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INCREMENTAL COST ANALYSIS FOR MITIGATION

1F.1 Purpose

The purpose of the incremental cost analysis is to evaluate mitigation alternatives to compensate for project-related adverse effects to biological resources resulting from the American River Watershed Long-Term Study. By applying the findings of this analysis, the project proponents propose to compensate for these adverse effects in the most cost-effective manner.

Guidance for developing this incremental cost analysis comes from Engineer Regulations (ER) 1105-2-100 and 1105-2-50, Engineer Circular 1105-2-185, and the Institute for Water Resources Report 94-PS-2. The goal of this analysis is to develop, through the economic justification of mitigation alternative, the "least-cost plan" that still fully compensates for project-related effects. The analysis is a two-step process. First, a cost-effectiveness analysis is done to ensure that the least-cost solution is identified for each possible level of environmental mitigation output. This step eliminates economically inefficient and ineffective mitigation solutions. Second, an incremental cost analysis of the least-cost solutions is done to show changes in costs for increasing levels of environmental mitigation output. This second step is termed "justifying the last-added increment of mitigation effort."

The environmental output analysis is based on habitat evaluation procedures (HEP) that define the relationship between increasing habitat value with each increase in compensation increment features and increases in environmental output. The analysis then compares successive environmental outputs and associated incremental increases in costs. Compensation measures (increments) for each significant habitat are then combined to show their cumulative increase in environmental output and cost. Combinations of increments are developed for each habitat that approximate the habitat value replacement goal developed during the HEP. Each grouping of compensation measures for each habitat type is then combined with other habitat-specific increments to become mitigation proposals for one or more proposed mitigation sites, each of which is habitat specific. Decisions could then be made on selecting the proposal(s) that compensate for adverse effects while being cost effective and incrementally justified.

Under the provisions of the Fish and Wildlife Coordination Act, the U.S. Fish and Wildlife Service (USFWS) has prepared a draft coordination act report (Draft CAR) that includes the HEP analysis for this project (U.S. Fish and Wildlife Service 2001). The purpose of the Draft CAR is to assess project-related effects to biological resources in the project area. This incremental analysis reflects the findings of the HEP report and incorporates the mitigation strategy developed by the HEP team that identifies the important biological resources that should be included in the analysis. A major purpose of this incremental analysis is documenting the "steps" taken in identifying mitigation alternatives and developing a recommended compensation plan. The incremental analysis helps ensure compliance with the statutory requirements of the Fish and Wildlife Coordination Act and agency regulations, both of which state that the project proponents give full consideration to Federal and State agency comments and recommendations resulting from resource agency consultation.

1F.2 Environmental Values

There are nine primary environmental habitat types within the project area. Of these habitat types, the areas that have the highest environmental values (no net loss of in-kind habitat value) for wildlife are: (1) blue oak-gray pine woodland; (2) oak woodland; (3) riparian woodland; and (4) seasonal wetlands. Chaparral, also present within the project area, has a no net loss of habitat value, while minimizing loss of in-kind habitat value. The areas that have the least environmental value in the project area are: annual grasslands, sierran mixed conifer forest, montane riparian scrub, and other areas (highly disturbed or paved). Additional discussion of mitigation planning goals and resource categories is provided in Section V of the Draft CAR.

1F.2.1 Folsom Reservoir

The various habitats in the Folsom Reservoir area include blue oak-gray pine woodland, oak woodland, riparian woodland, seasonal wetlands, chaparral, annual grasslands, and other. The area surrounding Folsom Reservoir supports a mix of habitat types, dominated by blue oak-gray pine woodland. Gray pines are relatively scarce in most of this habitat, contributing perhaps 1% or less of canopy cover. The lower foothill area near Folsom Dam contains large areas of oak woodland, with scattered blue oaks and interior live oaks. Small areas of chaparral extend to the reservoir's upper edge particularly along the South Fork arm. Annual grassland areas are interspersed throughout the area, and human-disturbed habitats occur around boat-launch facilities. Relatively small areas of riparian habitats can found along tributaries to the reservoir and in seep areas. Willow stands and individual trees have become established within some areas of the reservoir pool. Wetland vegetation is located on the landside of Mormon Island Auxiliary Dam and consists predominantly of cattails.

The area around Folsom Reservoir supports an animal community characteristic of the lower Sierra Nevada western slope. Although the range of elevation is small, habitats are diverse, in part, because the reservoir extends about 20 miles into the Sierra Nevada foothills, from gentle hills near the dam to steep-walled canyons along the forks of the American River. More than 50 species of mammals live in these areas. Common species include mule deer, striped skunk, black-tailed jackrabbit, brush rabbit, raccoon, California ground squirrel, and a diverse assemblage of small mammals including mice, voles, and pocket gophers. Less common mammals include river otters, mountain lions, badgers, and bobcats. Birds typical of oak-dominated habitats include acorn woodpeckers, scrub jays, ash-throated flycatchers, and California quail. Oaks provide acorns, a nutrient-rich and important food source for mule deer, acorn woodpecker, northern flicker, Nuttall's woodpecker, white-breasted nuthatch, and scrub jay. In addition to a diverse community of small passerine birds, other birds such as woodpeckers, California quail, introduced wild turkeys, Canada geese, and various birds of prey are fairly common near the reservoir.

The presence of year-round water provides habitat for many water-associated species such as raccoon, Canada geese, wood duck, common merganser, mallard, black phoebe, great blue heron, greater yellowlegs, belted kingfisher, and common yellowthroat.

Mammals typical of a mix of riparian habitat and woodland habitats with a grassy understory include California vole, ringtail, black-tailed jackrabbit, coyote, striped skunk, and mule deer.

Reptile and amphibian species likely found in the study area include western fence lizard, gopher snake, western rattlesnake, common kingsnake, Pacific treefrog, and western toad.

Wildlife species that forage or breed in oak woodlands include dusky-footed woodrat, western bluebird, and southern alligator lizard.

Areas dominated by annual grassland provide foraging habitat and cover for California ground squirrel, pocket gopher, turkey vulture, coyote, western fence lizard, western rattlesnake, western kingbird, and western meadowlark. Grassland areas are important to many foraging raptors; red-tailed hawk, golden eagle, ferruginous hawk, rough-legged hawk, American kestrel, and prairie falcon all spend time in the area, as wintering and/or breeding birds.

1F.2.2 French Meadows Reservoir

The area around French Meadows Reservoir consists of a mixture of two habitat types: Sierran mixed-conifer forest, and montane riparian scrub. The spillway channel is flanked by stands of mixed conifer forest. Dominant tree species include red fir, douglas fir, ponderosa pine, incense cedar, sugar pine, and white fir. Shrubs include red-flowering currant, bitter cherry, western chokecherry, and snowberry.

Riparian scrub occurs along portions of the margins of the scoured channel where disturbance has been minimal. Much of the channel has been constructed in bedrock material that has little or no vegetation. Typical riparian species include narrow-leafed willow, red willow, shining willow, and Scouler's willow; mountain and thin leaf alder; black cottonwood; American dogwood; mountain spiraea; and bitter and western chokecherry.

The Sierran mixed conifer habitat in the vicinity of the reservoir supports a variety of mammal, avian, and amphibian species. Typical mammals include deer, bear, and a wide variety of small mammal species. Typical bird species include osprey, Cooper's hawk, sharp-shinned hawk, northern goshawk, swallows, owls, woodpeckers, and numerous songbird species. Amphibian species could include northwestern pond turtle and foothill yellow-legged frog.

1F.2.3 Downstream of Folsom Dam (Temporary Construction Bridge)

The area just below the Folsom Dam and where the Temporary Bridge will be located is a generally disturbed area with steep-sloped walls down to the river. Patches of oak woodland and riparian habitat types including elderberry shrubs and nonnative plants growing in river rock and tailings characterize the area.

The rest of the Lower American River, below the original Folsom Dam, although highly modified from conditions of 150 years ago, supports a diverse and highly valuable area for biological resources. The 23-mile long reach encompasses about 4,800 acres of floodplain, containing large areas of grasslands and pasture, riparian cottonwood and oak woodlands,

herbaceous plants and riparian scrub-shrub, bare sand and gravel, and surface waters of the river and associated sloughs and dredge ponds. About 4,000 acres of undeveloped uplands above the floodplain provide upland habitats including oak woodland and grasslands.

The Lower American River corridor provides a mosaic of riparian, riverine, grassland, and oak woodland habitat. These diverse habitats support a corresponding diversity of wildlife.

The Lower American River provides feeding, resting, and/or nesting habitat for as many as 200 bird species. Many of the bird species require use of the river and backwaters as well as the riparian vegetation found throughout the ecosystem. Riparian areas are known to support a species-rich songbird community. The Lower American River also provides habitat for many raptors, including Swainson's hawks, red-shouldered hawks, Cooper's hawks, and great-horned owls, all of which require or are closely associated with riparian vegetation. Bald eagles, which can be found around Folsom Reservoir, will occasionally use the lower river, which provides roosting and foraging habitat. Numerous species of waterfowl, especially mallards, also use the area extensively.

More than 50 species of mammals have been recorded in the Lower American River area. Common species include beaver, black-tailed jackrabbit, striped skunk, Virginia opossum, raccoon, California ground squirrel, gophers, and many small rodents and insectivores including voles, moles, shrews, deer mice, and pocket gophers. Uncommon species include mule deer, and several carnivores, such as badger, long-tailed weasel, river otter, gray fox, coyote, bobcat, and mink.

Reptile species of the Lower American River include common kingsnake, Gilbert and western skinks, southern alligator lizard, western fence lizard, gopher snake, several garter snakes, western rattlesnake, and the western pond turtle, which is a species of special concern. Common amphibians include Pacific treefrog, chorus frog, California newt, California slender salamander, western toad, and the introduced bullfrog.

Relatively little is known about invertebrates of the Lower American River, but elderberry plants are fairly common in areas, and provide habitat for the endangered valley elderberry longhorn beetle.

1F.3 Project-Related Effects Requiring Mitigation

A HEP analysis was performed to determine potential adverse effects within the project area. A HEP analysis is a habitat-based evaluation methodology developed for use in adverse effect assessment and mitigation planning. A HEP analysis is based on the assumption that the value of a habitat for selected species or the value of a community can be described in a model, which produces a Habitat Suitability Index (HSI). This HSI value (from 0.0 to 1.0) is multiplied by the area of available habitat to obtain Habitat Units (HUs). HUs are converted to Average Annual Habitat Units (AAHUs) or an annualized computation of HUs expressed as a derivation of habitat value across all years in the economic life of the project. The HUs and AAHUs, over the life of the project, are then used in the following comparisons: (1) the relative value of different areas at the same point in time; and (2) the relative value of the same areas at future points in time. By combining the two types of comparisons, various project-related effects can

be quantified. This information can also be used for mitigation planning to identify compensation needs. Additional information on the HEP and associated HSI models used for this project are in Appendix A of the USFWS Draft CAR, provided in Volume II of the American River Watershed, Long-Term Study, Final Supplemental Plan Formulation Report/Environmental Impact Statement/Environmental Impact Report (SPFR/EIS/EIR). Table 1 provides acres impacted by habitat type, AAHUs lost, and the compensation objectives. Additional information on project effects is found in Chapter 7.0 of the SPFR/EIS/EIR.

Table 1. Project Related Adverse Effects

Habitat Type	Acres Impacted	AAHU's Lost	Compensation Objective (acres)[1]	Compensation Increment Analyzed in Draft CAR[2]
Folsom Dam, Mormon Island Auxiliary Dam, and Dikes				
Blue oak/gray pine woodland	3.8	4.73	10.5	Moderate
Oak woodland	21.4	17.67	59.41	Moderate
Riparian woodland	9.0	2.42	9.0	Moderate
Seasonal wetland	0.3	0.13	0.30	High
Annual grassland	80.0	N/A	Replant	N/A
Other	152.2	N/A[3]	N/A	N/A
Folsom Dam Operation and Maintenance Road and Bridge				
Blue oak/gray pine woodland	2.9	3.61	8.01	Moderate
Oak woodland	1.7	1.4	4.72	Moderate
Riparian woodland	1.3	0.34	1.30	Moderate
Annual grassland	0.5	N/A	Replant	N/A
Other	4.6	N/A[3]	N/A	N/A

Source: U.S. Fish and Wildlife Service 2001

N/A =Not Applicable
[1] Extent of compensation habitat required to achieve mitigation based on the compensation increment analyzed in the Draft CAR.
[2] See Section 6.0 "Compensation Strategy Increments" for definitions of compensation increments.
[3] The proposed staging areas for this construction were not analyzed for impacts because they were all located at bare ground areas.

1F.4 Compensation Objectives

According to ER 1105-2-100, the first step in mitigation planning is to avoid effects if possible and then to minimize adverse effects through design modification. For those project effects that are unavoidable, the compensation objective is to fully restore lost habitat values through reasonable and justifiable in-kind, onsite replacement.

Direct construction impacts are those that would cause immediate and complete loss of habitat values at a particular site at the time of project construction. These immediate impacts would occur in the footprint area of the enlarged facilities and within all temporary and permanent construction easement areas. Trees and other woody vegetation within temporary

construction easement areas would not be reestablished once construction is completed. Impacts to herbaceous vegetation that would occur within staging and borrow areas would be temporary because these areas will be reseeded after construction. All woody vegetation at, or adjacent to, the staging and borrow sites would be avoided. Temporary impacts would also occur to herbaceous vegetation on the slopes of raised levees and stability berms that will not undergo revetment. The mitigation strategy or objective for this proposed project is to fully replace the habitat values lost due to project implementation. Compensation objectives are provided in Table 1. The compensation objective includes wetlands that are to be "fully mitigated" through actions to avoid, minimize, and compensate for unavoidable losses to meet the goal of no net loss of wetlands, (Water Resources Development Act of 1990, Section 307 (a); ER 1105-2-100, paragraph 7-35g).

In accordance with ER 1105-2-110, project lands (lands required for authorized project purposes) are considered for mitigation purposes first, followed by public lands (lands owned or otherwise legally entrusted to a local, State, or Federal agency), and then private lands. For this project, Federally owned lands were considered for the mitigation of all habitat types. The compensation areas are discussed in the following section.

1F.5 Mitigation Sites to Compensate for Habitat Loss

HEP procedures were used to evaluate potential mitigation sites to compensate for habitat losses identified as a result of construction and operation of the project. Habitat values that could be developed on a site were quantified for each of the cover-types impacted. Annual grassland areas were chosen as the preferred baseline cover type and would be converted to the appropriate cover-type. The HEP analysis assumed the compensation sites would not currently support any woody vegetation and would be capable of supporting the cover-type proposed for the site (i.e., a site would have the appropriate hydrology to support seasonal wetlands or riparian cover-types). The preferred sites included lands adjacent and within the Mormon Island Preserve wetlands near Mormon Island Auxiliary Dam; and lands around Folsom Reservoir within the existing State and Federal property boundaries. The assumptions used to develop the compensation site scenarios are listed in Appendix A-1 of the USFWS Draft CAR.

A specific compensation site was not analyzed in the HEP analysis. Instead a typical site was developed, and assumptions were made that the site would be an annual grassland area without existing woody vegetation for a baseline condition. For the riparian and seasonal wetland cover-types, a critical assumption was made that any site selected for compensation would require the appropriate hydrology to support these cover-types. The HEP noted that suitable lands for oak woodland, blue oak/gray pine woodland, and riparian were observed at Mormon Island Auxiliary Dam, and other lands around the reservoir owned by the Federal or State government.

Three parcels of Federal land that best fit the necessary criteria were selected. The three parcels total 275 acres and are available as a mitigation site. Of the 275 acres and based on the compensation increments analyzed in the Draft CAR (Table 1), approximately 93 acres will be needed to complete the mitigation requirements. The three parcels are located south-southeast of Mormon Island Auxiliary Dam and Dike 8 on Folsom Reservoir; and are situated on both sides

of Blue Ravine Road, west of the El Dorado/Sacramento County line, and north-northeast of Green Valley Road.

1F.6 Compensation Strategy Increments

According to ER 1105-2-100, a management/compensation plan increment consists of one or more management features. Plan increments may interrelate and complement one another, but they cannot be functionally dependent upon another increment. Low intensity, medium intensity, and high intensity plan increments were developed for the blue oak woodland/gray pine, oak woodland, riparian woodland, and seasonal wetland habitat types. These plan increments are made up of one or more management features (or measures). When deciding on compensation strategy increments, the following items were considered.

- Two or three increments provide a full range of planning possibilities for mitigation. The possibilities range from little compensation to a logical maximum level of effort while keeping the number of possible measure combinations manageable.
- Each of the increments can stand alone as a possible mitigation measure.
- Combining more features into each successive increment is logical since each increment incorporated the previous increment's mitigation features to add its cumulative increase in habitat value.
- Combining compensation features into the two or three increments and then tailoring the increments to each habitat type being compensated allows the analysis to show the HU gain specific to that habitat.

This analysis compares implementation strategies for *one* mitigation site, the Mormon Island Auxiliary Dam site. Three compensation increments were identified for each compensation habitat type:

- Increment 1—minimum (application of low-cost mitigation measures that generally provide fewer AAHUs than more expensive measures);
- Increment 2—moderate (application of moderate-cost mitigation measures that generally provide fewer AAHUs than more expensive measures, but provide more AAHUs than lower cost measures); and
- Increment 3—maximum (application of high-cost mitigation measures that generally provide greater AAHUs than low and moderate increments).

The compensation increments vary in the level of effort (i.e., labor, materials, equipment, and other cost-related items) required to implement each compensation increment and, as a result of different levels of effort, would be expected to provide varying levels of output in the form of AAHUs generated. The compensation increments for each habitat type are summarized in Tables 2, 3, 4, and 5.

The results of the analysis are expressed as the absolute per-acre AAHUs provided by each compensation increment for each mitigated habitat and per-acre mitigation cost per AAHU generated under each of the increments for each habitat.

The cost of each compensation increment for each compensation habitat type is calculated based on the combined costs of its mitigation features multiplied by the mitigation site acreage needed to compensate project impacts (Appendix A). Compensation costs were then compared by increment. This comparison allows an analysis of each compensation increment's cost compared to its increase in HSI values. The combination of increments and their environmental output determines the potential mitigation strategy that will be recommended for the project. Compensation increments with varying compensation measures were developed for each of the main habitat types affected by project work.

Specific criteria were developed for each habitat type to ensure the success of the low to the high intensity compensation increments. These criteria remained constant throughout the analysis and are essential to the long-term biological success of the compensation. Costs for the criteria listed below are included in the compensation costs of each increment with the exception of monitoring, access/maintenance roads, and developing the Operations and Maintenance manual (O&M manual).

- Blue Oak/Gray Pine Woodland—Dedicate lands (currently annual grasslands); prepare annual grasslands for planting; provide access and maintenance roads; assume 10% mortality; replant as necessary to ensure minimum plant establishment; assume maximum growth rate of 12 inches/year; and develop O&M manual.

- Oak Woodland—Dedicate lands (currently annual grasslands); prepare annual grasslands for planting; provide access and maintenance roads; assume 10% mortality for each of first 3 years; assume maximum growth rate of 12 inches/year; and develop O&M manual.

- Riparian Woodland—Dedicate lands; prepare annual grasslands for planting; provide access and maintenance roads; grade site to facilitate natural seasonal flooding; assume maximum growth rate of 12 inches/year; and develop O&M manual.

- Seasonal Wetland—Dedicate lands (proposed site baseline is Condition C wetland); design portion of wetland to have permanent water; do not stock carp; provide access and maintenance roads; plant cover crop on all disturbed non-wetland areas; and develop O&M manual.

Table 2. Blue Oak/Gray Pine Woodland Compensation Plan—Increments 1-3

Compensation Increments	Description
Increment 1 – Low Intensity	Plant 500 acorns per acre; do not irrigate or provide plant protection; monitor plant survival and replant acorns as necessary to maintain 250 trees per acre
Increment 2 – Moderate Intensity	Plant 400 trees (4” x 4” x 10” size) per acre (90% blue and live oaks and 10% gray pine); seed cover crop; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years; provide general maintenance and cleanup into perpetuity; monitor for 3 years and replant to ensure <10% mortality
Increment 3 – High Intensity	Plant 600 trees (4”x4”x10” size) per acre (90% blue and live oaks and 10% gray pine); seed cover crop; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years; provide general maintenance and cleanup into perpetuity; monitor for 3 years and replant to ensure <10% mortality

Table 3. Oak Woodland Compensation Plan—Increments 1-3

Compensation Increments	Description
Increment 1 – Low Intensity	Plant 500 acorns per acre; do not irrigate or provide plant protection; monitor plant survival and replant acorns as necessary to maintain 250 trees per acre
Increment 2 – Moderate Intensity	Plant 400 trees (4”x4”x10” size) per acre (live and blue oaks); seed cover crop; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years; provide general maintenance and cleanup into perpetuity; monitor for 3 years and replant to ensure <10% mortality
Increment 3 – High Intensity	Plant 600 trees (4”x4”x10” size) per acre (90% blue and live oaks and 10% gray pine); seed cover crop; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years; provide general maintenance and cleanup into perpetuity; monitor for 3 years and replant to ensure <10% mortality

Table 4. Riparian Woodland Compensation Plan—Increments 1-3

Compensation Increments	Description
Increment 1 – Low Intensity	Allow site to revegetate naturally; grade site to facilitate natural seasonal flooding
Increment 2 – Moderate Intensity	Plant 200 trees (4”x4”x10” size) per acre as overstory (oak, cottonwood, and willow trees) and 200 understory shrubs (4”x4”x10” size) per acre (wild rose and wild grape); seed cover crop; grade site to facilitate natural seasonal flooding; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years; provide general maintenance and cleanup into perpetuity; monitor for 3 years and replant to ensure <10% mortality
Increment 3 – High Intensity	Plant 400 trees (4”x4”x10” size) per acre as overstory (oak, cottonwood, and willow trees) and 400 understory shrubs (4”x4”x10” size) per acre (wild rose and wild grape); seed cover crop; grade site to facilitate natural seasonal flooding; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years; provide general maintenance and cleanup into perpetuity; monitor for 3 years and replant to ensure <10% mortality

Table 5. Seasonal Wetland Compensation Plan—Increments 1-3

Compensation Increments	Description
Increment 1 – Low Intensity	Grade site to facilitate natural flooding to maintain 20% of wetland area with 4-9 inch deep water throughout the summer; allow site to naturally revegetate; plant cover crop on disturbed upland areas
Increment 2 – Moderate Intensity	Grade site to maintain 20% of wetland area with 4-9 inch deep water throughout the summer; plant wetland plugs 12 inches on center over 80% of the wetland area; plant cover crop on disturbed upland areas; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years or until site is self-sustaining; provide general maintenance and cleanup into perpetuity
Increment 3 – High Intensity	Grade site to maintain 40% of wetland area with 4-9 inch deep water throughout the summer; plant wetland plugs 12 inches on center over 60% of the wetland area; plant cover crop on disturbed upland areas; provide site specific irrigation system; provide watering, weeding, and pest control as needed for 3 years or until site is self-sustaining; provide general maintenance and cleanup into perpetuity

1F.7 Mitigation Comparisons and Cost Effectiveness

The extent of compensation habitat required to fully compensate impacts on habitat for each compensation increment is presented in Table 6. The AAHUs and compensation acres shown in Table 3 for Increment 3 of the seasonal wetland compensation plan and Increment 2 for the remaining habitat types are based on the HEP analysis conducted for the Draft CAR (Table 1). Per acre AAHUs that would be generated with implementation of Increments 1 and 2 for seasonal wetland and with implementation of Increments 1 and 3 for the remaining habitat types were estimated based on:

- professional experience with conducting HEP analyses,
- an assessment of how each of the compensation increments would effect outputs of the HSI models used by the USFWS to conduct the Draft CAR HEP analysis, and
- assumptions about the rate at which key habitat variables would develop under each of the compensation increments relative to assumptions used for the increments analyzed in the Draft CAR HEP analysis (see Section 8.0 "Assumptions").

Total compensation costs and per acre compensation costs for each increment and habitat type are presented in Table 7. Costs per AAHU generated for each compensation increment and habitat type are presented in Table 8. Incremental cost comparisons for each habitat type are shown in Tables 9, 10, 11, and 12.

Table 6. Mitigation Acreage Comparisons for Each Habitat Type

Habitat Type	AAHUs Needed for Compensation	Average Annual Habitat Unit Gain					
		Increment 1		Increment 2		Increment 3	
		AAHU Gain (per acre)	Compensation Objective (acres)	AAHU Gain (per acre)	Compensation Objective (acres)	AAHU Gain (per acre)	Compensation Objective (acres)
Blue Oak/ Gray Pine	8.34	0.11	75.8	0.45	18.5	0.60	13.9
Oak Woodland	19.07	0.08	238.4	0.30	64.1	0.40	47.7
Riparian Woodland	2.76	0.03	92	0.27	10.3	0.23	12
Seasonal Wetland	0.13	0.20	0.65	0.35	0.4	0.43	0.3

Notes:
AAHU = Average Annual Habitat Units
AAHU Gain = Difference in AAHUs between existing AAHUs and AAHUs generated with implementation of the compensation increment

Table 7. Cost per Acre by Compensation Increment

Habitat Type	Increment 1			Increment 2			Increment 3		
	Total Compen-sation Cost	Compen-sation Objective (acres)	Cost per acre	Total Compen-sation Cost	Compen-sation Objective (acres)	Cost per acre	Total Compen-sation Cost	Compen-sation Objective (acres)	Cost per acre
Blue Oak/ Gray Pine	$895,577	75.8	$11,815	$524,865	18.5	$28,371	$503,581	13.9	$36,228
Oak Woodland	$2,816,696	238.4	$11,815	$1,769,289	64.1	$27,602	$1,679,483	47.7	$35,209
Riparian Woodland	$920,000	92	$10,000	$424,430	10.3	$41,207	$687,980	12	$57,332
Seasonal Wetland	$44,030	0.65	$67,738	$65,042	0.4	$162,605	$63,984	0.3	$213,280

Table 8. Cost of Average Annual Habitat Unit per Acre

Habitat Type	Increment 1			Increment 2			Increment 3		
	AAHU Gain (per acre)	Per Acre Cost	Cost per AAHU	AAHU Gain (per acre)	Per Acre Cost	Cost per AAHU	AAHU Gain (per acre)	Per Acre Cost	Cost per AAHU
Blue Oak/ Gray Pine	0.11	$11,815	$107,409	0.45	$28,371	$63,046	0.60	$36,228	$60,380
Oak Woodland	0.08	$11,815	$147,687	0.30	$27,602	$92,007	0.40	$35,209	$88,022
Riparian Woodland	0.03	$10,000	$333,333	0.27	$41,207	$152,618	0.23	$57,332	$249,269
Seasonal Wetland	0.20	$67,738	$338,690	0.35	$162,605	$464,585	0.43	$213,280	$496,000

Table 9. Incremental Cost Analysis for Blue Oak/Gray Pine Woodland

Increment	Per Acre AAHU	Per Acre Cost	Incremental AAHU Gain	Incremental Cost
Increment 1	0.11	$11,815	0.11	$11,815
Increment 2	0.45	$28,371	0.34	$16,556
Increment 3	0.60	$36,228	0.15	$7,857

Table 10. Incremental Cost Analysis for Oak Woodland

Increment	Per Acre AAHU	Per Acre Cost	Incremental AAHU Gain	Incremental Cost
Increment 1	0.08	$11,815	0.08	$11,815
Increment 2	0.30	$27,602	0.22	$15,787
Increment 3	0.40	$35,209	0.10	$7,607

Table 11. Incremental Cost Analysis for Riparian Woodland

Increment	Per Acre AAHU	Per Acre Cost	Incremental AAHU Gain	Incremental Cost
Increment 1	0.03	$10,000	0.03	$10,000
Increment 2	0.27	$41,207	0.24	$31,207
Increment 3	0.23	$57,332	-0.04	$16,125

Table 12. Incremental Cost Analysis for Seasonal Wetland

Increment	Per Acre AAHU	Per Acre Cost	Incremental AAHU Gain	Incremental Cost
Increment 1	0.20	$67,738	0.20	$67,738
Increment 2	0.35	$162,605	0.15	$94,867
Increment 3	0.43	$213,280	0.08	$50,675

Cost estimates for compensation implementation and maintenance were prepared for each compensation increment. The details of this cost estimate for each habitat type are provided in Appendix A. No long-term maintenance, monitoring, or contingency costs were included in these cost estimates. The cost estimates do not include any costs associated with vegetation, hydrology, or wildlife monitoring surveys and are based on estimates prepared for similar projects.

1F.8 General Assumptions Used

To conduct this analysis, HEP-generated AAHUs provided by the USFWS in the Draft CAR were used. The USFWS only generated AAHUs for one compensation increment for each habitat type. Compensation increments analyzed in the Draft CAR include the following:

- Blue oak/gray pine woodland—Increment 2
- Oak woodland—Increment 2
- Riparian woodland—Increment 2

- Seasonal wetland—Increment 3

Therefore, to make comparisons among the compensation increments for each habitat type, AAHUs needed to be generated for the increments that were not analyzed in the Draft CAR. Using the HSI models used by the USFWS to conduct the Draft CAR HEP analysis, AAHUs for compensation increments not analyzed in the Draft CAR HEP were estimated based on the following criteria:

- **Blue oak/gray pine woodland–Increment 1.** Increment 1 employs planting acorns without supplemental irrigation for establishment and, therefore, a longer period would be required for trees to establish than under Increment 2. Consequently, it is assumed that Increment 1 will accrue habitat values at 25% of the rate of Increment 2.

- **Blue oak/gray pine woodland–Increment 3.** Increment 3 increases the planting density 150% above Increment 2, therefore, it is assumed the tree canopy will close more rapidly under Increment 3.

- **Oak woodland–Increments 1 and 3.** Increments 1 and 3 have the same assumptions as blue oak/gray pine woodland.

- **Riparian woodland–Increment 1.** Increment 1 allows for natural regeneration of the riparian plant community and, therefore, it will take considerably longer for Increment 1 to develop shrub crown cover and forest overstory. Consequently, it is assumed that Increment 1 will accrue habitat values at 10% of the rate of Increment 2.

- **Riparian woodland–Increment 3.** Increment 3 increases the planting density of both shrub and overstory species. It was estimated that 10 years after planting, Increment 2 would have 25% shrub cover while Increment 3 would have 50% shrub cover. In the HSI model used for this habitat type, values for this variable drop once 50% shrub crown cover is reached, therefore Increment 3 was given a lower value than Increment 2.

- **Seasonal wetland–Increment 1.** Increment 1 would develop volunteer vegetation 50% as fast as planted vegetation in Increment 3.

- **Seasonal wetland–Increment 3.** Increment 2 would be constructed to provide approximately 50% the open water area as Increment 3 (i.e., more area would be planted with wetland species in Increment 2 and less area would be open water).

1F.9 Summary and Recommendations

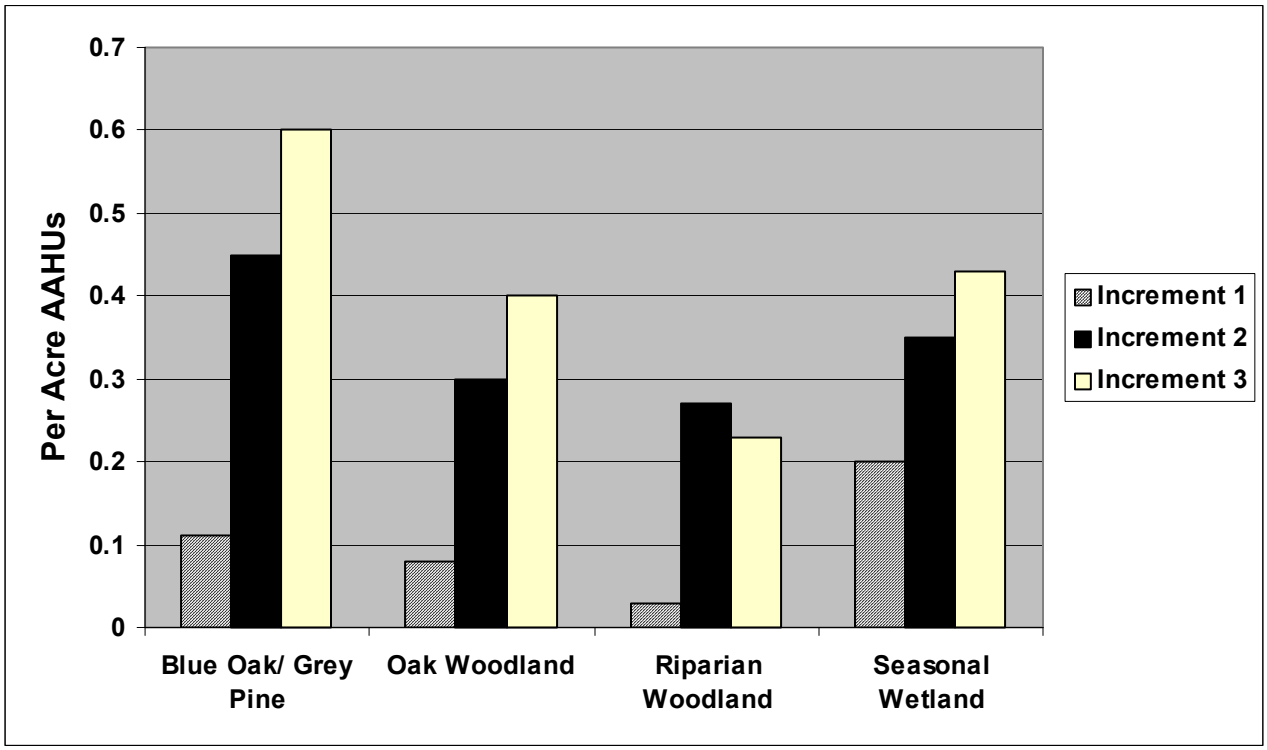
The cost effectiveness analysis compares the relevant changes in cost and environmental output upon which compensation decisions can be made. The compensation objectives for each habitat type are listed below.

- Blue oak/gray pine woodland—8.34 AAHUs

- Oak woodland—19.07 AAHUs
- Riparian woodland—2.76 AAHUs
- Seasonal wetland—0.13 AAHUs

As stated earlier, this analysis is intended to compare the relative cost of per-acre AAHUs for three compensation increments: minimum, moderate, and maximum. This analysis does not compare the merits of various mitigation sites. All the increments apply to one site. The per-acre AAHUs generated by each compensation increment are presented in Figure 1 and Table 6.

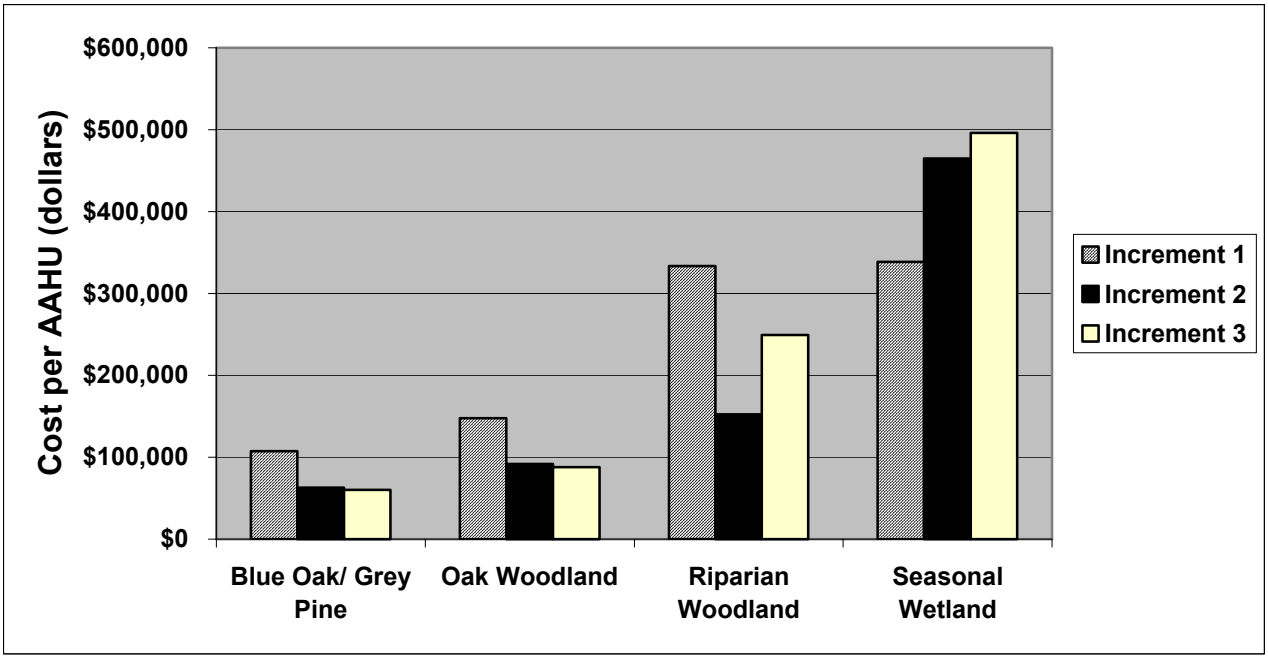
Figure 1. Average Annual Habitat Units Gain per Acre Provided by Compensation Increment



The general hypothesis is that greater input results in greater habitat value measured in AAHUs. According to the analysis, this hypothesis is true as the mitigation inputs increase from minimum to moderate increments. It is also true as mitigation inputs increase from moderate to maximum increment with the exception of the riparian woodland habitat type, although the relative increase is substantially smaller. The reason for the decrease from moderate to high for riparian woodland habitat is due to the increase in shrub density in Increment 3. In the great horned owl HSI model (used to identify riparian woodland compensation requirements in the Draft CAR), values decrease once shrub crown closure becomes greater than 50%, thus planting a greater number of understory shrubs per acre do not gain habitat value for this species.

The per-acre AAHU costs for implementing each compensation increment are presented in Figure 2 and Table 8. The cost per AAHU for the blue oak/gray pine habitat is similar for Increments 2 and 3 (moderate and maximum), but substantially higher for Increment 1 (minimum). This is because of the relatively low habitat value and thus increased compensation area (acres) for Increment 1. The oak woodland cost per AAHU mirrors the outcome of the blue oak/gray pine habitat. Per AAHU costs for riparian woodland are most expensive under Increment 1 because of per acre AAHUs gained are relatively low and, therefore, the extent of land needed to compensate for project impacts is substantially greater than for other increments. Per AAHU cost under Increment 3 is also substantially higher than for Increment 2. Per AAHU costs progressively increases with the level of input only for the seasonal wetland habitat type.

Figure 2. Cost per Annual Average Habitat Unit Gained by Compensation Increments



Numerous strategies are available for achieving compensation objectives for each of the habitat types. Generally this cost analysis showed that greater inputs do not necessarily provide greater habitat benefit. Overall, Increment 2-moderate input provided greater benefit than the minimum increment. The high increment is somewhat more expensive and more intensive, but in this case is greatly dependent on the specific variables changed as to whether or not it will meet the habitat goals or needs of a specific species. Recommendations for most cost efficient compensation increment per AAHU gained for each habitat type are listed below.

- **Blue oak/gray pine woodland—Increment 3.** This increment gains 0.60 AAHUs per acre, has a total compensation cost of $503,581, and meets the compensation requirements of the USFWS as presented in the Draft CAR report.

- **Oak woodland—Increment 3.** This increment gains 0.40 AAHUs per acre, has a total compensation cost of $1,679,483, and meets the compensation requirements of the USFWS as presented in the Draft CAR report.

- **Riparian woodland—Increment 2.** This increment gains 0.27 AAHUs per acre, has a total compensation cost of $424,430, and meets the compensation requirements of the USFWS as presented in the Draft CAR report.

- **Seasonal wetland—Increment 1.** This increment gains 0.65 AAHUs per acre, has a total compensation cost of $43,250, and meets the compensation requirements of the USFWS as presented in the Draft CAR report.

1F.10 Reference

U.S. Fish and Wildlife Service. 2001. Draft Fish and Wildlife Coordination Act Report for the American River Watershed Investigation Long-Term Evaluation. Prepare for the U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA. Prepared by U.S. Department of the Interior Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA. August.

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Engineer Regulations (ER 1
habitat evaluation procedures (HEP 1
U.S. Fish and Wildlife Service (USFWS 1
Habitat Suitability Index (HSI 4
Habitat Units (HUs 4
Average Annual Habitat Units (AAHUs 4
Supplemental Plan Formulation Report/Environmental Impact Statement/Environmental Impact Report (SPFR/EIS/EIR 5
Operations and Maintenance manual (O&M manual 8

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