CHAPTER 3 – ALTERNATIVE PLANS

3.1 PLAN FORMULATION METHODOLOGY

The formulation, evaluation, and comparison of alternative plans comprises the third, fourth, and fifth steps of the Corps' planning process. These steps are often referred to collectively as plan formulation. Plan formulation is a highly iterative process that involves cycling through the formulation, evaluation, and comparison steps many times to develop a reasonable range of alternative plans and then narrow those plans down to a final array of feasible plans from which a single plan can be identified for implementation.

Plan formulation for flood damage reduction (FDR) and ecosystem restoration (ER) presents a challenge because alternative plans produce both monetary and non-monetary benefits. Comparison of the trade-offs among alternative plans is difficult because monetary and non-monetary benefits cannot be directly compared. To facilitate the plan formulation process, the methodology outlined in the Corps' Engineering Circular 1105-2-404, "Planning Civil Work Projects Under the Environmental Operating Principles," 1 May 2003, was used. The steps in the methodology are summarized below:

- Formulate and screen management measures (referred to hereafter simply as measures) to achieve planning objectives and avoid planning constraints. Measures are the building blocks of alternative plans.
- Identify a primary project purpose. For this study, it is anticipated that ecosystem restoration will be identified as the primary purpose. This is because there is strong interest by the SRCAF, TNC, and CALFED in restoring this area, indicating that there is high restoration potential. Also, based on previous studies, it is unlikely a feasible plan can be developed for flood damage reduction only.
- Formulate, evaluate, and compare an array of alternative plans to achieve the primary purpose (ecosystem restoration) and identify a feasible plan that reasonably maximizes National Ecosystem Restoration (NER) outputs (outputs minus costs). This plan is called the National Ecosystem Restoration plan.
- Formulate and screen plans that achieve both ecosystem restoration and flood damage reduction (combined plans).
- Evaluate and compare trade-offs among the combined plans and rank them. The highest ranked combined plan is the plan that reasonably maximizes total net NER and National Economic Development (NED) outputs.
- Determine whether the highest ranked combined plan is justified; that is, whether the benefits of the plan exceed the costs. If the highest ranked plan is not justified, move to the next ranked plan. Continue to move down through the ranked plans until a justified plan is identified. The highest ranked, justified, combined plan is the NED/NER plan or the Combined Plan. If no combined plan is justified, the NER plan shall be recommended for implementation.

3.2 PLANNING CRITERIA

Planning criteria are used to formulate, screen, evaluate, and compare measures and alternative plans. Four specific screening criteria are required in Corps water resource studies: completeness, effectiveness, efficiency, and acceptability. These criteria are

generally subjective and are useful in narrowing down the array of possible alternative plans. With the exception of completeness, these criteria are also useful in screening potential measures.

- Completeness. Completeness is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree that the outputs of the plan are dependent upon the actions of others. Plans that depend upon the actions of others to achieve the desired output were dropped from consideration.
- Effectiveness. Effectiveness is the extent to which a measure or alternative plan achieves the planning objectives. Measures or alternative plans that clearly make little or no contribution to the planning objectives were dropped from consideration.
- Efficiency. Efficiency is a measure of the cost effectiveness of the plan expressed in net benefits. Benefits can be both monetary and non-monetary. Measures or alternative plans that provided little benefit relative to cost were dropped from consideration.
- Acceptability. Acceptability is a measure of the ability to implement a measure or alternative plan. In other words, acceptability means a measure or plan is technically, environmentally, economically, and socially feasible. Unpopular plans are not necessarily infeasible, just unpopular. Measures or plans that were clearly not feasible were dropped from consideration.

Measures and plans that pass the screening criteria are evaluated and compared against more specific evaluation criteria. Evaluation criteria are described later in this chapter in Section 3.5. Evaluation criteria can include costs, outputs, or effects and reflect the planning objectives or constraints. Some or all of the evaluation criteria may be used at various stages in the plan formulation process to compare alternative plans. Effective evaluation criteria must be measurable and reveal differences or trade-offs between alternative plans.

3.3 MEASURES

A measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. Table 3-1 lists the various measures identified for this study and identifies the individual objectives to which they contribute.[1]

[1]The U. S. House Report 108-357 (Conference Report accompanying the Energy and Water Development Appropriations Act, 2004, P.L. 108-137) urged the Secretary of the Army to incorporate locally preferred options that provide protection to agricultural lands and residential properties. Measures considered include such options.

TABLE 3-1: OBJECTIVES AND MEASURES

General Measures	Objectives					
	Reduce flood risk	Reduce flood damages	Increase river meander	Increase flooding in floodplain	Increase quantity and quality of habitat	Increase VELB habitat
Raise/Floodproof Community	x	x				
Raise/Floodproof Individual Structures	x	x				
Relocate Community	x	x				
Relocate Individual Structures	x	x				
Acquire Flowage Easements or Fee Title Floodplain Lands	x	x				
Enhance Flood Warning System		x				
Modify Existing Reservoirs	x	x				
Construct New Reservoirs	x	x				
Construct High Flow Bypass Channel	x	x				
Increase Flows into Butte Basin	x	x				
Strengthen "J" Levee	x	x				
Construct Setback Levee	x	x		x	x	
Construct Training Dike	x	x				
Passive Restoration					x	
Restoration of Native Vegetation					x	x
Remove Non-native Seed Source					x	
Remove Non-native Species from Riparian Areas					x	
Remove Orchards					x	
Reestablish Hydrologic Connection of River and Floodplain				x	x	
Remove Bank Protection			x	x	x	
Passive Removal Bank Protection			x	x	x	

Measures are the building blocks that are grouped together to form alternative plans. The wide variety of measures listed above were screened to determine whether each measure should be retained for use in the formulation of alternative plans. Descriptions of the

measures and the decision to retain or drop each measure from further consideration are presented next.

3.3.1 Flood Damage Reduction Measures

These measures primarily achieve flood damage reduction objectives in the study area, but may also contribute to the ecosystem restoration objectives. Flood damage reduction measures can be nonstructural or structural. Nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding. Damage reduction from nonstructural measures is accomplished by changing the use made of the floodplains, or by accommodating existing uses to the flood hazard. In contrast, structural measures alter the nature or extent of flooding. Structural measures accomplish flood damage reduction by modifying the magnitude, duration, extent, or timing of flooding.

When considering if there are opportunities to apply flood damage reduction measures in the study area, an understanding of the basic magnitude of costs to construct the measures is useful when compared to the maximum potential flood damage reduction benefits possible. Reduction in flood damages translates into monetary benefits that are used to determine if the benefits of doing something outweigh the costs, which in turn helps determine if the Federal government can participate in a project. For a frame of reference, the maximum flood damage reduction benefits possible in the Hamilton City area would not economically justify flood damage reduction measures exceeding $11 million in total costs.

Non-Structural Measures

- Raise/floodproof community. Dropped as a measure. There is little community support for this measure as the method of reducing flood damages. The measure does not reduce the threat to public safety and it does not appear to be cost effective on a large scale, based upon the current number of structures within the floodplain.
- Raise/floodproof individual structures. Dropped as a measure. There are no opportunities in the potential project area to raise or floodproof individual structures.
- Relocate community. Dropped as a measure. There is little community support for this measure as a method of reducing flood damages and it does not appear cost effective on a large scale, based upon the current number of structures within the floodplain.
- Relocate individual structures subject to flooding. Dropped as a measure. There are no opportunities in the potential project area to relocate individual structures.
- Acquire flowage easements or fee title interest in floodplain lands. Retained for further consideration. Acquiring flowage easements or purchasing lands in fee title to allow flooding and limit future development can reduce flood damages and provide opportunities for ecosystem restoration. The availability of willing sellers is uncertain for some potential project lands.
- Enhance Flood Warning System. Dropped as a measure. The existing County Emergency Response Plan was found to be up to date and thorough. Potential improvements to the flood warning system considered included the addition of

gages along Stony Creek, which was determined to be too far downstream to have benefits to Hamilton City. Other potential improvements include the addition of gages in the upper tributaries like Cottonwood Creek, which would benefit a much larger region. (Because there are many communities throughout approximately a 50-mile region that could benefit from such improvements, this measure was considered to be more appropriately considered in a regional context and was not retained for further consideration in this feasibility study. (A regional approach is being investigated by the Corps and the Reclamation Board in a separate study, the Enhanced Flood Response and Emergency Preparedness Feasibility Study.)

Structural Measures

- Modify existing reservoirs. Dropped from further consideration. The primary risk of flooding to Hamilton City is from unregulated tributary streams along the Sacramento River between Shasta Dam and Hamilton City. Modification of Shasta Dam (Sacramento River) or Black Butte Dam (Stony Creek) would affect only relatively rare flooding events and not address the more frequent high flows caused by runoff from the unregulated tributaries.
- Construct new reservoirs. Dropped from further consideration. New reservoirs on several of the unregulated tributaries upstream of Hamilton City would likely be required. Construction of the new reservoirs is considered too costly and environmentally damaging.
- Construct high flow bypass channel. Dropped from further consideration. Constructing a bypass channel to convey high flows around Hamilton City would not likely be cost effective.
- Increase flows into the Butte Basin. Dropped from further consideration. Increasing flows into the Butte Basin could reduce stages in the Hamilton City area, but would be expensive, have significant effects to landowners in the basin, and have little support from Butte Basin residents.
- Strengthen "J" levee. Dropped from further consideration. Strengthening the "J" levee would likely cause significant environmental effects to existing riparian habitat along the levee without creating opportunities for habitat replacement. Strengthening the "J" levee would also require a substantial amount of rock to be placed on the waterside of the levee to reduce the risk of erosion to the levee. The requirement for rock on the levee makes this measure cost prohibitive.
- Construct setback levee. Retained for further consideration. Constructing a setback levee could reduce flood risk and flood damages. Past reconnaissance study efforts indicate that it is not likely cost effective for a single-purpose flood damage reduction project. However, construction of a setback levee would be necessary as part of the ecosystem restoration measure "Reestablish hydrologic connection between the Sacramento River and its floodplain." Construction of a setback levee has potential to be cost effective as a single-purpose ecosystem restoration measure. This presents an opportunity that the measure could be cost effective as part of a combined project that would provide both flood damage reduction and ecosystem restoration benefits. Construction of any levee would include acquiring a flood protection easement for the levee.

- Construct Training Dike. Retained for future consideration. A training dike, considerably less costly than a levee, could be cost effective based on damages prevented. Construction of a training dike would include acquiring a flood protection easement for the levee.

3.3.2 Ecosystem Restoration Measures

These measures primarily achieve ecosystem restoration objectives in the study area, but may also contribute to the flood damage reduction objectives. Ecosystem restoration measures can involve the removal of the cause of degradation and manipulating the ecosystem to re-establish the desired function. Removing the cause of degradation improves the ecosystem by eliminating the stressors that depleted the ecosystem to begin with and allowing the natural processes to return the ecosystem to health. Reviving ecosystem function through manipulation of the environment involves actively restoring the area to "jump start" the recovery process. The ecosystem restoration measures considered in the study were:

- Passive restoration of vegetation. Dropped from further consideration. Passive restoration is a technique whereby the restoration area is left to recruit native vegetation naturally with little or no intervention. On the Sacramento River, 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 (Alpert et al. 1999; Peterson, unpubl.).
- Restoration of native vegetation. Retained for further consideration. Restoration of natural habitats by active means such as planting trees and shrubs or removing exotic plants and animals. Active restoration is necessary as a measure to reduce the potential for the spread of invasive species, reduce the seed predation and girdling of young trees by rodents, reduce browse pressure from herbivores, and reduce the amount of erosion from exposed areas.
- Remove non-native seed source. Dropped from further consideration. Removal of non-native seed source requires a regional involvement to alleviate non-native seed sources that are outside the immediate study area. Removal of the non-native seed source was dropped as a measure due to the expansive nature of the problem. Non-native seed sources extend throughout the watershed and removal of these sources would be expensive and the probability of success low.
- Remove non-native species from existing riparian areas. Dropped from further consideration. The removal of non-native species from established riparian areas outside of proposed restoration areas was found to be extremely costly as a separate restoration measure. The removal of non-native species, along with orchards, hay, and grain is included in the restoration areas prior to any planting.
- Remove orchards. Retained for further consideration. In areas of highly humid and relatively temperate climates, abandoned orchards are susceptible to a variety of pests and diseases. Orchard areas need to be kept clean of trash and weeds. Trees need to be well pruned to facilitate good air movement in order to keep pest populations at an acceptable level. Common pests that may attack trees include: codling moth that attacks walnuts and plums; peach twig borer that attacks almond, plum and prune trees; brown rot fungus that attacks almond trees; leaf

curling aphids that attack plum trees; red humped caterpillars that attack plum, prune, and walnut trees; and, fruit worms and thrips that attack a host of orchard trees. Abandoned orchards are seen as a sort of "incubator" for many of these pests and diseases. Surrounding orchards are considered at risk to infestation and must be monitored closely to control pests and diseases from entering into health orchards.

- Reestablish hydrologic connection between the Sacramento River and its floodplain. Retained for further consideration. In order to reestablish the hydrologic connection between the Sacramento River and its floodplain, the "J" levee or other private levees could be lowered or removed. Degrading or removing the existing "J" levee would reconnect the Sacramento River to its historic floodplain by allowing the river to overflow its banks. The restoration of this important hydrologic function would provide conditions for the restoration of a diverse mosaic of riverine habitats. Additional measures, such as constructing a setback levee, may be necessary to offset negative effects of degrading an existing levee. Construction of a setback levee also has potential to reduce damages from flooding. Construction of any levee would include acquiring a flood protection easement for the levee.
- Remove bank protection. Dropped from further consideration. There is potential to remove about 5,000 linear feet of bank protection (predominately rock) from the west bank of the Sacramento River near Hamilton City south of Dunning Slough, but it would add an estimated $5 to $10 million in setback levee reinforcement costs. The removal of rock would increase erosion and, therefore, sediment, gravel, and woody debris contribution to the system, allowing for the creation of cutbanks and mid-channel bars. In this reach, however, the river has historically migrated extensively and it is difficult to accurately predict how the river would respond if the bank protection were removed. Due to the uncertainty in river movement which would require extensive study, the physical and public safety concerns (largely due to the controversial nature of the subject), and the anticipated increase in maintenance costs to protect a new setback levee and/or private lands from accelerated river migration, this measure was dropped from further consideration as part of this study.
- Passive removal bank protection. Dropped from further consideration. There is potential to cease maintenance of existing bank protection (predominately rock) placed as part of the Chico Landing to Red Bluff Bank Protection Project from the west bank of the Sacramento River near Hamilton City south of Dunning Slough. Cessation of maintenance would increase erosion and, therefore, sediment, gravel and woody debris contribution to the system, allowing for the creation of cutbanks and mid-channel bars. In this reach, however, the river has historically migrated extensively and it is difficult to accurately predict how the river would respond if the bank protection were no longer maintained. Due to the uncertainty in river movement which would require extensive study, the physical and public safety concerns (largely due to the controversial nature of the subject), and the anticipated increase in maintenance costs to protect a new setback levee and/or private lands from accelerated river migration, this measure was dropped from further consideration as part of this study.

It should be noted that none of the measures that would contribute to the planning objective to increase river meander were retained. Since no measures were retained that would address river meander, the planning objective to increase river meander will not be attained as part of a potential project.

The next step in the plan formulation process is to formulate alternative plans for the primary project purpose. Results from the measures identification and screening process verify that the primary project purpose for this study is ecosystem restoration. Table 3-2 summarizes the measures screening process.

3.4 FORMULATION AND EVALUATION OF PRELIMINARY ECOSYSTEM RESTORATION ALTERNATIVE PLANS

Guidelines to developing multipurpose projects (in this case flood damage reduction and ecosystem restoration) were followed in evaluating and comparing alternative plans. First, a primary project purpose was identified. For this study, it was anticipated that ecosystem restoration would be identified as the primary purpose because there is strong interest by the SRCAF, TNC, and the CALFED Bay-Delta Authority in restoring the ecosystem of this area, which indicated that there was high ecosystem restoration potential. Further, based on previous flood damage reduction studies, it was considered unlikely that a flood damage reduction-only project would be cost-effective.

A preliminary and then a final array of single-purpose ecosystem restoration alternative plans were developed, evaluated and compared to identify a plan that reasonably maximizes the NER outputs (outputs minus costs). The preliminary array of ecosystem restoration alternative plans primarily consisted of various setback levee alignments with habitat restoration to the waterside of the new levee. The NER plan was identified, indicating that there is likely Federal interest in implementing an ecosystem restoration-only alternative plan.

Alternatives were formulated through coordination with agencies, landowners and other stakeholders. The retained ecosystem restoration measures generally needed to be combined with the other retained ecosystem restoration measures in order to develop complete preliminary ecosystem restoration alternative plans. While each individual measure contributes to the ecosystem objectives, most need to be applied in combination with the others to accomplish ecosystem restoration. Therefore, all preliminary ecosystem restoration alternative plan includes all of the retained ecosystem restoration measures.

For analysis purposes, the study area was split into nine potential restoration zones (see Figure 3-1: Restoration Zones Map). These zones are used in various combinations in the preliminary alternative plans. Each of the preliminary alternative plans formulated fit into one of four general categories:

TABLE 3-2: SUMMARY OF MEASURES RETAINED OR DROPPED

Measures	Retained	Dropped
Flood Damage Reduction		
Non-Structural Measures		
Raise/Floodproof Community		X
Raise/Floodproof Individual Structure		X
Relocate Community		X
Relocate Individual Structures		X
Acquire Flowage Easements or Fee Title in Floodplain Lands	X	
Enhance Flood Warning System		X
Structural Measures		
Modify Existing Reservoirs		X
Construct New Reservoirs		X
Construct High Flow Bypass		X
Increase Flows into the Butte Basin		X
Strengthen "J" Levee		X
Construct Setback Levee	X	
Construct Training Dike	X	
Ecosystem Restoration Measures		
Passive Restoration of Vegetation		X
Restoration of Native Vegetation	X	
Remove Non-native Seed Source		X
Remove Non-native Species from Existing Riparian Areas		X
Remove Orchards	X	
Reestablish Hydrologic Connection of River and Floodplain	X	
Remove Bank Protection		X
Passive Removal of Bank Protection		X

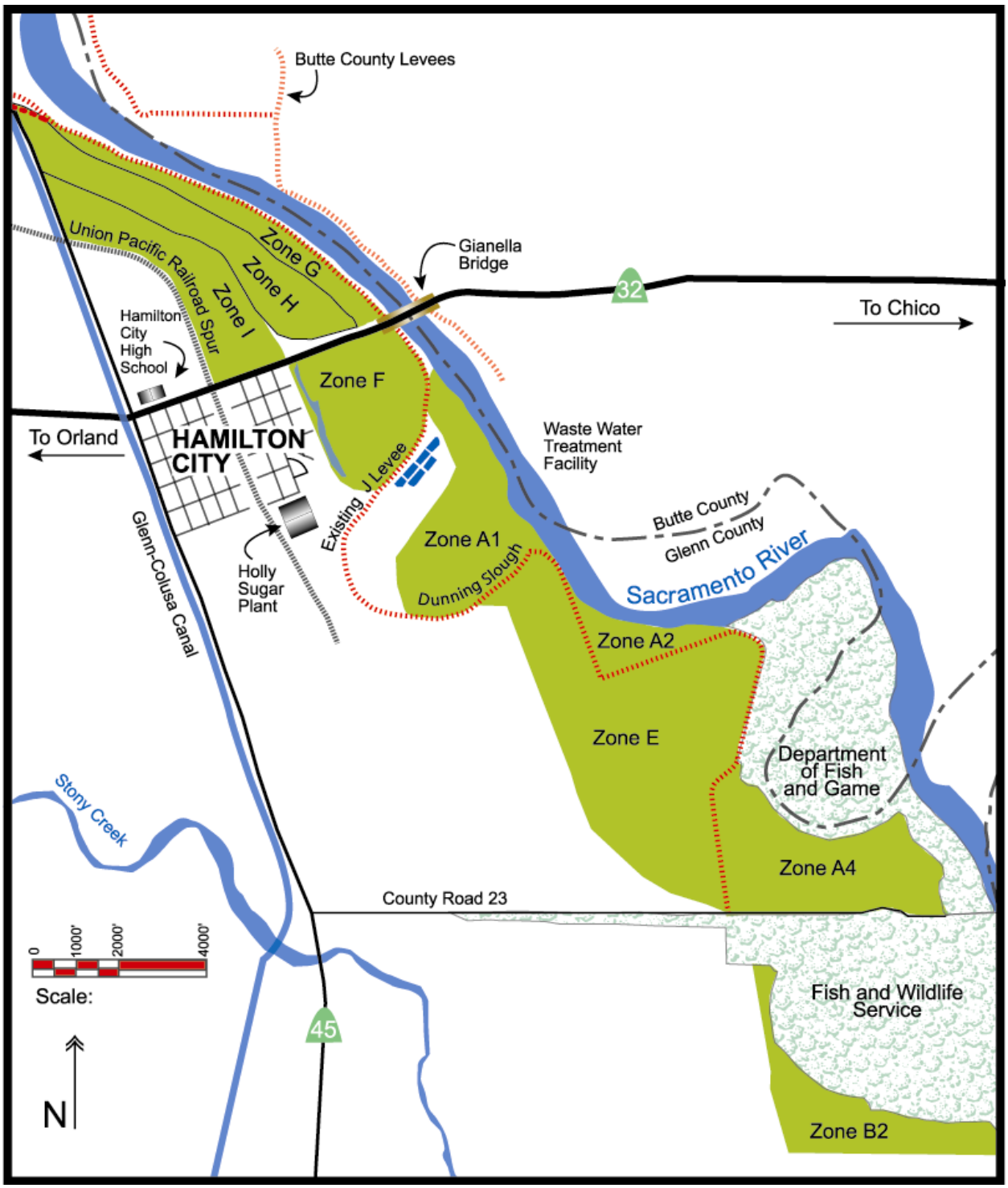

Figure 3-1: Restoration Zones Map

The first category was the alternative of doing nothing. The Corps is required to consider the option of "*No-Action*" as one of the alternative plans in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the No-Action alternative, which is synonymous with the future 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 serves the planning process by providing the base against which all other alternatives are measured and ensuring that any action taken is more in the public interest than doing nothing.

The second category was alternative plans that restored native vegetation without removing or degrading the existing "J" levee. For these alternatives, it was assumed the "J" levee would continue to function as a private flood control levee, but that some amount of land within the study area would be restored to native habitat. The areas proposed for restoration were predominately lands owned by TNC (see Figure 2-4, Conservation Ownership Map). Two additional areas in other private ownership were also considered for restoration. These areas were the land to the east of Hamilton City, between Highway 32 and Dunning Slough, and a portion of the land within Dunning Slough (excluding the Hamilton City Wastewater Treatment Facility and adjacent areas to the west). These lands were identified for potential restoration because they could be combined with other lands to create continuous blocks of native habitat.

Numerous amounts and combinations of restored areas were investigated. In most cases, the effectiveness of the restoration (as measured against the planning objectives) was limited because the "J" levee was not degraded.

The "J" levee constrains the Sacramento River, preventing it from overflowing or meandering into the floodplain. This has numerous adverse effects on the ecosystem (as described in Chapter 2) and limits the value of riparian habitat restored on the landside of the levee (opposite the river) because the habitat is not periodically flooded as it would be under more natural conditions. Due to these limitations, an alternative plan in this category was not carried forward for further analysis.

The third category was alternative plans that restore native vegetation, degrading or removing the "J" levee, and relocate or raise structures to avoid induced flooding. Degrading or removing the "J" levee allows the Sacramento River to flood the floodplain and improves habitat quality, but it also increases the risk of flooding in and around Hamilton City. Both treatments of the "J" levee would accomplish reconnection of the river and floodplain. The question then first becomes one of cost effectiveness. It was initially thought that "breaching" the existing "J" levee would be less expensive than removing the "J" levee. However, subsequent hydraulic modeling determined that in order to avoid an increase in stage from the construction of the setback levee, most of the existing "J" levee would need to be removed. Thus in keeping with the planning constraint to avoid adverse hydraulic effects, the alternatives were refined to include the more costly method of floodplain reconnection – to remove most of the existing "J" levee.

Raising or relocating flood-prone structures could minimize this effect but, as noted in the discussion of measures earlier in this chapter, relocating or raising structures on a large scale are not cost effective for the conditions in the study area. Furthermore, raising or relocating a large number of structures within Hamilton City would be strongly resisted by the

residents, particularly to offset the effects of removing the "J" levee for environmental restoration. No alternatives in this category were carried forward for further analysis, but raising or relocating structures on a limited scale were considered as potential components of alternative plans in the fourth category.

The fourth category included alternative plans that restore native habitat, degrade the "J" levee, and provide a new levee setback from the river to prevent induced flooding. Numerous potential setback levee alignments were considered, including alignments set back varying distances from the river, alignments that wrapped closely around the southern side of town, and alignments that extended south of town to protect agricultural areas.

Following is a list of the preliminary ecosystem restoration plans considered. A description of each preliminary ecosystem restoration alternative plan can be found in Appendix A – Supporting Plan Formulation Information. Table 3-3 shows the restoration zones occurring in each alternative plan.

- No-Action
- Alternative 1 – Locally Developed Setback Levee
- Alternative 2 – Intermediate Setback Levee
- Alternative 3 - Ring Levee
- Alternative 4 - Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough
- Alternative 5 - Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough
- Alternative 6 - Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32

In general, the most cost efficient plans aligned the new levee as far from the river as possible. This allowed the greatest extent of floodplain flooding and habitat restoration, maximizing ecosystem restoration benefits, which in turn reduced the cost of constructing the levee relative to the benefits. Aligning the levee away from the river also reduced the risk that the river channel could meander into the toe of the levee, requiring substantial expense to protect the levee.

Exceptions to this general rule were levee alignments that hugged the town closely. These alignments tended to require significant modifications to infrastructure, raising overall project costs. In addition, the purchase of flowage easements was necessary for levee alignments that wrapped around the south of town and did not extend as far south as the "J" levee. The flowage easements were used to offset the induced flooding caused by removing the "J" levee. Residents voiced strong opposition to alignments that were aligned too closely to town due to fear of levee failure, particularly near residences and schools, and to perceived constraints on future growth. Flowage easements were equally unpopular with farmers, who wanted less frequent flooding, not more frequent.

TABLE 3-3: ZONES INCLUDED IN EACH PRELIMINARY ECOSYSTEM RESTORATION ALTERNATIVE PLAN

	Ecosystem Restoration Zones								
Preliminary Alternatives	Zone A1	Zone A2	Zone A4	Zone B2	Zone E	Zone F	Zone G	Zone H	Zone I
1–Locally Developed Setback Levee	X	X	X	X	X		X		
2-Intermediate Setback Levee	X	X	X		X	X	X	X	
3-Ring Levee	X	X	X		X	X	X	X	X
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough	X	X	X		X		X		
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough	X	X	X	X	X	X	X	X	
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32	X	X	X	X	X		X	X	

The top of levee elevation for all setback levee alignments would be approximately the same elevation as the top of the "J" levee. This criterion reflects that in the past, with intense flood fighting, the "J" levee has withstood river stages to near the top of the levee without failing. Constructing a setback levee to the same elevation as the "J" levee provides the community the possibility of passing similar river stages in the future.

The preliminary ecosystem restoration alternative plans were screened against the four planning criteria. Standards were established to determine if the alternative plans meet each planning criteria. For an alternative plan to be carried forward for further consideration, minimum standards had to be met. The No-Action alternative plan was not included in this screening process because it must be carried forward in the process in order to serve as the baseline against which all retained alternative plans are compared.

Standards established for each criterion and results of each screening are:

- Completeness. To be complete, an alternative must not rely on other activities to function. An alternative plan is either complete or it is not complete. Each alternative plan is considered to be complete.
- Effectiveness. An alternative must contribute to at least 1 of the 4 ecosystem planning objectives to be considered effective enough to be retained for further consideration. Each alternative plan's ability to meet those objectives is identified in Table 3-4. Each of the alternative plans would meet at least one of the ecosystem restoration planning objectives.
- Efficiency. To be considered efficient, an alternative plan must be cost effective. For this screening, all cost effective plans are retained. Cost effective means that for a given level of non-monetary output, no other plan costs less, and no other plan yields more output for less money.

TABLE 3-4: EFFECTIVENESS OF PRELIMINARY ECOSYSTEM RESTORATION PLANS IN ATTAINING ECOSYSTEM RESTORATION PLANNING OBJECTIVES

Preliminary Alternatives	Ecosystem Restoration Planning Objectives			
	River Meander	Flooding Floodplain	Floodplain Habitat	Increase VELB Habitat
1-Locally Developed Setback Levee	No	Yes	Yes	Yes
2-Intermediate Setback Levee	No	Yes	Yes	Yes
3-Ring Levee	No	Yes	Yes	Yes
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough	No	Yes	Yes	Yes
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough	No	Yes	Yes	Yes
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32	No	Yes	Yes	Yes

When there is no monetary measure of benefits but project outcomes can be described and quantified in some dimension, cost effectiveness analysis can be used to assist on the decision making process. Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining the objective? The ability to identify the least costly among several alternatives having the same outcome is very useful. Cost effectiveness can also aid choice among projects that differ in their outcomes, but in the absence of monetized benefit estimates cannot remove all ambiguity.

Results of the cost effectiveness analysis are shown in Table 3-5 and in Figure 3-2. Information presented in Table 3-5 was used to conduct a cost effectiveness analysis. IWR-PLAN Decision Support software version 3.33 was used for the analysis. The program assisted in identifying the plans that are best financial investments and displaying the effects of each on a range of decision variables.

TABLE 3-5: COST EFFECTIVENESS SCREENING FOR EFFICIENCY OF PRELIMINARY ECOSYSTEM RESTORATION ALTERNATIVE PLANS ($1,000)[1]

Preliminary Alternatives[2]	Increase in Habitat Units (AAHU)	Restoration Costs[3]	Setback Levee Cost	Real Estate Cost[4]	EDSA[5]	Total First Cost	Annualized First Costs	Total Annual Costs[6]	Cost Effective
3-Ring Levee	895	$15,742	$7,042	$30,630	$5,278	$58,692	$3,527	$3,558	No
5-Intermediate Upstream of Dunning Slough, Locally Developed Downstream of Dunning Slough	937	$16,606	$9,689	$17,284	$5,943	$49,522	$2,976	$3,021	Yes
2-Intermediate Setback	795	$14,524	$7,409	$21,595	$5,112	$48,640	$2,923	$2,957	No
6-Intermediate Setback Upstream of Hwy 32, Locally Developed Downstream of Hwy 32	888	$14,725	$9,816	$13,909	$5,147	$43,597	$2,620	$2,669	Yes
1–Locally Developed Setback	783	$13,068	$9,652	$14,459	$5,161	$42,340	$2,545	$2,592	Yes
4-Locally Developed Upstream of Dunning Slough, Intermediate Downstream of Dunning Slough	642	$10,986	$7,486	$18,464	$4,291	$41,227	$2,478	$2,515	No

[1] Based on October 2003 price levels, 5 5/8 percent rate of interest, and a 50-year period of analysis.

[2]Alternatives are ordered from highest to lowest total annual costs.

[3]Restoration costs include remove orchards, plant, irrigate and establish, removal of majority of "J" Levee

[4] Includes relocation costs

[5]Excludes Lands and Relocation costs.

[6]Total annualized first costs and annual OMRR&R (which assumes $8,000 for habitat restoration and $7,000 per mile of setback levee.)

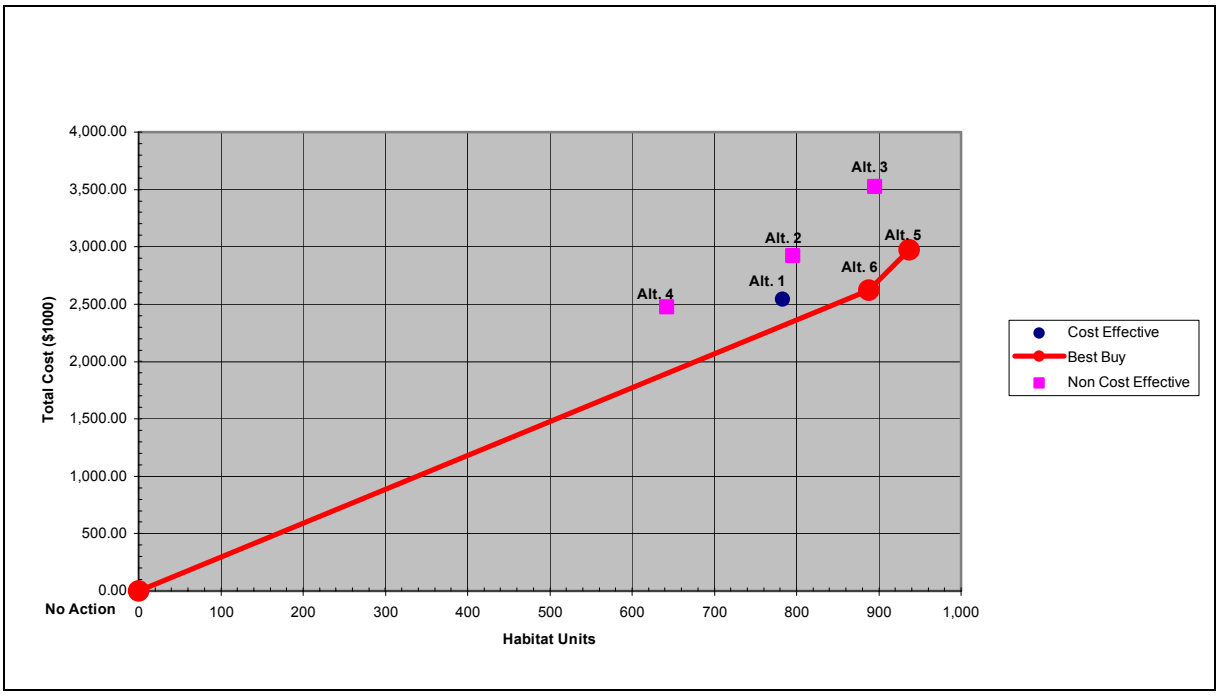

Figure 3-2. Cost Effectiveness Analysis of Preliminary Ecosystem Restoration Alternative Plans

Ecosystem benefits are characterized in terms of average annual habitat units (AAHU). The increase in habitat units was calculated using USFWS Habitat Evaluation Procedures (HEP) models. The HEP analysis measures habitat value for wildlife at baseline or without project conditions in the project area and compares that value with the estimated value at various points in time throughout the 50-year period of analysis. The HEP analysis is based on the assumption that the value of habitat to a selected species or group of species can be described in models that use variables that represent habitat suitability for wildlife. Because each of the proposed alternatives would result in an increase in both quality and quantity of habitat, there is also a net gain in the AAHU's as compared to the baseline or future without project conditions. Results of the HEP analysis can be found in Appendix B.8. Results from the HEP analysis were used as input into IWR-Plan for the cost effectiveness analysis.

Total annual costs include annualized project first cost (cost to initially implement the plan) and annual operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs. First costs were annualized at a rate of $5\ ^{5}/_{8}$ percent for a 50-year period of analysis. These costs were used as input into IWR-Plan for the cost effectiveness analysis.

Alternatives 1, 5, and 6 were considered to be cost effective. Table 3-5 shows the efficiency screening.

- Acceptability. Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations and pubic policies. An alternative plan must be considered within these parameters to be a satisfactory way of addressing problems identified. For the purposes of this screening, the question

asked is, "In general, do the State, local entities and public find construction of setback levees and/or habitat restoration to be an acceptable method of accomplishing ecosystem restoration, consistent with existing laws, regulations and public policies?" An alternative plan is either considered acceptable or not acceptable. Each of the alternative plans includes a setback levee and/or habitat restoration, which are generally acceptable features to accomplish ecosystem restoration. For the purposes of this screening, all of the alternative plans are considered to be acceptable.

To recap, the preliminary ecosystem restoration alternative plans that meet all four planning criteria standards are Preliminary Alternatives 1, 5, and 6. Alternatives 2, 3 and 4 did not meet the standard for efficiency and were not retained. The results of the screening of preliminary ecosystem restoration alternatives are shown in Table 3-6.

The retained preliminary alternative plans were carried forward as the final array of ecosystem restoration alternative plans, which were next evaluated and compared to identify the NER plan.

3.5 ANALYSIS OF FINAL ARRAY ECOSYSTEM RESTORATION ALTERNATIVE PLANS

Following is a description of the final array of ecosystem restoration alternative plans.

3.5.1 Description of Final Array Ecosystem Restoration Plans

The basic features of each plan are described below. A detailed description of each final array ecosystem restoration plan, along with corresponding maps, is included in Appendix A, Supporting Plan Formulation.

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. Refer to the Study Area Map (Figure 2-2) for a depiction of the No-Action Alternative. A description of assumptions for the No-Action alternative are provided in Appendix A, Supporting Plan Formulation, as well as later in this chapter as part of the discussion of Combined Alternative Plans.

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 5.5 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.

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

Costs. Total project first cost for this alternative plan is estimated to be $42,340,000. The average annual OMRR&R cost is estimated to be $47,000, of which $39,000 is for levee maintenance and $8,000 is for habitat restoration.

TABLE 3-6: SCREENING OF PRELIMINARY ECOSYSTEM RESTORATION ALTERNATIVE PLANS

Preliminary Alternatives	Completeness	Effectiveness	Efficiency	Acceptability	Overall
1–Locally Developed Setback Levee	Yes	Yes	Yes	Yes	Retained
2-Intermediate Setback Levee	Yes	Yes	No	Yes	Dropped
3-Ring Levee	Yes	Yes	No	Yes	Dropped
4-Locally Developed Upstream of Dunning Slough, Intermediate Downstream of Dunning Slough	Yes	Yes	No	Yes	Dropped
5-Intermediate Upstream of Dunning Slough, Locally Developed Downstream of Dunning Slough	Yes	Yes	Yes	Yes	Retained
6-Intermediate Upstream of Hwy 32, Locally Developed Downstream of Hwy 32	Yes	Yes	Yes	Yes	Retained

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 includes restoration of Zones A1, A2, and A4, B2, E, F, G, and H waterside of the setback levee.

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

Costs. The total project first cost for this alternative plan is estimated to be $49,522,000. The average annual OMRR&R costs are estimated to be $45,000, of which $37,000 per year is for levee maintenance and $8,000 per year for habitat restoration.

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 includes Zones A1, A2, A4, B2 E, G, and H waterside of the setback levee.

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

Costs. The total project first cost for this alternative plan is estimated to be $43,597,000. The average annual OMRR&R costs are estimated to be $48,000, of which $40,000 per year is for levee maintenance and $8,000 per year for habitat restoration.

3.5.2 Evaluation and Comparison of Alternative Plans for Ecosystem Restoration for Determination of National Ecosystem Restoration Plan

Action Versus No-Action

The No-Action alternative ranks lower than the action alternatives in that it is not effective in meeting any of the planning objectives. It has no positive benefits or effects, since it is the basis from which the effects and benefits are measured. It does not, however, involve incurring the implementation cost or adverse effects of the action alternatives.

Action Alternative Plans

To identify the NER plan, an incremental cost analysis was performed using the information in Table 3-5 and IWR-Plan software. Earlier, the efficiency of each cost effective plan was determined and used as a basis for screening out preliminary ecosystem restoration alternative plans. Of the cost effective plans, the most efficient in production of outputs are identified as "Best Buy" plans. The decision rule in incremental analysis is to identify the cost-effective plan with the lowest cost per unit of output as the first "Best Buy" and then remove from consideration any plans that provide a smaller output level than the first "Best Buy" plan. Each remaining plan is then compared to the first "Best Buy" plan. The remaining plan with the lowest additional cost per unit of additional output is identified as the second "Best Buy" plan, and any remaining plans that provide a smaller output level than the second "Best Buy" plan are eliminated. This iterative process continues until there is only one remaining plan, which is the final "Best Buy" plan. These "Best Buy" plans provide the greatest increase in output for the least increase in cost and have the lowest incremental costs per unit of output relative to the other cost effective plans. Through this process, Alternatives 5 and 6 were identified as "best buys." Because Alternative 1 was not identified as a "best buy" plans, it was no longer considered in identifying the NER plan.

The comparison of the incremental outputs for Alternatives 5 and 6 are displayed in Figure 3-3. Based upon the cost effectiveness analysis and the incremental cost analysis, Alternative 6 produces outputs at an incremental cost per AAHU of $4,900. The next level of output (Alternative 5) produces an incremental cost per AAHU of $7,300. The question now becomes is the next level of output "worth" the cost; that is, whether the environmental

benefits of the additional output in the next level are worth the additional cost. Since the additional output of Alternative 5 is relatively small and the cost is relatively great, Alternative 6 is determined to be the alternative plan that reasonably maximizes ecosystem restoration benefits compared to costs and is therefore identified as the NER plan.

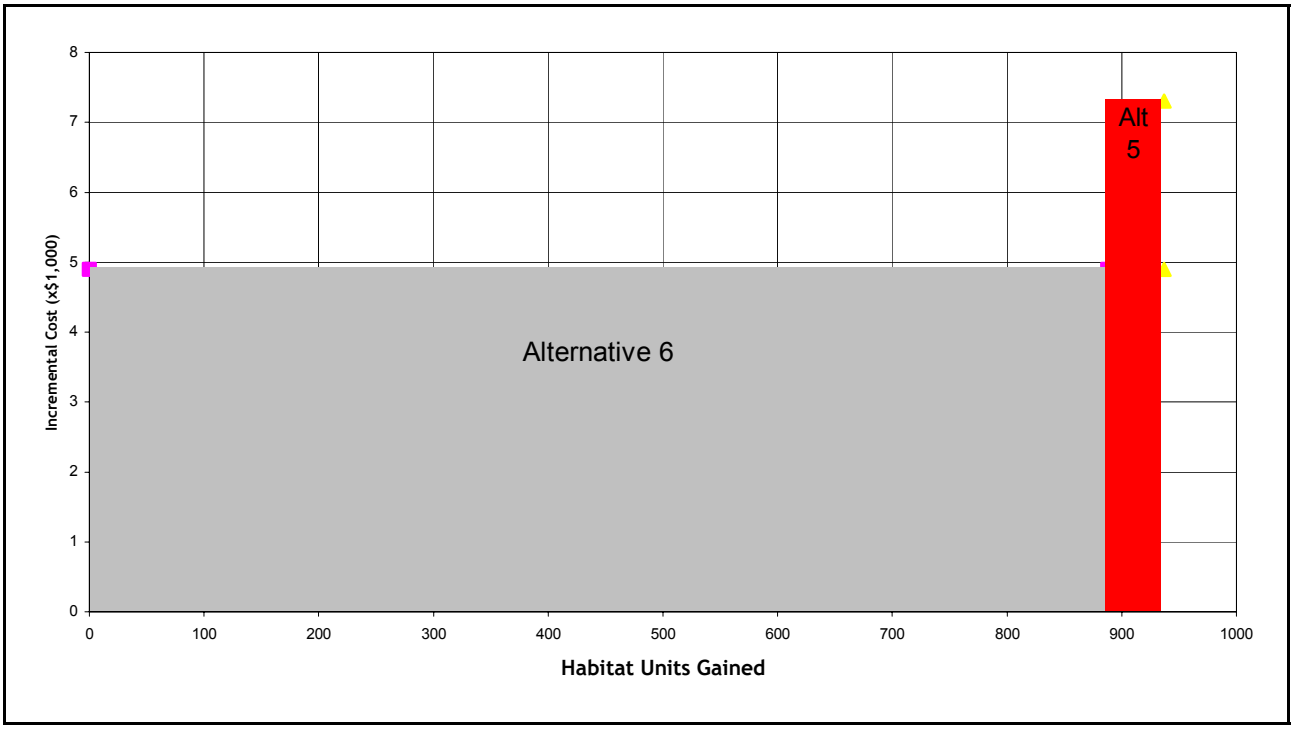

Figure 3-3. Comparison of Incremental Outputs of Ecosystem Restoration Alternatives 5 and 6 (Best-Buy Plans)

3.6 FORMULATION OF PRELIMINARY COMBINED ALTERNATIVE PLANS

Following identification of the NER Plan, combined alternative plans were formulated that address other problems and opportunities as well as the primary problem under study. The emphasis of the formulation process will be on formulating alternatives that take advantage of the synergies created by the plans that address both the primary purpose (ecosystem restoration) and flood damage reduction.

3.6.1 Opportunities for Flood Damage Reduction

Formulation of combined plans consisted of developing a preliminary array of combined alternative plans, using flood damage reduction and ecosystem restoration measures retained.

Additional formulation to arrive at combined plans consists of exploring construction of setback levees. Since the ecosystem restoration alternative plans explored an array of

setback levee alignments, formulation of combined plans begins with consideration of those ecosystem restoration alternative plans that included construction of setback levees and their contributions to the combined purposes. The accomplishments of Alternatives 1, 2, 3, 4, 5, and 6 (now combined alternative plans) in terms of flood damage reduction benefits were identified.

Combined alternative plans with a setback levee that extends south to County Road 23 (as opposed to a ring levee) include a "training dike" at the southern end of the setback levee. The training dike would be a few feet high and extent for about 1 mile south of County Road 23 in order to provide additional reduction of flood damages to structures, contents and agriculture. This feature has been added to Combined Alternatives 1, 5 and 6.

3.6.2 Maximization of Preliminary Combined Alternative Plans For Flood Damage Reduction Opportunities

In order to reasonably maximize net benefits for flood damage reduction for each preliminary combined alternative plan, an array of levels of performance was evaluated. These different levels of performance were attained through raising each levee height by varying degrees and identifying corresponding levels of flood damage reduction. For each combined alternative, three levee heights were evaluated. Risk-based procedures were used to formulate and identify a reasonably optimized flood damage reduction component to define each preliminary combined alternative plan (Table 3-7). Table 3-7 shows the annual net benefits for each combined alternative.

Not all the combined alternative plans were optimized due to the planning constraint that project performance not be greater than a 90 percent chance of passing the 75-year event and not less than a 90 percent chance of passing the 125-year event. Both lower and higher levels of project performance may be considered. Lower levels of project performance have been included in the analysis. Based on current estimates of incremental costs and benefits, optimized combined alternatives 1, 5 and 6 are thought to provide around the 90 percent chance of passing the 113-year event, which is within the range precluded by a planning constraint. As such, optimized alternatives 1, 5 and 6 have not been included. Because of this, if the recommended plan is either combined alternatives 1, 5 or 6, it will be identified as a locally preferred plan (LPP). Optimized combined alternatives 2, 3 and 4 are thought to provide around the 90 percent chance of passing the 190-year event. No additional benefits will occur past the 90 percent chance of passing the 190-year event due to a combination of flood waters outflanking the project levee and backwaters.

Based upon information presented in Table 3-7, the constrained maximum flood damage reduction component for combined alternatives 1, 5 and 6 is an increase in height of the setback levee so as to provide a 90 percent reliability of passing a 75-year flood event in the Northern Impact area. In order to accomplish this, the setback levee would be constructed to the 320-year water surface elevation in the Northern Impact area. The reasonably optimized flood damage reduction component for combined alternatives 2, 3, and 4 is an increase in height of the setback levee so as to provide a 90 percent reliability of passing a 190-year flood event in the Northern Impact area. In order to accomplish this, the setback levee would be constructed to the 500-year water surface elevation in the Northern Impact area. In addition, Combined Alternatives 1, 5 and 6 would have a 1.1 mile training

TABLE 3-7: OPTIMIZATION OF PRELIMINARY COMBINED ALTERNATIVE PLANS FOR FLOOD DAMAGE REDUCTION

Preliminary Combined Alternative Plan	Average Levee Height (Feet)	90 Percent Reliability by Flood Event[1]	Increase in Habitat Unit Benefits (AAHU)	Flood Damage Reduction Benefits ($1,000)	Incremental Benefit ($1,000)[2]	Total Project Annualized First Cost ($1,000)[3]	Incremental Cost ($1,000)[2]	Justified Increment
Alt. 1	6.0	26	783	465	43	2,575.6	31	Yes
	7.0	59	783	549	84	2,584.6	9	Yes
	7.5	75	783	576	27	2,596.0	11	Yes
	9.0	190	783	667	91	2,712.1	116	No
Alt. 2	6.0	26	795	331	0	2,913.1	0	Yes
	7.0	59	795	411	80	2,922.8	10	Yes
	7.5	75	795	437	26	2,930.5	8	Yes
	9.0	190	795	526	89	2,959.9	29	Yes
Alt. 3	7.0	26	895	327	0	3,517.2	0	Yes
	8.0	59	895	402	75	3,531.6	14	Yes
	8.5	75	895	428	26	3,539.2	8	Yes
	10.0	190	895	513	85	3,580.2	41	Yes
Alt.4	6.0	26	642	334	0	2,467.5	0	Yes
	7.0	59	642	418	84	2,476.0	9	Yes
	7.5	75	642	446	28	2,484.5	9	Yes
	9.0	190	642	536	90	2,531.0	47	Yes
Alt. 5	7.0	26	937	462	43	3,007.3	31	Yes
	8.0	59	937	542	80	3,025.9	19	Yes
	8.5	75	937	568	26	3,038.1	12	Yes
	10.0	190	937	657	89	3,154.7	117	No
Alt. 6	6.0	26	888	467	43	2,651.2	31	Yes
	7.0	59	888	540	73	2,664.8	14	Yes
	7.5	75	888	577	37	2,676.6	12	Yes
	9.0	190	888	667	90	2,796.6	120	No

1 Northern Economic Impact Area, which includes the community of Hamilton City

2 The Incremental Benefits and Incremental Costs are listed with respect to ecosystem restoration single purpose plans. First increment adds training dike for Alternatives 1, 5 and 6 only.

3 Does not include cultural resource preservation ($10,200 annualized).

dike extending south of County Road 23 that would provide an additional flood damage benefit to agriculture and urban structures in southern Hamilton City. The training dike would be constructed to the 20-year water surface elevation.

- Preliminary Combined Alternative 1 – Locally Developed Setback Levee (7.5-foot levee).
- Preliminary Combined Alternative 2 - Intermediate Setback Levee (9.0-foot levee).
- Preliminary Combined Alternative 3 - Ring Levee (10.0-foot levee).
- Preliminary Combined Alternative 4 - Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough (9.0-foot levee).
- Preliminary Combined Alternative 5 - Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough (10.0-foot levee).
- Preliminary Combined Alternative 6 - Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32 (9.0-foot levee).

Ecosystem restoration and flood damage reduction elements are included in each of the preliminary combined alternative plans (Table 3-8). Now that the preliminary combined alternative plans have been defined, the next step is to screen them.

3.7 SCREENING OF PRELIMINARY COMBINED ALTERNATIVE PLANS

The preliminary combined alternative plans were screened against the four planning criteria. This process is similar to the screening performed for the preliminary ecosystem restoration alternative plans, except now both ecosystem restoration and flood damage reduction purposes are considered. Standards were established to determine if the alternative plans meet each planning criteria. For a combined alternative plan to be carried forward for further consideration, minimum standards had to be met. The No-Action alternative plan was not included in this screening process because it must be carried forward in the process in order to serve as the baseline against which all retained combined alternative plans are compared.

Standards established for each criterion and results of each screening are:

- Completeness. To be complete, an alternative must not rely on other activities to function. An alternative plan is either complete or it is not complete. Each alternative plan is considered to be complete.
- Effectiveness. An alternative must contribute to at least 1 of the 6 planning objectives to be considered effective enough to retain for further consideration. Each alternative plan's ability to meet those objectives is identified in Table 3-9. All plans were considered to be effective.

TABLE 3-8: ER AND FDR INCLUDED IN EACH PRELIMINARY COMBINED ALTERNATIVE PLAN

	Restoration Zones							Infrastructure		
Preliminary Combined Alternatives	**Zones A1, A2, and A3**	**Zone B2**	**Zone E**	**Zone F**	**Zone G**	**Zone H**	**Zone I**	**Protects Waste Water Treatment Facility**	**Protects Holly Sugar Plant**	**Protects Agricultural Land South of Town with Levee**
1–Locally Developed Setback Levee	X	X	X		X			X	X	X
2-Intermediate Setback Levee	X		X	X	X	X			X	
3-Ring Levee	X		X	X	X	X	X			
4-Locally Developed Upstream of Dunning Slough, Intermediate Setback Downstream of Dunning Slough	X		X		X			X	X	
5-Intermediate Upstream of Dunning Slough, Locally Developed Downstream of Dunning Slough.	X	X	X	X	X	X			X	X
6-Intermediate Upstream of Hwy 32, Locally Developed Downstream of Hwy 32	X	X	X		X	X		X	X	X

- Efficiency. To be considered efficient, an alternative plan must be cost effective. Please refer to section 3.4. Formulation of Preliminary Ecosystem Restoration Alternative Plans, Efficiency, for a description of cost effectiveness. To be considered cost-effective, an alternative must provide more total benefits than less expensive alternatives. Monetary (flood damage reduction) and non-monetary (ecosystem restoration) benefits were combined for this analysis by subtracting the flood damage reduction benefits from the total project costs to calculate "remaining costs." An alternative that has higher total costs and lower restoration benefits than another alternative can be cost-effective only if the first alternative has additional monetary benefits that exceed its additional costs, resulting in lower remaining costs for the first alternative than for the second alternative. Therefore, a cost-effective alternative must provide more restoration benefits (AAHU's) than any alternative with lower remaining costs. Cost effectiveness based on total costs is also indicated in Table 3-10 for use in the trade-off analysis. An alternative cannot be eliminated based on total costs unless it has lower restoration benefits and lower flood damage

reduction benefits than a less expensive alternative. Results of the cost effectiveness analysis are shown in Table 3-10 and Figure 3-4.

TABLE 3-9: EFFECTIVENESS OF PRELIMINARY COMBINED ALTERNATIVE PLANS IN ATTAINING PLANNING OBJECTIVES

Preliminary Combined Alternatives	Planning Objectives					
	Ecosystem				Flood Damage Reduction	
	River Meander	Flooding Floodplain	Floodplain Habitat	Increase VELB Habitat	Reduce Risk from Flooding	Reduce Damages
1-Locally Developed Setback Levee	No	Yes	Yes	Yes	Yes	Yes
2-Intermediate Setback Levee	No	Yes	Yes	Yes	Yes	Yes
3-Ring Levee	No	Yes	Yes	Yes	Yes	Yes
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough	No	Yes	Yes	Yes	Yes	Yes
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough	No	Yes	Yes	Yes	Yes	Yes
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32	No	Yes	Yes	Yes	Yes	Yes

- Acceptability. An alternative plan must be considered by the general public to be a satisfactory way of addressing problems identified. For the purposes of this screening, the question asked is "In general, does the public find construction of setback levees and habitat restoration to be an acceptable method of accomplishing ecosystem restoration?" An alternative plan is either considered acceptable or not acceptable. Each of the alternative plans includes a setback levee and habitat restoration, which are generally acceptable features to accomplish ecosystem restoration. Similarly, setback levees are generally considered to be an acceptable form of flood damage reduction. For the purposes of this screening, each of the alternative plans is considered to be acceptable.

TABLE 3-10: COST EFFECTIVENESS SCREENING FOR EFFICIENCY OF ANNUALIZED PRELIMINARY COMBINED ALTERNATIVE PLANS[1]

Preliminary Combined Alternatives[2]	Increase in Habitat Units (AAHU)	Flood Damage Reduction Benefits[3] ($1,000)	Total Costs[4] ($1,000)	Cost Effective (Total Costs)	Remaining Costs[5] ($1,000)	Cost Effective (Remaining Costs)
3-Ring Levee	895	513	3,590	No	3,077	No
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough	937	568	3,048	Yes	2,480	Yes
2-Intermediate Setback Levee	795	526	2,970	No	2,444	No
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32	888	577	2,687	Yes	2,110	Yes
1-Locally Developed Setback Levee	783	576	2,606	Yes	2,030	Yes
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough	642	536	2,541	Yes	2,005	Yes

[1]Based on October 2003 price levels, 5 5/8 percent rate of interest and a 50-year period of analysis.

[2]Alternatives are ordered from highest to lowest remaining costs.

[3]All benefits and costs are average annual equivalents.

[4]Total costs and remaining costs includes CRP costs of $10,200 annualized

[5]Remaining Costs equal total costs less flood damage reduction benefits.

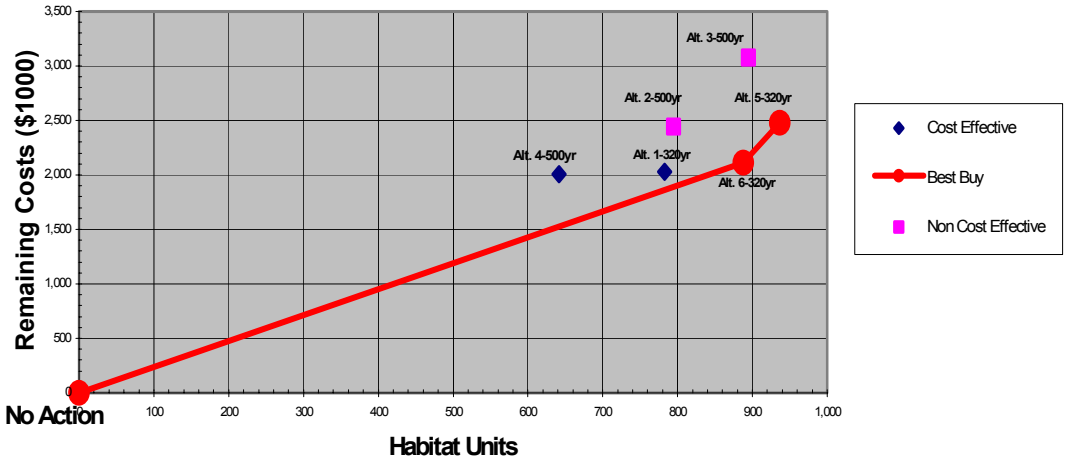

Figure 3-4. Cost Effectiveness Analysis of Preliminary Combined Alternative Plans

To recap, the preliminary combined alternative plans that meet all four planning criteria standards are Alternatives 1, 4, 5 and 6. Alternatives 2 and 3 did not meet the meet the standard for efficiency and were not retained. The results of the screening of preliminary combined alternatives are shown in Table 3-11.

The screening process eliminated preliminary Combined Alternatives 2 and 3 from further consideration. All other preliminary combined alternative plans are retained for further evaluation. Combined alternative plans were carried forward as the final array of combined alternative plans, which were next evaluated and compared to identify the alternative plan with Federal interest.

3.8 ANALYSIS OF COMBINED ALTERNATIVE PLANS

Following is a description of the final array of combined alternative plans.

3.8.1 Description of Combined Alternative Plans*

Following is a description of each alternative in terms of its features, accomplishments, uncertainties, effects, operation, maintenance, repair, replacement and rehabilitation (OMRR&R) requirements, and costs.

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. Refer to the Study Area Map (Figure 2-3) for a depiction of the No-Action Alternative. 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.

TABLE 3-11: SCREENING OF PRELIMINARY COMBINED ALTERNATIVE PLANS

Preliminary Combined Alternatives	Completeness	Effectiveness	Efficiency	Acceptability	Overall
1-Locally Developed Setback Levee	Yes	Yes	Yes	Yes	Retained
2-Intermediate Setback Levee	Yes	Yes	No	Yes	Dropped
3-Ring Levee	Yes	Yes	No	Yes	Dropped
4-Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough	Yes	Yes	Yes	Yes	Retained
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough	Yes	Yes	Yes	Yes	Retained
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32	Yes	Yes	Yes	Yes	Retained

- Agricultural lands would continue to decline due to seepage, erosion, flooding and scouring that are associated with the close proximity of the lands to the Sacramento River.
- 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.

- 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 USFWS that pertains to the valley elderberry long-horned beetle and includes the study area.
- Based on historical migration rates, it is estimated that 200 feet of migration could be expected for an exceedence interval of 50 years specific to River Mile 186 to 198. Rock riprap bank protection usually lasts about 50-years with significant deterioration starting about 20-years from its time of placement. Existing rock riprap bank in the future. About 20 to 25 percent of existing riprap cover has eroded from the bank, mostly to the south end of 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 (Thomas, 2004) and it is unlikely to do so in the future.

Combined 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 and is 6.6 miles long. On average, the levee would be 7.5 feet high (6 feet for the prevention of induced flooding due to ecosystem restoration, and an additional 1.5 feet for flood damage reduction) 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. The plan is shown in Figure 3-5. The levee would have a 90 percent reliability of passing a 75-year event in the Northern impact area (which includes Hamilton City).

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 removing 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, so this rock would not need to be replaced.

The new setback levee would begin about 2 miles north of Hamilton City, tying into high ground near the northern end of the "J" levee. Tying into high ground at this location

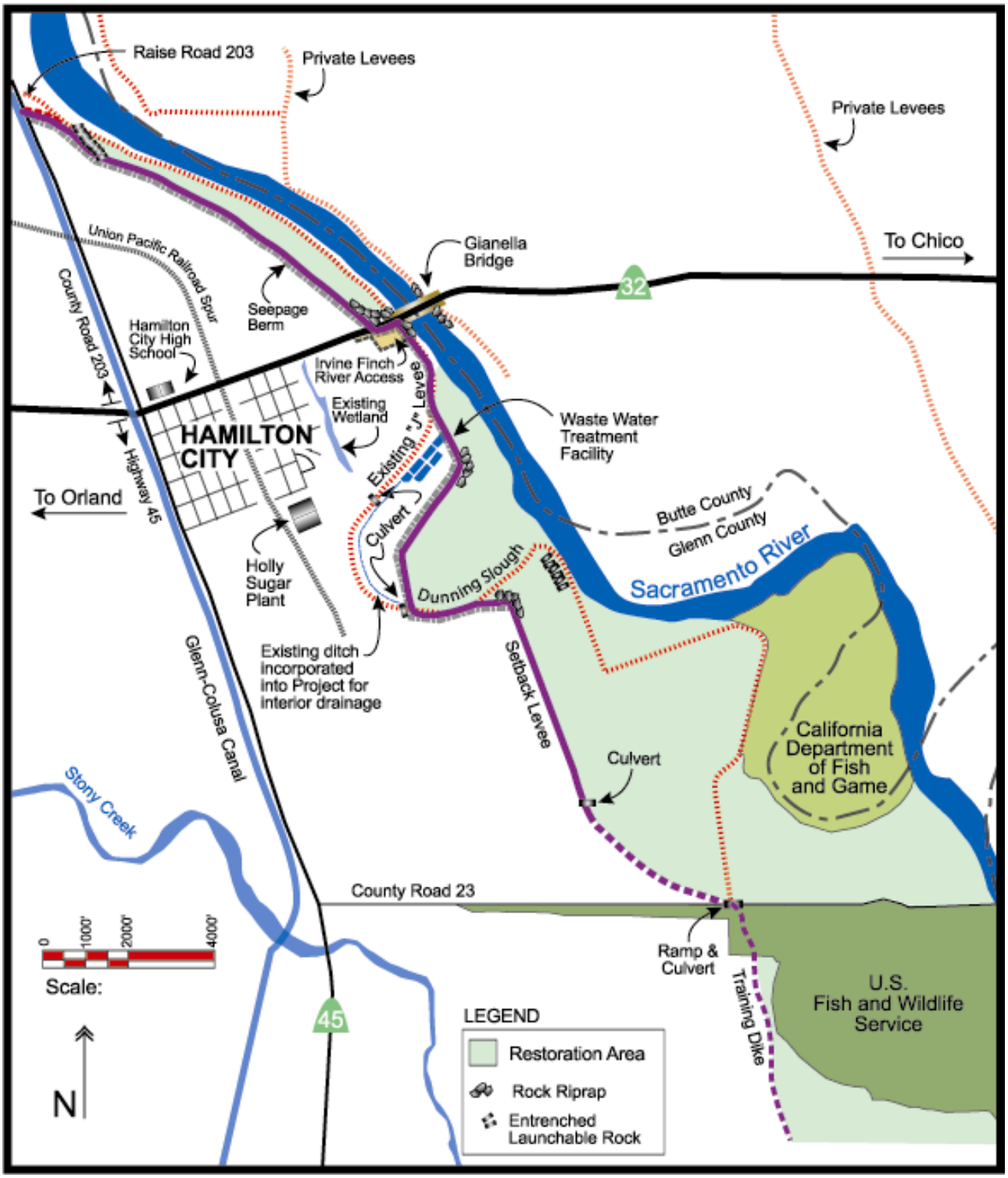

Figure 3-5: Combined Alternative 1 - Locally Developed Setback Levee

would prevent flows greater than the 250-year event from possibly wrapping around the setback levee and over County Road 203. The setback levee would be extended to a point just west of County Road 203, and County Road 203 would be ramped approximately 2.5 feet from its current height over the setback levee. Glenn County constructed a short setback levee near the northern end of the "J" levee in 2003, which would be incorporated into the new setback levee. Entrenched rock would be placed on the waterside of the setback levee to direct flows and possible river migration away from the setback levee.

South of Dunning Slough, the alignment would roughly follow along the western edge of the habitat restoration area before turning east and merging with the southern end of the "J" levee at County Road 23. As the levee turns east, the levee height would gradually decrease from 7.5 feet to approximately 3 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 be constructed to the 20-year water surface elevation. The training dike would continue for about a mile south of County Road 23, running along the western portion of the USFWS property. A small ramp with culverts on either side would be constructed over the training dike at County 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 to flow over it's top and gently spread out into the agricultural areas while reducing the high velocities that cause extensive damage to the orchards.

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 USFWS 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 approach would be exposed to direct flows. It is not currently exposed to these direct flows, which could scour the approach. 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. Also, up to 100 feet of rock would be placed under the Gianella Bridge at Highway 32 abutment specifically to protect it from exposure to the 320-year water surface elevation attainable by the flood damage reduction component of the project.

- 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, 1,600 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. South of Dunning Slough, 1,600 feet of entrenched rock would be placed to protect the new levee from erosion and river migration.
- 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. This alternative plan would be constructed to avoid hydraulic impacts, primarily through slightly decreasing the habitat restoration.

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. Expected annual flood damages would be reduced by about $576,000 (including avoided flood fighting costs). Residual expected annual flood damages would be $264,000. This damage reduction is smaller than what is shown in Table 3-9 because the levee height decreases from north to south (from 7.5 to 3 feet).

Costs. The total project first cost for this alternative plan is estimated to be $43,534,000. Annual OMRR&R costs are estimated to be $54,000. Levee maintenance costs are estimated to be $46,000. Maintenance costs for habitat restoration are estimated to be $8,000 per year.

Combined Alternative 4 - Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough

This alternative would consist of constructing a levee about 4.1 miles long and set back roughly 500 to 2,700 feet from the river, removing the existing "J" levee, and actively restoring about 1,100 acres of native habitat. The levee alignment is shown in Figure 3-6. On average, the levee would be 9 feet high (6 feet for the ecosystem restoration increment of levee, and an additional 3 feet for the flood damage reduction increment). The levee would provide the community with a 90 percent level of confidence of passing the 190-year event. The levee alignment follows that of Combined Alternative 1 from the north down to the southern end of Dunning Slough. At that point, the alignment would wrap around the Holly Sugar Plant and tie into high ground along Highway 45. It would protect the wastewter treatment plan and Holly Sugar plant, but not the agricultural lands south of town. The lands restored in this alternative would be the same as Combined Alternative 1, with the exception of Zone B2, which would not be included. The existing "J" levee would be removed to allow overbank flooding of the flooplain. Flowage easements may need to be purchased south of the Holly Sugar Plant and west of the existing "J" levee to compensate landowners for increased flooding due to the removal of the existing "J" levee.

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

Uncertainty. See Combined Alternative 1.

Hydraulic Effects. This alternative would not result in any adverse hydraulic effects.

Accomplishments. This alternative plan would restore 1,050 acres and provide 642 AAHU's. Reduces expected annual flood damages by about $536,000 (including avoided flood fighting costs). Residual expected annual flood damages would be $190,000.

Costs. The total project first cost for this alternative plan is estimated to be $42,453,000. The average annual OMRR&R cost is estimated to be $37,000, of which $29,000 is for levee maintenance and $8,000 is for habitat restoration.

Combined 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 6.4 miles long, and about 7.5 feet high (6 feet for the ecosystem restoration increment of levee, and an additional 1.5 feet) for the flood damage reduction increment), and removing most of the existing "J" levee. The alternative plan is shown in Figure 3-7 and includes restoration of Zones A1, A2, and A4, B2, E, F, G, and H waterside of the setback levee. The levee would have a 90 percent reliability of passing a 75-year event in the Northern impact area (which includes Hamilton City).

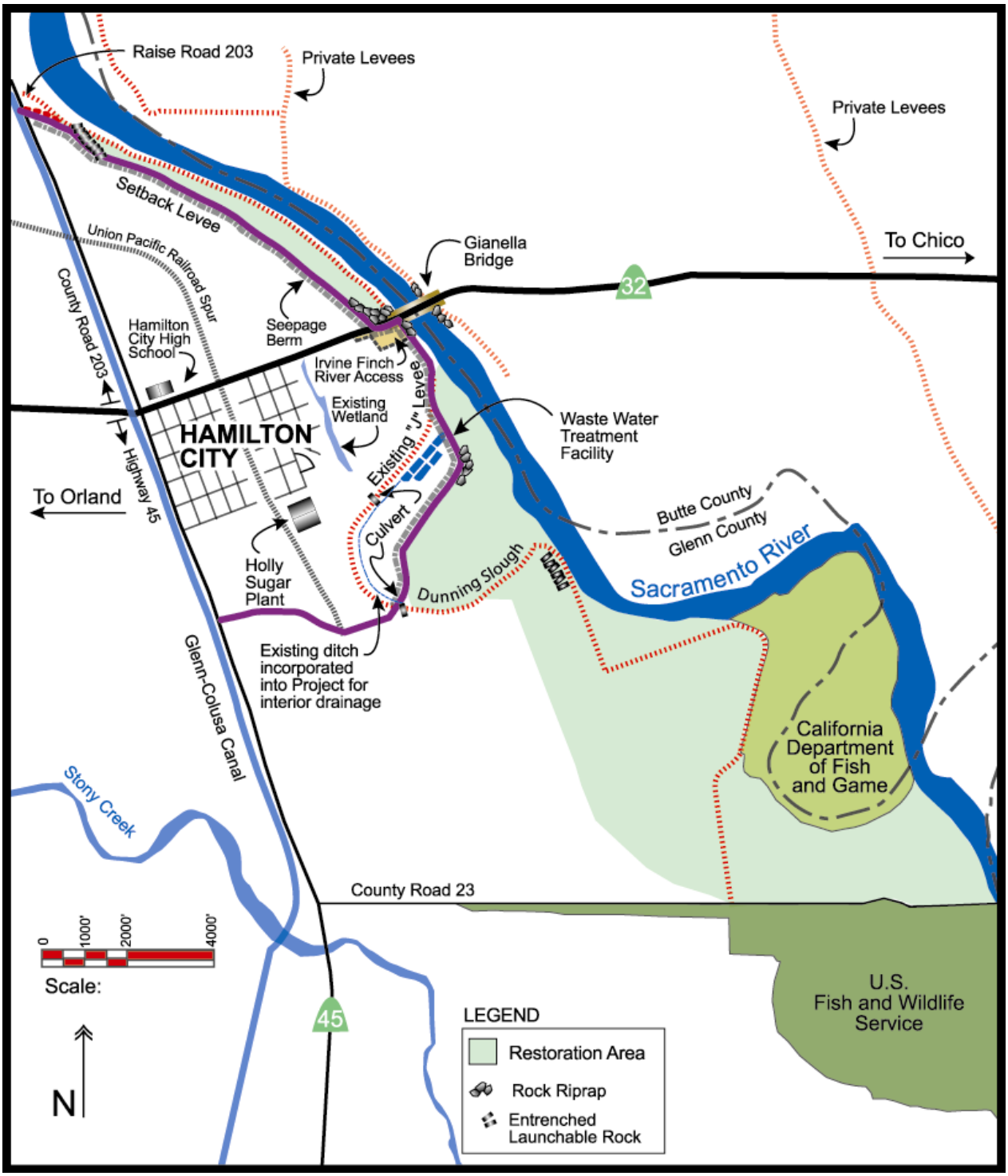

Figure 3-6: Combined Alternative 4 - Locally Developed Setback Upstream of Dunning Slough, Intermediate Setback Levee Downstream of Dunning Slough

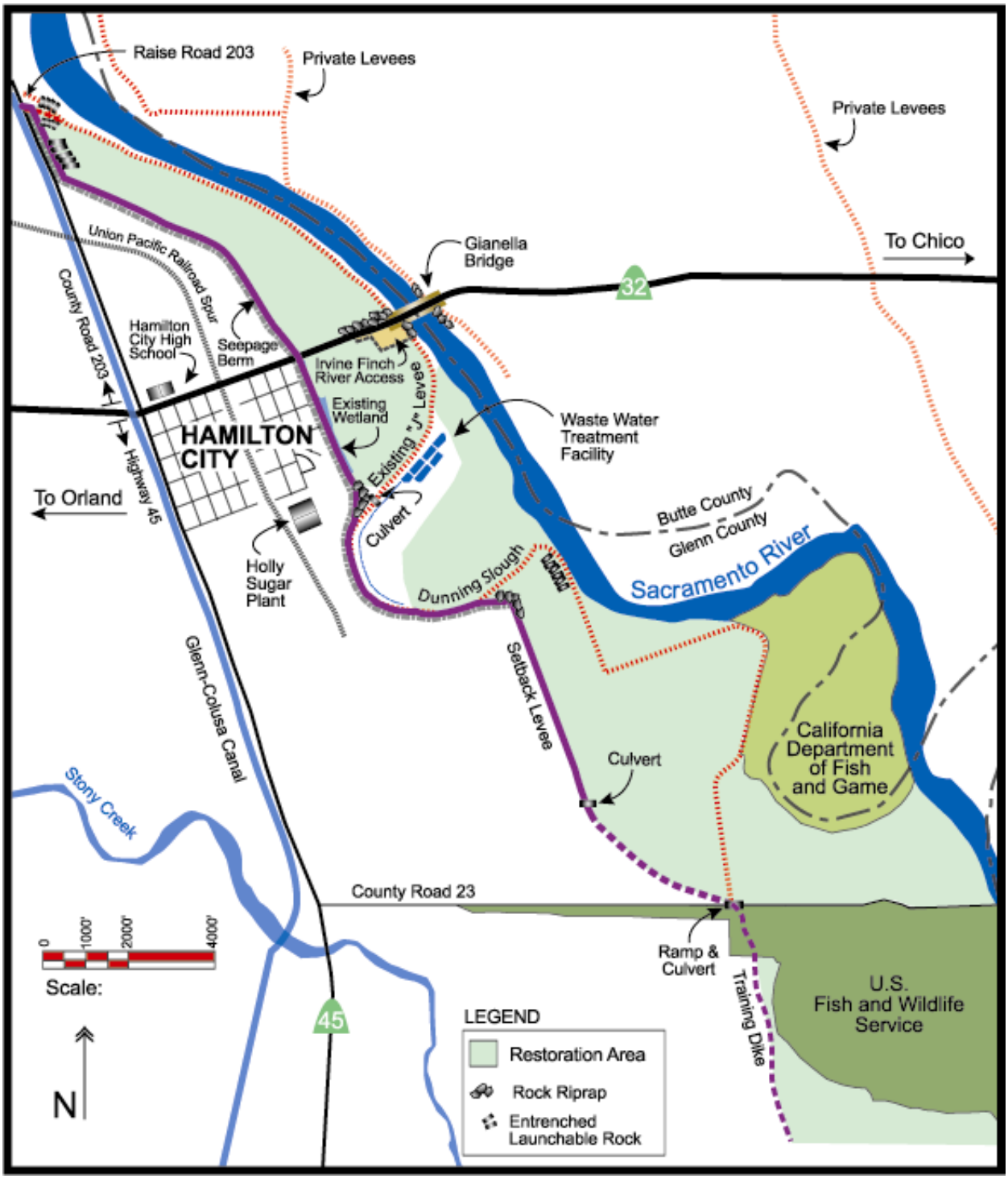

Figure 3-7: Combined Alternative 5 - Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough

The new setback levee would begin about 2 miles north of Hamilton City, tying into high ground near the northern end of the "J" levee. Tying into high ground at this location would prevent flows greater than the 250-year event from possibly wrapping around the setback levee and over County Road 203. The setback levee would be extended to a point just west of County Road 203, and County Road 203 would be ramped approximately 2.5 feet from its current height over the setback levee. Glenn County constructed a short setback levee near the northern end of the "J" levee in 2003, which would be used as a "training dike" for the new setback levee. Entrenched rock would be placed either on the waterside or the landside of this training dike to direct flows and possible river migration away from the new setback levee. The "training dike" south of County Road 23 would be the same as for Combined Alternative 1.

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. Erosion protection would be the same as for Combined Alternative 1.

Uncertainty. See ecosystem alternative 1.

Hydraulic Effects. Hydraulic modeling of Combined Alternative 6 (which includes a levee set closer to the river than Combined Alternative 5) shows that there would be about a 0.1 to 0.6-foot decrease associated with the 342,600 cfs flow event in portions of Butte County. For the 75-year flood event, existing levees along the eastern side of the Sacramento River would be overtopped. By widening the floodway on the western side of the Sacramento River, this alternative plan could be expected to further reduce stages in Butte County landside of the eastern levees.

Accomplishments. This alternative plan would restore 1,600 acres and provide 937 AAHU's. Reduces expected annual flood damages by about $568,000 (including avoided flood fighting costs). Residual expected annual flood damages would be $272,000. This damage reduction is smaller than what is shown in Table 3-9 because the levee height decreases from north to south (from 7.5 to 3 feet).

Costs. The total project first cost for this alternative plan is estimated to be $50,890,000. The average annual OMRR&R cost is estimated to be $53,000, of which $45,000 is for levee maintenance and $8,000 is for habitat restoration.

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

This alternative is largely the same as Alternative 6 (NER). This alternative plan consists of actively restoring about 1,500 acres of native vegetation, constructing a setback levee about 6.8 miles long, and about 7.5 feet high (6 feet for the ecosystem restoration increment of levee, and an additional 1.5 foot for the flood damage reduction increment), and removal of most of the existing "J" levee. The alternative plan is shown in Figure 3-8 and includes Zones A1, A2, A4, B2 E, G, and H waterside of the setback levee. The levee would have a 90 percent reliability of passing a 75-year event in the Northern impact area (which includes Hamilton City).

The new setback levee would begin about 2 miles north of Hamilton City, tying into high ground near the northern end of the "J" levee. Tying into high ground at this location would prevent flows greater than the 250-year event from possibly wrapping around the setback levee and over County Road 203. The setback levee would be extended to a point just west of County Road 203, and County Road 203 would be ramped approximately 2.5 feet from its current height over the setback levee. Glenn County constructed a short setback levee near the northern end of the "J" levee in 2003, which would be used as a "training dike" for the new setback levee. Entrenched rock would be placed either on the waterside or the landside of this training dike to direct flows and possible river migration away from the new 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 County 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 "training dike" south of County Road 23 would be the same as for Combined Alternative 1.

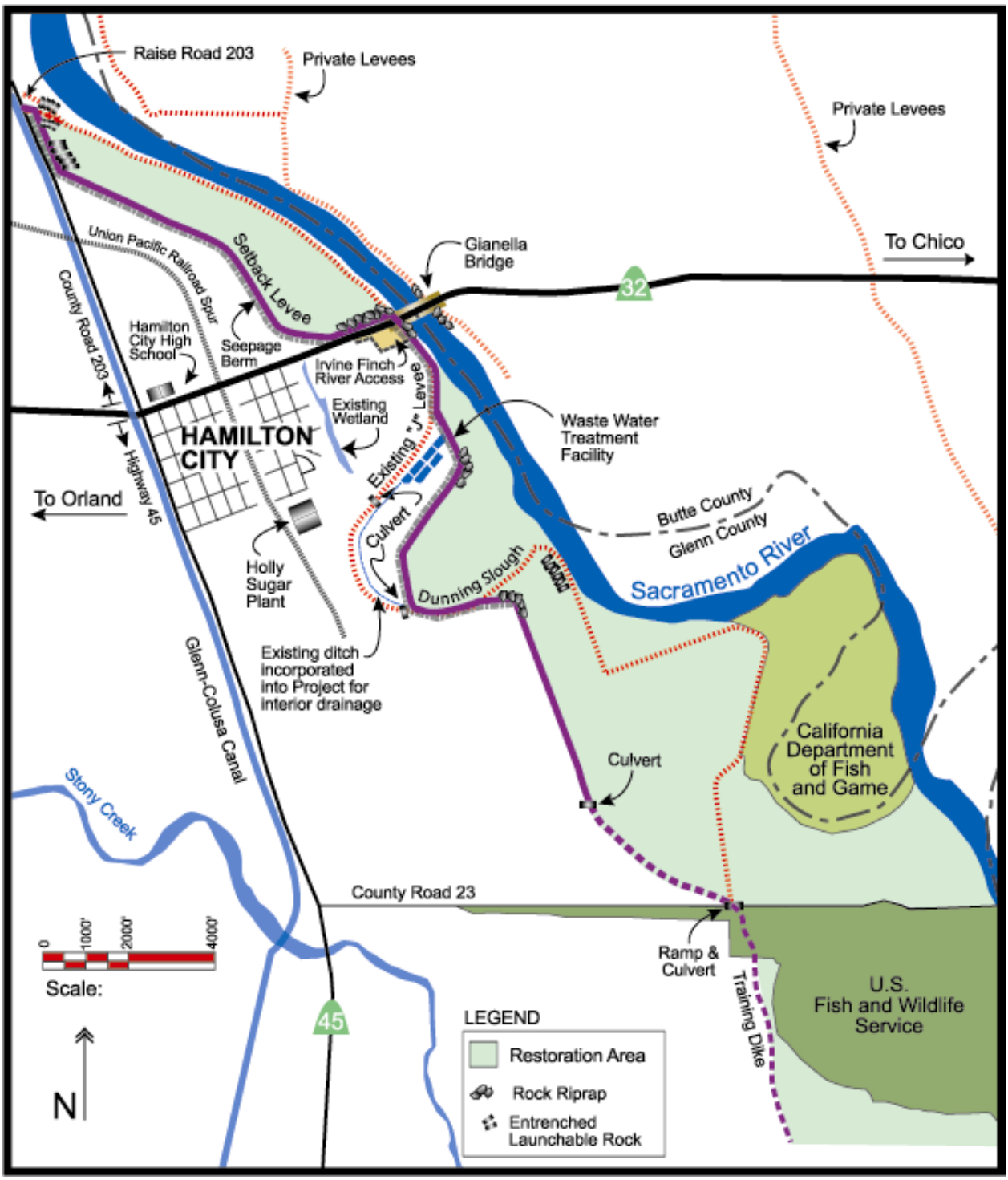

Figure 3-8: Combined Alternative 6 - Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32

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. 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.

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

Uncertainty. See ecosystem Alternative 1.

Hydraulic Effects. Hydraulic modeling of the recommended plan shows that there would be about a 0.1 to 0.6-foot decrease associated with the 342,600 cfs flow event (320-year flood event) in portions of Butte County. For the 75-year flood event, existing levees along the eastern side of the Sacramento River would be overtopped. By widening the floodway on the western side of the Sacramento River, this alternative plan would reduce stages in Butte County landside of the eastern levees.

Accomplishments. This alternative plan would restore 1,500 acres of habitat and provide 888 AAHU's. Reduces expected annual flood damages by about $577,000 (including avoided flood fighting costs). Expected residual flood damages would be $263,000. This damage reduction is smaller than what is shown in Table 3-9 because the levee height decreases from north to south (from 7.5 to 3 feet).

Costs. The total project first cost for this alternative plan is estimated to be $44,876,000. Annual OMRR&R costs are estimated to be $55,000, of which $47,000 is levee maintenance and $8,000 is for habitat restoration.

3.8.2 Evaluation and Comparison of Combined Alternative Plans

No-Action versus Action

The No-Action alternative would not meet any of the planning objectives. It has no positive benefits or effects since it is the basis from which the effects and benefits are measured. It does not, however, involve incurring the implementation costs or adverse effects of the action alternatives.

Trade-Off Analysis between Cost Effective Combined Alternative Plans

Trade-off analysis is the procedure used to identify the potential gains and losses associated with producing a larger or lesser amount of a given output or outputs, and is required in the Corps' Engineering Circular 1105-2-404, "Planning Civil Work Projects Under the Environmental Operating Principles," 1 May 2003. This process is used to help identify the best Combined Plan to be further considered. Table 3-12 illustrates the comparison

between the cost-effective plans (Combined Alternatives 1, 4, 5, 6) by describing the advantages of each alternative over the other.

Percentage of Maximum method was used for trade-off analysis, as it is the most commonly used normalization technique. Criterion measurements used for trade-off included annual Flood Damage Reduction Benefits, Total Costs, and Average Annual Habitat Units gained. The weighting assigned for each criterion was 50 percent for Habitat Gained and 8 percent for Flood Damage Reduction benefits and 42 percent for Total Costs. (To make a dollar of flood damage reduction benefits equal in weight to a dollar of costs, the normalized units of cost must be given a weight that is 5.3 times as much as the weight given to the normalized units of flood damage reduction benefits, because the maximum annual costs ($3,048,000) represented by one normalized unit of cost is 5.3 times as much as the maximum annual flood damage reduction benefit ($577,000) represented by one normalized unit of flood damage reduction benefit.) Because of the normalization process used in the trade-off analysis, this subjective weighting implies that the maximum ecosystem restoration benefit (937 AAHU's) is equally as valuable as the sum of the maximum annual flood damage reduction benefit ($577,000) and the maximum total annual cost ($3,048,000). Table 3-13 shows the application of the Percentage of Maximum Method. Because ecosystem restoration and flood damage reduction are equally important to stakeholders in the study area, the Project Delivery Team selected an intermediate set of weightings that gives balanced consideration to environmental and economic factors. The total weight to economic factors (0.08 for monetary benefits and 0.42 for monetary costs) is equal to the total weight to non-monetary environmental benefits (0.50). Table 3-14 shows the entire array of preference assignments for sensitivity analysis, along with the ranking of each alternative. All four of the alternatives that were cost-effective based on total costs are included in the trade-off analysis.

TABLE 3-12: TRADE-OFF ANALYSIS ($1,000)

ORIGINAL DECISION MATRIX[1]

Combined Alternative	Annual Flood Damage Reduction Benefits	Average Annual Habitat Units Gained	Total Annual Cost
1	576	783	2,606
4	536	642	2,541
5	568	937	3,048
6	577	888	2,687

[1] Annualized costs.

TABLE 3-13: DECISION MATRIX NORMALIZED BY PERCENT OF MAXIMUM METHOD WITH ASSIGNED WEIGHTED PRODUCT

Alternative	Flood Damage Reduction Benefits	Average Annual Habitat Units Gained	Total Annual Cost	Weighted Product	Ranking
1	0.9983	0.8356	-0.8550	0.1386	3
4	0.9289	0.6852	-0.8337	0.0668	4
5	0.9844	1.0000	-1.0000	0.1588	2
6	1.0000	0.9477	-0.8816	0.1836	1
Preference Assignment	0.08	0.50	.42		

TABLE 3-14: SENSITIVITY ANALYSIS SUMMARY

Preference Assignments			Ranking
AAHU Gained	Total Costs	FDR Benefits	
0.10	0.76	0.14	1, 4, 6, 5
0.20	0.67	0.13	6, 1, 4, 5
0.30	0.59	0.11	6, 1, 5, 4
0.40	0.5	0.10	6, 1, 5, 4
0.50	0.42	0.08	6, 5, 1, 4
0.60	0.34	0.06	6, 5, 1, 4
0.70	0.25	0.05	5, 6, 1, 4
0.80	0.17	0.03	5, 6, 1, 4
0.90	0.08	0.02	5, 6, 1, 4

Final Ranking

Alternative 6 is the highest ranked plan, which means it performs best relative to all other plans formulated, the criteria identified and the determined set of preferences. It should be noted that Combined Alternative 4 did not rank first in any of the sensitivity iterations. Since Combined Alternatives 1, 5 and 6 did rank first in some of the sensitivity iterations, they constitute the final array of combined alternative plans that are considered in further detail.

Incremental Cost Analysis of "Best Buy" Combined Alternative Plans

Of the cost effective plans, the most efficient in production of outputs are identified as "Best Buy" plans. These "Best Buy" plans provide the greatest increase in outputs for the least increase in cost and have the lowest incremental cost per unit of output relative to the other cost effective plans. Through this process, Combined Alternatives 5 and 6 were identified as "best buy" plans. Because Alternative 1 was not identified as "best buy" plan, it was no longer considered in determining Federal interest in a combined plan. However, it should be noted that the Federal government could potentially participate to some degree in implementing any of the cost effective alternative plans.

An incremental analysis of Combined Alternatives 5 and 6 was performed to assist in the decision-making process. The incremental analysis considered ecosystem restoration benefits and "remaining costs" (total costs less flood damage reduction benefits). Using incremental cost analysis to help maximize ecosystem restoration benefits relative to remaining costs is equivalent to using incremental cost analysis to help maximize total benefits relative to total costs.

The comparison of the incremental outputs for Alternatives 5 and 6 are displayed in Table 3-15 and in Figure 3-9. Based upon the cost effectiveness analysis and the incremental cost analysis, Alternative 6 produces outputs at an incremental remaining cost per AAHU of $2,380. The next level of output (Alternative 5) produces an incremental remaining cost per AAHU of $7,550. The question now becomes is the next level of output "worth" the cost; that is, whether the environmental benefits of the additional output in the next level are worth the additional cost. Since the additional output of Alternative 5 is relatively small and the cost is relatively great, Alternative 6 is determined to be the alternative plan that reasonably maximizes both ecosystem restoration and flood damage reduction benefits compared to costs and is therefore identified as the Combined Plan. Table 3-16 presents a summary of the best buy plans.

TABLE 3-15: INCREMENTAL COST ANALYSIS OF "BEST BUY" COMBINED ALTERNATIVE PLANS

Preliminary Combined Alternatives[2]	Increase in Habitat Units (AAHU)	Flood Damage Reduction Benefits[3] ($1,000)	Total Costs[4] ($1,000)	Remaining Costs[5] ($1,000)	Incremental Remaining Costs per AAHU ($1,000)
5-Intermediate Setback Upstream of Dunning Slough, Locally Developed Setback Downstream of Dunning Slough	937	568	3,048	2,480	7.55
6-Intermediate Setback Upstream of Highway 32, Locally Developed Setback Downstream of Highway 32	888	577	2,687	2,110	2.38

[1]Based on October 2003 price levels, 5 5/8 percent rate of interest and a 50-year period of analysis.

[2]Alternatives are ordered from highest to lowest remaining costs.

[3]All benefits and costs are average annual equivalents, includes CRP costs of $10,200 annualized.

[4]Total Costs and Remaining costs included CRP costs of $10,200 annualized.

[5]Remaining Costs equal total costs less flood damage reduction benefits.

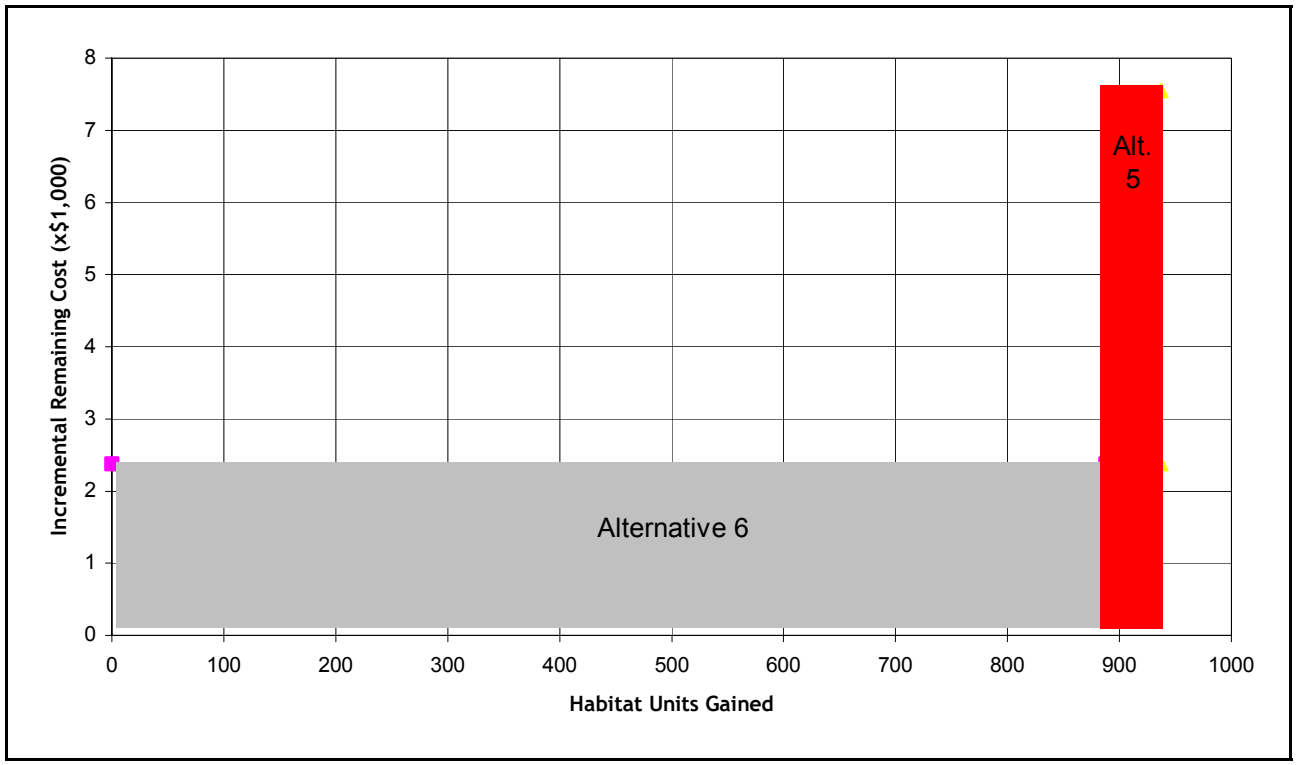

Figure 3-9: Incremental Cost Analysis for "Best Buy" Combined Plans

TABLE 3-16: BEST BUY PLANS SUMMARY

Alternative	Incremental Output	Incremental Cost/ Unit Output
No Action	0	0
Alternative 6	888	$2,380
Alternative 5	49	$7,550

Preliminary Cost Allocation

Multiple-purpose projects are cost shared in accordance with the cost sharing policies applicable to each project purpose. Before determining the required cost sharing for projects, an allocation of total project costs to each purpose must be accomplished. Table 3-17 presents the preliminary cost allocation for Combined Alternative 6. A preliminary cost allocation was conducted for the recommended plan. All separable and joint costs include associated PED costs. Separable costs were assigned to their respective project purposes, and all joint costs were allocated to the purposes for which the project was formulated.

TABLE 3-17. PRELIMINARY COST ALLOCATION
Combined Alternative 6
Recommended Plan[1]
(Flood Damage Reduction and Ecosystem Restoration)

	Annual Costs ($1,000)
Total Project Cost (*a*+*b*+*c*) [2]	$2,687
a) Flood Damage Reduction (FDR) Separable Costs	$ 67
b) Ecosystem Restoration (ER) Separable Costs	$1,797
c) Joint Costs	$ 823

	Annual Costs and Benefits ($1,000)		
	FDR	ER	Total
d) Average Annual Benefits	577	888 *AAHU*	
e) Least Cost Alternative Plan (single purpose)	922 (Alt 1)	3,521 (Alt 3)	
f) Limited Benefits (lesser of *d* and *e*)	577	3,521	
g) Separable Costs (*a* and *b*)	67	1,797	
Remaining Benefits (*f* minus *g*)	510	1,724	2,234
h) Percentage of Remaining Benefits	23 percent	77 percent	
i) Allocated Joint Costs (*c* x *h*)	189	634	823
j) Total Allocated Costs (*i*+*a* and *i*+*b*)	256	2,431	2,687

[1] Preliminary costs include PED and Construction Management and final cost allocation would be determined after construction.

[2] Total Project Cost include cultural resource preservation ($10,200 annualized).

Separable Costs

Ecosystem Restoration.

Habitat restoration activities are considered to be a separable ecosystem restoration cost. Annual costs would be $931,835.

Removal of most of the existing "J" levee, which would be done for ecosystem restoration purposes, would also be a separable ecosystem restoration cost. Annual costs would be $134,539.

Lands waterside of the setback levee would need to be acquired in fee title to enable habitat to be restored. All fee title lands would be a separable cost allocated to ecosystem restoration. Annual costs would be $730,430.

Total separable annual costs for ecosystem restoration would be $1,796,804.

Flood Damage Reduction

The additional levee height of 1.5 feet for the setback levee that is intended to provide additional flood damage reduction benefits would be considered a separable flood damage reduction cost. The annualized cost would be $23,928.

The training dike would be constructed specifically to reduce flood damages and would be considered a separable flood damage reduction cost. Annual costs would be $41,195.

Rock placed along the abutments under the Highway 32 bridge (Gianella Bridge) would be required for any additional flows that would be associated with the flood damage reduction increment. This higher design flow and associated rock would be considered a separable flood damage reduction cost. Annual costs would be $1,548.

Total separable flood damage reduction annual costs would be $66,671.

Joint Costs

The setback levee, up to the height of 6 feet, would be required for either ecosystem restoration or flood damage reduction. Costs consist of mobilization/demobilization, clearing and grubbing, levee material, the road crown, hydroseeding, fencing and the seepage berm. Annual costs would be $424,068.

Entrenched rock and riprap rock would be needed to protect the setback levee from river migration and erosion. Annual costs would be $286,801.

Construction of the setback levee would require various relocations of utilities, irrigation ditches and roads. Annual costs would be $40,737.

A levee easement would be acquired for lands associated with the setback levee and training dike (for both the levee footprint and for access). The training dike would be constructed on lands that would be acquired in fee title for ecosystem restoration if flood damage reduction was not a project purpose. Because levee easements are valued the same as fee title, there is no change in land costs associated with the training dike. Annual costs would be $71,712.

Total joint annual costs would be $823,318.

Identification of the "Least Cost Alternatives"

For cost allocation purposes, a "least cost alternative" must be identified for each project purpose that produces the same amount of benefits as the recommended plan. The least cost ecosystem restoration alternative identified for this analysis must meet the following criteria:

- Produce the same level of non-monetary output as would be provided by the multipurpose project;
- Be cost effective when compared to other single purpose plans, but not necessarily more cost effective than the multipurpose plan; and
- Be a dissimilar project.

Ecosystem Restoration. To identify the least cost alternative for ecosystem restoration, an alternative was identified that was closest to providing the same benefit outputs as the recommended plan and then prorated to adjust the costs and benefits. Alternative 5 is the most cost effective plan that would provide at least as much outputs as the recommended plan (Alternative 6). However, Alternative 5 is too similar to Alternative 6 to meet the third criteria of being a dissimilar project. Therefore, Alternative 3 was used as the basis for the least cost alternative for ecosystem restoration since Alternative 5 and 6 are excluded from consideration. Alternative 3 becomes the only cost-effective plan that would provide as much output as the combined plan (Alternative 6).

Ecosystem Restoration Alternative 3 was used for the ecosystem restoration least cost alternative plan. Alternative 3 produces 895 AAHU's and the recommended plan produces 888 AAHU's. The prorating factor of 0.992 was applied to the alternative 3 annual cost of $3,549,000, which sets the annual cost of the least cost ecosystem restoration alternative at $3,521,000.

Flood Damage Reduction. To identify the Least Cost Alternative for flood damage reduction, an alternative was identified that that provided similar benefit outputs ($577,000 annual benefits) as the recommended plan, then prorated to adjust the costs and benefits. The prorating factor of 1.002 was applied to the Alternative 1 ($576,000 annual benefits) annual cost of $919,000, which sets the annual cost of the least cost flood damage reduction alternative at $921,000. These costs were determined as follows: a variation of alternative 1 was used for the Flood Damage Reduction Least Cost alternative plan, with all ecosystem restoration features removed from the cost. The features included in the flood damage reduction least cost alternative plan are:

The total setback levee costs (which consist of site preparation, levee material, seepage berm, road crown, entrenched and riprap erosion protection, hydroseeding, and fencing) annual costs would be $687,642 x 1.002 = $689,017.

The flood damage reduction increment (which consist of the additional height of levee when optimized for flood damage reduction, erosion protection under the Highway 32 bridge, and the training dike (including site preparation, levee material, road crown, hydroseeding, and a seepage berm) annual costs would be $167,288 x 1.002 = $167,623.

The annual cost for lands (levee easement) would be $64,491 x 1.002 = $64,620.

The total annual cost for the least cost flood damage reduction alternative would be $922,000.

Plan Justification

Combined Alternative 6 was the top ranked plan and was subsequently determined to be justified. Combined Alternative 6 is identified as the Combined Plan.

Comparison of Combined Plan and the NER Plan

The final step in selecting the plan to be recommended is to compare the Combined Plan (Combined Alternative 6) with the single-purpose NER Plan identified in Section 3.5.2. Combined Alternative 6, while costing slightly more ($67,000 in annual costs) than the NER Plan produces $153,000 more annual flood damage reduction benefits and the same average annual habitat units as the NER Plan. The additional benefits of combined Alternative 6 exceed the additional costs. This comparison is shown in Table 3-18.

TABLE 3-18: COMPARISON OF COMBINED ALTERNATIVE 6 AND THE NER PLAN

Alternative	AAHU's	Annual Flood Damage Reduction Benefits ($1,000)	Annual Total Cost ($1,000)
NER	888	424	2,620
Combined Alternative 6	888	577	2,687
Difference	0	+153	+67

Identification of Recommended Plan

To summarize, Combined Alternative 6 has been determined to reasonably maximize total ecosystem restoration and flood damage reduction benefits compared to costs within the planning constraints. Combined Alternative 6, while costing slightly more ($67,000 in annual costs) than the NER Plan, produces $153,000 more annual flood damage reduction benefits and the same average annual habitat units as the NER Plan. Therefore, Combined Alternative 6 is identified as the recommended plan. The non-Federal sponsor has indicated that they are willing to sponsor Combined Alternative 6. Since this plan is not fully optimized plan, due to the planning constraint regarding levels of protection requested by the sponsor, it is considered to be a locally preferred plan.

Under Corps guidance, the locally preferred plan qualifies for a categorical exception to recommendation of the NED plan for the flood damage reduction purpose because the with-project residual risk is not unreasonably high and the plan desired by the non-Federal sponsor has greater net benefits than smaller scale plans.