October 31, 2008

Chorro Creek Ecological Reserve Long Term Restoration and Management Plan: Conceptual Design Report

Prepared for The Morro Bay National Estuary Program &
The California Department of Fish and Game

Prepared by Philip Williams & Associates, Ltd.
with
H.T. Harvey Associates, Ltd., Padre Associates, Inc., & Tenera Environmental, Ltd.

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1. INTRODUCTION

The client team (Morro Bay National Estuary Program [MBNEP]), the California Department of Fish and Game (CDFG) with funding from the California Coastal Conservancy) acquired the Chorro Creek Ecological Reserve (CCER) site with the goal of restoring riparian and special status species habitat in the reserve area, and reducing sediment loading to Morro Bay estuary. This report describes potential project elements leading to the selection and description of a preferred project alternative to support these goals.

1.1 PROJECT BACKGROUND

In the first phase of the project the Philip Williams & Associates (PWA) consultant team (including H.T. Harvey & Associates, Padre Associates, and Tenera Environmental) assessed the existing site conditions and identified a series of opportunities and constraints for habitat restoration and sediment trapping (PWA, 2005). Key findings are summarized here:

- The upper reaches of the creek are well-connected to the floodplain (inundation at, or close to, the two-year flood) but downstream the creek becomes progressively less connected to its floodplain (inundated at the 10-year flood level) due to channel incision.
- Inundation frequency of some upstream areas is reduced by a series of low agricultural levees: removal or breaching of the levees will increase inundation, sediment trapping and natural channel/floodplain interaction.
- There are greater opportunities to restore habitat and trap sediment on the floodplain upstream, while downstream the channel is itself a net source of sediment through bank erosion.
- The channel location separating downstream erosion and upstream deposition is a knickpoint that appears to be arrested on bedrock or massive boulders that form a natural grade control in the channel.
- The channel is attempting to avulse around this natural grade control, and form a new channel across the floodplain. This avulsion has the potential to trigger extensive sediment production and headward migration of channel incision through the upstream reach.
- There are several sites that are suitable for creation of habitat ponds for California red-legged frog and California Tiger Salamander.
- There are some upland areas of existing native grassland, and areas that are suitable for restoration of native grasses.
- There are a number of culturally sensitive sites on the project area. Proper project planning can avoid adverse impacts to these.

The opportunities and constraints assessment identified a series of actions that could be taken to restore habitat and increase sediment trapping at the site (PWA, 2006). In addition, opportunities to provide appropriate trail access and educational opportunities were presented. These included:

- Removing agricultural levees to increase the frequency of floodplain flows,
- Lower less-connected floodplain areas to increase the frequency and duration of floodplain flows,
- Re-grade and stabilize unstable downstream banks to reduce sediment supply from channel erosion,
- Prevent or manage the channel avulsion to avoid channel degradation in response,
- Create log and boulder structures in the creek to enhance and create habitat for steelhead trout and California red-legged frog and to raise flows onto the floodplain,
- Create ponds for California red-legged frog and California Tiger Salamander,
- Create additional habitat areas (native grassland and oak/sycamore woodland),
- Create segments of a regional trail parallel to US Highway 1,
- Avoid and protect cultural resources.

The purpose of this report is to describe the conceptual design of the preferred alternative. Chapter 2 explains the project approach including expected geomorphic and biological outcomes. Chapter 3 provides a construction cost estimate, and Chapter 4 provides recommendations on post-project monitoring and maintenance. Supporting information can be found in the Existing Conditions Assessment (PWA, 2005) and the Restoration Alternatives Memo (PWA, 2006).

2. PROJECT DESCRIPTION

The conceptual restoration design for the CCER includes a combination of engineering elements (grading, construction of channel and bank elements, creation of ponds), ecological elements (exotic species control, planting, irrigation), and management activities to implement the project.

To aid the description of project elements, we divided Chorro Creek into 5 reaches based on variations in geometry, geomorphic processes and stability through the project site (Table 1 and Figure 1) (PWA, 2005). Project elements include stabilizing an active avulsion channel, levee removal and biotechnical bank stabilization, installation of large woody (LWD) structures (Figures 2 to 5), construction of California Red-Legged Frog (CRLF) habitat, invasive plant eradication, and re-vegetation of the riparian plant communities (Figures 6 & 7).

Table 1. Reach Stationing for Conceptual Design

Reach	Beginning Stationing (ft)	End Stationing (ft)
Reach 1	0	2,700
Reach 2	2,700	4,000
Reach 3	4,000	7,100
Reach 4	7,100	10,000
Walters Creek	0	766

2.1 PHYSICAL PROCESSES AND ENGINEERING ELEMENTS

2.1.1 Avulsion Channel Stabilization

PWA (2006) identified the avulsion channel in Reach 1 as a key constraint on habitat restoration and a potential future significant impact to the success of the project. The avulsion channel has the potential to destabilize large sections of creek by bypassing a natural grade control that currently prevents incision from migrating upstream. Stabilization of the avulsion channel to prevent the release of sediment from the immediate reach, and the reaches upstream through knickpoint migration, is a key project objective. Specific options to stabilize and enhance the avulsion channel were discussed with the Technical Advisory Committee (TAC) (PWA, 2006) and focused on three possible approaches: allowing it to avulse, stabilizing the avulsion channel in its present size and location to ensure that it does not capture more flow and become the master channel, and filling the avulsion channel and widening the constricted existing main channel and floodplain. Allowing the channel to avulse would generate large volumes of sediment immediately, and continued sediment as headward knickpoint migration occurred. Stabilizing the avulsion channel in place could prevent erosion but has a higher risk of failure and requires significant in-channel work, involving large amounts of bed and channel stabilization. Without associated floodplain lowering the avulsion channel is likely to have dry (non-riparian) surroundings and a marginal habitat value relative to the risk and cost associated.

For the preferred alternative, we recommend filling the avulsion channel and grading the adjacent floodplain to slope gently towards the channel (Figures 2 and 4). Fill will be obtained by removing the adjacent channel levee and excavating a lowered floodplain at the 2-year flood elevation. The balance between excavating the current mainstem channel floodplain and filling the avulsion channel amounts to approximately 19,000 cubic yards of fill, depending on the preferred floodplain morphology, and the linear extent of the fill placement. A bank repair structure would be constructed where the current avulsion channel rejoins the mainstem of Chorro Creek at the downstream end (see Section 2.3) (Figures 2 and 4). In addition, an aggressive floodplain stabilization program would be required, including re-vegetation and some structural elements. This would prevent a new avulsion channel establishing on the floodplain during a high flow especially immediately following construction when the newly graded floodplain roughness is low.

2.1.2 Floodplain Grading

PWA used a computer hydraulic model to develop an initial grading plan to create areas of floodplain that would be inundated at approximately the 2-year flood elevation, the level at which floodplains tend to form under stable conditions, and optimal level for riparian habitat function along this stream (PWA, 2006). We recommend that during final design the floodplain design elevation be varied by up to 2 feet around this mean level to promote floodplain heterogeneity and to allow for natural variability and uncertainty in frequency of floodplain inundation.

The floodplain will be graded either from the outboard edge of existing riparian habitat or the approximate elevation of the 2 yr flood surface to an elevation approximately 2 feet below existing grade (Figures 4 and 5). From 2 feet below existing grade, the floodplain will be sloped at 3:1 to meet existing grade. The design floodplain will have a slope of approximately 30:1 to sufficiently lower velocity for sediment deposition while directing overbank flows back into the main channel. The selection of the grading depth is based on the trade-off between the benefit of sediment trapping and habitat restoration and grading costs.

Creating floodplain areas adjacent to heavily incised portions of the channel will require greater volumes of excavation to lower the surface to the 2 year water level. Therefore, we recommend narrow floodplain widths compared with the less incised areas, where the floodplain is currently more actively connected to the channel. For example, the width of Floodplain Area 4 varies depending on the level of incision in the channel (Figure 2). Based on input from the Client Team and the TAC, PWA adjusted the extent of grading to optimize the overall volume of material and project cost. Floodplain Areas 4, 5, and 7 will be the focus areas for floodplain grading, producing the largest volumes of material (Table 2). Existing depressions on the floodplain will be enhanced to form seasonal wetlands.

Lowering the floodplain in area F8 to the surface of the 2 year water level was not recommended. Since the elevation of the floodplain is only 0.5 to 1 foot above the 2 year water surface in this floodplain area, we recommend raising water surface elevations through the use of Large-Woody Debris (LWD) structures. These will also encourage aggradation of the channel bed (see Section 2.1.4) and a more active channel-floodplain connection.

Table 2. Floodplain Grading Volumes

Floodplain Area	Cut Volume (CY)
F4	57,564
F5	28,062
F7	15,082
Total	100,707

Excavated material from the floodplain and channel bank will be placed at the boundary of the floodplain limits at the toe of the surrounding hillslopes. This method will help stabilize the surrounding hillslopes, and it will protect surrounding areas on the north side of the channel from flooding (e.g. Highway 1 in Reach 3). Locations for placement of the fill will consider existing cultural resources, which will be either buried or remain undisturbed depending on permitting recommendations/requirements.

Following excavation, the soils at the design grade should be analyzed to determine if the texture and fertility are adequate for the establishment of the target vegetation. It may be preferable to stockpile the top foot of excavated topsoil, over-excavate by a foot, and replace this material with the topsoil. In addition, organic matter may need to be added to the subsoil with the potential for the addition of inorganic amendments to further increase the fertility of the soil. As part of the final soil preparation the graded areas should be track-walked on contour to create micro-topography to trap soil particles, seed and moisture.

2.1.3 Levee Removal and Biotechnical Bank Stabilization

Some of the project goals can be accomplished by removing or breaching the creekside levees and stabilizing stream banks rather than by full floodplain re-grading (Figures 4 and 5). The existing conditions hydraulic assessment revealed that breaching or removing levees in Reaches 2-4 would significantly increase the inundation frequency of the floodplain in these reaches.

In Reach 1, the outside stream bank downstream of the avulsion channel will be stabilized while preserving the existing riparian habitat. The channel bank will be re-graded from the existing riparian vegetation to the existing floodplain elevation at a slope of approximately 3:1 (Figure 4). Brush mats will be installed where the bank is re-graded, and this area will be planted with native grasses to prevent future erosion of the stream bank. Rock will be installed along the inside toe of the channel to prevent loss of the existing willows.

The levees along Chorro Creek were constructed with a mix of soil and old concrete debris. Due to the presence of concrete rubble in the levees, the levee material should either be disposed of off-site or buried at least 3 feet deep in the areas designated for fill placement on the north side of the creek, outside the floodplains.

2.1.4 Large Woody Debris (LWD) Structures

Large woody debris structures will be installed in the channel bed in Reaches 2, 3, and 4 by keying logs and boulders into the channel bank and bed (Figure 5). These structures will increase the amount of cover, lower water temperatures and increase channel complexity. The increased channel roughness will also reduce the potential for channel erosion. The structures will be spaced approximately 180 feet apart based on existing pool habitat structure and previously established relationships with stable channel width (Keller and Mellhorn, 1978; PWA, 2005). The spacing is approximate and the structures will be field fitted based on local site conditions and geomorphic and hydraulic considerations.

2.1.5 Walters Creek

Our design recommendations for Walters Creek assume that the Cal Poly land exchange is included in the restoration plan. During the evaluation of existing conditions, PWA (2005) reviewed historic aerial photographs that showed that Walters Creek once occupied a wider channel, located closer to the center of the floodplain area between Walters Creek and Chorro Creek.

Walters Creek appears to have been straightened and located against a hillside coincident with the development of agriculture on site. A levee was constructed on the right bank of Walters Creek which reduces the floodplain connection in this reach. Construction of this levee likely accompanied modification of the planform geometry.

Early design stages (PWA, 2006) proposed removal of the levee. However, the current aerial photograph, taken as part of the site survey in 2005, indicates that the channel is already outflanking the levee to re-align with the low point in the floodplain. In addition, H.T. Harvey & Associates notes that the current Walters Creek channel contains breeding habitat for CRLF. Since earthwork performed on the existing levee would impact this breeding habitat (requiring additional permitting and mitigation), we recommend constructing a new channel adjacent to Walters Creek in the low point of the floodplain which will continue to capture water from the existing channel and eventually become the dominant watercourse, without requiring an active channel relocation plan (Figure 3).

2.1.6 California Red-legged Frog Breeding Ponds

The CCER CRLF Protocol Survey Report (Tenera Environmental, 2005) documents observations of CRLF in both Chorro and Walters Creeks. In addition, CRLF predators (pike minnow and bullfrogs) were also observed in both creeks. Therefore, creation of seasonal off-channel breeding ponds would benefit the CRLF population along Chorro Creek by providing refugia with reduced predation. The breeding ponds would be designed to provide a maximal ponding depth of at least 3 feet during the peak of the rainy season and at least 6 inches of ponding through July.

Five potential locations for CRLF breeding ponds were identified by H.T. Harvey & Associates (Figures 6 and 7). Three of the five locations would initially involve straightforward construction methods at a moderate cost. Pond 1 is situated near to toe of the uplands to the south of Chorro Creek where an ephemeral drainage flows off Hollister Peak (Figure 6). The pond would be constructed in-line with the drainage, downstream of a culvert under an old ranch road. There are a few active headcuts within the channel that would require stabilization to ensure they do not migrate upstream, and drain into the constructed pond.

Pond 2 is situated at an active seep on the hillside on the south side of the creek near the downstream end of the project reach (Figure 7). This pond would be constructed by excavating a portion of the seep. The area appears to also be slumping downslope, therefore a geotechnical investigation may be necessary to refine the design of this pond.

Pond 3 is located on the north side of the creek and would consist of converting an existing stock pond to a CRLF breeding pond (Figure 7). Currently the stock pond is fed via a culvert under the ranch road (runs parallel to Highway 1and upstream by another culvert underneath Highway 1). It is assumed that with maintenance of the ranch road culvert, the hydrologic connection to the drainage will be adequate to support the design ponding depth and duration for CRLF breeding. The existing hydroperiod of Pond 3 can be monitored to support the preliminary recommendations. Figure 8 provides a typical cross-section of the CRLF breeding ponds. Actual designs for each pond will vary depending on the constraints of each individual pond location.

Ponds 4 and 5 would be initially more expensive, but would provide additional CRLF breeding habitat. Pond 4 is located on the north side of the creek approximately in the middle of the project reach (Figure 6). Currently there is a drainage culvert under Highway 1 and flows between Highway 1 and the adjacent ranch road for approximately 150 feet. It goes through a culvert under the ranch road through a third culvert under a spur ranch road and then into Chorro Creek. On-going erosion is occurring at the outlet of the culvert under Highway 1 as well as the inlet to the first culvert under the ranch road. Repairing these features would be expensive. An alternative would be to locate the culvert under the ranch road in line with the culvert under Highway 1 and build a CRLF pond in the field downstream of the new culvert. The drainage could then be designed to connect to the existing culvert under the spur ranch road and drain into Chorro Creek. This alternative would require a greater initial investment, but would improve the site drainage and provide an additional CRLF breeding pond.

Pond 5 is on the eastern end of the project site where a small tributary drainage enters Chorro Creek (Figure 6). The pond would be constructed in-line with the drainage. Upstream of the pond location the drainage runs adjacent to an agricultural field, managed by Cal Poly for hay production, for approximately 1,500 feet. Runoff to the drainage comes from upstream of Highway 1 from the hills to the north. The Cal Poly land manager confirmed the management practices for the hay field includes herbicide and fertilizer application (Gary Ketchum, *pers. comm.*, 2007). Currently the field is tilled and planted right up to the edge of the channel. Due to its close proximity to the drainage it is likely that herbicide and fertilizer could be delivered into the drainage. Therefore, runoff from this field into the pond could compromise its function for CRLF breeding. If the land owner/manager was willing to maintain an adequate buffer strip (10-15 foot wide) along the channel, runoff from agricultural products may be a lesser concern. In addition, multiple active headcuts are visible in the channel upstream of the pond site. These headcuts would require stabilization or sediment deposition in the pond may require periodic removal to maintain adequate ponding depths for CRLF breeding.

2.2 ECOLOGICAL AND LAND USE ELEMENTS

2.2.1 Invasive, Non-native Weed Eradication

The eradication of a number of invasive, non-native weed species should be addressed as part of the overall site preparation. The dominant invasive, non-native species within the project reach is Cape ivy, which infests the understory of large portions of the existing willow riparian habitat along Chorro Creek. Treatment of this species includes labor intensive manual removal or herbicide treatment with essential follow-up removal of resprouts in perpetuity. Due to known Cape ivy populations both up and downstream of the site, this species could be controlled but not fully eradicated. Herbicide treatment, during the middle of winter when most native trees are dormant, with a herbicide approved for use in aquatic habitats may be an option. However, with CRLF and steelhead known to be in Chorro Creek, this approach may not be appropriate. A recent interim settlement agreement between the Center for Biological Diversity and the U.S. Environmental Protection Agency (EPA) prohibits the use of numerous herbicides in CRLF habitat until the EPA completes Endangered Species Act Consultation with the U.S. Fish and Wildlife Service (Center for Biological Diversity, 2006). Other new innovative eradication techniques could be investigated, such as flaming with hand torches or steam application. However, due to federally-listed species on-site the U.S. Fish and Wildlife Service and NOAA Fisheries should be consulted on any proposed herbicide application or control programs to determine if it would be permissible.

On-going control of giant reed (*Arundo donax*) by the San Luis Obispo County Agriculture Department appears to be effective and should continue. Other exotic species that have been identified within the project reach including, wooly distaff thistle (*Carthamnus lanatus*), poison hemlock (*Conium maculatum*), castor bean (*Ricinus communis*), and tree of heaven (*Ailanthus altissima*) should be eradicated through hand removal or herbicide application (if located outside the riparian corridor and permitted by the regulatory agencies). The locations of these problem species were mapped as part of the

Existing Conditions Report (PWA, 2005). These mapped areas should be used to guide prioritization of eradication.

2.2.2 Re-vegetation and Planting Plan

This conceptual planting plan is based on currently available information. One important parameter for the plan is the depth of groundwater. The actual depth to ground water at various site locations should be quantified prior to the detailed design phase of the project, to locate the transition zones from willow riparian to riparian woodland to grassland.

2.2.2.1 Floodplain Restoration Areas

Excavated floodplain areas will be planted with the Willow Riparian Plant Association along the outer edge of the existing riparian corridor and will transition to a more xeric Mixed Riparian Woodland Association moving laterally away from the creek (Figures 6 and 7). The actual transition zone will be determined based on results of groundwater investigations. Figure 9 presents a typical cross-section of the floodplain planting design. Table 3 outlines the planting palettes for each of the floodplain planting associations.

The floodplain area between Walters Creek and Chorro Creek is mapped as Cropley clay by the USDA. Copley Clay is a very deep, moderately well drained soil found on alluvial fans and plains. A field investigation of soil conditions, performed by H.T. Harvey & Associates staff, confirmed the USDA mapping units within the CCER. The heavy clay subsoil may preclude successful establishment of willow riparian habitat depending on the depth to groundwater. There is a small area between the floodplain and Walters Creek, which contains coarser alluvium and currently supports some scattered willows (Figure 6). This area will be planted with the Willow Riparian Association shown in Table 3. No large-scale grading is proposed for the floodplain area between Walters Creek and Chorro Creek, although the plan does specify the enhancement of an existing swale parallel to Walters Creek. The depth to the late summer groundwater table should be assessed along this swale, during the detailed design phase of the project. Depending on the depth to ground water, this swale may be initially planted with willow riparian habitat or planted with seasonal wetland vegetation if groundwater is too deep to support willow establishment, prior to the expected shift of Walters Creek to this more stable location. The remainder of this floodplain area will be planted with the Mixed Riparian Woodland Association shown in Table 3.

Table 3. Floodplain Restoration Area Planting Palette

Plant Association	Common Name	Scientific Name	On-center Spacing	Container Size*	Percentage
Willow Riparian	arroyo willow	*Salix lasiolepis*	See Table 4	cutting	85%
	Fremont cottonwood	*Populus fremontii*	See Table 4	cutting	15%
Mixed Riparian Woodland	coast live oak	*Quercus agrifolia*	16	treepot	25%
	California sycamore	*Platanus racemosa*	16	treepot	30%
	box elder	*Acer negundo*	14	treepot	5%
	Blue elderberry	*Sambucus Mexicana*	12	treepot	10%
	California rose	*Rosa californica*	8	deepot	10%
	coyote brush	*Baccharis pilularis*	8	deepot	5%
	coffeeberry	*Rhamnus californica*	8	deepot	15%

*treepot = 4” x 14”; deepot = 2.5” x 10”; cutting = 24” long x 1-2 “ diameter

2.2.2.2 Willow Riparian Area

Post-project evaluation of the Chorro Flats Project downstream of the CCER indicates that active planting may not be necessary to accomplish the goal of rapid willow forest establishment. Chorro Flats included an active replanting project. During the first winter following installation, flood flows damaged numerous plantings and deposited a fresh layer of sediment on the floodplain. Subsequently the lower areas of the floodplain were naturally colonized by willows and established into a dense willow riparian habitat contiguous with the existing habitat along Chorro Creek (Coastal San Luis Resource Conservation District, 2002). This indicated that willows would naturally colonize areas with a high groundwater table and the planting and monitoring should be focused on the higher riparian species and areas.

Based on these monitoring results, it was decided to take a multiple planting approach at CCER to save on up front costs and allow for adaptive management if deemed necessary. There are three proposed planting approaches for the willow riparian areas, which are summarized below in Table 4.

Table 4. Willow Riparian Area Planting Approaches

Revegetation Elements	No Planting	Moderate Planting	Dense Planting
On-center Spacing of Cuttings	n/a	3-4 feet in clumps (size of clumps to be determined by range of sprinkler)	3-4 feet throughout entire planting area
Irrigation	n/a	Sprinkler	Sprinkler
Foliage Protection	n/a	No	No
Maintenance	n/a	No	No
Cost	None	Low	Moderate

Figures 6 and 7 show the proposed zones for each planting approach. The "No Planting" zones are located in areas that will likely have high groundwater and receive the most frequent overbank flows, thereby increasing the likelihood of natural recruitment. The "Moderate" and "Dense" planting zones were then spread out across the remaining portions of the floodplains to allow comparisons of plant establishment and growth. These observations will guide future site planting to achieve the project goals.

The proposed sprinkler irrigation system is preferred on floodplains due to the likelihood of floodplain flows that would damage on-grade irrigation lines typically used for drip and bubbler irrigation systems. Foliage protection cages are also not proposed for the floodplain planting areas due to the high density of plantings and the likelihood of the cages catching large amounts of flood debris. Without protection cages, the plantings will experience some browse, but the large quantity of cuttings to be installed and the rapid rate of establishment should offset the expected moderate browse. In addition, due to the high density of planting the logistics of installing and maintaining protection cages and regular weeding would be difficult.

It is expected that with irrigation in Year-1, the willows and cottonwoods should quickly attain heights where competition for light should not be an issue. Within 2-3 years the plants should reach heights where browse impacts would be reduced. Considering the large acreage to be planted, the "Dense Planting" approach could result in a requirement for too many cuttings to be harvested from available source areas. In that case, the "Dense Planting" areas would be planted using the "Moderate Planting" approach.

All disturbed soil within the floodplain creation areas will be drill seeded with a native seed mix (Table 5). Drill seeding results in better native grass establishment due to greater seed/soil contact compared to hydroseeding. In addition, for large relatively flat areas, drill seeding is less expensive.

Table 5. Riparian Seed Mix

Common Name	Scientific Name*	Growth Form	Pounds of PLS (pure live seed)/Acre
Meadow barley	Hordeum brachyantherum	perennial grass	14
Creeping wild rye	Leymus triticoides	perennial grass	12
Blue wild rye	Elymus glaucus	perennial grass	10
Purple needlegrass	Nassella pulchra	perennial grass	6
Mugwort	Artemesia douglasiana	perennial herb	2
Mulefat	Baccharis salicifolia	perennial shrub	2

*Use local ecotypes to the extent they are commercially available

2.2.2.3 Avulsion Channel

Figure 7 shows the location of the avulsion channel that will be filled then stabilized with vegetation. The portion of the filled channel that is within the willow riparian planting area will be planted with the dense planting approach described above. The remainder of the filled channel will be planted with the Mixed Riparian Woodland Plant Association with specific species chosen from that palette to maximize soil stabilization, such as box elder, California sycamore, and elderberry.

2.2.2.4 Fill Areas

Planting of fill areas depends on available funding but at a minimum the areas will be seeded with a native upland seed mix (Table 6).

Table 6. Upland Native Seed Mix

Common Name	Scientific Name*	Growth Form	Pounds of PLS/Acre
California brome	*Bromus carinatus*	perennial grass	20
blue wild rye	*Elymus glaucus*	perennial grass	12
purple needlegrass	*Nassella pulchra*	perennial grass	8
three weeks fescue	*Vulpia microstachys*	annual grass	6
arroyo lupine	*Lupinius succulentus*	annual legume	8
California poppy	*Eschscholzia californica*	annual/perennial forb	4
California sagebrush	*Artemesia californica*	shrub	1
black sage	*Salvia mellifera*	shrub	4

*Use local ecotypes to the extent they are commercially available

2.2.2.5 California Red-legged Frog Ponds

Planting palettes will vary slightly for frog ponds depending on their location on the landscape and predicted hydrology. The side slopes of all constructed ponds will be broadcast seeded with meadow barley (*Hordeum brachyantherum*) and creeping wildrye (*Leymus triticoides*) at application rates of 15 and 10 pounds of pure live seed/acre, respectively. Table 7 summarizes the species to be installed at each of the proposed ponds.

Table 7. CRLF Pond Planting Palettes

Common Name	Scientific Name	Location	On-center Spacing	Container Size*
spikerush	*Eleocharis macrostachya*	Ponds 2 and 3 0-12 inches below high water line	3-feet	treeband
common rush	*Juncus effusus*	Ponds 1-5 0-12 inches above high water line	3-feet	treeband
common bur-reed	*Sparganium eurycarpum*	Ponds 2 and 3 0-12 inches below high water line	3-feet	treeband
arroyo willow	*Salix lasiolepis*	Ponds 2, 3, and 4 0-12 inches above and below high water line	6-feet covering 50% of the perimeter of the ponds	cutting

** Treeband = 2.25" x 5"; cutting = 24" long x 1-2" diameter*

2.2.3 Plant Installation

2.2.3.1 Container Stock (Mixed Riparian Woodland and CRLF Ponds)

Container grown plants should be installed between October and March, following the onset of winter rains. Planting holes for treepots and deepots should be approximately 2-feet diameter x 2-feet deep and moistened to field capacity if the soils are dry at the time of planting. Planting holes for treebands should be 6 inches x 6 inches. All rocks greater than 3 inches should be removed from the excavated soil. Plants should be installed so that their root crowns are at or slightly above grade following soil settlement, which occurs after initial irrigation. A 3-foot diameter irrigation basin with a 4-inch high, 4-inch wide earthen berm should be constructed around each tree and shrub. Irrigation basins are not required for the wetland plants.

A 3-inch thick layer of wood chip mulch should be spread throughout the bottom of each irrigation basin. Mulch should be free of salt, leaves, soil clods, sticks, rocks, weeds or weed seeds.

In the riparian woodland area, foliage protection cages should be installed on all plantings to provide protection from deer and rodent browse. Cages should be constructed from welded wire (or comparable material) and measure 4-foot diameter x 5-foot high. Cages should be supported by two wooden support stakes. Supports stakes should be a minimum of 6-foot long and installed 2 feet into the ground directly across from each other on the outside of the irrigation basin. Cages should be secured to support posts in a manner that allows easy removal and replacement for maintenance activities (e.g. retractable zip ties).

2.2.3.2 Cuttings (Willow Riparian)

Cuttings to be installed in the willow riparian and CRLF pond planting areas should be harvested from existing arroyo willow (for riparian and CRLF pond) and Fremont cottonwood (for riparian only) trees along Chorro Creek. Cuttings should be harvested and installed during January-February, while the trees are dormant. Prior to going dormant, arroyo willow and Fremont cottonwood trees should be identified to ensure the correct plant material is harvested. Cuttings should be "greenwood" (relatively young branches and stems) approximately 24-inches long and 1 to 2 inches in diameter. Any cuttings that exhibit insect damage should be discarded. Cuttings should be installed so that the lower ¾ (18 inches) of the cutting is below ground. Cuttings should not be installed using a hammer or mallet but rather a pilot hole should be driven with a digging bar or metal stake. Soil should be compacted firmly around the cutting to eliminate voids. All cutting harvest and installation work should be conducted under the supervision of a qualified restoration ecologist. The length of cuttings may be adjusted based on observed depth to groundwater following floodplain excavation.

2.2.3.3 Fencing

Cattle and sheep will continue to graze within the CCER and will cause significant damage to the plantings, as well as natural recruits if the planted areas are not fenced. Therefore, cattle/sheep exclusion fencing will be required around the perimeter of the riparian (including the "No Planting" areas) woodland planting area. In addition, the CRLF ponds will require cattle/sheep exclusion fencing for at least the first 5-10 years, following construction, to allow for willows and wetland vegetation establishment.

2.2.3.4 Irrigation

Irrigation design will depend on the capability of available water sources. According to Gary Ketchum, there are 2-3 functional wells on the south side of the creek and a spring box on the north side of Highway 1, which was the water source for the ranch house (Gary Ketchum, *pers. comm.*, 2007). The suitability of these water sources will be assessed during the detailed design phase of the project.

The "No Planting" areas will not receive any irrigation. Irrigation for the "Dense and Moderate Planting" willow riparian areas would likely be either from a sprinkler irrigation system or truck watering. A sprinkler system could be used if it can be directly connected to a water source that provides adequate water pressure and volume. If a sprinkler system is not feasible due to water source constraints, the willow riparian revegetation areas could be irrigated via a water truck directly spraying the areas that are within reach and hose watering the extremities. The mixed riparian woodland area would ideally be irrigated by a bubbler (or drip) system. This will also depend on the size and distance to a water source. If water source constraints preclude this option, then truck or hand watering would be other options. A number of other irrigation designs are possible for the site based on the availability and size of water sources.

Irrigation frequency should provide all planting with adequate soil moisture throughout the first growing season (approximately 10 gallons per plant, two times per month). Following the first year, the willow riparian planting areas should be assessed for the need for further irrigation. The mixed riparian woodland should continue receiving irrigation at a diminished frequency for another two years (approximately 10 gallons per plant, 1-2 times per month in Year-2 and 0-1 time per month in Year-3).

3. CONSTRUCTION COST ESTIMATE

PWA recommends that the restoration in the CCER be conducted in a single construction effort to minimize disruption and mobilizations costs from creek dewatering.

3.1 CONSTRUCTION COST ESTIMATE

PWA compiled a cost estimate for construction of the project elements described in Section 2.1. It is anticipated that this cost will be refined in future phases of design. We used unit cost estimates of various project elements that can be applied to the number or scope project elements selected by the client team. For example, the cost estimates for floodplain grading are based on an estimated unit cost for excavation and placement of $10 per cubic yard (based on recent floodplain projects). Actual costs may vary depending on excavation complexity, availability of local contractors, timing, and other factors.

Table 8. Estimated Cost of CCER Project Elements

Item	Project Element	Unit Cost	Unit	Quantity	Cost	Note
1	**Site Preparation**					
	Mobilization/Demobilization		Lump Sum	1	$ 200,000	4
	Clearing and Grubbing	$ 500	Acre	27	$ 13,500	5
	Dewatering (all in channel work)	$ 100,000	Month	4	$ 400,000	6, 7, 8, 9
2	**Earthwork**					
	Grading F4	$ 10	Cubic Yard	57,564	$ 575,640	10, 11
	Avulsion Grading and Fill	$ 10	Cubic Yard	19,000	$ 190,000	10, 11
	Grading Top Soil	$ 10	Cubic Yard	21,572	$ 215,720	10
	Grading F5	$ 10	Cubic Yard	28,062	$ 280,620	11
	Grading F7	$ 10	Cubic Yard	15,082	$ 150,820	11
	Levee Breaching	$ 50	Linear Foot	2,000	$ 100,000	11
3	**Structure & Habitat Elements**					
	Bank & Toe Stabilization	$ 250	Linear Foot	1,500	$ 375,000	12, 13
	LWD Structures	$ 10,000	Each	10	$ 100,000	14
	RLF Pond	$ 7,000	Each	6	$ 42,000	15
4	**Revegetation & Public Access**					
	Native Grassland	$ 5,000	Acre	20	$ 100,000	16
	Upland Vegetation	$ 55,000	Acre	6	$ 330,000	17
	Riparian Vegetation	$ 100,000	Acre	6	$ 600,000	18, 19
	Trail (Asphalt)	$ 12	Linear Foot	8,000	$ 96,000	
				SUBTOTAL	$ 3,769,300	
				Contingency (25%)	$ 942,325	
				TOTAL	**$ 4,711,625**	

Item	Additional Items					
A	Technical and Design Services				$ 753,900	20
				PROJECT TOTAL	**$ 5,465,525**	

Notes

1 Unit costs are based on cost estimates and bid prices from other similar, recently constructed projects. Costs are based on schematic level design.
2 Estimated construction costs were discussed and reviewed by Hanford ARC (1/24/08).
3 Costs may be reduced through design development and refinement as well as local partnering strategies.
4 Assume 5% of total construction costs for staging, equipment, rentals, etc.
5 Assume that remaining vegetation and roots will be mulched into topsoil (after mowing) using soil mower or equivalent.
6 Assume two part dewatering system including coffer dam and site specific sump set up.
7 Assume dewatering will be separated into 2 to 3 sections/reaches.

8 Assume 12-inch pump and smaller backup pump to supply gravity system (24-inch bypass pipe) to provide redundant/distribution system if water is contaminated. Outlet protection/ energy dissipation.
9 Dewatering item assumes purchase of pipe; does not include costs for fish relocation.
10 Assume topsoil harvest, stockpiling and re-spreading.
11 Excavate edge of flood plain at channel with excavator; utilize scrapers for middle of terrace.
12 Assume willow baffle structures include provision, hauling, delivery, staging and installation of live material.
13 Assume vegetated rock toe protection and live brush mattress on cut bank areas.
14 LWD - assume provision, hauling, delivery, staging and installation of logs.
15 Assume 500 square foot pond.
16 Assume seed placement by drill seeder and tractor.
17 Assume 50 Tree-pots per acre, temporary irrigation and browse protection.
18 Assume planting of D-pots, Tree-pots and live cuttings; seed placement by drill seeder and tractor.
19 Estimate assumes prevailing wage (government funding).
20 Assume 20% of total construction costs.
21 Assume 5% cost increase/escalation annually on all project elements (wages, fuel, etc) after 2009.

4. PROJECT BENEFITS

The fundamental purpose of the CCER project is to restore and enhance the floodplain and channel habitat of Chorro Creek, while reducing sediment loading to Morro Bay Estuary. The detailed Goals and Objectives of the CCER Long Term Restoration and Management Plan were reviewed by the Technical Advisory Group and the public as part of the Existing Conditions Assessment (PWA, 2005). Goals represent a general outcome of the project, and objectives provide specific measurable outcomes. Objectives are independent of one another, and ultimately trade-offs may be required where objectives are mutually exclusive.

The goals and objectives are shown in Table 9 to provide a context for the project benefits (Note: the goals have been re-ordered to fall into similar groups):

Table 9. Goals and Objectives of the CCER Project

Goal 1: Floodplain restoration – allowing the floodplain, which has been modified by levees and grading for agriculture, to return to a more natural function. **Objective 1A: Increase the frequency and extent of floodplain inundation** **Objective 1B: Remove impediments to lateral creek migration** **Objective 1C: Increase channel geomorphic stability**
Goal 2. Sediment capture – preventing as much sediment as possible from entering the bay downstream, without jeopardizing other important resources. **Objective 2A: Increase the amount of sediment trapped on the floodplain** **Objective 2B: Intercept gully erosion and sediment from Hollister Peak**
Goal 3. Erosion control – reducing, to the extent possible, erosion from existing conditions and preventing significant erosion from future modifications to the site. **Objective 3A: Prevent knickpoint migration from incised to less-incised channel reaches** **Objective 3B: Reduce bank erosion in incised reaches** **Objective 3C: Stabilize the avulsion channel and other eroding floodplain channels and gullies**

Goal 4. Freshwater wetlands habitats – expanding the width of the riparian corridor, developing (or re-creating) freshwater wetlands, overflow channels and ponds. **Objective 4A: Increase the area and enhance the function of riparian woodland** **Objective 4B: Increase the area of shallow (1-2 foot depth) seasonal wetland** **Objective 4C: Increase the number of deeper (3-5 foot depth) ponds** **Objective 4D: Increase the number and length of overflow channels**
Goal 5. Special status species – the protection and enhancement of habitat for special status plant and animals. Increase the amount and function of habitat for the following species: **Objective 5A: California Red-Legged Frog,** **Objective 5B: western pond turtle,** **Objective 5C: Coast horned lizard,** **Objective 5D: California legless lizard,** **Objective 5E: Long-eared Owl,** **Objective 5F: Burrowing Owl,** **Objective 5G: Northern Harrier,** **Objective 5H: White-tailed Kite,** **Objective 5I: Loggerhead Shrike,** **Objective 5J: California Horned Lark,** **Objective 5K: Least Bell's Vireo,** **Objective 5L: California Yellow Warbler,** **Objective 5M: Yellow-breasted Chat,** **Objective 5N: Golden Eagle,** **Objective 5O: Peregrine Falcons,** **Objective 5P: Morro shoulderband snail.**
Goal 6. Steelhead habitat enhancement – improving in-stream habitat, including the possibility of mitigating impacts from non-native pike minnow. **Objective 6A: Increase the amount and function of habitat for steelhead** **Objective 6B: Ensure that increasing floodplain connectivity does not increase fish stranding**

Goal 7. Restoration of native vegetation and exotics control – the need to mitigate a wide range of exotic plant species, including some that are potentially noxious (distaff thistle, yellow start thistle, arundo) and the possibility of restoring native species in the floodplain. **Objective 7A: Increase the extent and function of native vegetation** **Objective 7B: Remove non native species** **Objective 7C: Manage revegetation by native species to permit natives to outcompete non-natives during establishment phase** **Objective 7D: Long-term site adaptive management to control non-native species**
Goal 8. Avoiding downstream flooding – avoiding the project's exacerbation of any potential flooding downstream of the site. **Objective 8A: Design the project so that flood conveyance/detention capacity is increased, reducing downstream peak flows** **Objective 8B: Prevent any increase in flood hazards to off-site facilities; return floodplain flows to the channel upstream of the property boundary**
Goal 9. Conservation of archaeological and historical resources – appropriate treatment of these resources; possible excavation of historic subsurface resources. **Objective 9A: Ensure that cut and fill areas are appropriate for the preservation of cultural resources** **Objective 9B: Ensure that channel does not erode cultural resources** **Objective 9C: Route trails to avoid sensitive cultural resources where appropriate, and to allow viewing of less sensitive resources if desired**
Goal 10. Public access and education – access lateral to the highway, eventually to link with a San Luis Obispo to Morro Bay trail; access for public education in a manner not detrimental to the natural resources of the property. **Objective 10A: Plan for nature viewing areas and trails that will minimize natural impact**
Goal 11. Monitoring and research – accommodation of monitoring and researcher requiring site access and its resources in a manner not detrimental to the natural resources of the property. **Objective 11A: Plan for site access** **Objective 11B: Document pre-project and as-built conditions to allow performance monitoring and adaptive management** **Objective 11C: Provide measurable objectives to facilitate subsequent monitoring and evaluation**

4.1 RESTORED GEOMORPHIC AND HABITAT ELEMENTS

Restoration of the CCER will add an important upstream element to the linked aquatic, estuarine and riparian ecosystem that extends inland from Morro Bay through Chorro Flats and will now extend further into the watershed, and connect with adjacent upland areas. It provides the opportunity to add valuable channel aquatic, floodplain, tributary channels and upland habitat to this sequence of ecosystem elements. It expands the range and diversity of habitats that are within public agency management, while providing additional opportunities to protect and enhance the downstream habitat areas via sediment retention, improved steelhead habitat, connectivity for other listed or important wildlife and vegetation species, exotic species management, public access and use, and visual resources.

Changes in sediment yield from the proposed project have two components:

- An increase in floodplain sediment trapping because of the larger floodplain areas and roughness
- A decrease in channel erosion because of a reduction in channel flow depth and velocity during out-of-bank flows and stabilization of the eroding avulsion channel (which is currently generating a high sediment load).

Sediment transport models developed by PWA (2006) suggest that creating graded floodplain areas may increase the long-term amount of sediment trapped on the floodplain by approximately 500 cubic yards (cy) per year, from approximately 1,300 to 1,800 cy. This is equivalent to a depth of 0.12 inches per year over the entire floodplain area (0.25 inches as an upper bound estimate). There will be less channel erosion under the project conditions as flow elevations and velocities will be lower than under project conditions. Scour potential will be reduced or eliminated in the later design stages of the project by designing smoother transitions from the floodplain to the channel, and by introducing channel roughness elements such as LWD weirs. The avulsion channel has contributed about 19,000 cy of sediment downstream over the past five years. Stabilization of this feature will eliminate further contributions of the sediment source.

Channel bank and bed stabilization will reduce sediment loading and increase the habitat value of the reach by creating more diverse channel habitat. Approximately 10 LWD structures will increase floodplain connectivity and enhance conditions for CRLF and other species by providing increased cover, lowered water temperatures, and increased channel complexity. These structures will enhance the existing habitat and floodplain connectivity in Reaches 2 to 4. CRLF habitat also will be enhanced through the creation and enhancement of five ponded areas on site.

The proposed design will produce a mosaic of native vegetative and wildlife habitats. Floodplain grading and levee breaching will create approximately 40 acres of riparian woodland habitat. In addition, approximately 20 acres will be restored to native grasslands. The success of the vegetation in these areas will be augmented by invasive plant eradication and thorough maintenance and monitoring (see Chapter 5).

Managed public access and recreation will be provided on the site. This will include a linkage to the proposed San Luis Obispo to Morro Bay Regional Trail, along the existing frontage road alignment as a bike and/or pedestrian route. Directed onsite access will be provided for research and maintenance purposes and other access as determined by the client team.

5. MONITORING AND MAINTENANCE RECOMMENDATIONS

One of the project goals is to establish an ongoing monitoring and research program for the CCER site. We recommend that monitoring include both physical processes (geomorphology/hydrology) and ecological elements. We provide a preliminary monitoring plan for the CCER that can be refined in later project stages.

5.1 PHYSICAL PROCESSES MONITORING AND MAINTENANCE

5.1.1 Monitoring

The project monitoring plan will provide information to identify maintenance activities during the establishment period, guide future project implementation phases, and provide valuable "lessons learned" to improve future restoration practice. There are several goals of post-project monitoring from a physical processes standpoint:

1. Monitoring channel and bed stability, lateral and longitudinal channel migration, to ensure establishment of dynamically stable channel
2. Quantifying sediment reduction
3. Measuring flood inundation to inform future post-project hydraulic models and to quantify reduction in flood hazards.

To accomplish these goals, PWA recommends performing baseline surveys of the post-project channel topography, photo points at key locations, and periodic site inspections. A representative cross section should be established in each reach, across each floodplain area, and in key locations such as the avulsion channel. These cross section locations should be monumented using survey grade GPS to ensure accurate occupation over time. Key geomorphic features will be represented in both the cross section and profile surveys: top of bank; toe of bank; knickpoint locations; channel thalweg; toe of slopes; grade breaks; depositional surfaces on floodplain terraces; and channel bars. The cross section locations will be photo documented. These cross sections can be surveyed on a yearly basis and should be occupied following the first flood event after construction.

Ground-based LiDAR technology is rapidly becoming an effective method for monitoring restoration projects because large areas can be surveyed with high precision. The ground-based LiDAR technology could be applied in the channel and floodplain areas immediately surrounding the avulsion channel and downstream bank stabilization. We recommend that the post-construction survey cross-sections be re-surveyed at years 1, 2, 5, and 10 following project implementation.

Maximum water surface elevations should be marked during flood events at or exceeding the 2-year frequency (those floods which exceed channel banks and inundate the floodplain restoration areas). These elevations can be used to calibrate future hydraulic models which can be compared to existing conditions to estimate the reduction in flood hazards and velocities resulting from the project design. Water surface elevations can be monitored additionally by installation of a flow gauge at the upstream end of Reach 4.

5.1.2 Maintenance

The physical processes monitoring will provide a basis for any recommended maintenance activities. These would include maintenance or repair of any of the in-channel, bank-side, or pond facilities that may undergo erosion or damage during high-flow events in the establishment period. The monitoring will also be used to guide additional site enhancement opportunities.

5.2 ECOLOGICAL MONITORING AND MAINTENANCE

5.2.1 Monitoring

The following section presents H. T. Harvey & Associates' recommended approach to long-term ecological monitoring of the riparian vegetation and CRLF habitat restoration components of the conceptual plan. Our approach is designed to provide adequate input to the restoration site manager(s) and regulatory agency personnel to:

1. Determine if the habitat goals of the restoration plan are being achieved
2. Facilitate adaptive maintenance and management decision-making during the first 5-10 years following construction to steer site development toward the long-term habitat goals

This section is intended to provide the broad framework for long-term ecological monitoring. As such, it does not provide detailed monitoring methodology which would be developed in future planning phases.

5.2.1.1 Riparian Habitat Restoration Monitoring

The conceptual riparian revegetation plan targets the restoration of two different plant associations moving laterally away from the creek along the moisture gradient: willow riparian and mixed riparian woodland. The plan also calls for an experimental approach to revegetation of the willow riparian zone by installing three planting treatments: no planting areas, moderate planting areas, and dense planting areas. The purpose of this approach is to determine via long-term monitoring the effect of active willow planting on willow habitat establishment. This information can then be utilized both to determine whether and what type of active planting should be implemented in the no planting areas on-site and to inform future designs at similar sites.

The riparian restoration monitoring summarized below will be conducted for a minimum of 10 years following construction during years 1, 2, 3, 4, 6, 8, and 10.

Vegetation monitoring will focus on the following questions:

1. How does the rate and spatial extent of willow riparian habitat establishment compare between the active planting treatments: no planting, moderate planting, dense planting?
2. Is the mixed riparian habitat successfully establishing in the revegetation zone?
3. How does the spatial extent of willow riparian and mixed riparian habitat establishment relate to flood and sedimentation events and natural recruitment (based on qualitative visual observations in the field)?
4. What adaptive management/revegetation maintenance actions should be taken to promote successful habitat establishment?

Questions 1 and 2

A restoration ecologist will conduct quantitative sampling to estimate the following response variables:

- percent survival by woody riparian species and riparian invasive species
- average percent cover by species, habitat type, and willow planting treatment
- average tree height by species
- average health and vigor by species

The sampling and data analysis will be designed to characterize the changes in the composition of each planted habitat type over time (willow, mixed riparian) and to compare average percent cover between the no planting, moderate planting, and dense planting treatments.

Question 3

A restoration ecologist will conduct a reconnaissance survey of the willow riparian and mixed riparian habitat restoration areas to qualitatively characterize natural recruitment in relation to visual evidence of flooding and sedimentation. Substantial patches of native riparian woody species recruitment will be mapped and the relationship of these patches to areas with evidence of flooding/sedimentation will be noted.

Question 4

The information collected to answer the above questions will be utilized to determine if adaptive management/maintenance actions are necessary to help achieve the revegetation goals (stated above in the conceptual restoration plan section). In addition, the locations of riparian invasive species such as giant reed will be mapped to facilitate eradication, and the locations of dead plants to be replanted will be flagged. The restoration ecologist also will inspect revegetation maintenance activities (e.g., adequacy of weed control, irrigation, irrigation system functioning, foliage protection cages and fencing) to help determine if changes in revegetation maintenance are warranted to facilitate establishment of the target vegetation.

5.2.1.2 California Red-legged Frog Monitoring

The conceptual restoration plan proposes several measures designed to benefit the CRLF. The plan proposes the construction of up to 5 new CRLF breeding ponds upslope of the active Chorro Creek and Walters Creek floodplains. The purpose of the ponds is to create high quality CRLF breeding habitat that is relatively free of CRLF predators which are present in Chorro Creek (e.g., pike minnow and bullfrog). Achieving this goal should substantially increase the abundance and help support the long-term persistence of CRLF in the project vicinity. In addition, the concept design includes a series of large woody debris structures within the Chorro Creek streambed to stabilize the channel and increase aquatic habitat quality. These structures will likely create scour pools in their vicinity which could increase breeding habitat for CRLF in Chorro Creek.

The CRLF monitoring summarized below will be conducted annually for a minimum of 5 years following construction. All of the constructed off-channel ponds will be monitored. In addition, a representative subset of the instream pools will be monitored. Long-term CRLF monitoring will be conducted to answer the following questions:

1. Do the constructed, off-channel CRLF ponds provide breeding habitat for CRLF? Does the hydroperiod and vegetation provide habitat typically adequate for breeding? Are CRLF actually breeding in the ponds?
2. Do the in-stream woody debris structures and associated pools in Chorro Creek provide breeding or nonbreeding habitat for CRLF? Does the hydroperiod and vegetation provide habitat typically adequate for breeding? Are CRLF actually breeding in the ponds?
3. If Walters Creek does avulse into the adjacent swale within Floodplain Area A, does this avulsion substantially degrade the habitat quality for CRLF within Walters Creek?

Questions 1 and 2

Water depth and topography (along a typical section) will be monitored in each of the constructed off-channel ponds and in a subset of representative instream pools to characterize the hydroperiod. In addition, a herpetologist will qualitatively assess the overall habitat quality for CRLF in both the off-channel ponds and instream pools.

A herpetologist holding a 10(a)(1)(A) permit for the CRLF from the U. S. Fish and Wildlife Service, or authorized to handle CRLF under this project's Biological Opinion, will conduct 4 surveys annually for CRLF adults and larvae. These surveys should be conducted with the same methodology before and after restoration. The surveys will be conducted monthly from May to July and will include 4 daytime dipnet surveys for larvae and 4 nighttime headlamp surveys for adults and juveniles. The number and location of larvae, juveniles, and adults will be recorded. However, it should be understood that such surveys typically have a high degree of variability based on numerous factors that are not related to the project's restoration actions, such as temperature and precipitation. Therefore, the primary goal of these surveys is to determine if CRLF are successfully breeding in the construction ponds/pools and to provide a crude measure of minimum abundance, not to determine temporal changes in population size. Successful breeding in the constructed off-channel ponds would indicate that the project is having a beneficial effect on CRLF in the area. Also, detection of a substantial and consistent increasing trend in CRLF abundance after restoration would provide some indication that the restoration actions are increasing CRLF abundance.

The herpetologist will also record the presence and abundance of predators (e.g., bullfrogs) observed during the surveys.

Question 3

A herpetologist will conduct 4 daytime and 4 nighttime surveys annually in a representative reach of Walters Creek according to the same methods prescribed above. In addition, water depth in Walters Creek will be measured 4 times annually at representative locations to characterize its hydroperiod. This approach will facilitate an assessment of the effects of an avulsion on CRLF if this event occurs during the monitoring period.

5.2.2 Maintenance

Within the willow riparian planting zone, the "No Planting" areas will require no regular maintenance unless invasive, non-native weeds colonize them. The "Dense and Moderate Willow Planting" areas will require no regular maintenance except for irrigation. If any of the Willow Riparian Revegetation areas become infested with invasive, non-native plants, maintenance (i.e. weed eradication) will be implemented as adaptive management to provide the best opportunity for the planted willows and cottonwoods to successfully establish. Maintenance in the mixed riparian woodland would consist of the following:

- Irrigation for 3-year plant establishment period
- Hand weeding within irrigation basins
- Maintaining foliage protection cages in good order
- Maintaining irrigation basins so that earthen berms are sufficient to provide adequate water holding capacity and mulch is 3 inches thick

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8. LIST OF FIGURES

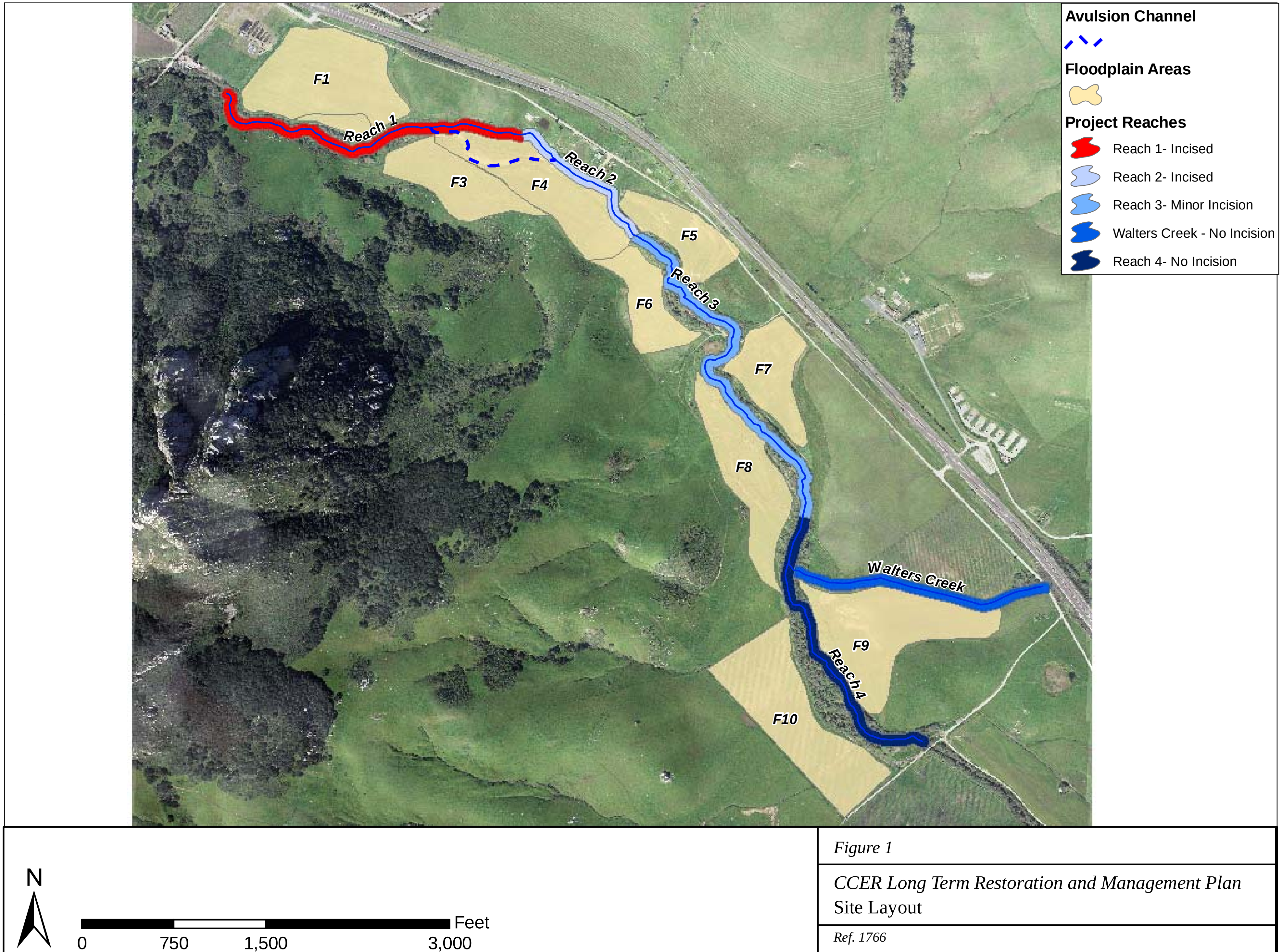
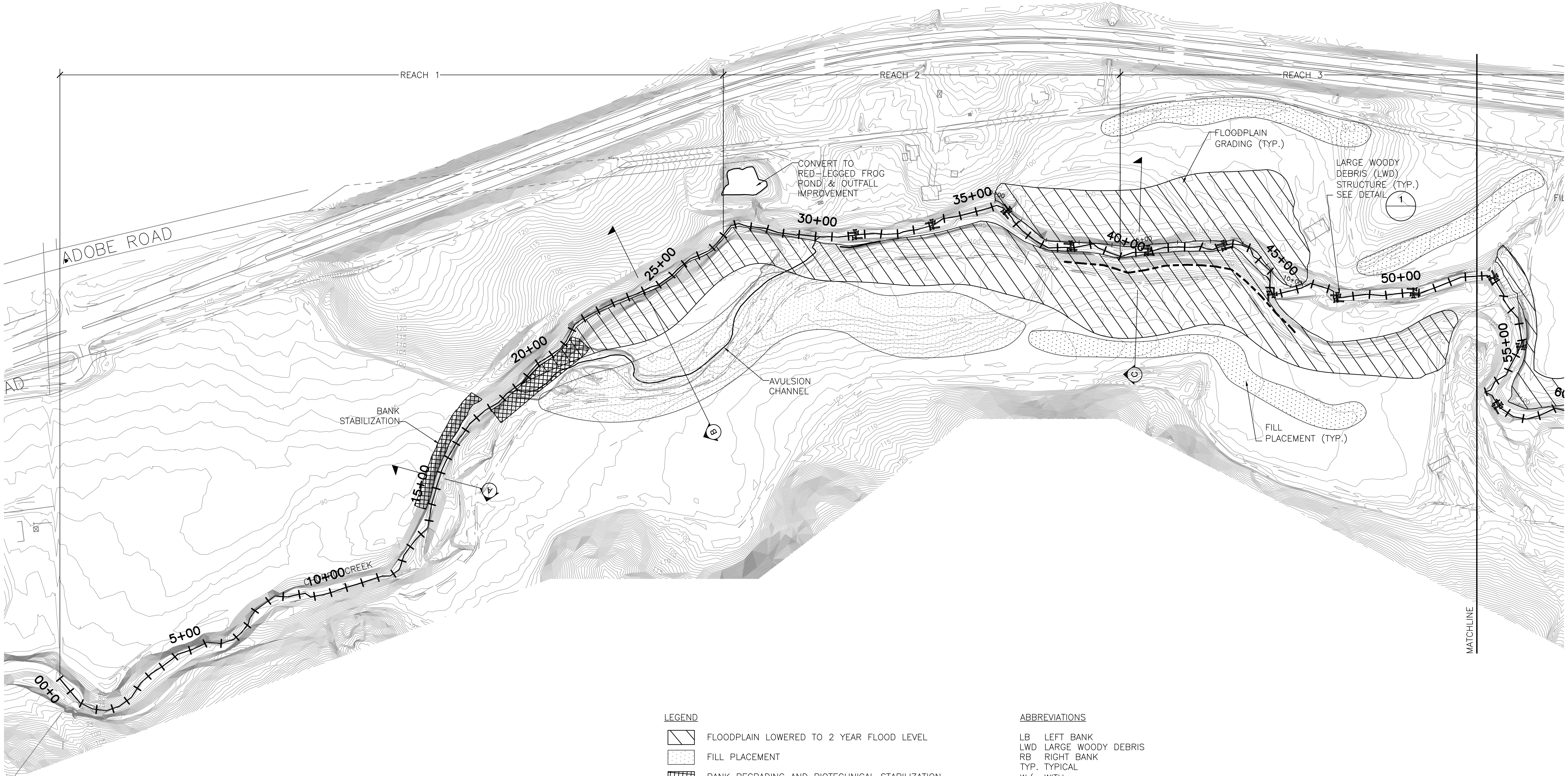


Figure 1

CCER Long Term Restoration and Management Plan
Site Layout

Ref. 1766



LEGEND

- FLOODPLAIN LOWERED TO 2 YEAR FLOOD LEVEL
- FILL PLACEMENT
- BANK REGRADING AND BIOTECHNICAL STABILIZATION
- REMOVE LEVEE
- LWD HABITAT STRUCTURES (TYP.) (TO BE FIELD LOCATED)
- BOULDER STEP-POOL STRUCTURES

ABBREVIATIONS

LB LEFT BANK
LWD LARGE WOODY DEBRIS
RB RIGHT BANK
TYP. TYPICAL
W/ WITH

N

100 0 100 200 300
SCALE (FEET)

PRELIMINARY
NOT FOR CONSTRUCTION

REVISED GRADING LIMITS 05-23-2007

REV. NO.	DATE	BY	DESCRIPTION

ENGINEER'S STAMP

DESIGNED	AC/AP
DRAWN	PLL
CHECKED	JH
PWA JOB NO:	1766

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CCER LONG TERM RESTORATION AND MANAGEMENT PLAN

RESTORATION PLAN
LOWER REACH

SCALE	DATE
1" = 300'	10-17-08

FIGURE
2

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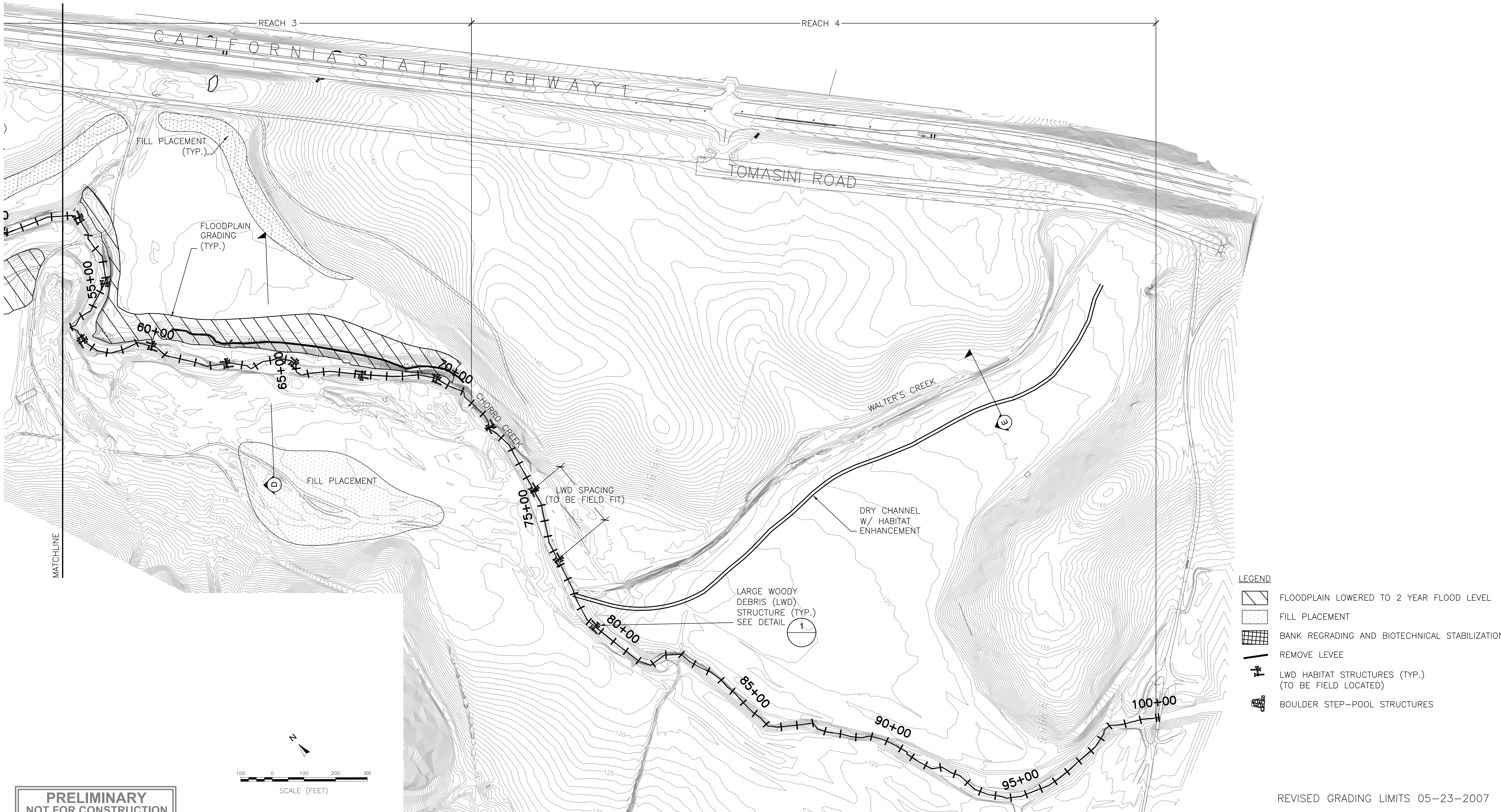

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REV. NO.	DATE	BY	DESCRIPTION	ENGINEER'S STAMP	DESIGNED AC/AP
					DRAWN PLL
					CHECKED JH
					PWA JOB NO: 1766

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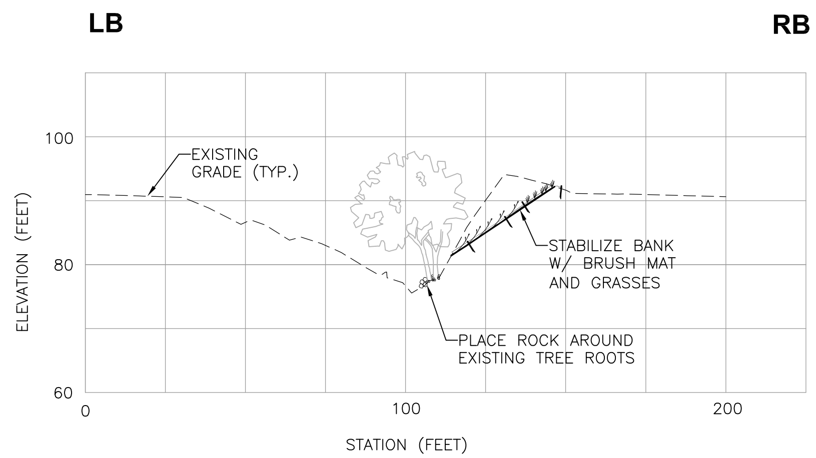
CCER LONG TERM RESTORATION AND MANAGEMENT PLAN

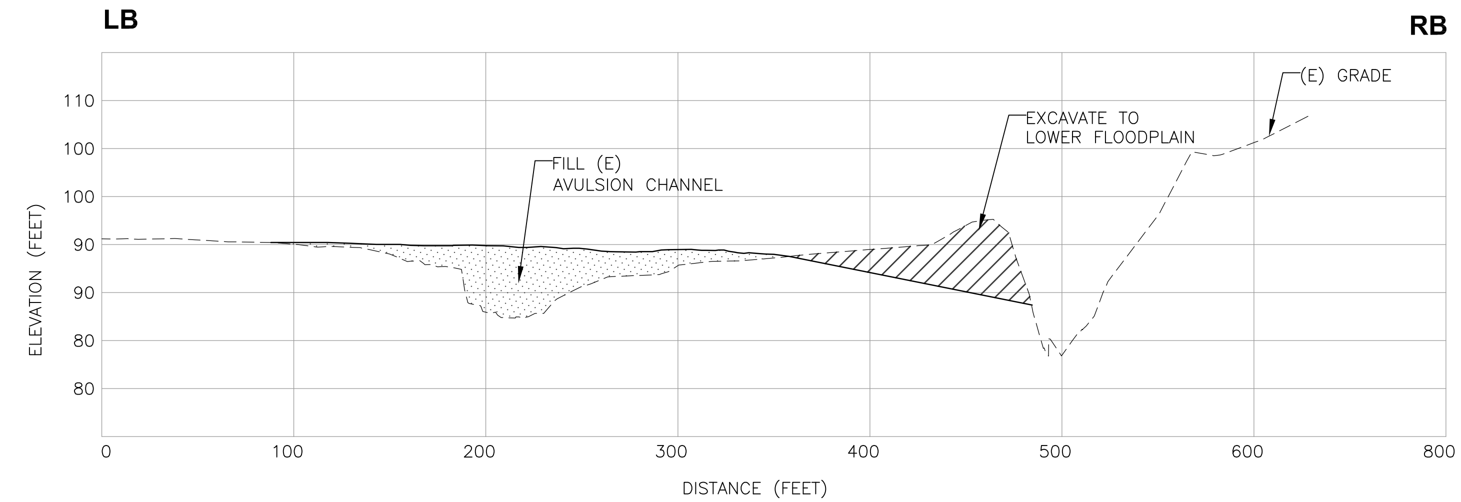
RESTORATION PLAN UPPER REACH

SCALE	DATE
1" = 300'	10-17-08
FIGURE 3	



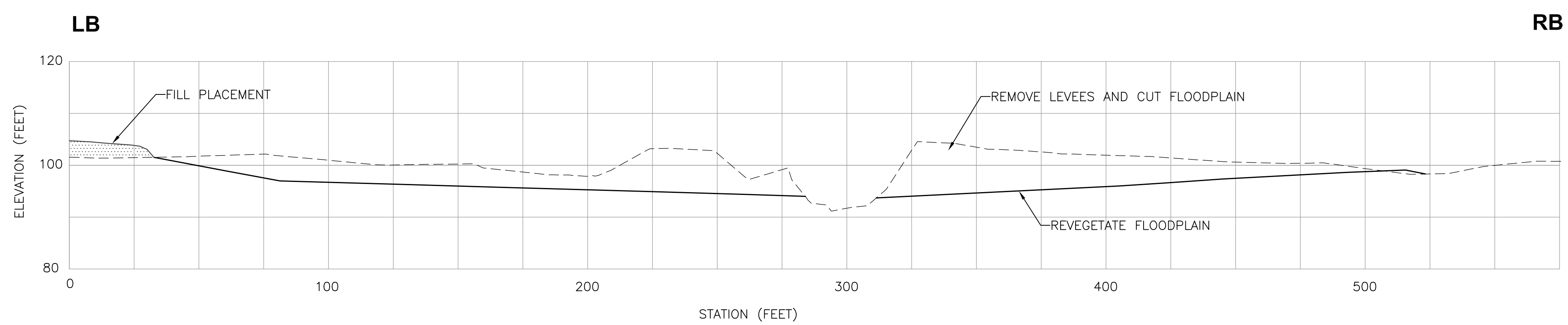
A CROSS-SECTION

SCALE:
HORIZ. 1"=60'
VERT. 1"=30'



B CROSS-SECTION

SCALE:
HORIZ. 1"=60'
VERT. 1"=30'



C CROSS-SECTION

SCALE:
HORIZ. 1"=60'
VERT. 1"=30'

PRELIMINARY
NOT FOR CONSTRUCTION

NOTE
1. RIGHT BANK (RB) AND LEFT BANK (LB) ARE DEFINED WHEN FACING DOWNSTREAM.

REV. NO.	DATE	BY	DESCRIPTION

ENGINEER'S STAMP

DESIGNED AP/AC
DRAWN RAF
CHECKED JH
PWA JOB NO: 1766

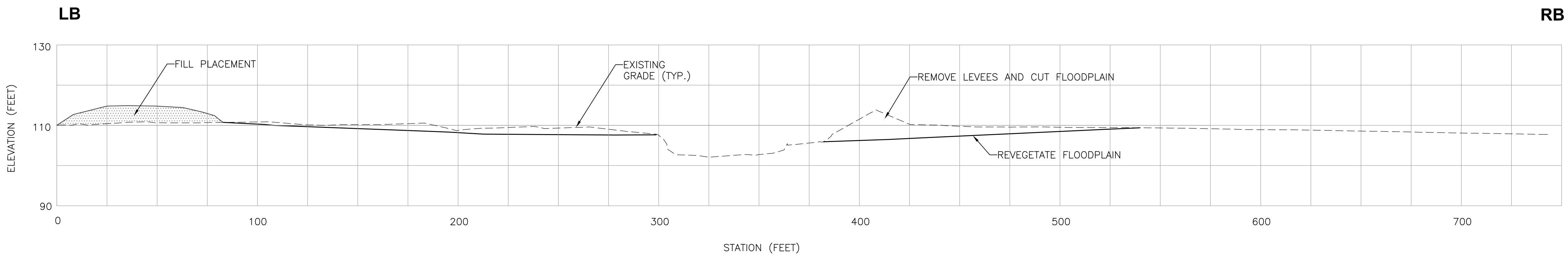
PREPARED FOR:
MORRO BAY NATIONAL ESTUARY PROGRAM
601 EMBARCADERO, SUITE 11
MORRO BAY, CA 93442
805-772-3834
AND
RESOURCES AGENCY CALIFORNIA DEPARTMENT OF FISH & GAME

PREPARED BY:
PWA
PHILIP WILLIAMS & ASSOCIATES, LTD.
ENVIRONMENTAL HYDROLOGY
550 KEARNY STREET, SUITE 900
SAN FRANCISCO, CALIFORNIA 94108
PHONE (415) 262-2300 FAX (415) 262-2303

CCER LONG TERM RESTORATION AND MANAGEMENT PLAN

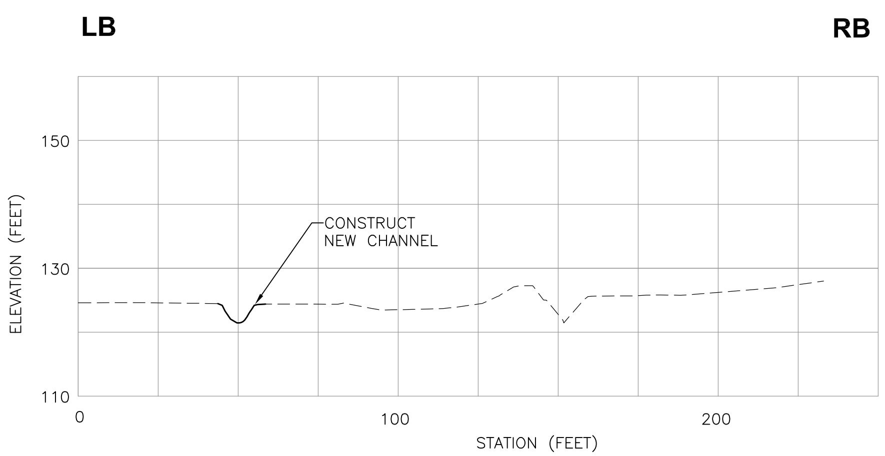
GRADING SECTIONS

SCALE AS SHOWN
DATE 10-17-08
FIGURE 4



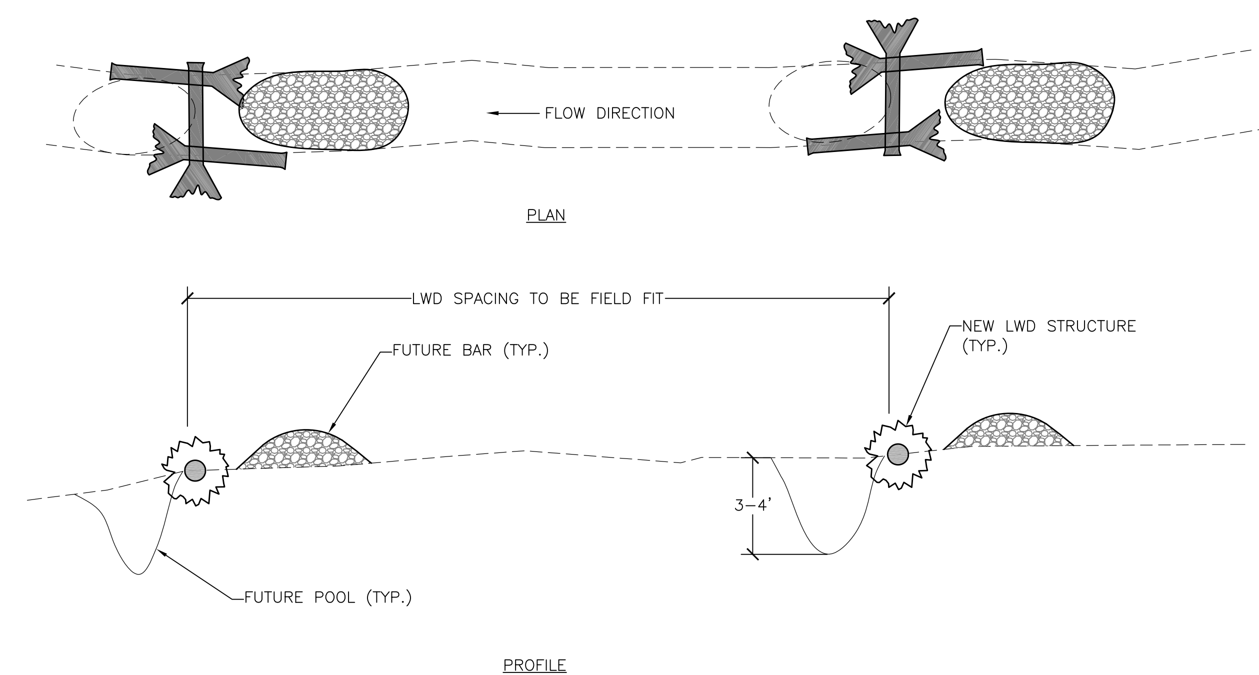
D CROSS-SECTION

SCALE:
HORIZ. 1"=60'
VERT. 1"=30'



E CROSS-SECTION

SCALE:
HORIZ. 1"=60'
VERT. 1"=30'



1 LARGE WOODY DEBRIS STRUCTURE
TYPICAL DETAIL

SCALE:
NOT TO SCALE

PRELIMINARY
NOT FOR CONSTRUCTION

NOTE
1. RIGHT BANK (RB) AND LEFT BANK (LB) ARE DEFINED WHEN FACING DOWNSTREAM.

Q:\Projects\1766_Chorro\drawings\Final Report\1766_XS_Fig4-5.dwg 10-30-08 04:16:55 PM p.luecking

REV. NO.	DATE	BY	DESCRIPTION

ENGINEER'S STAMP

DESIGNED	AP/AC
DRAWN	RAF
CHECKED	JH
PWA JOB NO:	1766

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MORRO BAY NATIONAL ESTUARY PROGRAM
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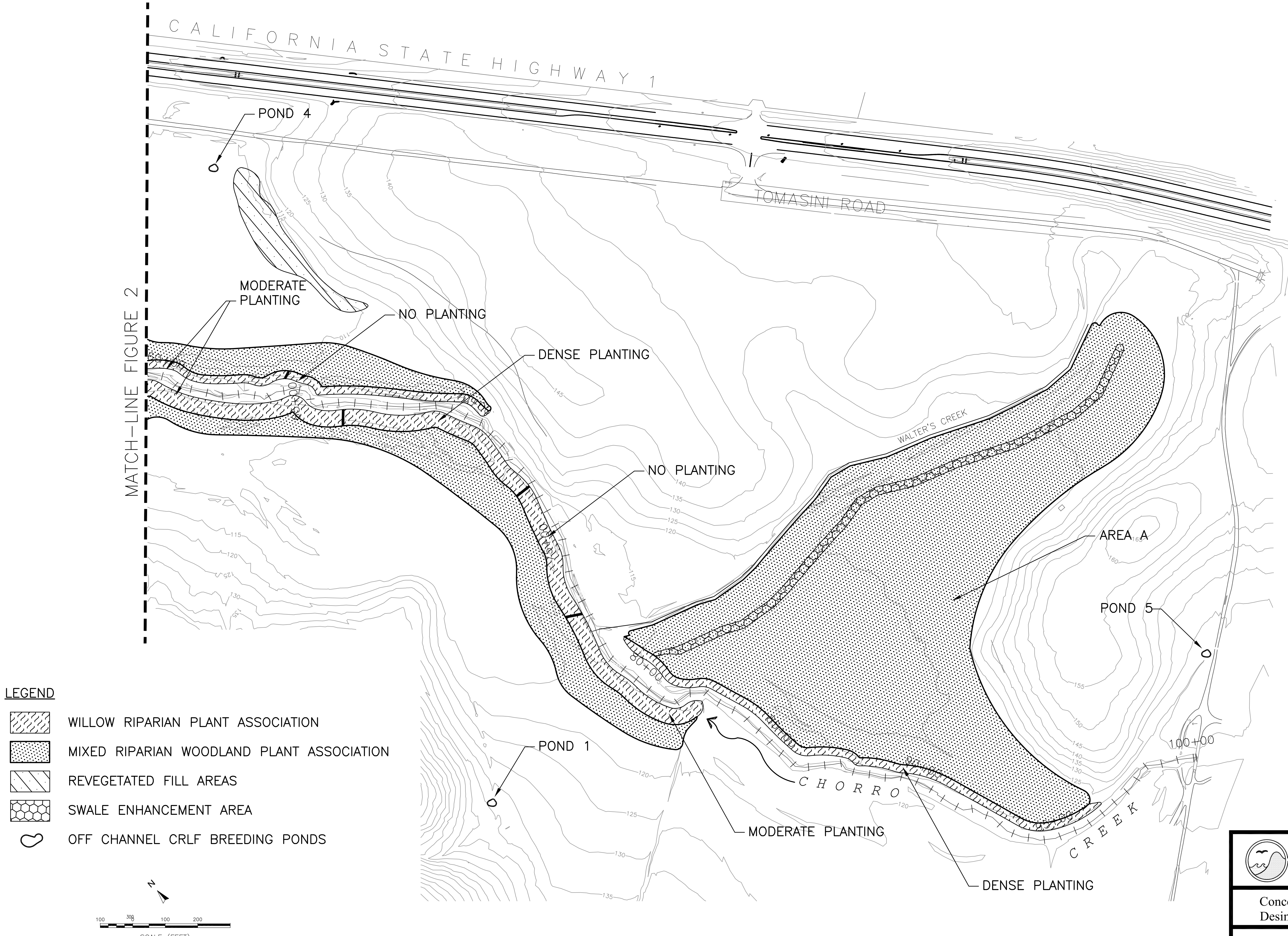
CCER LONG TERM RESTORATION AND MANAGEMENT PLAN

GRADING SECTIONS

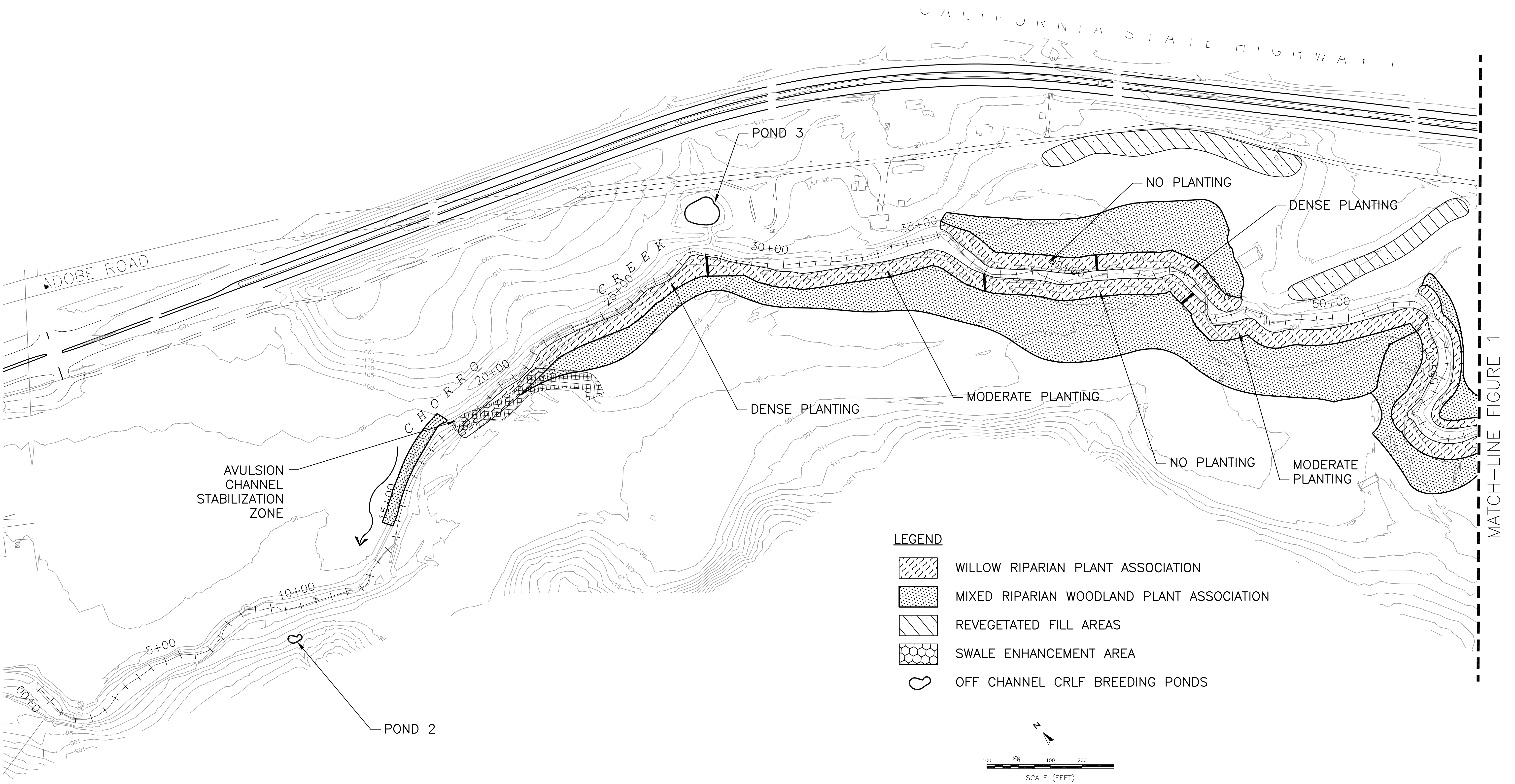
SCALE	DATE
AS SHOWN	10-17-08
FIGURE	5



H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

Conceptual Revegation & CRLF Breeding Pond Desing: Plan View of Upper Reach

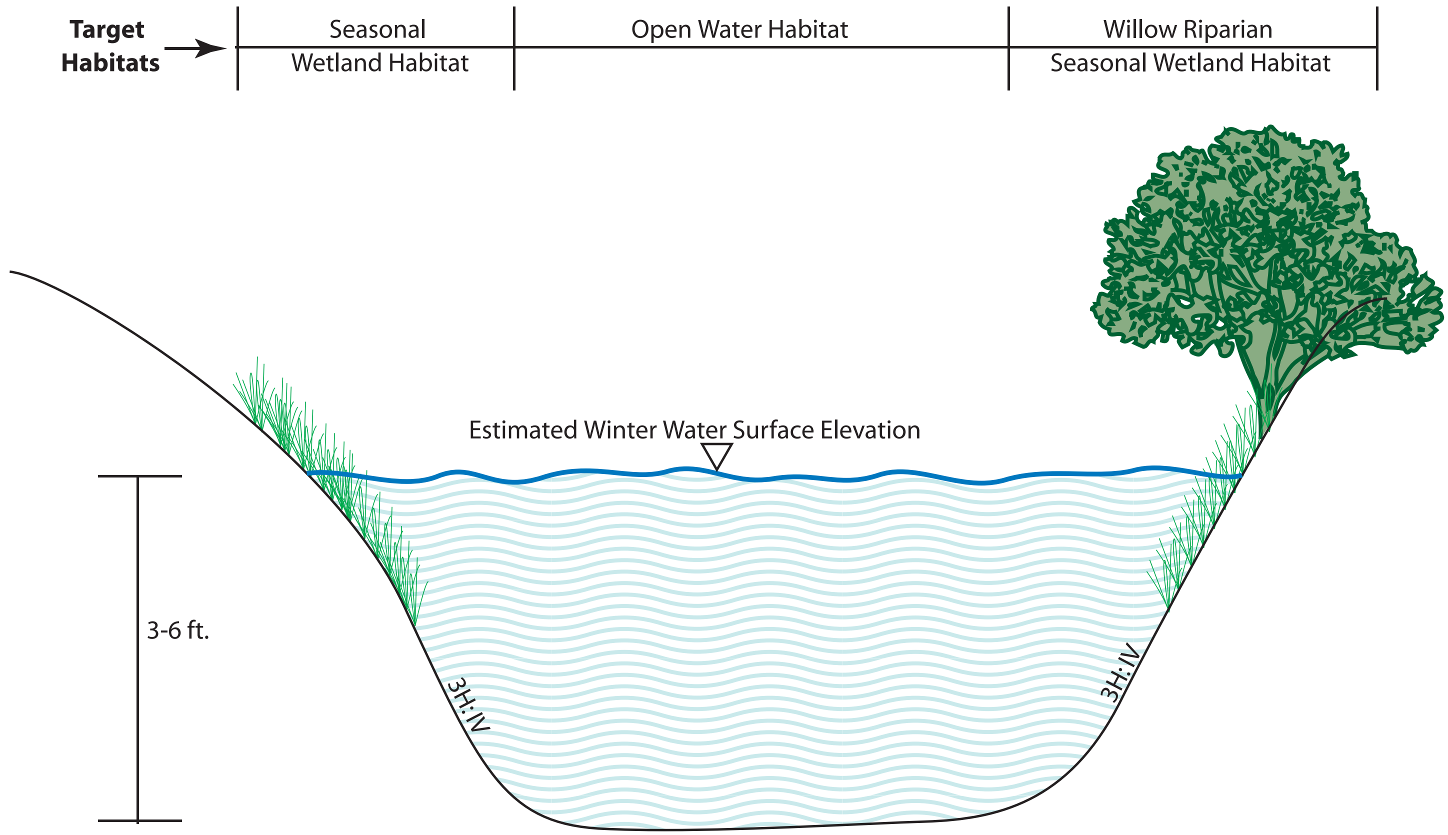
Proj No. 2487-01	Date Feb 2007	Figure 6
JMH	2487\01\Gr\Cad	



H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

Conceptual Revegetation & CRLF Breeding Pond Design: Plan View of Lower Reach

Proj No. 2487-01	Date Feb 2007	Figure 7
JMH	2487\01\Gr\Cad	



Not - to - Scale

Legend

Seasonal Wetland Vegetation

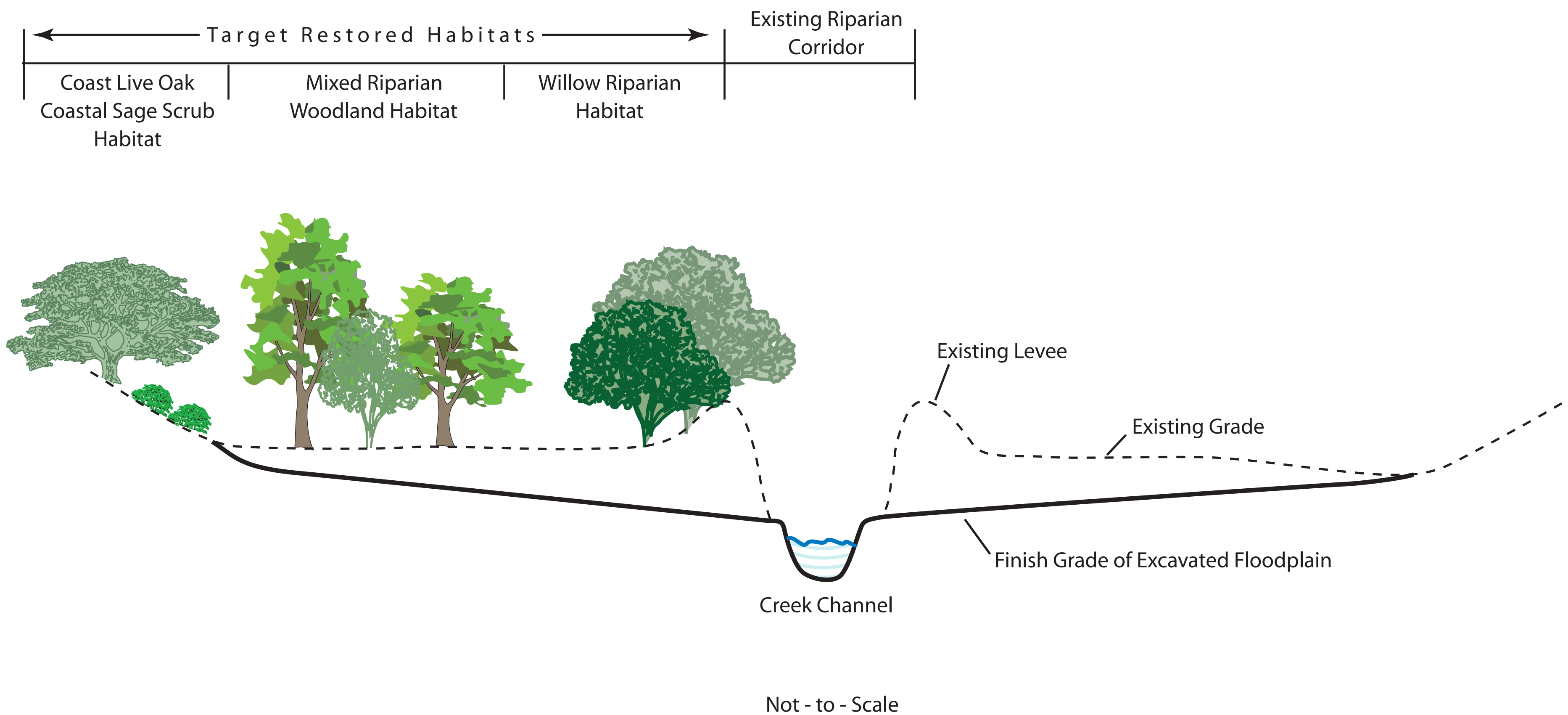
Willow Riparian Vegetation (planted along approximately 50% of perimeter of pond)

Chorro Creek Ecological Reserve Conceptual Restoration Plan

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

CRLF Breeding Pond Conceptual Design:
Typical Cross-section

File No. 2487-01	Date Jan. 2008	Figure 8



H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

Conceptual Revegetation Plan:
Typical Cross-section

File No. 2487-01 | Date Feb 2007 | Figure 9

Chorro Creek Ecological Reserve Conceptual Restoration Plan