SAN PEDRO CREEK RESTORATION PLAN

Volume IV

Prepared By
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San Pedro Creek
Restoration Plan

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SAN PEDRO CREEK MASTER PLAN RESTORATION AND BANK STABILZATION TREATMENTS AND PLANS

1.1 INTRODUCTION

This Master Plan defines the range of bank stabilization and revegetation techniques that are most appropriate for the lower 2.5 miles of San Pedro Creek. The Master Plan emphasizes minimizing structural approaches or adapting them to include revegetation techniques (non-native species removal, native planting), where possible. The conceptual details and associated text are based on the San Francisquito Creek Master Plan produced by a collaborative effort by the Cities of Menlo Park, Palo Alto, East Palo Alto, the San Mateo Flood Control District and the Santa Clara Valley Water District. San Francisquito Creek is similar to San Pedro Creek in terms of the urban setting and channel down cutting and flows. Power Engineering and Phillip Williams and Associates developed the majority of the stabilization and revegetation techniques provided in this Master Plan.

Bank stabilization and revegetation techniques in this Master Plan are described at a conceptual level of detail. The general repair techniques will have to be developed in more detail and located with more accuracy by the design team in the preparation of the construction plans and specifications. The final design team will include a professional civil engineer, geomorphologist, geotechnical engineer, revegetation specialist, and fish/wildlife biologist. The design would then be reviewed and subject to approval by the City and the landowners. The construction will proceed once funding is secured.

1.2 OBJECTIVES

The primary goal of the Master Plan is to develop stabilization schemes for eroding banks that allow vegetation establishment for habitat development, streamside shading, and fisheries enhancement. Where bank protection currently exists, the plan provides a range of approaches, from complete removal and replacement to partial vegetation cover establishment using planting collars and other plant installation techniques. Where bank erosion is severe and close to existing structures, fewer approaches generally apply and tend to be less habitat-friendly.

Given the urbanized nature of the stream corridor, there are many constraints to bank stabilization and enhancement of riparian habitat. The guiding principles of the Master Plan are:

•To preserve and/or enhance the natural character of the urbanized San Pedro Creek by increasing the presence of native vegetation. This will improve overall habitat value and stabilize banks - while protecting or improving creek conditions for state-and federally-listed species.
•To stabilize banks to protect property without reducing floodwater conveyance of the creek.
•To enhance the value of the creek as a community amenity through access to public areas, interpretation and educational opportunities, and improved visual connections.
•To develop a unified approach to implementation of the plan within the project area and to streamline the permitting process for participating landowners.

1.3 EXISTING CONDITIONS

The natural habitats along the creek in the study area are mostly degraded. Bank instability is driven in large part by the predominant high banks, which range between 10 to 30 vertical feet in the study reach. The high banks are primarily a matter of concern due to their instability, coupled with the presence of nearby buildings and infrastructure. High banks that we see today are a result of this geomorphic setting, as well as anthropogenic changes in the watershed within the last century.

Bank conditions range from stable and well vegetated to nearly vertical and eroding. Most of the existing banks in the project reach are partially to mostly vegetated with native and non-native species, with the exception of those reaches with bank protection. Many sparsely vegetated banks are failing, either partially or completely.

Bank protection has generally been the responsibility of the individual landowner, except where large channel modifications were implemented. Agencies and individual property owners have responded with a variety of engineered and non-engineered bank protection schemes, some of which are failing or are incompatible with the upstream and downstream bank protection structures.

1.4 METHODS

1.4.1 GEOMORPHIC APPROACH

In the development of this Master Plan, a geomorphic approach to river management was adopted. This approach applies a holistic view of the watershed and river system, and interprets channel change in relation to basin-wide processes. In a more natural stream environment, the geomorphic approach could be applied through the Master Plan stage to characterize and predict at-risk banks based on existing and likely future geomorphic processes.

However, due to the superimposition of human development on the geologic context, bank stability cannot be easily predicted based on current fluvial processes alone. Instead, future bank instability will be a result of the interplay of the patchwork of bank stabilization projects in time and space, fluvial processes, and existing land uses. Therefore, the bank stabilization methods suggested in this Master Plan are based primarily upon existing bank conditions and adjacent land uses rather than long-term geomorphic processes. This decision-making process was selected for the following reasons:

1) Bank stabilization structures currently line most of the areas where the most extreme bank instability has occurred, including along the outside of meander bends in the study reach.

2) Banks are so steep and high that bank erosion potential is pronounced along the majority of the study reach, rather than simply concentrated in areas where hydraulic forces are maximized.

3) There is an inherent risk of increased bank instability by the installation of a number of different "fixes" over a long period of time. Therefore, it is the City's desire to proceed with a single bank stabilization project that addresses the entire stream from Peralta to Oddstatd Blvd as one permitted project and one construction project.

1.4.2 FIELD WORK

The existing geomorphic and vegetation conditions of the banks were documented during field inventories of bank, channel, and vegetation conditions.

Using extensive site investigation and detailed field mapping, the following geomorphic items were recorded:

- length of stable, eroding and revetted stream banks;
- bankfull width;
- terrace heights, condition and type of bank revetments;
- natural and anthropogenic sources and volumes of sediment supplied to the channel;
- sediment size class distribution of the channel bed;
- estimates of bed incision;
- number, volume, location, and causes of pools of 1 ft. or greater in depth;
- pool spacing;
- amount, species and location of large woody debris (LWD);
- woody debris spicing, and processes associated with LWD recruitment; and
- reach classification (Rosgen, 1994).

A general vegetation survey was conducted which enabled an analysis of frequency, dominance and the Relative Importance Value (RIV) for native and non-native species in the survey area. The information provides insights into good candidate species for use in revegetation and problematic NIS infestations that need control efforts. The survey also included the development of a detailed GIS map identifying and locating the results of the survey.

1.5 RESULTS

Ten bank stabilization and revegetation treatment alternatives are presented in this Master Plan. The treatments are adapted to the conditions found within the project reach to address the current range of physical and biological constraints. The treatments are at the conceptual level of detail. The treatments are described in order of increasing structural complexity and grading requirements. In general, costs increase as well. To the extent possible, a treatment should consider the establishment of some riparian habitat in the design.

A. No Action
B. Vegetation Only
C. Repair Protection
D. Vegetate Structure
E. Remove Structure
F. Regrade and Replant
G. Terrace
H. Riprap Toe
I. Vegetated Riprap
J. Vegetated Wall

1.5.1 TREATMENT ALTERNATIVES

“NO ACTION” ALTERNATIVE (A)

Conceptual Description
This treatment alternative includes leaving existing vegetation and/or structural bank protection in place with no revegetation. While in general the removal of exotics is recommended along San Pedro Creek, there may be certain mature, well-established species that are not invasive, provide moderate habitat, and help to stabilize the existing banks. For these reasons, in some locations existing vegetation should be retained even if composed of non-native species.

Where Appropriate
This alternative is appropriate where: 1) bank erosion is not sufficiently serious and threatening to adjacent property to warrant bank improvements or changes, 2) existing structural bank protection does not readily permit revegetation and 3) replacement of existing structural bank protection would be too costly, and/or 4) certain mature, well-established species are not invasive, provide good habitat, or stabilize banks.

How to Implement
No action will be taken. Existing vegetation and structural bank protection will be left in place. Non-native species will not be removed if they are deemed not invasive or provide limited wildlife habitat.

"VEGETATION ONLY" ALTERNATIVE (B)

Conceptual Description
This treatment alternative includes removal of non-native species and/or revegetation with native species according to restoration guidelines. This is a purely vegetative treatment and widely recommended where structural bank protection is unnecessary.

Where Appropriate
This alternative would be implemented in those reaches where banks are stable and erosion is not a serious problem. In many areas, this effort will be at the top of bank to provide shade, rather than along the face of the bank.

How to Implement
The removal of non-native vegetation will need to be designed cautiously so as not to result in a large-scale reduction of channel shading or increase erosion potential. For example, phased removal of non-native vegetation (e.g., staggered over several seasons) and concurrent replanting with native species, as appropriate, would minimize the reduction in shade levels over the creek which is important to maintaining steelhead habitat.

"REPAIR PROTECTION" ATERNATIVE (C)

Conceptual Description
Existing structural bank protection would be repaired. This approach is strictly structural and recommended only in local problem zones. It does not include non-native species removal or native revegetation as vegetation is not typically present at these sites. If not addressed, these erosion hotspots may significantly reduce the lifetime of the existing structure.

Where Appropriate
This treatment would be applied in those areas where existing structural bank protection is in good condition overall but small erosion problems have developed along the upstream or downstream end or toe of the existing revetment.

How to Implement
In these cases, the existing revetment can be fixed by reforming the damaged area and extending the structure an adequate distance back into the bank or bed to prevent repeated, local problems. Because no significant change will occur to the structure's position and form, revegetation and non-native species removal is typically not feasible with this type of treatment. However, in some cases it may be feasible to combine this alternative with the "Vegetate Structure" alternative.

"VEGETATE STRUCTURE" ALTERNATIVE (D)

Conceptual Description
This treatment alternative includes leaving existing bank protection in place and revegetating using planting collars or cuttings inserted between existing bank protection near the toe of the slope, if possible. This treatment is a cost-effective approach to providing some vegetation cover and creek shading without removing the existing bank protection.

Where Appropriate
This treatment is appropriate where sacked concrete (or some other articulated structural bank stabilization) currently exists, provided that the structure would remain stable if altered.

How to Implement
The existing bank protection (riprap, sacked concrete, etc.) is removed at a specific location, a planting collar is inserted and backfilled, and vegetation is planted.

Planting collars can be designed from a variety of materials including wooden beams and concrete boxes. Specific collars should be tailored to each individual site based on the unique needs and conditions of that site. However, only small trees and shrubs will be planted within the planting collars to minimize disturbing the existing bank protection.

Where possible, planting areas up to 6-feet long, 3-feet wide, and 2-feet deep are preferable over smaller planting areas to encourage the development of larger habitat pockets. Soil addition and/or decompaction and scarification of the edges of the planting area should be performed to foster vegetation establishment. Some type of irrigation, as outlined would be initially required. Cuttings may be planted along the upstream and downstream edges of sacked concrete to prevent erosion along the existing structure. Installation may be difficult, and equipment (backhoe, crane) may be needed to remove sections of the existing bank protection.

"REMOVE STRUCTURE" ALTERNATIVE (E)

Conceptual Description
This alternative includes removal (and replacement) of existing structural bank protection. In general, this will be a more expensive option than previous replanting approaches. It would

involve the extensive use of some hard labor and heavy equipment (backhoes, cranes, etc.) to remove the structures.

Where Appropriate
This alternative would be implemented where an alternative form of bank protection is strongly preferred and/or existing structural bank protection is in poor condition or has failed. In all cases, this alternative is recommended along with another treatment to replace the existing structure.

How to Implement
The existing structural bank protection would be removed manually and/ or by heavy equipment.

"REGRADE AND REPLANT" ALTERNATIVE (F)

Conceptual Description
This alternative uses regrading and biological techniques to provide bank stabilization. Existing vertical or near-vertical banks would be modified to a moderate (3H:1V or less) angle and replanted with native species. Roots of riparian vegetation, rather than structural measures, would provide bank stability. This regrading will disturb some existing vegetation, but will provide a more stable long-term riparian setting and will improve local hydraulic conveyance. *This method is considered a preferred method for enhancing aquatic and terrestrial habitat.*

Where Appropriate
Where sufficient right of way exists, a regraded bank is desirable. Regrading and replanting is most appropriate on higher portions of the banks, less frequently affected by high flows, or along lower banks where the water velocities are sufficiently low (less than 5 to 7 feet per second) during the design flow event. Regrading would be necessary where existing slopes are too steep (>3H:1V) to allow vegetation to become established.

How to Implement
Banks will be regraded, so that the top of bank is located back from the current top of bank. In no cases, should the toe of the regraded slope extend into the existing channel.

Vegetation re-establishment can be accomplished using fabrics, cuttings, seed material, or planting containers. Plastic netting, which can trap birds and other animals, is not to be used.

"TERRACE" ALTERNATIVE (G)

Conceptual Description
This alternative includes stabilizing banks by creating one or more terraces—wide benches cut into the streambank. The slope will be excavated and backfilled, as appropriate, to form the terraces. Revegetation techniques will be used to provide habitat and stability to the new bank surface. During floods, water will inundate the terrace(s) and interact with vegetation. *This method is considered a preferred method for enhancing aquatic and terrestrial habitat.*

Where Appropriate
Where sufficient right-of-way exists, a terraced bank is desirable. Terraces are often preferred over the creation of a smooth slope to the toe of bank as described in the "Regrade and Replant" alternative. Terraces are constructed without disturbing the lowest portion of the

bank, which is often desirable for habitat reasons.

How to Implement
One or more terraces are created at increasing elevations above the channel bed, each one supporting a different mix of vegetation species suited to the corresponding inundation frequency, physical setting, and biological conditions. The existing channel is not disturbed below a 1.5-to 2.0-year flow event, thereby maintaining a more confined low flow channel. During floods of greater magnitude, waters flows over the bank onto a wide terrace. The toe of the created terrace must not extend into the existing active channel or impinge upon the 1.5 to 2-year flow. The terrace should be gently sloped (e.g., 2% grade) to drain to the main channel.

Riparian vegetation shall be planted on all terraces, including the lowest one, in order to increase shading and the penetration of root masses into the low-flow channel. These features can increase the value of the creek for aquatic and terrestrial wildlife species by providing habitat and mitigating water temperatures.

"RIPRAP TOE" ALTERNATIVE (H)

Conceptual Description
This technique combines a biotechnical approach to bank stabilization with toe placement of sufficiently large rocks to prevent bank washout and toe scour. This alternative includes backfilling of the slope and revegetation within and above the riprap.

Where Appropriate
This technique is recommended where erosion problems are pronounced at the toe of the bank and may compromise overall bank stability if not addressed.

How to Implement
Excavate portions of bank, as necessary. Regrade lower portion of bank to consistent slope. Slopes of 1.5H:1V are acceptable only if rock is placed meticulously to achieve three-point contact between each rock (not dumped); otherwise, more gradual grading is required. The stones should be at the same angle as the slope of the designed streambank, and the total thickness of the stone layer should be at least the thickness of two times the rock diameter, with design diameter depending on the velocity of the design flow event at that location.

If desired, the riprap can be extended up the bank to the elevation of the design flow event. The riprap should extend below the predicted scour level and be on a solid foundation. The rock is underlain with filter layer or geotextile fabric, which also extends below the scour level and is secured around the lowest rocks. The entire installation should be keyed into the bank at each end to prevent upstream and downstream scour.

Vegetation should be planted on the top of the bank, as well as among the riprap. During rock placement, cuttings are placed between the rock close to the stream channel and earth backfill is used to fill voids between the rocks. The riprap would be carefully fitted with planting collars during installation to establish suitable areas for later planting of larger plant materials. The planting collars would provide a barrier between the rock riprap to allow the plants to access native soils below the riprap. Cutting can also be placed between the riprap. Biodegradable erosion control fabric and plantings extend above the rock to the elevation of the 100-year flood level.

"VEGETATED RIPRAP" ALTERNATIVE (I)

Conceptual Description
This alternative involves placing large riprap along the streambank to stabilize the bank surface, backfilling, and revegetating. The technique is effective in immediately securing a bank, and it provides stability while plants become established.

Where Appropriate
This alternative can also be applied where open space at the top of bank permits regrading of the channel banks to a slope of less than 1.5H:1V and steeper than 3H:1V. (For banks at 3H:1V or less, other, more desirable treatments are appropriate.)

In locations where banks are steep (up to 1.5H:1V) and the proximity of existing buildings/roads precludes the wider corridor necessary for regrading at a milder slope or terracing, this alternative represents the preferred methods of structural bank protection.

In addition, where flow strongly impinges upon an eroding bank, riprap can be used to minimize erosion hazards by directly armoring the bank.

How to Implement
Excavate portions of bank, as necessary for construction surface and to maintain flow conveyance. Regrade bank to consistent slope. Slopes of 1.5H:1V are possible only if rock is placed meticulously for three-point contact between rocks. Dumping of rock is not recommended. The stones should be at the same angle as the slope of the designed streambank, and the total thickness of the stone layer should be at least the thickness of two times the design rock diameter, with design diameter depending on the velocity of the design flow event at that location.

The uppermost riprap should reach above the elevation of the design flow event. The riprap should extend to the bottom of the bank and be on a solid foundation. The rock is underlain with filter or geotextile fabric, which also extends below the scour level and is secured around the lowest rocks. The entire installation should be inserted into the bank at each end to prevent upstream and downstream scour.

Vegetation should be planted on the top of the bank, as well as among the riprap. During rock placement, cuttings are placed between the rock close to the stream channel and earth backfill is used to fill voids between the rocks. The riprap would be carefully fitted with planting collars during installation to establish suitable areas for later planting of larger plant materials. The planting collars would provide a barrier between the rock riprap to allow the plants to access native soils below the riprap. Erosion control fabric and plantings extend above the rock to the elevation of the 100-year flood level.

"VEGETATED WALL" ALTERNATIVE (J)

Conceptual Description
This alternative involves stabilizing near-vertical to vertical banks using planted cribwalls. The

slope would be backfilled to the design grade, structural elements constructed, and then soil areas revegetated.

A planted cribwall is a rectangular framework of logs or other columnar members and woody cuttings designed to protect an eroding streambank.

This alternative would incorporate non-native species removal and revegetation, where possible, to promote local habitat enhancement. Plant selection would have to consider available planting and bank locations and abiotic conditions.

Where Appropriate
Steep banks caused by erosion, slumping or undercutting by the current will require additional stabilizing elements before planted vegetation can become firmly established. In locations where banks are exceptionally steep (>1.5H:1V) and the available setback distance is limited, these more intensive structural elements should be applied to protect the banks. High vertical walls should be avoided, except where an important feature (e.g., road or home) is located directly on the edge of the creek bank.

Vegetated cribwalls are generally preferred due to their greater aesthetic value, inclusion of adequate soil for plant growth, and habitat value. A timber or log cribwall may deteriorate more rapidly than walls constructed using metal or concrete materials. However, during this time period, planted riparian vegetation may become established, leaving a bank stabilized primarily by roots.

How to Implement: Cribwalls
Cribwalls would be constructed using timber or redwood logs, with openings between logs backfilled with soil and planted. Logs should be selected for soundness, durability, uniformity of size, and ease of handling and delivery. Timber can be interlocked progressively up the designed elevation along the bank. Concrete cribbing is also available, though less aesthetically pleasing than logs.

Cribbing should be embedded below the streambed. The cribwall base is dug parallel to the bank and below the existing streambed. The base log(s) (or other appropriate materials) are placed within this toe trench below stream grade to prevent undercutting of the structure. Base logs should be as long as can be manipulated while conforming to the contour of the stream bank. A good base log is necessary to ensure stability and durability of the treatment.

The next series of logs ("tieback logs") is placed at right angles to the first log. The ends of each log overlap the right angle log below. Each log is secured in place by cutting notches in the wood. Holes can be drilled through the overlapping logs, and steel pins are used to hold them securely. The openings are filled with cuttings and soil.

Tieback logs are embedded into the slope 4 to 6 feet, at grade with the base log. There should be at least two tiebacks per base log. Tiebacks can be secured to the base log using threaded rebar. Approximately halfway up the backside of the base log, geotextile fabric is stapled every six inches, and placed to seal the bedding of the structure. Once the first row of logs has had tiebacks and geotextile fabric installed, and has been backfilled to the top of the log, a second face log is placed on top of the tiebacks. This log is set back approximately 6 inches. The same procedure is repeated until desired height is reached. Stacked face-logs used in cribbing must be secured together.

A live vegetated cribwall can be built as either single or double walled structures. The double crib wall has far greater resistance to flows. As with most stabilization methods, cribwall works best when used with vegetation. As each lift of the crib wall is installed, long cuttings of riparian plants are inserted on top of each fill layer. The live branches must reach through the crib and into the soil of the bank to ensure rooting. The tips of the branches should protrude from the crib wallface. The tips should stick out from the wall no more than one quarter of the cuttings total length. They must not be packed too closely and bedded in soil for their total length in the crib in order to facilitate rooting over their whole length. The live plants function to replace the crib logs as they decay with time. Riparian plants can grow very rapidly and provide stream shade canopy and wildlife habitat during their first growing season.

1.5.2 MASTER PLAN MAPS

These detailed maps were developed to illustrate the recommended application of the conceptual treatment alternatives. Suggested treatment alternatives are shown superimposed on the existing topography of the project reach and listed by letter. In cases where erosion is not extreme, the "No Action" alternative is listed generally along with one or more other alternatives. These areas are considered relatively low-priority bank stabilization sites. The worst erosional hotspots have generally been assigned as the "Vegetated Riprap" and/or "Vegetated Wall" alternatives with the "No Action" alternative not listed as a possibility. These areas are high priority bank stabilization sites.