Stanislaus River
Oakdale Recreation Area
Restoration Project
Summary of Conceptual Designs

California Department of Water Resources
San Joaquin District
River Management Section

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November 27, 2002

Project Funded by:

The Fish Passage Improvement Program
Integrated Storage Investigations
Division of Planning and Local Assistance
Department of Water Resources

Report Prepared By:

California Department of Water Resources

San Joaquin District

River Management Section

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Background

The Oakdale Recreation Area is located approximately 1.5 miles northwest of the city of Oakdale between River Mile 40.1 and River Mile 39 of the Stanislaus River (Figure 1). This public recreation area owned by the U.S. Army Corps of Engineers, contains several isolated ponds (Ponds) and captured mining pits (Pits) that were created years ago by aggregate mining (Figure 2). Although the public enjoys the area for its accessibility and fishing, this portion of the lower Stanislaus River lacks suitable rearing habitat for juvenile chinook salmon. These abandoned gravel pits may also harbor predator fish that may be detrimental to juvenile survival. In addition, the migratory paths are affected for the adult and juvenile salmon, and from a geomorphic standpoint the ponds trap sediment moving through the reach, creating nick points and channel degradation. The following summary describes and illustrates three conceptual designs that focus on improving rearing habitat for chinook salmon. Restoration elements of the designs include floodway widening, pond isolation, and floodplain construction. Rearing design features include alcoves, backwaters, and secondary rearing channels.

Goals & Objectives

A planning group consisting of members of state, federal, and local agencies has formed to develop a solution to restoring a portion of the Stanislaus River at the Oakdale Recreation Area. It is equally important to have the input, ideas, and cooperative efforts of the local community, anglers, and landowners for this project to become a success. The primary goal of the Oakdale Recreation Area Project is to create and improve rearing habitat for juvenile chinook salmon. The planning group's specific objectives are:

- Increase quantity and quality of juvenile rearing habitat.
- Improve the adult and juvenile salmon migratory path.
- Reduce juvenile chinook salmon predator habitat by isolating and eliminating unnatural ponds.
- Improve river and floodplain dynamics by reconfiguring the channel to better conform with present flow regime.
- Restore native riparian plant communities within their predicted hydrologic regime.
- Fulfill objectives of USACE Master Plan, including keeping the channel capacity at 8,000 cfs, preserving existing fish and wildlife, preserving salmon and steelhead spawning gravel, and providing public access to the river.
- Preserve habitats for special status species (e.g. herons, ospreys, egrets)
- Replace recreational fishing lost in the large in-stream ponds with improved off stream ponds and fishing access (recreation enhancement).
- Educate the public about the Stanislaus River and its beneficial uses.

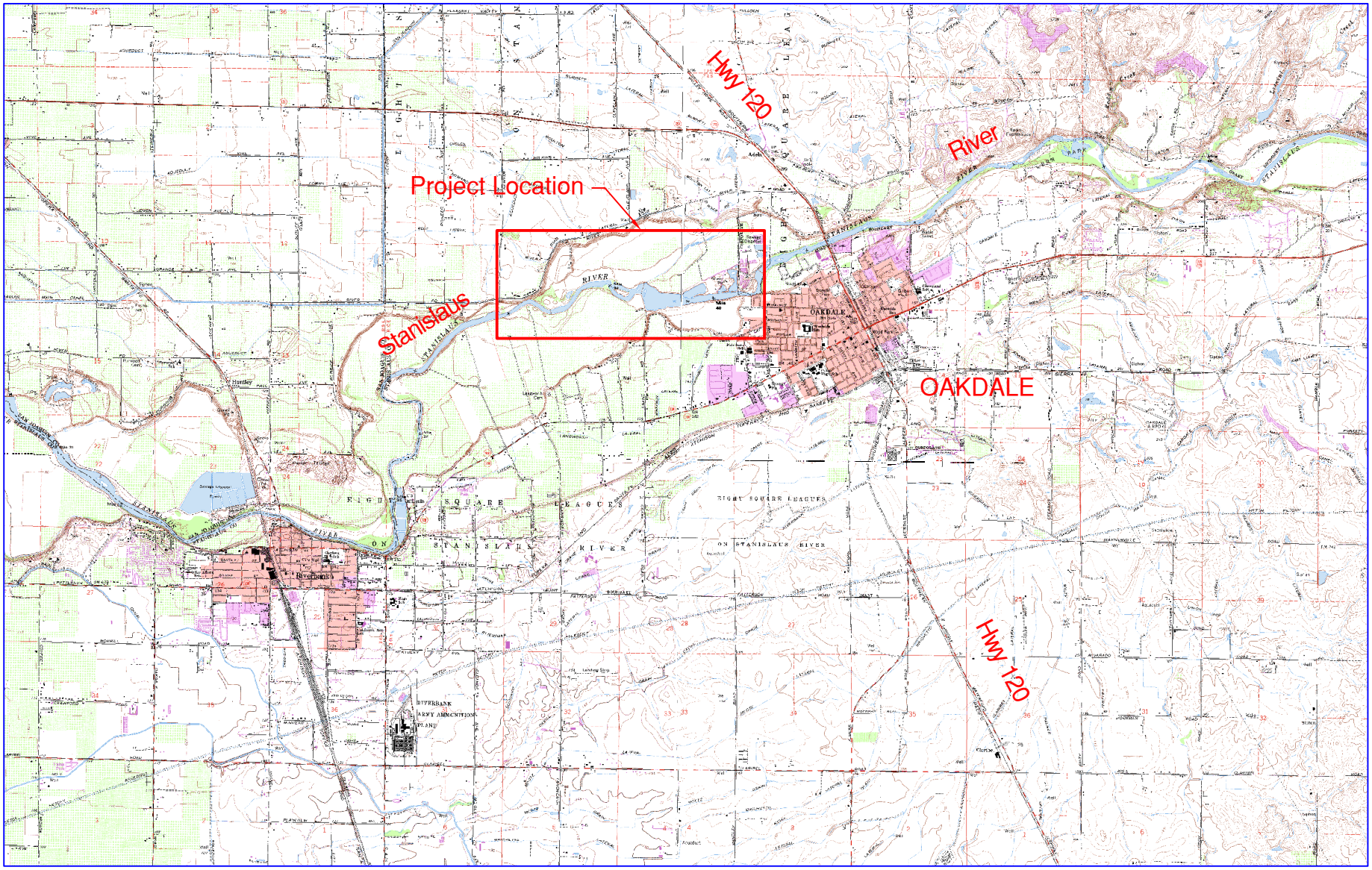


Figure 1
Site Location Map

OAKDALE RECREATION AREA
RESTORATION PROJECT

Stanislaus River

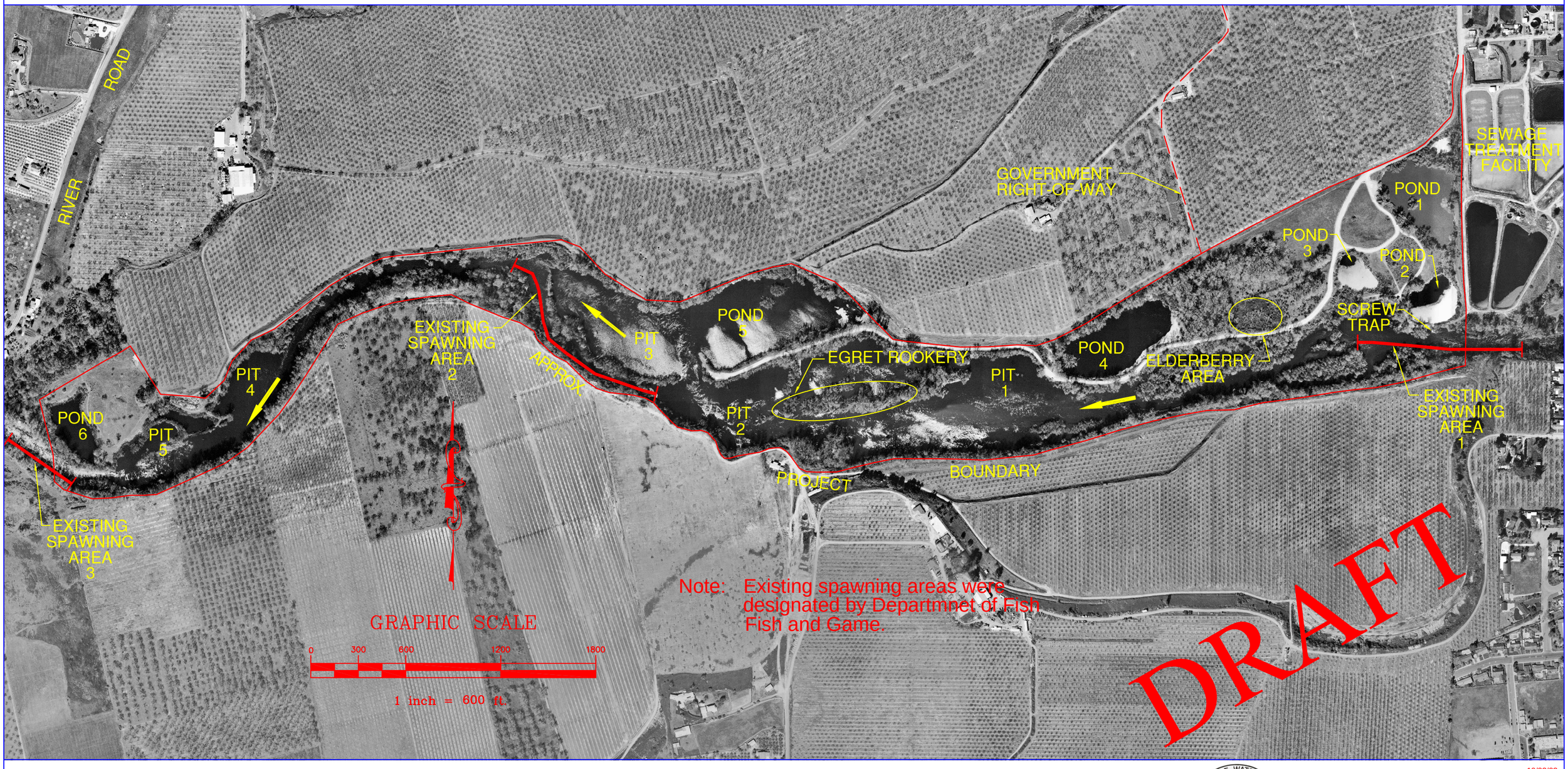


Figure 2
PROJECT SITE MAP

10/03/02
09/09/02
08/15/02
Last Revised: 07/19/02

DRAWN BY: R. Lampa	CHECKED BY: K. Faulkenberry	
DATE: January 2, 2002	Figure 2	p.3

Conceptual Design Alternatives

Three conceptual designs were developed from the goals and objectives previously listed. Each design is described and illustrated in this portion of the summary. The description includes the major features of the design, an estimated volume calculation, and a conceptual drawing plan of the project site (Appendix A). A list of potential restoration elements (Appendix B) was generated and used to develop the designs. The elements include floodplain, revegetation, wildlife habitat, fisheries, instream habitat, engineering structures, floodplain and channel diversity, educational facilities, recreational facilities, and monitoring and maintenance. Preliminary volume estimates were calculated to ensure viability of the plans and help determine a cost estimate for the project.

In all three alternatives, the intent was to preserve as much existing vegetation and habitat as possible. Preliminary site assessments were conducted to identify potential environmental issues and design constraints. During the site assessments, an Egret or Great Blue Heron rookery and an elderberry grove were identified and located (see Project Site Map, Figure 2) on site. A more detailed summary of the assessment is mentioned later in this report. Other concerns within the project site include a rotary screw trap owned and operated by S.P. Cramer & Associates, and several extant spawning areas identified by the Department of Fish and Game as shown on Figure 2.

Although much of the existing spawning riffles (areas 1 and 3) can be preserved, a portion of area 2 may be compromised (see Figure 2). However, pre-mining photos show that this area is a remnant of the original channel alignment and a portion of this existing channel may be preserved by creating a split-flow between a portion of this reach and the proposed channel (Alternatives 2 and 3). A split-flow is necessary since the existing channel width of spawning area 2 is relatively narrow and is likely inadequate to convey the design effective discharge. The length of spawning area 2 will be reduced due to the insufficient drop in the upper half of all three alternatives. The current drop across the upper portion of the project ranges from 0.0004 ft for Alternative 1 to 0.0005 ft for Alternatives 2 and 3. Preserving the entire reach of spawning area 2 may result in little or no slope for the remaining upper half of the project.

Alternative 1 - Floodway Widening & Rearing Habitat Restoration

In this first alternative, the concept will be to incorporate as many of the restoration elements as possible without considering cost. Restoration efforts span from the upstream project limit, located immediately downstream of the sewage treatment facility, to the lower project limit, approximately 1.1 river miles downstream. Descriptions of the elements follow in no particular order or priority.

The ponds will be isolated from the river using constructed berms (see Drawing A-2). These berms will be set back to create a wider floodway ranging from 500 - 800 feet wide. In this alternative, ponds 2, 4, and 5 will be affected by the berms.

Of these three ponds, pond 2 will be completely filled and eliminated (x-s C-C', Drawing A-3), whereas ponds 1, 3, 4 and 5 will be reconfigured. Pond 6 will also be completely filled. As for the captured mining pits, Pits 1, 2, 4, and 5 will be filled to the proposed floodplain grade with pit 3 being partially filled due to the proposed channel alignment. In this design, ponds 4 and 5 will be reduced in size by the berms, but the other half of pond 4 will be enlarged to increase fishing area (New Pond 2). Similarly, ponds 1 and 3 will also be enlarged and combined to create a single pond (New Pond 1).

Easier fishing access to the ponds will also be added by creating gradual side slopes and varying sinuous edges. In addition, proposed access roads will be constructed on the north side of New Pond 2 and east of New Pond 1 adjacent to the sewage treatment facility. The access road north of New Pond 2 will be approximately 1,000 feet long whereas the access road at the east end of the project continues south to the proposed constructed berm and connects back to the existing road. The access roads will also be incorporated in Alternatives 2 and 3.

A culvert structure will be placed between the two new ponds to allow water to flow from one pond to the other. By enlarging the ponds, excess material will be generated and will serve as a material source for the project. Table 1 compares the areas of the fishing ponds before and after construction (areas are approximate).

Table 1. Pond Areas

	Area Before (acres)	Area After (acres)	Loss (acres)	Gain (acres)
Pond 1	3.3	3.3		
Pond 2	1.7	0	-1.7	
Pond 3	1.0	1.0		
Sub Total	6.0	11.0*	-1.7	9.3
Pond 4	5.5	14.9		9.5
Pond 5	11.1	6.1	-5.1	
Pond 6	1.6	0	-1.6	
Total	24.2	32.0	-8.4	18.8

* Includes pond areas 1 and 3 plus additional area of 6.7 acres (see x-s C-C', Drawing A-2)

The proposed design is intended to create two large recreational fishing areas for public use and more than offsets the loss of fishing area due to the wider floodway and berms.

Included in the berms will be hydraulic structures consisting of large porous material such as boulders and cobbles. Some examples include equalization saddles, French drains, or other natural hydraulic control structures. An illustration of these structures can be seen in Figures 3 & 4. These structures

are intended to maintain the connectivity between the river and ponds to allow water to flow into and out of the ponds.

Figure 3. Equalization Saddles, Ratzlaff Project - Merced River

Figure 4. French Drain, Robinson Project - Merced River

A well-defined channel with floodplains will be created to improve fish passage in the project reach. Attached to the proposed channel in this alternative will be rearing features such as backwaters and an alcove (x-s B-B', Drawing A-3). Simulated abandoned channels (SACs) will also be created to provide floodplain diversity. The existing spawning areas in this reach will be affected by this alternative. Spawning areas 1 and 3 will have minimal impact due to their locations at the upper and lower ends of the project. As for spawning area 2, the

upper half of the existing spawning channel will be filled in to floodplain grade and the lower half will remain to create a backwater for rearing habitat.
At the lower end of the project, all isolated ponds and captured mining pits will be filled to create a floodplain, and a backwater channel will be added near the downstream boundary of the project. The low terrace will be graded to the proposed floodplain elevation, generating excess material to be used as fill in deep pits and ponds located at this end of the project (x-s A-A', Drawing A-3).

Alternative 2 - Pond Isolation & Rearing Habitat Restoration

This alternative shares similar restoration characteristics as the first, except the channel construction will begin approximately 2,000 ft downstream of the treatment facility (see Drawing A-4). The reasons for preserving the upstream reach are the relatively good condition of the reach, the existing rearing and spawning habitat, and cost savings. Like the first alternative, the upstream ponds will be preserved and enlarged, using the excess material for fill throughout the project (x-s D-D', Drawing A-5). However in this alternative, only one berm will be constructed to isolate pond 5 from the river (x-s B-B', Drawing A-5). In addition, the berm will not be setback but continued to the north bank, cutting the connection of pond 5 to the river. The floodway width in this alternative will range from approximately 250 - 800 feet wide. The floodway will be slightly narrower than the first alternative due to the lack of the berm setback. Hydraulic structures will also be constructed in this alternative to maintain the connectivity to the river as in alternative 1.

The proposed channel in this alternative will also contain backwaters for rearing. However, in lieu of an alcove, a secondary rearing channel will be incorporated in this design (x-s C-C', Drawing A-5). The secondary rearing channel is unique in that, under low flow conditions, the lower end of the channel is inundated, creating a backwater. In the event of higher flows, the upper portion of the rearing channel becomes inundated, which will create refugia for juvenile salmon with shallower water depths and lower water velocities. As previously mentioned, spawning area 2 will be partially preserved by incorporating a split-flow in this alternative (Drawing A-4). The design channel in this reach will be reduced in width to allow flow through the spawning area. The length of the existing spawning channel to remain will be determined in future detailed calculations.

As for the lower end of the project in this alternative, the ponds will be filled and the grade will be lowered to create floodplains (x-s A-A', Drawing A-5). The excavated material will be used for fill in the ponds, pits, and other areas of the project.

Alternative 3 - Floodplain Construction & Rearing Habitat Restoration

For this alternative, portions of the restoration elements from alternatives 1 and 2 were taken to develop this design. As you can see in Drawing A-6, the restoration features closely resemble alternative 2. As in the previous alternative, the upstream ponds will be enlarged and will serve as material

sources for the project (x-s D-D', Drawing A-7). In this alternative, pond 5 will contain a setback berm similar to the berm in alternative 1, which will widen the floodway to approximately 500 - 800 feet (x-s B-B', Drawing A-7). As in the previous alternatives, hydraulic structures will also be incorporated in this design.

The proposed channel features, including backwaters and secondary rearing channels, will be identical to those in alternative 2. The construction of the proposed channel will also begin approximately 2,000 ft downstream. This alternative also includes a split-flow to preserve a portion of existing spawning area 2 (Drawing A-6). The proposed channel will also be narrower in this reach while maintaining the original characteristics of the existing spawning channel. It may be necessary to modify the entrance and reduce the length of the existing spawning area to provide adequate slope and sediment transport for the upper half of the project.

The lower end of the project is similar to alternative 1, which contains a backwater channel, but slightly different with the addition of a simulated abandoned channel for floodplain diversity (x-s A-A', Drawing A-7).

A summary of the features previously discussed is shown in Table 2. The table lists the elements contained in each alternative and summarizes how each compares to the other.

Table 2. Alternatives Summary

Elements	Alternative 1	Alternative 2	Alternative 3
Upper End			
# of constructed berms	3	1	1
Floodway width	500-800 ft	250-800 ft	500-800 ft
# of Hydraulic structures	4	4	4
Channel construction length	6,800 ft	4,600 ft	4,600 ft
Backwater channels	Yes	Yes	Yes
Alcoves	Yes	No	No
Secondary rearing channels	No	Yes	Yes
Simulated abandoned channels	Yes	Yes	Yes
Split-Flow Channel	No	Yes	Yes
Lower End			
Backwater channel	Yes	No	Yes
Simulated abandoned channels	No	No	Yes
Channel construction length	2,200 ft	2,200 ft	2,200 ft
Total Acreage Created			
Floodplain	69.1	46.2	56.9
Rearing Habitat	7.9	4.4	6.0
Ponds	32.0	41.3	36.2

Volume Estimates

Preliminary calculations were done to determine volume estimates for each of the project alternatives. For estimating purposes, a typical riffle (not necessarily spawning) and pool section were used for a channel design. An estimated design effective discharge of 2,500 cfs was obtained using frequency and flow duration curves, and the estimated design low flow used was 400 cfs based on historical flow data. Using this information, cross sections for a riffle and pool were developed. The floodplain elevations were calculated using the riffle and pool cross-sections along with the appropriate proposed slopes. The elevations were taken to generate a point file in AutoCAD 2000i Land Development Desktop and the volumes were calculated using several methods and then averaged. Table 3 illustrates the total estimate amount of material to be manipulated for each alternative.

Table 3. Material Quantities

Alternative	Total Quantity of Material to be Manipulated (yd^3)
1	**800,000**
2	**500,000**
3	**600,000**

Preliminary estimates indicate that all alternatives are viable from a materials volume standpoint. However, larger material, such as cobbles, may be imported to construct the hydraulic structures. The restoration features for each alternative are subject to change and may affect the quantities and assumptions made in this report.

Preliminary Estimated Costs

The costs shown in Table 4 on the next page are preliminary dollar amounts for each alternative. A more detailed cost will be provided as the project progresses and a final design is selected.

Table 4. Estimated Costs

Phase		Alternative 1	Alternative 2	Alternative 3
Planning				
	Environmental Documents	$150,000	$150,000	$150,000
	Design and Engineering	$250,000	$220,000	$220,000
Construction				
	Environmental Compliance	$150,000	$115,000	$125,000
	Construction Management and Surveys	$280,000	$280,000	$280,000
	Bid Specifications and Contract Management	$250,000	$250,000	$250,000
	Gross Materials Management	$2,340,000	$1,590,000	$1,800,000
	Hydraulic structures	$689,200	$485,600	$485,600
Revegetation				
	Design	$100,000	$65,000	$85,000
	Implementation ($2000/acre)	$156,000	$100,000	$125,000
Adaptive Management and Monitoring				
	Geomorphic (5 year period)	$200,000	$180,000	$180,000
	Revegetation (5 year period)	$100,000	$100,000	$100,000
	Sub-total	$4,665,200	$3,535,600	$3,800,600
	10 percent contingency	$466,520	$353,560	$380,060
	Grand Total	**$5,131,720**	**$3,889,160**	**$4,180,660**

Environmental Assessment Summary

The Oakdale Recreation Area, as delineated in Figure 2, was evaluated by a DWR Environmental Scientist on 24 January and 19 June 2002. The purpose of these site visits was to conduct a preliminary evaluation of the sensitive resources potentially present in the project area. Information from this preliminary environmental assessment will be used by DWR project design engineers during the draft design phase, so that the project can be designed to minimize and avoid impacts to sensitive resources when possible.

The project area was evaluated on foot and via windshield and boat surveys. Surveys were limited in the area downstream of Pond 5 (as delineated in Figure 2), since access to this area is privately owned.

Survey Results

Large elderberries (*Sambucus sp.*), the host plant for the Federally (Threatened) Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*, commonly referred to as VELB) are prevalent throughout the project area. A particularly dense aggregation of elderberry plants is identified on Figure 2 as the

Elderberry Area. Because of the local abundance of elderberry plants on the project site, it is certain that some elderberry plants will be impacted by any of the 3 proposed conceptual designs. However, avoiding project-related impacts to the Elderberry Area would greatly reduce the number of elderberry plants that would be adversely affected. Because the VELB host plant will be affected by the proposed project, formal consultation with the U.S. Fish and Wildlife Service (USFWS) will be required and a Biological Opinion will be required prior to project construction. The USFWS requires that all elderberries that would be directly impacted by construction be transplanted between November 1st and February 15th (while still dormant) to a permanently protected on-site or adjacent area. Additional mitigation is also usually required. Stem counts and a detailed search for VELB exit holes have not yet been conducted, but will be necessary at a later date.

Western pond turtle (*Clemmys marmorata*), a Federal Species of Concern and a State Species of Special Concern were observed in the Project Area. Three individuals were observed at the upstream end of Pond 5, along with one red-eared slider, a non-native turtle species. It is likely that Western pond turtles are abundant in most of the Project Area ponds. Pond isolation and/or creation will create and protect habitat for this species.

A Great Blue Heron (*Ardea herodias*) or Great Egret (*Ardea alba*) rookery was identified in the Project Area (delineated on Figure 2). A minimum of 40 nests were observed in this rookery. During the January site visit, Great Blue Herons were the predominant bird species using this area. During the June visit, several Great Egrets were also observed using this area. Regardless of which bird species is nesting in this area, both types of rookeries are protected by the California Department of Fish and Game (DFG). Since these birds are colonial nesters, impacts to a nesting colony can have local population level impacts. As a result, impacts to the rookery trees should be avoided, and construction should be timed to minimize disturbance during the nesting season.

A few other special status bird species were observed in the Project Area such as Cooper's Hawk (*Accipiter cooperii*) and Osprey (*Pandion haliaetus*).

<u>Additional Issues</u>

A potential Swainson's Hawk (*Buteo swansoni*), a State Threatened species and Federal Species of Concern, was observed during the June site visit. Although the Swainson's Hawk identification was not confirmed, it is likely that a Swainson's Hawk's nest is in or adjacent to the Project Area. This determination was made based on the habitat present in the Project Area related to Swainson's Hawk habitat preferences, and on previous reports of Swainson's Hawks in the Project Area vicinity (CNDDB reports). Surveys for Swainson's Hawk according to DFG recommendations will be necessary for project permitting purposes. If a Swainson's Hawk nest tree is identified in or adjacent to the Project Area, formal consultation with DFG and/or mitigation may be required.

The riparian brush rabbit (*Sylvilagus bachmani riparius*), a Federal and State Endangered species, and the riparian woodrat (*Neotoma fuscipes riparia*), a Federally Endangered and State Species of Special Concern, both require mature riparian habitat. One of the last remaining known populations of these two species is at Caswell State Park, which is located downstream of Highway 99 on the Stanislaus River, approximately 34 river miles downstream of the Project Area. Although the areas with dense riparian vegetation in the Project Area are narrow and have a steep gradient, these areas do contain habitat elements required by these two species, such as thick blackberry brambles and dense woody thickets. Regardless of whether or not these species are confirmed as inhabiting the Project Area, formal consultation with the USFWS for these species will likely be required prior to Project construction.

Several vernal pool plant and animal species are reported in the CNDDB for the Oakdale Quad. However, preliminary surveys of the accessed areas did not detect any vernal pools or seasonal swales within the Project Area boundaries. Follow-up surveys are required in the areas where access rights have not yet been obtained.

Future Biological Evaluation

More detailed biological surveys will need to be conducted in the Project Area for Project permitting purposes. Future surveys will be focused on specific special status species, so that an adequate pre-project impact analysis can be performed. These surveys will commence once a conceptual engineering design is decided upon.

Conclusions

Presented in this summary were three potential alternatives for the Oakdale Recreation Area Restoration Project, which focuses on rearing habitat. Restoration elements such as alcoves, backwaters, secondary rearing channels, and others mentioned in the report can be implemented to enhance juvenile salmon survival. The purpose of these three alternatives is to illustrate the restoration potential of the Oakdale Recreation Area and also allow for additional suggestions and comments from interested parties.

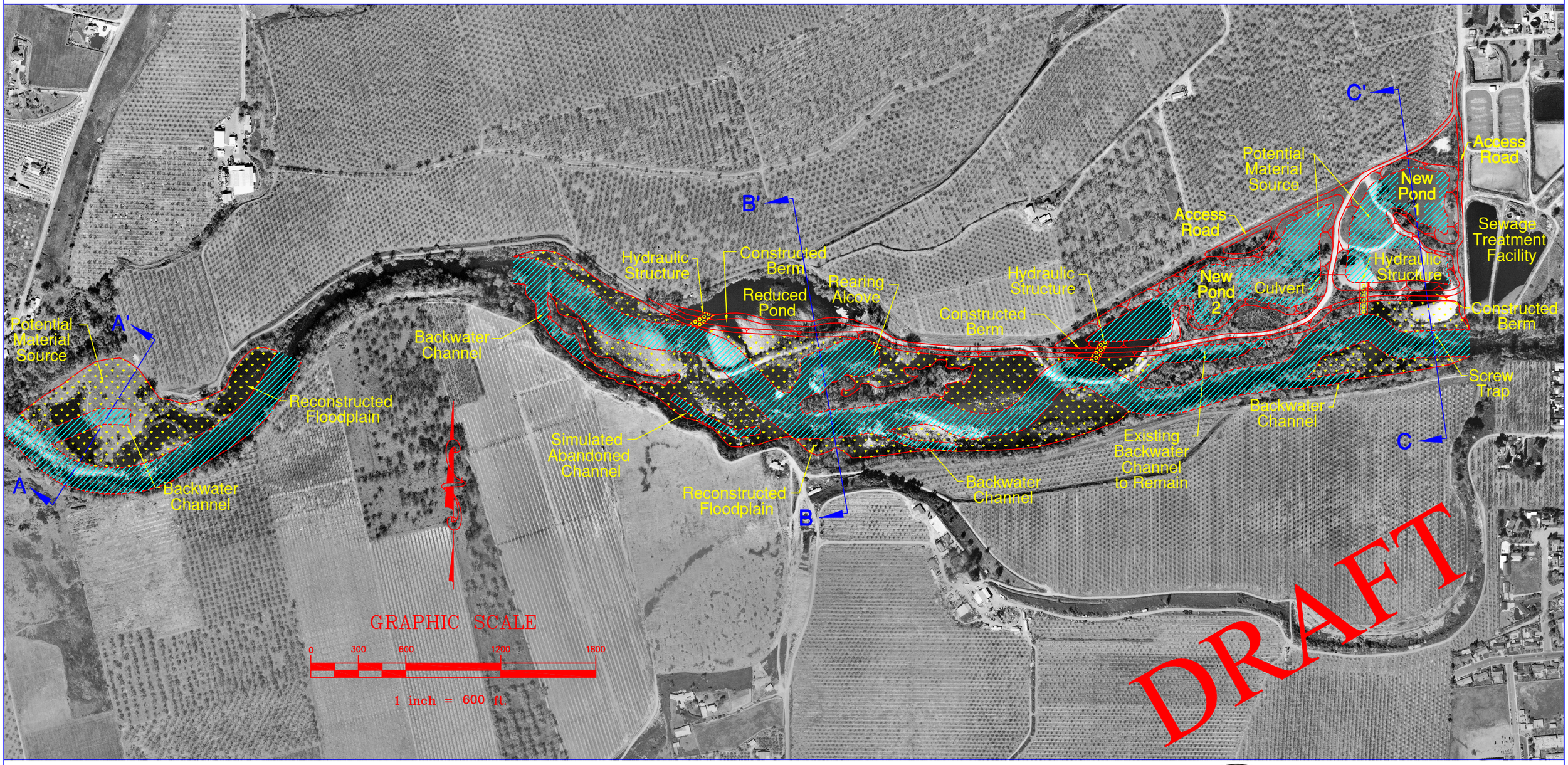
According to the alternatives included in this report, the Oakdale Recreation Area Restoration Project has the potential and opportunity for salmon habitat restoration that can be enjoyed by all…fish, wildlife, and humans.

This summary has been prepared for review and comments by the planning group and to be presented to The Stan Fish Group Technical Advisory Committee.

APPENDIX A
Conceptual Design Drawings

OAKDALE RECREATION AREA
RESTORATION PROJECT

Stanislaus River



CONCEPTUAL DESIGN
Alternative 1
Floodway Widening & Rearing Habitat Restoration

09/09/02
07/22/02
05/01/02
Last Revised: 01/28/02

DRAWN BY:	CHECKED BY:
R. Lampa	K. Faulkenberry
DATE: January 2, 2002	A-2

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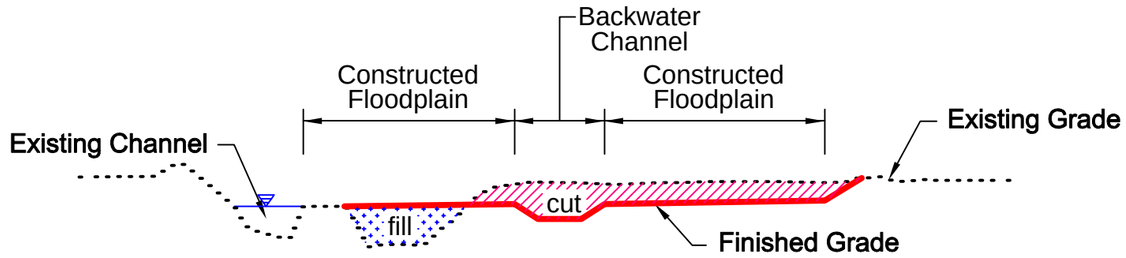

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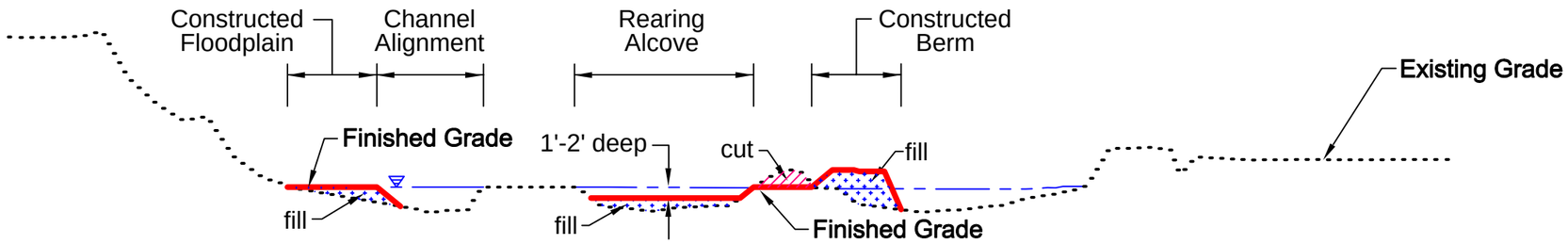

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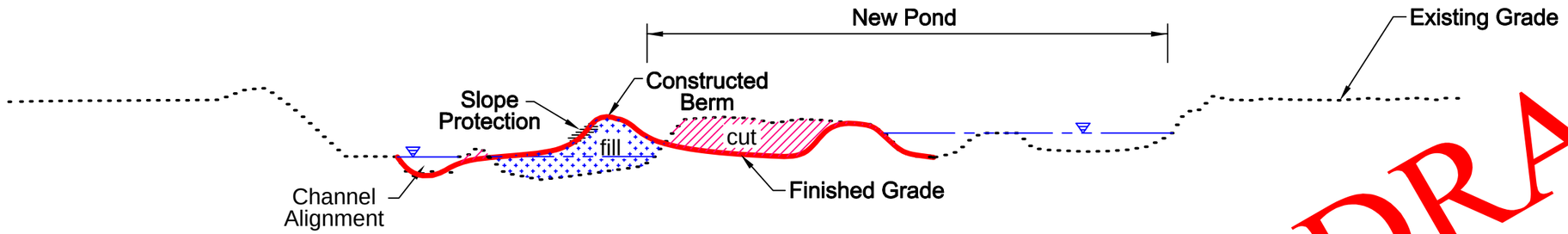

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CONCEPTUAL DESIGN X-SECTIONS
Alternative 1
Floodway Widening & Rearing Habitat Restoration

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

07/22/02
Last Revised: 01/28/02

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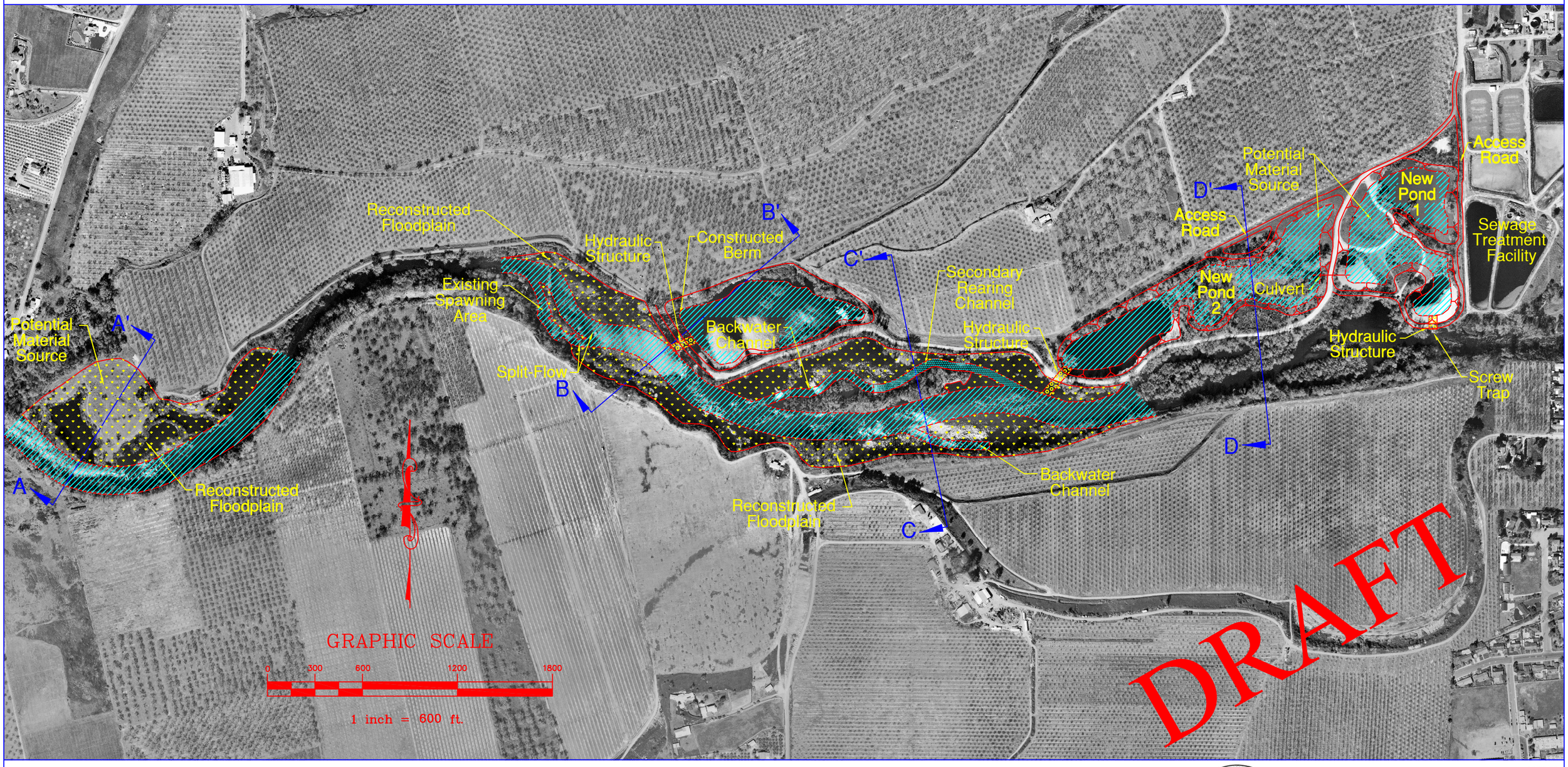
R. Lampa	K. Faulkenberry
DATE:	
January 2, 2002	A-3

OAKDALE RECREATION AREA
RESTORATION PROJECT

Stanislaus River



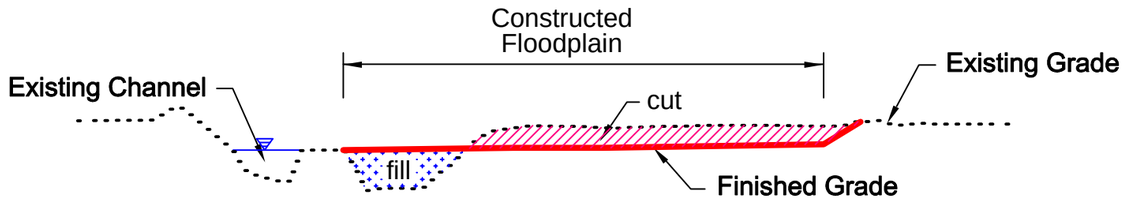
CONCEPTUAL DESIGN
Alternative 2
Pond Isolation & Rearing Habitat Restoration

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

10/22/02
09/09/02
08/15/02
Last Revised: 07/22/02

DRAWN BY:	CHECKED BY:
R. Lampa	K. Faulkenberry
DATE: May 2, 2002	A-4

Section A-A'



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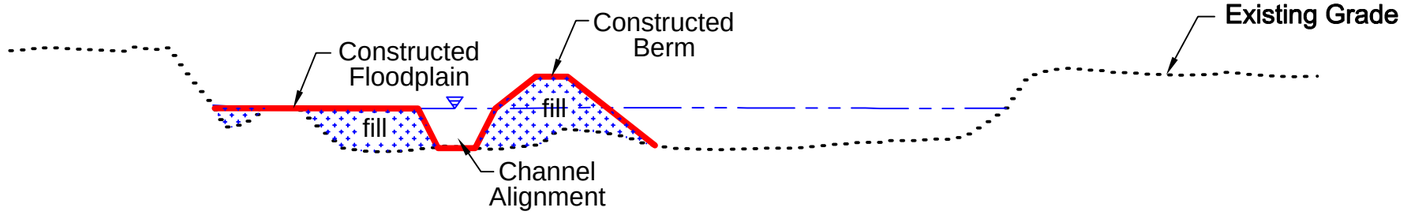

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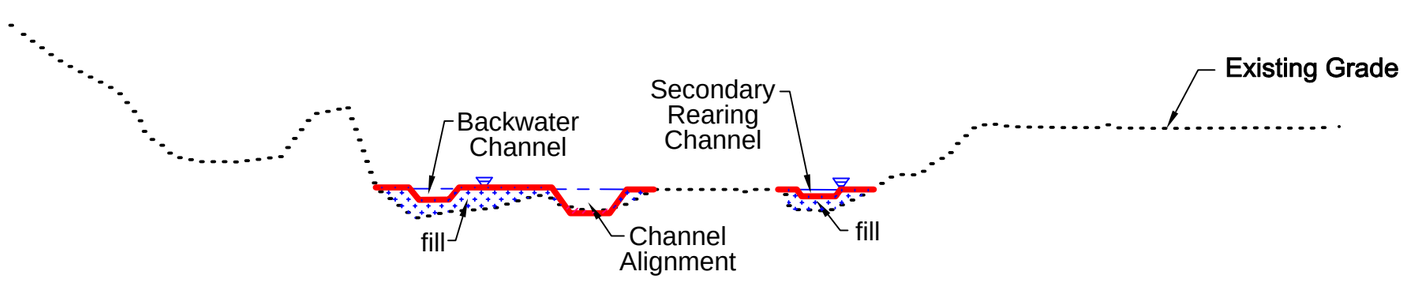

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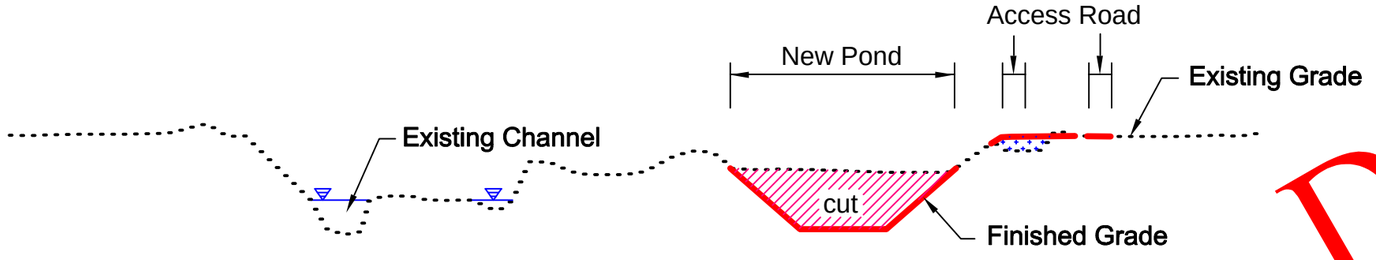

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CONCEPTUAL DESIGN X-SECTIONS
Alternative 2
Pond Isolation & Rearing Habitat Restoration

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

10/22/02
10/04/02
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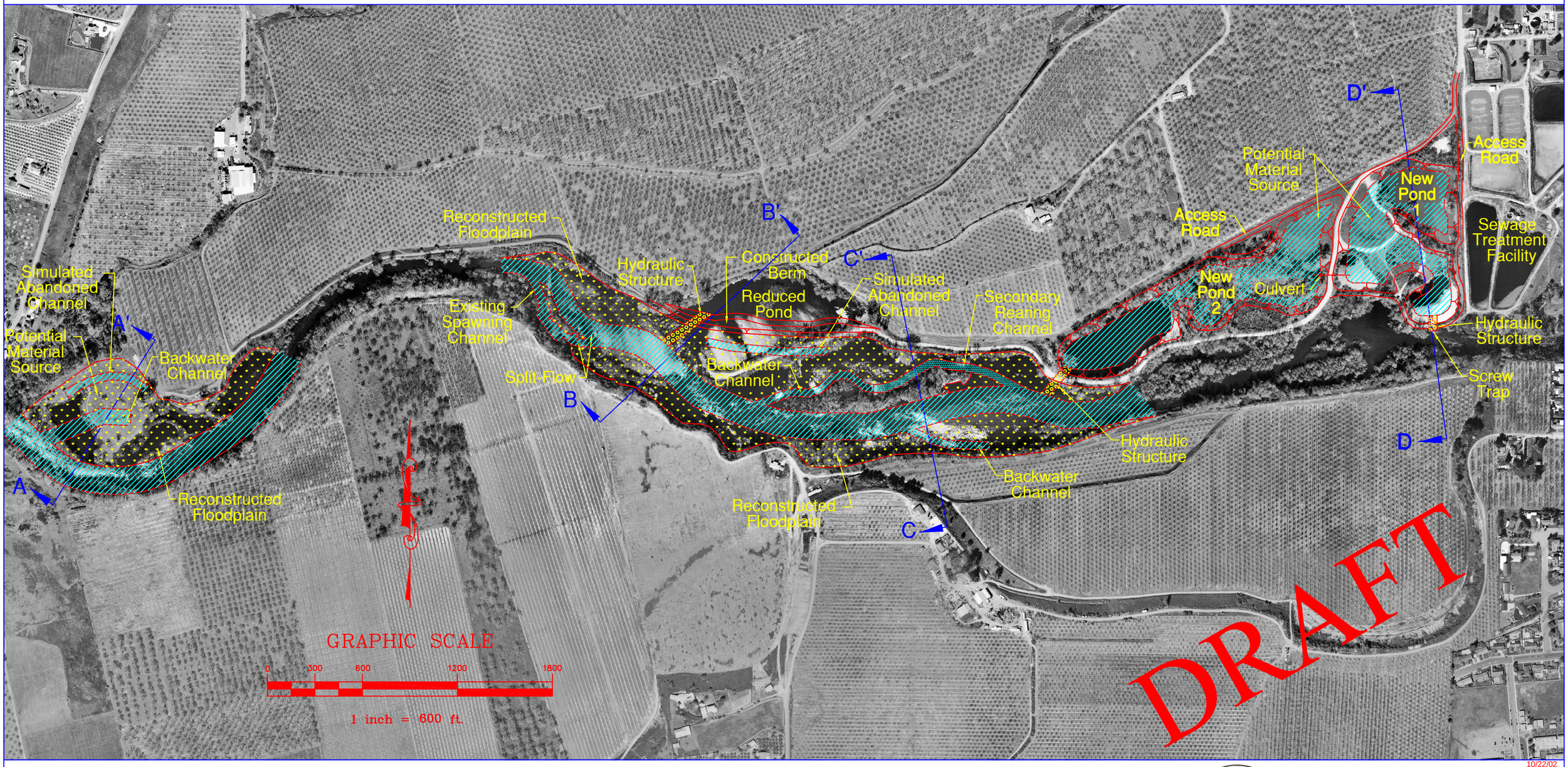
DRAWN BY: R. Lampa	CHECKED BY: K. Faulkenberry
DATE: May 2, 2002	A-5

OAKDALE RECREATION AREA
RESTORATION PROJECT

Stanislaus River



CONCEPTUAL DESIGN
Alternative 3
Floodplain Construction & Rearing Habitat Restoration

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

10/22/02
10/04/02
09/11/02
08/15/02
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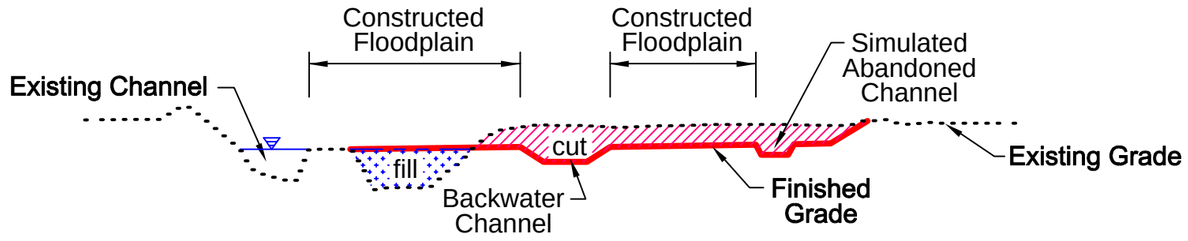
R. Lampa	K. Faulkenberry
DATE: May 2, 2002	A-6

Section A-A'



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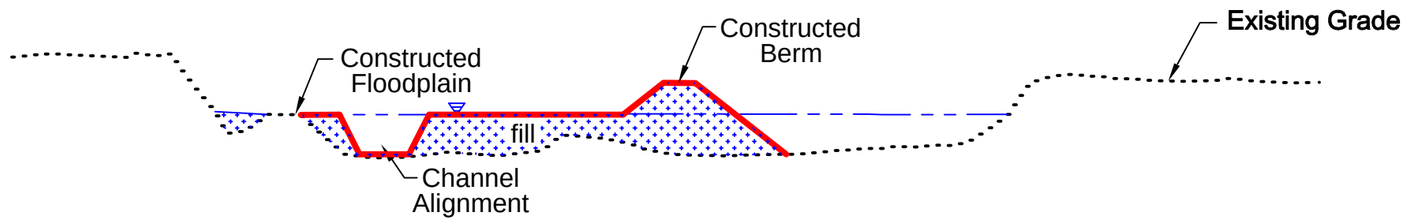

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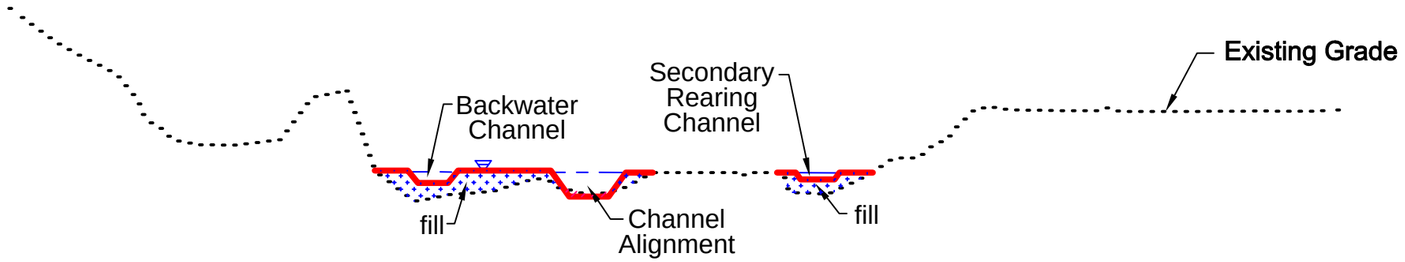

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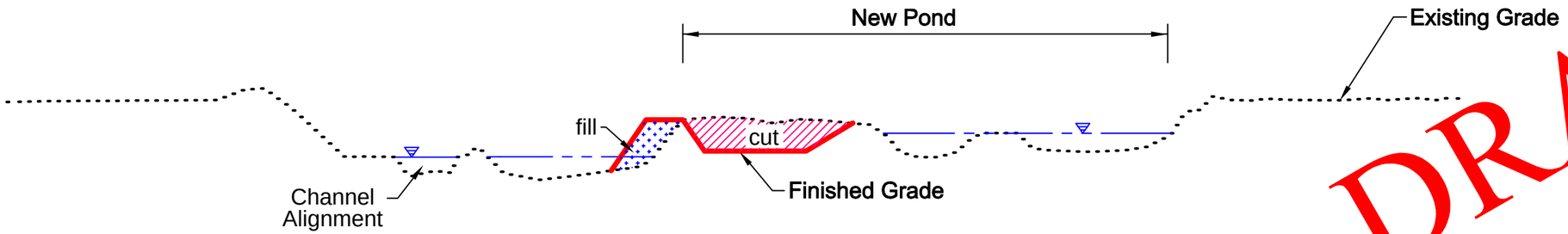

DRAFT

CONCEPTUAL DESIGN X-SECTIONS
Alternative 3
Floodplain Construction & Rearing Habitat Restoration

10/04/02
Last Revised: 07/22/02

DRAWN BY:	CHECKED BY:
R. Lampa	K. Faulkenberry
DATE: May 7, 2002	A-7

APPENDIX B
Restoration Elements

OAKDALE RECREATION AREA
RESTORATION PROJECT
Potential Project Restoration Elements

GOALS and OBJECTIVES:

1. Increase quantity and quality of juvenile rearing habitat.
2. Improve the adult and juvenile salmon migratory path.
3. Reduce juvenile chinook salmon predator habitat by isolating and eliminating unnatural ponds.
4. Improve river and floodplain dynamics by reconfiguring the channel to better conform with present flow regime.
5. Restore native riparian plant communities within their predicted hydrologic regime.
6. Fulfill objectives of USACE Master Plan, including keeping the channel capacity at 8,000 cfs, preserving existing fish and wildlife, preserving salmon and steelhead spawning gravel, and providing public access to the river.
7. Preserve habitats for special status species (e.g. herons, ospreys, egrets)
8. Replace recreational fishing lost in the large in-stream ponds with improved off stream ponds and fishing access (recreation enhancement).
9. Educate the public about the Stanislaus River and its beneficial uses.

RESTORATION ELEMENTS:

FLOODPLAIN ELEMENT

Fulfills goal no. ('s): 2, 3, 5, 7, and 9

Features:

- Reconstruct floodplain
- Construct a new engineered riverbank/berm separating ponds; provides long-term sustainability and withstands high flood flows
- Modify river channel geometry to create width to depth ratio to maintain transport of sediment or material
- Reinforce the pond-side of the existing riverbank; slope the backside of the new and existing berms to create a larger footprint increasing berm strength in addition to creating shallow-water habitat in the pond
- Include either passive or controlled hydraulic structures that allow freshwater flows into and out of ponds
- Add floodplain complexity to provide foundation for geomorphic and ecological diversity
- Scrape surface and lower ground elevation on Corps property to reestablish connectivity between the river and the floodplain surface
- Use excess material to construct berms, levees, or fill
- Fill all or part of on-site ponds
- Add floodplain geomorphic complexity to provide foundation for hydrological and ecological diversity

REVEGETATION ELEMENT

Fulfills goal no. ('s): 6, 7, and 8

Features:

- Plant communities should be created, restored, and enhanced throughout the site using native trees, shrubs, grasses, herbaceous plants and vines
- Removal of undesirable species, weedy and invasive
- Replanting areas w/ more desirable species

WILDLIFE HABITAT ELEMENT

Fulfills goal no. ('s): 6, 7, and 8

Features:

- Retain habitat already on-site (to the extent possible) i.e. trees, snags
- Manage existing riparian habitat i.e. willows and cottonwoods
- Keeping existing native plants
- Removing invasive plants
- Providing bare soil near the native trees to encourage germination
- Planting native trees to enhance wildlife habitat species selected that represent those present on-site
- Providing a shaded riverine aquatic habitat revegitation
- Grading of steep banks increases shallow water habitat for fish and wading birds
- Variation on bank slope
- Creating sinuous edges
- Island creation

FISHERIES ELEMENT

Fulfills goal no. ('s): 1 - 9

Features:

- Retain habitat on-site
- Manage existing riparian habitat
- Build berms to separate cold-water river form the warm-water pond.
- Island creation provides diversity to the habitat

INSTREAM HABITAT ELEMENT

Fulfills goal no. ('s): 1 - 9

Features:

- Create floodplain and diverse channel type
- Pool-riffle sequences, spawning sites, and aquatic cover

ENGINEERING STRUCTURES ELEMENT

Fulfills goal no. ('s): 1 - 9

Features:

- Biotechnology by establishing dense vegetation and root structure at locations w/ high erosion and shear stress potential
- Include brush mattresses, and pole cuttings
- Pond water control
  - Passive hydraulic control (i.e. Ratzlaff Project) - conduit of porous material like gravel or cobble
  - Active hydraulic control - water controlled by mechanical means i.e. pump and gates

FLOODPLAIN and CHANNEL DIVERSITY ELEMENT

Fulfills goal no. ('s): 2, 5 - 9

Features:

- Add high elevation secondary channels
- Add low elevation depressions
- Construct side channel backwaters
- In-stream gravel deposits

EDUCATIONAL FACILITIES ELEMENT

Fulfills goal no. ('s): 9

Features:

- Opportunity to share restoration experience w/ the public at-large and w/ local schools, colleges, and provide the resources for scientific research

- Provide information on variety of topics, including: aggregate mining restoration, natural river processes and ecology, habitat and wildlife types and linkages, nature studies, conservation
- Provide interpretive signs

RECREATIONAL FACILITIES ELEMENT

Fulfills goal no. ('s): 2 and 7

Features:

- Fishing
- Public access
- Pond access for small boats and canoes
- River access for rafts and canoes
- Support facilities such as service roads, parking, telephones, and restrooms (sited away from environmentally sensitive areas)

MONITORING and MAINTENANCE ELEMENT

Fulfills goal no. ('s): 1 - 8

Features:

- Monitoring provides information necessary to determine success
- Records evolutionary changes
- Allows for adaptive management
- Measure physical and biological parameters
- Results of monitoring will define maintenance required