within the designated floodway. Lands outside of both the Board's designated floodway and the FEMA 100-year regulatory floodplain are subject to local development policies. An area with better flood protection than another area could be considered more desirable for development.

5-11 In our May 2004 comment letter on the project, we recommended that the potential indirect impacts of the project on adjacent farmlands be discussed and, as necessary, mitigated. As detailed in the May comment, examples of such impacts could include depredation of crops from wildlife drawn to the project, limitation on agricultural practices due to the proximity of protected wildlife habitat, spread of weeds from the retired lands of the project site, seepage, etc.

Response: The third bullet on page 9-13 of the draft document states: "The tentatively recommended plan includes a buffer from the landside toe of the levee to the waterside restoration plantings that will be planted with native grasses which are compatible with both farming and habitat restoration objectives. ... The planting plan includes limiting the area of planting elderberries on areas adjacent to agricultural fields. The width of the elderberry buffer would be 300 feet, consistent with the current TNC "good neighbor" practices. It is anticipated that the restoration plan will allow the non-Federal sponsor to remove elderberries under 1-inch diameter from the buffer strip...". During the next phase of the project ("Preconstruction, Engineering and Design" or PED), an Operations and Maintenance (O&M) Manual would be developed that lists noxious species that would not be allowed to become established in the restoration areas.

5-12 **One of the mitigation measures of the CALFED ROD ... is the use of agricultural land conservation easements. We recommend that this mitigation measure, as well as the use of working landscape elements (see Alternatives, above), be considered as at least partial mitigation of the project's direct, growth-inducing and cumulative impacts on agricultural land.**

The CALFED ROD lists 30 other measures that should be considered in mitigating CALFED project impacts on agricultural land. In our February 2004 comment letter, we listed nine measures from the list of 31 that we specifically recommended for your consideration in the DEIR/S. We continue to recommend that at least these measures be discussed and considered in the final EIR/S.

Response: The project will not have a significant effect on agricultural lands as defined by CEQA. Nevertheless, the development of alternatives considered the measures listed in the CALFED ROD. The following statement can be found in Chapter 9 and is followed by a description of how the project is consistent with 12 of the specific measures listed in the ROD:

> *"Because this project is intended to be consistent with the CALFED ROD, the Corps and the Reclamation Board considered the strategies described in the ROD, Attachment A, in developing the project description and the alternatives. In addition, the agencies considered the programmatic commitments related to implementation of CALFED actions to ensure that this project would be consistent with the ROD. The project would be consistent with both specific measures in the in the ROD, as well as programmatic commitments related to implementation of CALFED actions to ensure that this project would be consistent with the ROD."*

For this project area, the use of agricultural land conservation easements and working landscapes elements would not provide the benefits that would be necessary to justify the project. Therefore, these measures were not adopted.

6-1 **Summary Page 4, "Some modification of the existing boat ramp may be required". Some modification of the boat ramp and associated facilities will be required. (As delineated in alternative 6, raising the levee and covering the existing park**

landscaping and parking area with a levee will require the replacement of impacted parking and associated landscaping. The project may require replacement of the existing boat ramp, roads, and associated structures depending upon final levee design.)

Response: Through coordination with the Department of Parks and Recreation, Alternative 6 was aligned to minimize effects to existing facilities. Any structures removed, moved, or otherwise impacted by the project will be replaced as an integral part of the project. The word "may" has been changed to "would" in the document.

6-2 **Page 8-9, " Federal Water Project Recreation Act". There are opportunities for this project to enhance recreation. The project could add additional parking and camping on lands adjacent to Irvine Finch River Access. The opportunity exists for cost sharing of these recreation enhancements adjacent to the Irvine Finch River Access owned and operated by the State of California, Department of Parks and Recreation. Up to 250 additional day use and boat parking spaces, and a campground (with 50 family campsites and 3 group sites) could be developed on adjacent lands impacted by the project.**

Response: Recreation elements were initially investigated as a part of the project. The recreation plan that was developed was dropped due to the complicated nature of including more than two objectives, the increased cost for the recreation elements, the lack of a recreation sponsor, a separate and ongoing recreation project, and the potential slip in the project schedule that would have resulted from including this additional project purpose. The stakeholders and project partners considered this unacceptable. The recreation plan that was developed is still available for potential development as a separate project by stakeholders if and when a sponsor is identified.

6-3 **Page 5-45, "Mitigation measures"..."These effects shall be minimized through...redirection to the nearest comparable facility within the proposed project effected area". Unfortunately, no comparable facilities exist for launching boats in the Sacramento River in the vicinity of Chico. The nearest comparable ramp downstream is Ord Bend (River Mile 184), and upstream the next ramp is at Woodson Bridge (River Mile 218). The Woodson Bridge ramp is frequently closed due to silt build-up. The next comparable ramp upstream is Red Bluff (River Mile 243). The two nearby ramps are Scotty's and Pine Creek. Both of these ramps are severely restricted. The ramp at Scotty's Boat Landing is substandard and without parking. The ramp at Pine Creek is substandard with very limited parking and a very shallow channel to the river.**

Response: Recreation impacts will be temporary and would only occur during construction windows. Other recreation facilities, however further away and not of as high quality, are still available for recreational use during the limited time of construction. In addition, Scotty's Bar has been upgraded and has a completely renovated boat launching facility. Best Management Practices will be implemented to minimize any potential impacts to recreation to the least amount possible. These impacts have been assessed to be less than significant.

6-4 **The recreation mitigation suggested in the report "Provide notice and signage to redirect use" is insufficient. We suggest that every effort be made to keep the existing boat ramp and parking at Irvine Finch open to boaters during the salmon fishing season (fall and winter), and limit any boat ramp closures to short periods during other times of the year. Temporary river access, temporary boat launching and temporary parking should be maintained during the construction period. The boat ramp is extremely busy during the fall salmon fishing season. During the prime fishing season, it would be inexcusable to close the ramp, or severely limit parking.**

Response: As a part of recreational Best management Practices, facilities will be left open whenever possible for recreational use. Only when absolutely necessary will the facilities be closed and the public redirected to other facilities (see answer to 6-3). The construction windows are in spring and summer and would not affect prime fishing seasons, which occur during the fall and winter.

7-1 **The Board has accepted the TAC (Technical Advisory Committee) recommendation that the Hamilton City Project meets the principles and guidelines outlined in our Handbook, and the information presented in the Draft FR/EIS/EIR is accurate and acceptable.**

Response: We appreciate the TAC's comments and their assistance in coordinating the communication between agencies and the public to develop the best project possible for Hamilton City.

8-1 **This community has a very low median and mean income and $1.8 million ... is a lot of money to share among a thousand households; and then another ... $100,000 a year, $145,000 a year to share among a thousand households is a lot of money.**

Response: The local community will vote to develop a levee maintenance district to help pay for the O&M of the levee.

8-2 **...there is habitat, coyotes, birds, all sorts of habitat that lives in that canal on those ditches, banks.**

Response: The terrestrial habitat that exists within the dredged material disposal area is very low quality habitat composed mostly of low-density, ruderal vegetation. Any wildlife utilizing the dredge material disposal area is getting only a small portion of their habitat needs met on this site. The area may be used as a movement corridor or for resting by some bird species. Wildlife will temporarily use other areas during construction and can return to utilize the area once construction is complete.

8-3 **...(the dredged material along the canal) serves as a sound breaker for the homes there.**

Response: Any excess dredge material can be left in place to serve as a noise barrier from Highway 45.

8-4 **It (the dredged material along the canal) also serves as a flood control for Colusa Canal in the winter when it floods.**

Response: The dredge material was not designed to be utilized as a flood control barrier and would not function well in this capacity. Furthermore, we would expect that floodwaters would generally approach the Colusa Canal from the east. Since most of the dredged material is on the west side of the canal, it would not provide any protection from this flooding. Finally, the proposed project would provide more flood protection to the Colusa Canal than the existing dredged material berm.

8-5 **...leave it (the dredged material along the canal) so it looks nice because right now they go in there and remove the dirt, they track it everywhere and it looks horrible...**

Response: Best Management Practices (BMPs), such as the wetting of dredge material, will be utilized as a part of this project to minimize dirt or dust that may be stirred up during the moving of the fill material. After removal of needed material, the borrow site would be graded and seeded, if necessary to minimize erosion from the site.

9-1 **The local district (should) have access to the land as park area ...If we are going to be asked to pay for this through the levee district, ... we should have access to it.**

Response: There are both Department of Fish and Game and U.S. Fish and Wildlife areas totaling over 1,000 acres in the restoration area. The mission of both of these agencies includes public access and use of their lands. These lands will continue to be available for public use. No new roads are included in the other restoration areas as a part of this project due to public objection of neighbors next to the restoration areas. Road 23 will continue to remain open and public access will continue to be available through this roadway. Also, see response to comment # 6-2.

10-1 **The project proponent may need to apply for a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers. A Section 404 permit is required for activities involving a discharge of dredged or fill material to waters of the United States.**

Response: As explained in Section 8.1.6: "Although the Corps does not issue itself permits for its own Civil Works projects, Corps regulations state that the Corps does have to comply with the intent of the Regulatory permitting process and must apply the guidelines and substantive requirements of Section 404 to its activities." The Corps has determined that this project as proposed is consistent with the Section 404(b)(1) guidelines and in compliance with the Clean Water Act.

10-2 **Projects requiring a Section 404 permit also require a water quality certification (pursuant to Section 401 of the Clean Water Act) verifying that the project does not violate State water quality standards. A water quality certification is required for any project that impacts water of the State (such as streams and wetlands).**

Response: Section 404 (r) of the Clean Water Act waives the requirement to obtain state water quality certification for Corps Civil Works projects if certain criteria are met. As explained in Section 8.1.6: "The Corps has determined that this project as proposed . . . meets the Section 404(r) exemption criteria. The Corps plans to seek an exemption during the next phase of the project ("Preconstruction, Engineering and Design" or PED) from the requirement to obtain State water quality certification under section 404(r) of the Clean Water Act."

10-3 **Should the U.S. Army Corps of Engineers determine that isolated wetlands exist at the project site and should the project impact or have potential to impact the isolated wetlands, a Report of Waste Discharge and filing fee must be submitted prior to commencing the construction activity.**

Response: The tentatively selected plan would not affect any isolated wetlands. If plans should change, and Alternative 5 becomes the selected plan, a Report of Waste Discharge and filing fee would be submitted to the Regional Water Quality Control Board prior to commencing construction.

10-4 A Construction Activities Storm Water Permit is required for storm water discharges associated with a construction activity where clearing, grading, and excavation result in a land disturbance of one acre or more.

Response: A Construction Activities Storm Water Permit would likely be required and would be obtained prior to construction

10-5 A dewatering permit, General Order for Dewatering and Other Low Threat Discharges to Surface Water, may be required for construction activities.

Response: Corps construction representatives will coordinate with the Regional Water Quality Control Board prior to construction to determine whether a dewatering permit will be required. If required, the permit will be obtained prior to construction.

10-6 Construction dewatering discharges that are contained on land are allowed under a general waiver adopted under Regional Board Resolution No. R5-2003-0008, provided the following conditions are met: (1) the dewatering discharge is of a quality as good as or better than underlying groundwater; and (2) there is a low risk of nuisance.

Response: Corps construction representatives will coordinate with the Regional Water Quality Control Board prior to construction to determine whether this waiver would be applicable to construction activities.

11-1 ... the report presents that the Alternative 6 is the NER plan that is most cost effective and that adding the flood damage reduction increment where Average Levee Height = 7.5 feet for the Combined Alternative 6 (given the restriction on project performance where conditional non-exceedance probabilities are not allowed to be greater than 90% for the 1/75 event or less than 90% for the 1/125 event) optimizes incremental net benefits. Based on the report, the Combined Alternative 6 is the best NED-NER plan.

Response: Comment noted.

11-2 Alternative 3 is incorrectly identified as the least cost single purpose (NER) plan.

Response: Identification of the least cost single purpose plan (ecosystem restoration plan) requires that the plan identified (1) produce the same level of non-monetary output as would be provided by the multipurpose project; (2) be cost effective when compared to other single purpose plans, but not necessarily more cost effective than the multipurpose plan; and (3) be a dissimilar project. The third criteria is somewhat subjective, depending on the interpretation of "dissimilar" project. The intention of the guidance is that a dissimilar project be a project that is fundamentally different than the multipurpose project. The Corps determined that Ecosystem Alternatives 5 and 6 (National Ecosystem Restoration plan) are fundamentally too similar to Combined Alternative 6 to serve as the least cost single purpose ecosystem restoration plan.

Table 3-7 depicts information for the Preliminary Array of Combined Alternative Plans; it is not appropriate to take flood damage reduction benefits into consideration when identifying the least cost single purpose plan for ecosystem restoration.

11-3 **It appears that the only risk-based measure of with project performance was limited to defining the event that meets a Conditional Non-Exceedance Probability (CNP or as described in the report as reliability) of 90%. Why were Annual Exceedance Probabilities (AEP) and Long Term Risk excluded from the with project reporting?**

Response: In order to present risk statistics so that the general public could understand them, the statistic used by FEMA for conditional non-exceedance probability was presented in the main report. All of the other HEC-FDA generated project performance statistics for the without-project and the with-project conditions are summarized in Tables 31 and 32 of Appendix E - Economics.

11-4 **Was HEC-FDA used in the analysis? Can this information be found in any appendices and if so can you reference these sources in the Main Report?**

Response: The Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) computer program was used in the flood damage analysis, as described in Appendix E (Economics). HEC-FDA was designed to assist Corps of Engineers study team members in using risk-based analysis methods for flood-damage-reduction studies as required by the Corps (EM 1110-2-1419). The approach explicitly incorporates descriptions of uncertainty of key parameters and functions into project benefit and performance analyses. Appropriate references to the Economics Appendix have been added to the main report.

12-1 **The document mentions that an adjacent 157-acre parcel of land currently owned by The Nature Conservancy may be under consideration for a permanent agricultural easement. Please do not hesitate to contact the Division of Land**

Resource Protection as we may be of assistance in the establishment of such an easement.

Response: The comment will be passed on to The Nature Conservancy.

12-2 **Even with implementation of the mitigation measures, there remains a net loss of approximately 1,500 acres of agricultural lands, which, as the agency in California state government statutorily charged with monitoring farmland conversion, we consider to be a significant environmental impact.**

Response: We do not concur that the loss of 1500 acres of agricultural lands is a significant environmental impact. If this were a loss of agricultural lands to urbanization, it would be considered a significant environmental impact. However, conversion of agricultural lands to native habitat would have a beneficial effect on the environment. There is an adverse economic effect associated with conversion for any purpose. However, in this case, the adverse economic effect is offset by the beneficial economic effect of the project.

The criteria used to determine significance recognize the value of soil resource for agricultural production. Future generations may have different priorities and may have a need to return lands to agricultural production. Lands in native habitat would be much more economical to return to production than lands that have been developed for urban uses. In fact, the quality of the soil resource would likely be improved by the conversion to native habitat. The criteria used in this evaluation allow consideration of the permanency of the conversion.

Please refer to the response to comment 5-4.

12-3 **The majority of these lands (land to be restored) are currently under Williamson Act contract and within a Farmland Security Zone. Please contact the Division and the County for information regarding contract termination requirements.**

Response: The project non-Federal sponsor, the Reclamation Board of the State of California, is responsible for all lands, easements, rights-of-way, relocations and disposal sites (LERRDs). The non-Federal sponsor will have the task of ensuring that all project lands are available and legally unencumbered in order for the project to be constructed.

12-4 **As replacement of land is not possible, even with the mitigation measures, the lead agencies may wish to consider adopting a statement of overriding considerations at the time of certifying the environmental document.**

Response: Since the effect to farmlands is not considered significant, no mitigation would be required and no statement of overriding considerations would be necessary.

12-5 **The document provides a discussion in the Summary that concludes that the use of the LESA model is inappropriate for this project. The rationale provided in the discussion emphasizes that soil quality is the primary factor to consider, when it is just one of the factors. The discussion also appears to be inconsistent with the federal rating system. Regardless of whether or not an agency opts to utilize the model, if the reasons for not using it are included in the document, it is important that the rationale be appropriately and correctly reflected.**

Response: The discussion in the Summary about why the LESA is inappropriate for restoration projects, such as the subject project, indicates that there are many important factors that the model does not take into consideration. These include: that restoration projects actually provide a benefit to soils; that restoration of agricultural lands can be reversed much more easily than conversion to urban use; that the agricultural economy would benefit from increased flood protection; and that agricultural lands located close to the river are subject to seepage, erosion, and flooding which reduces their value for agriculture. Section 5.3.10 of the report includes more detail on this subject.

The rationale for concluding that the LESA model is inappropriate for use in evaluating this project is not at all inconsistent with the federal rating system. The federal rating system does not provide any guidelines for determining significance. As stated in Section 5.3.10 of the report, "*According to the Farmland Protection Policy Act, farmland receiving a rating less than 160 need not be given further consideration for protection, and alternative actions do not need to be considered. The US Department of Agriculture recommends that sites receiving scores totaling 160 or more be given increasingly higher levels of consideration for protection. Alternatives were considered, but all alternatives had similar ratings. Project objectives constrained the consideration of alternative locations for the project.*" The Corps determined that this level of consideration for protection was appropriate for lands with a score of 170 out of a possible 260.

13-1 **In our review of the document we found that the DEIS sufficiently addresses the environmental impacts of the proposed alternative. EPA has rated this document "*Lack of Objections*" (LO). ... Our rating reflects our overall view of the adequacy of the document.**

Response: We appreciate the EPA's review of the project document and concurrence with the assessment and resultant "Lack of Objections" for the EIS/EIR.