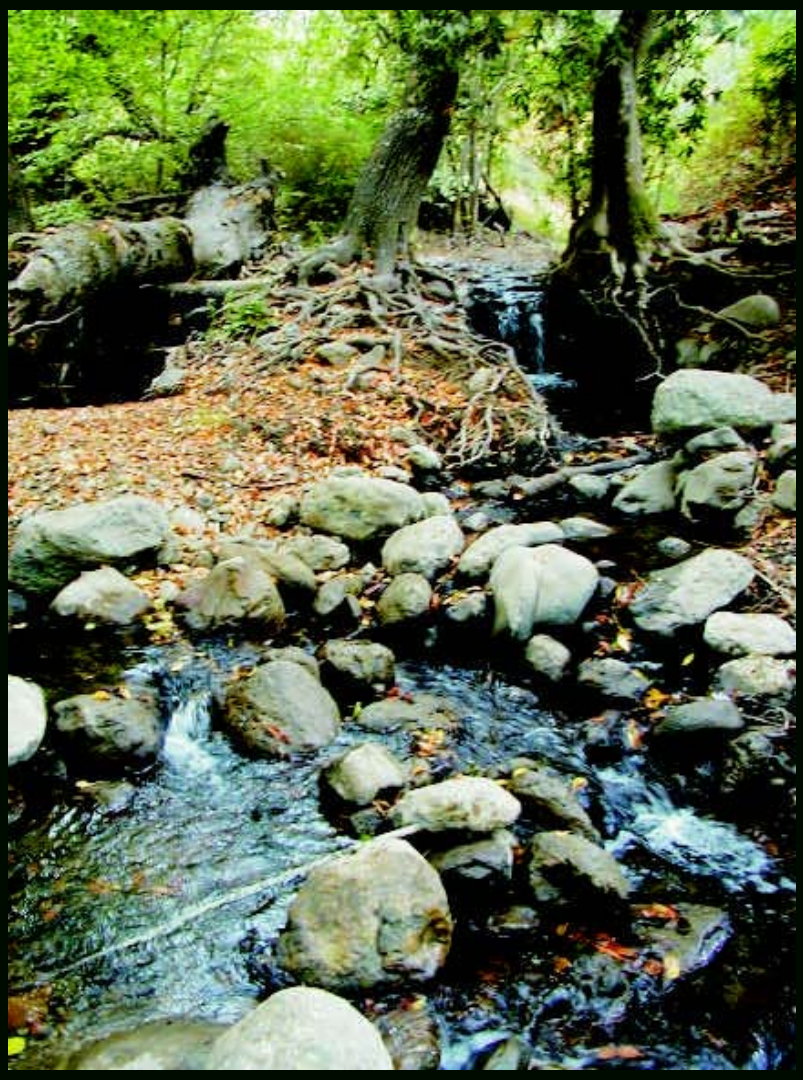
Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection









Prepared by Philip Williams & Associates, Ltd.
in collaboration with H.T. Harvey & Associates

PWA
Philip Williams & Associates, Ltd.
Consultants in Hydrology

Maintaining Corte Madera Creek:
A Citizens' Guide to Creek-Side Property Protection

Table of Contents

Acknowledgments

Executive Summary

Introduction **1**

1.1 Project Introduction

1.2 History

1.3 Goals

1.4 Typical Issues/ Challenges for Creekside Property Owners?

Purpose of the Study/ Report **7**

2.1 Overview

2.2 Project Approach

Creek Function **11**

3.1 How Do Creeks Work?

3.2 What is Riparian Habitat?

3.3 Riparian Functions and Values

3.4 Creek Terminology/ Glossary

Corte Madera Creek Watershed - Existing Conditions **23**

4.1 Existing Conditions

4.2 Geomorphic Setting and Conditions

4.2.1 Geomorphic Approach

4.3 Corte Madera Creek – Study Area Reaches

4.4 Reach 4/ The Headwaters

4.5 Existing Bank Stabilization Treatments

4.6 Existing Biotic Conditions of Corte Madera Creek
4.6.1 Fish and Wildlife of Corte Madera Creek
4.6.2 Habitat Descriptions
4.7 Special-Status Species
4.7.1 Regulatory Overview

Conceptual Restoration Approaches and Permitting **59**

5.1 Introduction
5.2 Methods
5.3 How to Protect Creek Banks?
5.4 Conceptual Restoration Approaches
5.5 Undertaking a Stabilization Project
5.6 Permitting
5.7 Recommended Trees and Plants for Corte Madera Creek
5.8 Non-Native/ Undesirable Plant Species on Corte Madera Creek

Creek Walks **89**
Next Steps **93**

Appendices

A. References
B. Example Projects
C. Creek Walk Materials

List of Figures

Figure 1 – Corte Madera Creek Watershed Map
Figure 2 – Project Study Area, Corte Madera Creek, Portola Valley
Figure 3 – Reach 1 (Mapache Drive to Westridge Bridge)
Figure 4 – Reach 2 (Westridge Bridge to Willowbrooke Drive)
Figure 5 – Reach 3 (Willowbrooke to Alpine Road)

Acknowledgements

The authors wish to acknowledge and thank a number of individuals, committees and agencies that provided their expertise, experience and importantly their time to review and provide input to the Report. The comments received helped to clarify and focus the organization, intent and content of the document:

- **Mayor Edward Davis**
- **Planning Commission Chairman Craig Breon**
- **Planning Commissioner Linda Elkind**
- **Angela Howard, Town Administrator**
- **Howard Young, Public Works Director**
- **George Mader, Town Planner, Spangle Associates**
- **Tom Vlasic, Deputy Town Planner, Spangle Associates**
- **John Wallace, Senior Engineering Geologist - Town Geologist (Cotton, Shires & Associates)**
- **Marge DeStaebler, Member of the Town of Portola Valley Conservation Committee**
- **Philippe Cohen, Administrative Director, Jasper Ridge Biological Preserve**

Acknowledgements

We also want to thank the following individuals for their interest, support and participation in the study:

- **Leslie A. Lambert, Planning Manager, Town of Portola Valley**
- **Kevin Murray, Project and Natural Resources Manager, San Francisquito Creek Joint Powers Authority**
- **Cynthia D'Agosta, Executive Director, San Francisquito Creek Authority**
- **Phil Chang, Former Watershed Coordinator and Project Director, San Francisquito Watershed Council**
- **Pam Sturner, Coordinator and Project Director, San Francisquito Watershed Council**
- **Robert Katz, Portola Valley Resident**
- **Philip & Jean Eastman, Portola Valley Residents**
- **Belinda Brent, Portola Valley Resident**
- **Kenneth Rosen & Larisa Fong, Portola Valley Residents**

Funding for the study was generously provided by the California Department of Water Resources' Urban Stream Restoration Program.

The primary authors of the report are:

- **Jorgen Blomberg, Philip Williams & Associates**
- **Dr. Andrew Collison, Philip Williams & Associates**
- **Max Busnardo, H.T. Harvey & Associates**
- **Matt Quinn, H.T. Harvey & Associates**

Executive Summary

The Corte Madera Creek Watershed sustains some of the most intact and valuable riparian habitat areas in the Santa Cruz Mountains and surrounding region. Corte Madera Creek has been impacted by a number of human (anthropogenic) actions including urban development, flood control and bank protection. These activities have constrained the creek to a narrow corridor and reduced native vegetation. Due to increased storm runoff in the watershed and the degraded and confined condition of the creek, erosion processes (high velocities and shear stresses) exist and create the need for bank protection. In response to ongoing erosion as well as specific emergency situations associated with significant storm events in the recent past, individual property owners in the Town of Portola Valley have employed a variety of engineered and non-engineered bank protection measures, some of which are failing or are incompatible with the upstream and downstream bank protection structures. Some of the existing bank stabilization measures have in turn created problems along the creek and generally reduced habitat values.

Creek channel and bank protection can be achieved through sustainable and cost effective approaches that are consistent with and potentially enhance creek function, habitat and aesthetic values. Geomorphic and engineering analyses are important to undertake effective long-term bank stabilization.

The intent of creating the Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report was to develop a tool for the Town and its residents to use in guiding bank stabilization and revegetation efforts along Corte Madera Creek within the Town of Portola Valley. Importantly the report was created to facilitate communications between the Town and private property owners who wish to address erosion and property loss. The guide was also developed to:

1. Provide guidelines to the Town and its residents for feasible and sustainable bank stabilization approaches that protect property while improving creek function and habitat values.
2. Develop a broader view of the Corte Madera Creek Watershed as a natural resource (habitats, water quality and interesting plant and animal species) and community amenity in an effort to build community stewardship of the Creek.
3. Facilitate permitting acquisition for property owners and project proponents.

The report builds on the growing local and regional experience with creek restoration efforts to assist property owners with the project planning process including analysis, design, permitting and implementation phases. The report emphasizes a holistic and balanced approach for bank protection that considers the Corte Madera Creek system as opposed to single isolated problems.

Conceptual Restoration Approaches

The Conceptual Restoration Approaches outlined in the Citizens' Guide provide an outline for property owners and stakeholders to use for design, permitting and construction of future stabilization and revegetation projects on Corte Madera Creek. The Conceptual Approaches presented in the Citizens' Guide are based on a series of geomorphic assessments and vegetation and habitat surveys undertaken by a multi-disciplinary team within the project study area. The recommendations emphasize limiting hard-armored solutions or adapting them to integrate roughness and revegetation components. Some typical guidelines for bank stabilization approaches include:

- Do not reduce the width of the creek, as this will almost certainly cause erosion both in the bed and downstream.
- Do not reduce the length of the creek (by straightening a bend for example). This action will steepen the bed profile, increasing erosion locally, and on the next bend downstream.
- Where possible, combine grading activities to flatten bank angle and use a mixture of biotechnical methods such as brush mats and willow planting.
- Where rock is required, place rock (mechanically or by hand) rather than by dumping. Dumped rock generally forms an unsustainably steep angle, which eventually collapses and rolls rock into the creek.
- Limit the upper vertical extent of placed rock for structural and erosion protection requirements on the bank slope to maximize plantable areas. Key rock into the bed several feet to prevent undercutting.
- Utilize rock sizes based on calculations of flow force and resistance.
- Integrate native trees such as willow and alder with the engineered rock bank protection. Integrated planting has several benefits:
    1. Roots anchor the soil beneath the rock, providing a living support system that increases the strength of the bank protection over time
    2. Vegetation slows water velocities, reducing erosion both at the bank and downstream, and
    3. Trees provide shaded cover for the creek, improving habitat conditions.

Six conceptual restoration approaches are described in the Citizens' Guide. The recommendations for bank stabilization and revegetation are intended to address physical and biological conditions found within the study area.

- Vegetated Rock
- Bulkhead Wall (Rock)
- Grade Control Structure (GCS)
- Biotechnical Stabilization
- Bioengineering Stabilization/ Planting
- Native Planting – Stable Channel

Planning and undertaking a successful stabilization project requires the coordination of different experts and review and approval from several key state and regulatory agencies. The process, key tasks and players required to undertake an environmentally sensitive bank stabilization project are outlined in order to inform potential future project sponsors about these expectations.

The Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report was prepared by:

- Philip Williams & Associates
- H.T. Harvey & Associates

Blank Page

SECTION 1 - Introduction

1.1 Project Introduction

The Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report is a collaborative effort between the Town of Portola Valley and the San Francisquito Creek Joint Powers Authority (JPA). The Citizens' Guide provides a tool for the Town and its residents to use in guiding bank stabilization and revegetation efforts along Corte Madera Creek within the Town of Portola Valley. The Guide was created to facilitate communications between the Town and private property owners who wish to address erosion and property loss. The report is also intended to:

1. Provide guidelines to the Town and its residents for bank stabilization approaches that protect property while improving creek function and habitat values.
2. Develop a broader view of the Corte Madera Creek Watershed as a natural resource and community amenity in an effort to build community stewardship.
3. Introduce feasible and sustainable approaches that promote improved watershed function and that streamline permitting acquisition for property owners and project proponents.
4. Provide an introduction to the Corte Madera Creek Watershed that describes the creek, its different habitats and the interesting species that live in the creek environment.

This document builds on the growing local and regional experience with creek restoration efforts to assist property owners with the project planning process including analysis, design, permitting and implementation phases. The recommendations presented in the Citizens' Guide are based on a series of geomorphic assessments and vegetation and habitat surveys undertaken by a multi-disciplinary team within the project study area. The Citizens' Guide emphasizes a holistic approach to bank protection that considers the entire Corte Madera Creek system as opposed to single isolated problems.

1.2 History

In June 1999, the Town of Portola Valley Town Council formed an ad-hoc "Creekside Corridor Committee" to provide feedback and reactions to the Town's policies as they related to creeks, creek management and preservation, and private property protection. The Committee was charged with providing recommendations for the Town Council consideration on these issues, as well as being involved in the preparation of a community educational component. The Committee produced a "Creekside Corridor Regulations: Analysis and Recommendations" Report dated June 2001. That report included general recommendations for the Town to protect riparian resources using regulatory controls.

The Town Planning Commission began review of the committee report in the fall of 2001 and conducted one public workshop, a creek field trip, and commission-level discussions to consider a

riparian protection ordinance for the town. On each of those occasions, creek-side property owners and other interested parties provided the Commission with valuable comments on the best methods to address the health and stability of the Town's creeks while protecting the legitimate interest of the property owners. The Planning Commission has not taken final action on their recommendations for regulations and policies, and has decided to hold their work in abeyance to allow the JPA/Town "Project" to be completed.

Funding for the 'Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection' report has been provided by a grant from the California Department of Water Resources, administered by the San Francisquito Creek Joint Powers Authority.

In Spring of 2002, the JPA organized and hosted a grants workshop to inform interested parties in San Mateo and Santa Clara Counties of the availability of grant funding to conduct local stream protection and restoration projects. The Town of Portola Valley, JPA and the San Francisquito Watershed Council began discussions on project ideas to assist the Town and property owners along Corte Madera Creek.

The JPA agreed that this would be a valuable project, and that since Corte Madera Creek represents a dynamic and integral portion of the San Francisquito watershed, a project of this type would serve the mission of the JPA to protect and maintain the watershed and its environs.

The JPA conducted a search of funding sources, authored a grant application to the California Department of Water Resources (DWR) Urban Stream Restoration Program, and submitted the grant request in partnership with the Town. The Watershed Council (through Acterra) agreed to sign on as the required non-profit co-sponsor of the grant application.

DWR considered the project a high priority, and awarded the JPA and Town $73,000 to conduct this study and generate this Citizens' Guide. DWR identified priorities to assess the riparian conditions, habitat values, and characterize erosion problems on Corte Madera Creek and provide conceptual design recommendations for the typical problem conditions observed. The primary objective of the Citizens' Guide is to provide a user-friendly tool for landowners that describes planning approaches for effective, ecologically sensitive bank stabilization projects. The JPA has administered the grant contract and funding of this project, and has jointly managed the creation of the Citizens' Guide with the Town.

Corte Madera Creek has been impacted by significant storm events and flood flows in the recent years. These impacts include bank and bed erosion leading to responses – some well-designed and some detrimental – for stabilization. The study area covers an approximately 6-mile section of the creek including the most heavily developed reach through town. The study area was divided into four separate reaches based on geomorphic conditions and significant landmarks. In many of the cases observed along Corte Madera Creek, bank stabilization approaches attempt to armor the visible

problem and fail to address the underlying cause of the erosion. This project does not prescribe specific recommendations for specific sites within the study area and does not address emergency stabilization responses occurring during flood events.

This project included several key sequential tasks: assessments and surveys (study area definition), watershed characterization and description, conceptual stabilization designs and community presentation and outreach.

1.3 Goals

The primary goal of the Report is to describe preferred stabilization approaches to address bank erosion that improve overall creek function and expand opportunities for revegetation and associated habitat enhancement. In turn, the Report will facilitate future project evaluation and planning efforts between property owners and the Town of Portola Valley by expanding the understanding of creek and watershed function and resource values. The conceptual approaches will guide responses at existing and future erosion locations as well as for replacement of failed existing bank protection areas.

The goals for the Report were primarily defined by the growing concern about erosion and habitat conditions along Corte Madera Creek in the Town of Portola Valley. The Town and its residents have identified the need to clearly understand the creek and its watershed as a basis for establishing broad recommendations and approaches for banks stabilization and revegetation efforts.

1.4 Typical Issues/ Challenges for Creek-Side Property Owners

The natural character and function of riparian corridors like Corte Madera Creek make life along the creek both attractive and challenging. The creek enriches our experience of the physical environment with sounds of running water, cool air and shady vegetation. However, during big storms, the creek can become a force that presents real challenges for homeowners and property protection. These conflicting characteristics create a challenging environment for property owners and the Town regarding their activities and land use along and in the creek corridor.

Most adjacent property owners value the creek as an aesthetic and dynamic element and at the same time have a need to protect property and investment. Property values along creeks are typically higher than similar properties in other areas. Because of the complexity of creek processes, and the diversity of landowners, a wide variety of creek treatments have been applied over time. The perception of risk presented by the creek dictates actions taken by property owners. For example, some property owners have elected to turn their backs to the creek or armor the creek in order to maximize usable property. Unfortunately, these approaches often lead to more significant and costly problems.

SECTION 1 - Introduction

Many existing bank protection and armoring projects along Corte Madera Creek have been installed as emergency responses to erosion associated with the significant storm and flooding events that the region has experienced in recent years. Although there was a perceived threat more thoughtful, responsive and cost effective remedies should have been used. It is important for the Town and its residents to actively coordinate, evaluate and develop bank stabilization protection projects collaboratively in emergency scenarios in order to limit the number of non-engineered and ineffective responses.

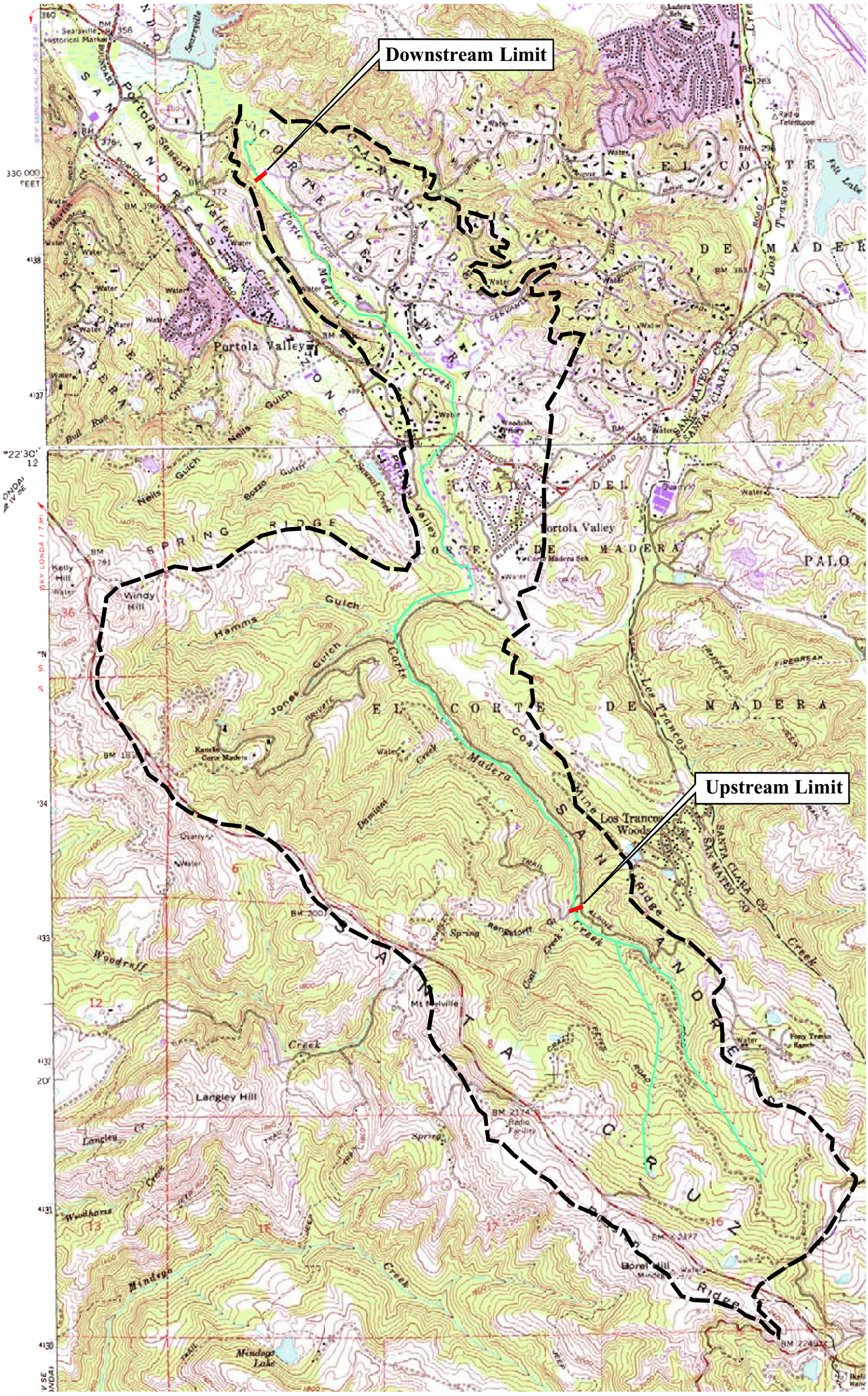


figure 1

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Watershed Map

Project # 1698/watershed v2.cdr

PWA

Blank Page

SECTION 2 - Purpose of the Study/ Report

2.1 Overview

The health and functioning of urban creeks are directly linked to a number of physical, biological and cultural processes and practices. Encroachment by humans across the **watershed** and into the riparian corridor in the form of development (buildings, roads, and other facilities) changes the **hydrologic** and **hydraulic** function and character of the creek. These impacts often lead to degradation of habitat values through increased erosion, loss of native vegetation and armoring of channel bed and banks. In turn, the aesthetic, educational and recreational values of the creek are also compromised.

Corte Madera Creek is a valuable resource – to frogs, birds, fish, plants and people. The creek is a physical, aesthetic, recreational and educational element that contributes to the character of Portola Valley. The large native redwood and oak trees and diverse plants that thrive along the creek provide habitat to many animals and birds that people enjoy and value. The creek is a place of solitude and contemplation, just as it is an opportunity to teach and learn about one of California's most valuable ecosystem types. Human actions along and within the creek directly affect its function and health and can, in fact, influence flood and property protection.

Over time, cumulative impacts from traditional responses to bank stabilization have contributed to and in some situations exacerbated the problems and issues experienced along Corte Madera Creek. Traditional bank protection responses are driven by limited objectives that rarely consider habitat values, project setting, creek function and aesthetic conditions. Well-planned and effective multi-objective bank stabilization approaches that consider and enhance these conditions can be implemented for property protection, erosion potential and creek enhancement.

The Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report provides a tool for the Town of Portola Valley, its staff, the residents and the community at large to use in considering bank stabilization and revegetation efforts on Corte Madera Creek. The Guide provides an overview of the Corte Madera Creek watershed, creek function and habitat values as a basis for understanding and developing proposed approaches for bank stabilization. Typical erosion conditions and problems as well as the less-than-desirable traditional means utilized for erosion protection are also identified and described.

The Guide recognizes the need and the right of property owners to protect their property from stream-induced erosion and property loss. While some, gradual erosion is a natural process within active creek systems, accelerated erosion resulting from watershed development damages both habitat and property. This report provides an examination and explanation of the natural conditions of Corte Madera Creek and the physical processes that create those conditions. Unfortunately many traditional **armoring** approaches and other informal methods of creek bank protection have degraded habitat conditions and generally increased erosion risk throughout the creek corridor. The Guide does not

address specific problems at specific locations, but will help to identify the typical problem conditions and less desirable bank protection measures by **reach** within the study area.

The Citizens' Guide is also a tool to engage the Portola Valley community to educate and encourage alternative and beneficial practices in creek bank protection, restoration and ultimately, watershed stewardship. The report is not a regulatory document, but should be used to inform and guide creek related stabilization and enhancement projects in the future. It is beneficial to integrate a watershed or system-based understanding of Corte Madera Creek so that future bank stabilization projects will not only effectively protect property, but are also realized as opportunities for improved creek function and habitat enhancement.

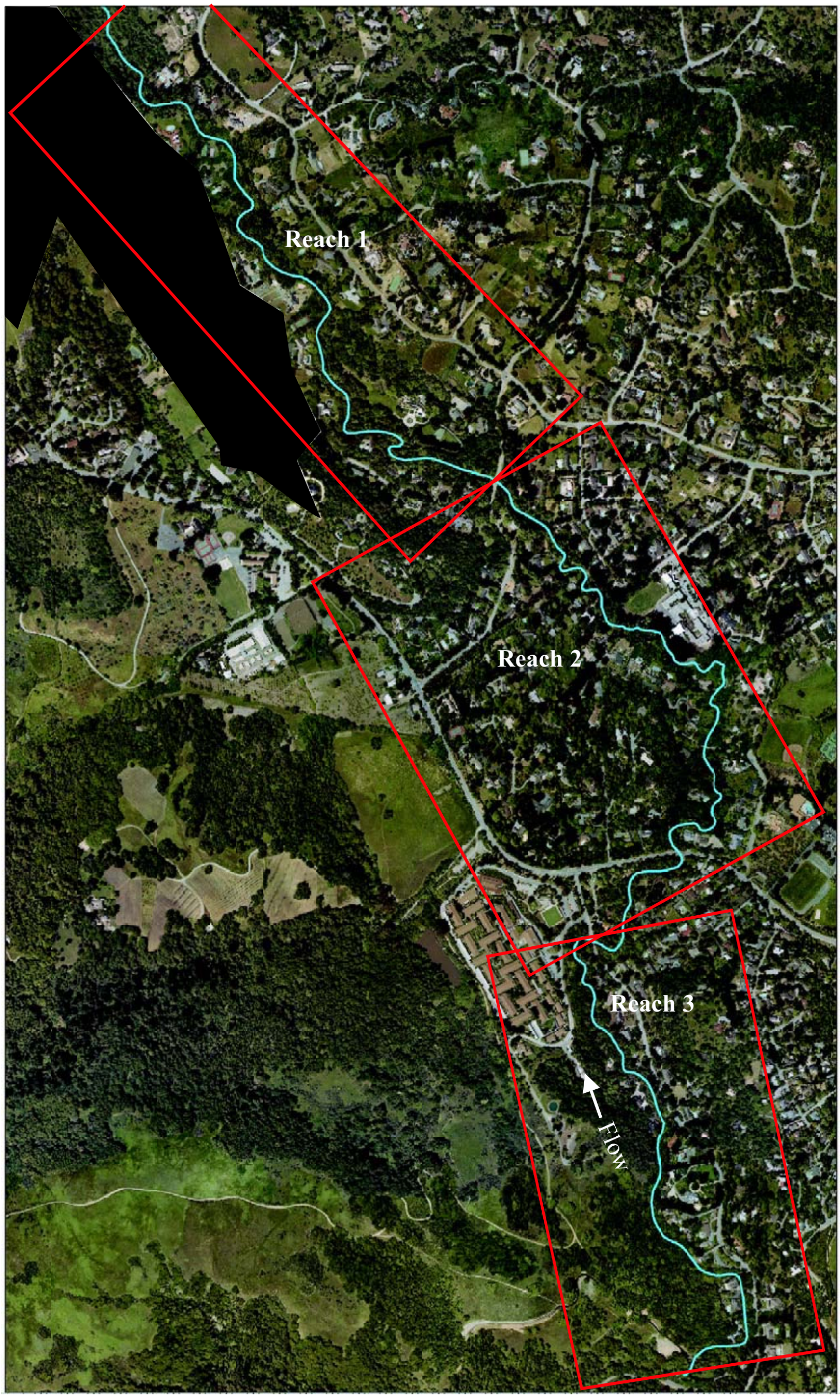
The project team initially focused on a series of reconnaissance level surveys, relevant expertise and experience working with creek restoration and bank stabilization efforts in addition to reviews of existing studies and reports to develop the study and report. The findings of the surveys and preliminary conceptual stabilization approaches were presented to the Town and JPA for review and comment as they were completed. Report sections were submitted to the Town, JPA and selected review committee. Discussions with and comments from the review committee helped to focus report content and format as well as to direct the outreach component of the project.

Through a series of coordinated and hosted 'Creek Walks' the project team introduced the Citizens' Guide, its intent and objectives to creek-side property owners and other stakeholders. The team solicited input from these public sessions.

2.2 Project Approach

The Guide focuses on a six-mile section of Corte Madera Creek defined by Mapache Road (downstream limits) and Rengstorff Gulch in the headwaters/ upper watershed to examine existing conditions and to propose conceptual restoration approaches. Design engineering experience was integrated with the reconnaissance surveys to develop realistic and cost effective **guidelines** for bank stabilization. The team's prior experience with a variety of tested multi-objective stabilization projects ranging from large scale restorations to site specific property and infrastructure protection efforts also serve as a basis for the conceptual approaches described in this document.

In addition, the report describes the study area of Corte Madera Creek in Portola Valley from a **geomorphic** and **biological** perspective. The presentation of the watershed, its resources and alternative approaches to bank stabilization and revegetation is intended to build awareness and support for beneficial stabilization practices.



N

0 1,000 2,000

feet

figure 2

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Project Location and Stream Reaches

Project # 1698/studyArea.cdr

PWA

SECTION 2 - Purpose of the Study/ Report

Blank Page

SECTION 3 - Creek Function

3.1 How Do Creeks Work?

Creeks form as the conduit to convey rainfall-runoff from the watershed to the sea. The channel form results from the complex combination of climatic conditions (rainfall amount, seasonality etc.), geology (underlying rock type, structure, topography) and ecology (vegetation type, patterns etc.). At any location, the creek channel shape (cross-sectional area, bank height, etc) forms primarily in response to the flow regime and underlying geologic conditions. While the shape may change over time, in a stable stream/watershed, these changes typically are slow and gradual, and often vary about a long-term equilibrium conditions.

From a geomorphic perspective, creeks are conveyor belts for sediment, transporting sediment eroded in the hills and ultimately depositing lower in the watershed or in the ocean. Landslides and soil erosion generate sediment in the **headwaters** of the creek, and the creek carries the material towards the sea. The amount of sediment a creek can transport depends on how steep it is and how deep and fast the water flows. If the creek has sediment carrying capacity to spare it will actively erode its banks, until it is carrying as much sediment as it can. Over time this process causes the land to become flatter, and creeks erode less and less. However, because the San Andreas Fault is still pushing up the Santa Cruz Mountains in the headwaters, Corte Madera Creek has never had the chance to become gentler and it is still a naturally highly erosive stream. Humans have added to this by changing the watershed, for example by increasing impermeable area such as buildings and parking lots, clearing woodland and constructing roads. As a result a naturally very dynamic (and possibly erosive) creek has become even more erosive. Where a buffer between the creek and structures can be maintained this is not a problem, as certain amounts of bank erosion are a natural process and provide important ecological niches. However, where homes or roads are sited close to the eroding creek bank there will be conflicts. This situation is not always easy to spot, since creeks are dynamic by nature. A bank may be stable for decades, and then start to erode because of either longer term changes reaching a critical threshold or more subtle changes such as a disruption in upstream sediment supply. For example, constructing a hard, smooth bulkhead to protect one reach of creek causes the water leaving the reach to accelerate, potentially creating greater erosion downstream.

Creek banks erode for two reasons. Firstly, they can erode because the creek migrates laterally into a bank, or water is directed from a straight reach onto a bank. This type of erosion can be controlled by increasing the erosion resistance of the bank, for example by planting vegetation on the bank toe or adding **toe** protection. Secondly, banks can slump because the creek channel cuts downwards (incises), leaving the bank too high and steep to remain stable. The higher a bank is, the flatter the angle must be to prevent slumping. For example, most soils will support a three-foot high vertical bank, but if the river cuts a deeper channel (say five feet) the bank will collapse under its own weight. A five-foot bank would need to be **graded** to a lower gradient to be as stable as a three-foot vertical bank, and a ten-foot high bank would have to be excavated to an even lower gradient to be stable.

The higher the bank, the lower the stable gradient becomes. The best treatment of an over-steepened bank is to reduce its slope to a stable angle, and protect the toe and face from future erosion so it doesn't become over-steepened again.

3.2 What is Riparian Habitat?

Riparian habitats are the plant communities (vegetation types) associated with the elevated soil moisture levels found within and adjacent to **watercourses**. The width of these areas depend on a number of factors including the size of the stream and contributing watershed, channel morphology, soil type, and topographic features, among others. Riparian areas are distinctly different from surrounding lands due to the unique soil and vegetation characteristics associated with the presence of water. They serve as the transitional zone between aquatic and terrestrial ecosystems. They are among the most important, diverse and productive ecosystems and support rich assemblages of wildlife. Unique water-loving, flood-tolerant trees and shrubs thrive along streams such as Corte Madera Creek and form a unique plant community referred to as riparian habitat. Corte Madera Creek supports a lush, diverse zone of riparian habitat along its watercourse.

Over 95% of the historic riparian vegetation in California has been lost to urbanization, agricultural conversion, livestock grazing, clearing for flood control, and invasion of non-native plant species. In the western United States, riparian areas comprise less than 1% of the land area, but are among the most valuable and productive natural resources. Accordingly, due to the critically important biological values that riparian habitat provides and the rarity of the habitat type, riparian areas are among the most sensitive habitat types in the region and extraordinary efforts are put into preserving, enhancing and restoring these areas.

The following section provides a general description of the riparian zone (typical) and the numerous ecological functions it performs.

3.3 Riparian Functions and Values

Riparian areas, such as those supported by Corte Madera Creek, provide the many important ecological functions of value to people as well as to fish and wildlife:

- **Maintain creek bank and channel stability**

Riparian vegetation is important in the prevention of stream bank erosion. Roots of riparian vegetation help to stabilize banks, reducing erosion by holding soil in place. Vegetation binds soil and creates "roughness" that reduces stream flow rates, particularly during floods. Vegetation at the "toe" of riverbanks is especially important to riverbank stability, particularly on outside bends of

meanders and on other banks where flow is deflected. In addition, roots and rootballs allow the formation of overhanging banks, which provide high quality habitat for many aquatic organisms.



California bay, a component of the riparian habitat along Corte Madera Creek, provides bank protection and overhanging roots afford shelter for frogs and salamanders.

- **Provide vital habitat for many wildlife species**

Riparian habitats in California provide critical habitats for wildlife, supporting a great diversity and abundance of fish, mammals, birds, amphibians, insects and reptiles. In the western United States, riparian habitats occupy less than 1% of the total land area and are particularly important for migratory songbirds. Remaining riparian areas are crucial for bird species that have migrated through California for many thousands of years. Migratory birds use riparian habitats for resting, nesting, and most importantly, for foraging. Many songbird species forage on small insects and spiders that are abundant in the moist habitats along streams. Many other species of wildlife use riparian habitats as well. The complex vegetation structure, usually with a dense under-story of shrubs and a higher canopy of trees, provides numerous nesting, resting, and foraging habitats for wildlife. Riparian habitats provide critical habitat for fish and other aquatic organisms by regulating water temperature, providing food and nutrient input, as well as coarse woody debris to enhance in-stream structure. Streams, such as Corte Madera Creek, provide year-round drinking water for a variety of wildlife

species, and moist habitats provide habitat for amphibians, and for numerous invertebrates, which provide prey for larger animals. Particularly in developed areas, like the San Francisco Bay area, riparian corridors also provide pathways for wildlife movement and dispersal.

- **Provide nutrient and food input to the aquatic ecosystem**

Fine material produced by the breakdown of decaying plants and animals provides the foundation of the aquatic food chain within the creek.

- **Reduce stream water temperature**

Riparian vegetation, especially the portion overhanging or shading the water, regulates water temperature. Even small increases in water and air temperature may lead to substantial changes in the population structure of fish, aquatic insect, and other riparian species.



Deep shade cast by dense riparian vegetation keeps the creek water cool benefiting aquatic organisms.

- **Provide input of coarse woody debris to enhance in-stream habitat**

As riparian vegetation along the stream dies and falls into the channel it provides **coarse woody debris** adding diversity to the ecosystem. This helps create and maintain pools within the creek channel that provide hiding places for many aquatic organisms from predators, reduce stream velocities providing shelter during high flows, and form areas of slower moving water where prey for fish and amphibian predators are concentrated.



In-stream habitat formed by accumulation of coarse woody debris.

- **Moderate downstream flooding**

A well-vegetated riparian corridor serves a number of valuable functions for flood control. Low-lying floodplain areas next to stream channels combined with riparian vegetation reduce the water velocity and allows floodwaters to spread out through the riparian corridor and re-enter the main channel slowly, thus reducing downstream flood potential. Additionally, floodplain soils are often quite porous and roots of riparian vegetation further increase the porosity of the soil allowing large amounts of water to infiltrate and reduce the overall volume of water moving downstream. Furthermore, riparian vegetation uses large amounts of water in the process of transpiration, pulling water out of the soil, which increases the overall water holding capacity of the floodplain soil.

- **Provide water storage (groundwater recharge) and conservation**

Non-compacted soil along with passageways created by decaying roots and animal burrows within the riparian corridor provides a porous medium with very high infiltration rates. This allows for large volumes of water to percolate relatively deeply into the ground, recharging the local groundwater table as well as providing slow groundwater releases from upstream areas to the channel later in the year, increasing the base flow volume in the creek. This phenomenon of high infiltration rates replenishing the groundwater and recharging aquifers is important to both groundwater driven public water supplies as well as private wells.

- **Improve water quality/water filtration**

Excessive nutrients (nitrates, phosphates, etc.) can cause aquatic environments to become unbalanced. Manure and/or commercial fertilizer applied to adjacent lands as well as septic system leachate entering streams can cause excessive algal and plant growth which depletes the dissolved oxygen in the water. Too little oxygen is harmful and potentially fatal to many aquatic organisms. Nitrates in excessive concentrations can result in making water unhealthy for animal or human consumption.

A healthy riparian corridor acts as a filter to maintain and/or improve overall water quality, including groundwater quality. Vegetation, both living and dead, will trap suspended materials and reduce water velocity. This allows time for other functions to occur such as deposition of sand and silt, filtration of pathogens and pollutants as the water passes through floodplain soils, reduction of excess nutrients via assimilation by vegetation and microorganisms, and breaking down of pollutants by soil bacteria.

- **Provide sediment filtering and erosion control**

Sediment suspended in the water can reduce or block the penetration of sunlight, adversely affecting the growth and reproduction of beneficial aquatic plants. Sediment deposited on the stream bottom can interfere with the feeding and reproduction of bottom dwelling fish and aquatic insects, weakening the food chain. Large deposits of sediment can fill stream channels and floodplains, greatly increasing the potential for downstream flooding. Several mechanisms of sediment removal are at work in the streamside forest. Some sediment settles out as the speed of the flow is reduced by the many obstructions encountered in the forest litter. Sediment is also filtered out by the porous soil structure, vegetation and organic litter as the runoff flows over and onto the floor of the streamside forest.

- **Provide aesthetic and recreational values**

People are naturally drawn to water for a number of reasons including fishing, boating, swimming or just to be near the water to contemplate its life-giving force. Riparian vegetation has an inherent aesthetic and intrinsic worth that is difficult to value in monetary terms.

3.4 Creek Terminology/ Glossary

Anthropogenic – Changes related to human actions.

Armoring – The installation of impermeable walls or other hardened structures (rock, concrete, etc), including gabions, which prevent or substantially limit the growth of native trees and other desirable native vegetation.

Bank Stabilization – Securing of a creek bank through utilization of vegetation (dead and live materials) and/or built structures.

Bankfull – Channel dimension/ volume defined by a storm that occurs statistically once every 2 years.

Bioengineering Stabilization - Utilization of biological (plant and tree) materials to construct living structures for erosion control and revegetation (habitat enhancement).

Biotechnical Stabilization - Utilization of structural and biological (plant and tree) materials to construct integrated living structures for erosion control and revegetation (habitat enhancement).

Biological – Of or relating to living elements and systems such as plants and animals.

Brush Mat - Bioengineering technique for bank restoration and revegetation.

Bulkhead Wall – Vertical or battered structural wall built in constrained locations along a river or creek.

Coarse Woody Debris – Accumulations of fallen trunk and branch materials along the creek channel.

Conveyance – Flow capacity of a watercourse that depends on channel cross-section dimensions, slope and banks conditions such as friction created by vegetation and other bank materials.

Cutting – A section of plant/ tree stem, branch or root that will regenerate when planted.

Dynamic Equilibrium – A condition in which creek conditions change slightly throughout the year but return to the same average condition

Erosion – Removal of soil and rock by weathering, mass movement, and the action of creeks, glaciers, waves, and wind and groundwater.

Federal Endangered Species Act – Set of laws (enforced at the Federal level) that protect specific plant and animal species that are threatened with extinction and regulate human activities that potentially impact these species.

Flanking – Removal of soil and rock by creek flows moving around the edges/ sides of a structure along the creek bank.

Fluvial – Relating to moving/ flowing water in a river or creek.

Gabion – A large basket made of galvanized wire mesh filled with stone and/ or cobble materials often utilized to armor creek banks.

Geomorphology/ Geomorphic – The study of processes that shape landforms.

Geotechnical – Relating to the scientific and engineering principles and mechanical characteristics of soils and geologic materials.

Geotextile – Durable synthetic construction fabrics (high tensile strength) used in the installation of drainage and bank protection applications. Fabrics limit the movement of soils through bank stabilization measures. Biodegradable materials such as coir and jute can be used for temporary soil stabilization to allow and support vegetation establishment.

Grade/ Graded – Excavation and/ or reshaping of a specific area of land.

Guidelines – A written set of criteria or parameters that help to direct specific actions to achieve more comprehensive goals and objectives.

Headwaters – The highest areas in a watershed where channels begin to take shape and concentrate surface runoff into creeks.

Hydraulic – Pertains to how the water is behaving in the creek channel. Typical measures of hydraulics include: flow depth and velocity.

Hydrologic – Relating to the rainfall runoff process. Hydrology describes/predicts how water is converted from rainfall to runoff volume in the creek at any location.

H.T. Harvey & Associates (HTH) – Biological resources consulting firm.

Impinging – Concentrated flow that is directed straight onto a bank or structure.

Incise/ Incision – Downward erosion of a river or creek bed across an entire section or reach.

Joint Powers Authority (JPA) – A multi-jurisdictional agency consisting of the cities of Menlo Park, Palo Alto, and East Palo Alto, San Mateo County, and the Santa Clara Valley Water District formed to improve community storm preparation and flood management at San Francisquito Creek.

Keyed – To embed a structure into the bed and banks of the creek to encourage smooth transitions and reduce potential for scour and flanking.

Layback – Excavate or regrade creek banks to create flatter, more stable slope conditions.

Philip Williams & Associates (PWA) – Hydrologic and environmental restoration consulting firm.

Reach – A continuous section of river or creek channel defined by similar physical characteristics.

Revegetation – Planting/ installation of desired vegetation (native plants, trees, and seeds) in areas that have been cleared of existing non-native species and/ or targeted for habitat enhancement.

Riffle – A short section of steep, shallow water that is moving more rapidly than the water up or downstream of it. Often marked by coarser bed material such as cobbles or boulders.

Riparian – Of or relating to the environments, eco-systems and species that have evolved in association with rivers and creeks.

Riprap – A layer of rock placed on a creek bank to armor surface against erosion, scour and sloughing.

Rock Size – Dimension and weight of rock material specified to meet design.

Scour – Localized erosion of material from the creek bed by flowing water.

Shear Stress – Force acting over the wetted surface created by flows in a river or creek (measured by force/ area).

Setbacks – Defined dimension along the creek where certain activities are regulated to protect creek conditions and functioning.

Top of Bank – Top of creek bank where the slope and terrace conditions meet.

Toe – Base of creek bank, slope protection or wall.

Vegetated Soil Lifts (VSL) - Biotechnical engineering technique for bank restoration and reconstruction.

Watercourses – Natural or human-made channels that convey water.

Watershed – The area draining into a river or stream.

3:1 – Definition of bank slope angle using relationship of horizontal to vertical dimensions (horizontal dimension: vertical dimension)

Blank Page

4.1 Existing Conditions

Many different types of bank protection measures occur along Corte Madera Creek in the town of Portola Valley. Due to altered hydrology in the watershed (increased storm runoff) and the degraded and confined condition of the creek, erosion processes (high velocities and shear stresses) exist and create the need for bank protection. In response to ongoing erosion as well as specific emergency situations associated with significant storm events in the recent past, individual property owners have employed a variety of engineered and non-engineered bank protection measures, some of which are failing or are incompatible with the upstream and downstream bank protection structures.

Creek channel and bank protection can be achieved through sustainable and cost effective approaches that are consistent with and potentially enhance creek function, habitat and aesthetic values. Geomorphic and engineering analyses are important to undertake effective long-term bank stabilization. Although some bank protection efforts on the creek have been effective in stemming erosion and protecting property, most channel bank protection observed has degraded creek function and habitat values. Additionally, many of these projects are 'band-aids' that address the visible problem condition without addressing the source of the problem, the active physical processes.

Most existing bank stabilization measures are in a state of decline and potentially acting to destabilize other adjacent sections of channel. Bank stabilization and protection efforts within the study area range from professionally-designed gabion and concrete structures to ad hoc assemblages of miscellaneous materials such as secrete, wood, pipes and even discarded tires. A consistent problem with much of the bank protection along the creek is that the selected materials have been applied to or on top of the bank often constricting channel dimensions and altering flows. The bank stabilization efforts are typically not keyed into the channel or adjacent banks and channel making them susceptible to undercutting, **flanking** and ultimately premature failure.

The existing banks within the study area are typically partially vegetated with native and non-native species, except in areas where significant sections of armored bank protection occur. These stabilization efforts generally do not utilize native vegetation. The materials and installation techniques used for the typical bank protection measures on the creek limit the establishment of valuable vegetation. The current armoring and hardening of Corte Madera Creek is the result of many individual, uncoordinated protection projects over a long period of time.

In response to these changes, the natural habitats along the creek in the study area are generally degraded. Bank protection has been the responsibility of the individual landowner, except where large channel modifications were implemented. More detailed descriptions of the existing conditions within the Corte Madera Creek study area are provided in Section 4 – Corte Madera Creek.

4.2 Geomorphic Setting

The purpose of the geomorphic survey was to gain both an understanding of Corte Madera Creek as a system (allowing us to break it down into a series of reaches that share similar processes and issues) and the nature of individual erosion problems. This allows the team to look beyond individual properties to see a broader picture of how the creek is functioning. The geomorphic survey included reconnaissance of the length of the creek from Mapache Road to Hamms Gulch (0.5 miles upstream of Kabcenell Bridge. The survey also included a brief reconnaissance of the creek upstream of the Hamms Gulch confluence to the boundary of Windy Hill Open Space above the confluence of Rengstorff and Coal Creeks (headwaters).

In the field, the team assessed both creek banks and bed, characterized the severity of bank erosion, identified likely underlying causes of erosion and developed conceptual alternatives for treating the erosion problems. A typical approach included identification of bank erosion severity, consideration of the "no action" option (ie, the consequences if no protection was added), and to evaluate the effects of several different possible treatments. Would the bank eventually stabilize itself, or would it continue to erode and threaten property? Where bank protection had been installed we considered its effectiveness, how long it might persist, what affect it would have on flows downstream (e.g. would it cause accelerated erosion up or downstream).

4.2.1 Geomorphic Approach

Traditional bank stabilization approaches address a bank area or channel section in isolation from its watershed context, creek dynamics and function. A geomorphic approach to bank stabilization and creek enhancement, however, involves a broader understanding and analysis of the creek's watershed and the influence of dynamic system function on a specific affected bank. The resulting solution is designed to respond to the full range of processes causing the erosion, be more sustainable, and not exacerbate problems on adjacent reaches.

The project team used a geomorphic approach to river management that provides an integrated view of the watershed and creek system, and interprets channel change in relation to watershed and creek processes. Land use changes and geologic context were used as a basis for understanding creek evolution and overall physical conditions today.

Human encroachment and development along the creek has degraded and altered creek dynamics and physical processes and as a result subsequent bank protection measures must address both current fluvial processes and the structural changes that have occurred. Therefore, the conceptual restoration approaches outlined in the report, are not strictly system-based and are, instead, based primarily upon observed existing bank conditions and adjacent land uses. This approach was selected for the following reasons:

1. Existing structures, primarily residences, are located along the reaches with the most severe bank instability. These structures represent real constraints and limiting factors for bank stabilization planning and design.

2. Existing bank conditions are high and steep resulting in a combination of bank erosion and bank armoring along the majority of each of the study reaches.

3. Future erosion conditions and habitat quality will depend on the interrelation of subsequent individual projects implemented within the study area. Significant long-term improvements may be realized as a majority of bank areas are stabilized and revegetated.

Effective bank stabilization projects should be developed from a watershed and geomorphic perspective so that an understanding of the destabilizing forces (natural stream function) at the site scale are understood and addressed. It is also important in many locations along Corte Madera Creek to recognize and differentiate between real erosion threats and natural erosion. Shear stress is a critical parameter for analyzing and designing appropriate bank stabilization approaches. In the most confined and constrained sections of Corte Madera Creek shear stresses are extremely high and necessitate structural approaches. In other situations lower shear stresses allow for 'softer' biotechnical engineering approaches for bank stabilization. In some cases, particularly in Reach 1, patience may be the best tool in response to erosion occurring in areas where no immediate threat to property exists. This reach reflects a combination of natural watershed-based erosion and less severe dynamic responses to human induced erosion. As discussed in Section 3, erosion is an important and natural process within creek and river systems and some episodic erosion may be acceptable.

4.3 Corte Madera Creek – Study Area Reaches

Based on the field evaluations, the Corte Madera Creek study area was divided into four reaches. While any reach classification is slightly arbitrary: there are different conditions found within each reach, and some common issues occur across reaches. However, in general the creek has a distinct character, issues and physical characteristics in each of the reaches.

- Reach 1: 257 Mapache Drive to Westridge Bridge,
- Reach 2: Westridge Drive to Willowbrook Drive,
- Reach 3: Willowbrook Drive to Hamms Gulch, and
- Reach 4: Headwaters / Hamms Gulch to Rengstorff Gulch

The reaches are described in more detail below.

- Reach 1 **(From 257 Mapache Drive to Westridge Bridge)**

This reach is downstream of the most developed section of Corte Madera Creek. The majority of properties in this reach do not severely encroach on the creek compared with properties further upstream (though there are some exceptions). Reach 1 has a medium gradient and a large number of riffle-pool sequences (indicating good aquatic habitat). The creek shows evidence of recent channel incision (approximately 1 to 2 ft) and is characterized by actively eroding outside bends. However, the reach is relatively stable compared with Reach 2 (see below). Most bank protection is patchy rather than continuous. Some bank protection is inappropriately heavy and may contribute to instability elsewhere in the system, (for example by increasing flow velocities along smooth concrete bulkheads). This reach has significant habitat areas that should be preserved and protected (e.g. gravel bed **riffles** and pools, riparian vegetation, overhanging banks). There is evidence of pools filling in with finer sediments; probably from upstream bank and surface erosion. This reach is very dynamic, with evidence of coarse sediment transport and deposition.

The creek channel bed through Reach 1 is dominated by shallow riffles with some relatively deep pools (2 to 3 ft). The channel is composed of mostly cobble-sized material with some smaller gravels and sand. There is very little aquatic vegetation, most likely due to heavy shading from the dense, overarching vegetation canopy. Where pools have formed, there is often coarse woody debris associated with them. This large woody material in the creek acts to hold back sediment, resulting in the creek scouring out the pools below. The relatively deep pools provide important habitat for a number of aquatic species including fish and amphibians.

The most common problems in Reach 1 are: erosion of over-steepened, unprotected outside bends (often with room for regrading behind them), and failure of gabion structures due to undercutting or age. In many cases, it does not appear that active intervention is warranted at this time. The best approach for this reach is to monitor future change, and observe if the channel stabilizes without intervention. The extent of lateral instability in the creek is limited and should guide decision-making and the need for (and scale of) bank stabilization approaches.

- Reach 2 **(Westridge Bridge to Willowbrook Drive)**

This reach is characterized by more urban land use and dense development, with significant property encroachment on the creek. This reach is more sinuous than Reach 1, with greater erosion on outside bends. There is limited and site specific incision. The incision is probably due to flow constriction and increased flow velocity along smooth, hardened structures. The incision is actively undermining sections of bank armoring. As a result, much of the existing bank protection is failing, with the exception of newer gabion installations and some robust bulkhead structures.



R E A C H 1
(257 Mapache Drive to Westridge Bridge)

Summary of Geomorphic Conditions
- Downstream of urban reach; quite dynamic, with much evidence of coarse sediment transport and deposition
- Low-moderate human impacts and encroachment
- Medium gradient, riffle-pool channel
- Previously incised (including up to 2 ft in the recent past), currently relatively stable vertically
- Erosion at outside bends and widening
- Patchy rather than continuous bank protection. Some bank protection is inappropriately heavy and may contribute to instability elsewhere in the system.
- Evidence for some pool infilling from fine sediment
- Good quality habitat.

Bank Conditions
82% Undisturbed
9% Eroding banks
3% Gabion baskets
3% Concrete
2.5% Non-engineered
0.5% Sacrete

Typical Problems
- Erosion of over-steepened, unprotected outside bends
- Failure of existing gabion and other bank protection structures

Conceptual Stabilization Approaches
- Regrade bank to 3:1 or flatter
- Toe scour protection to bankfull elevation
- Biotechnical stabilization on bank
- Vegetated Rock

N

0 500 1,000
f e e t

figure 3

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Reach 1 - Geomorphic Conditions & Conceptual Approaches

Project # 1698/reach1.cdr

PWA

Blank Page

The channel through Reach 2 is generally more confined than Reach 1 but still dominated by shallow riffles. There are fewer "deep" pools although there are a number of shallower pools (1-2 feet deep) usually on the outside bends of the creek.

The creek has a medium gradient, and a mixture of natural riffle-pool and some artificial channel bed conditions. Reach 2 has a good riparian canopy and potential ecological value, though the presence of some bank stabilization treatments is limiting creek habitat values (e.g. replacement of natural bed with artificial gabion bed channel, debris and rusted steel baskets from failing gabions, exposed geotextile filter fabrics from failed riprap slopes). The channel is incising, with recent incision of approximately 1 to 2 ft evident from undercut bank protection. Significant sections (approximately 50% of the reach) of continuous bank protection characterized by a mixture of gabions, rock (with and without planting),
wooden and concrete bulkheads typify the reach. There are some isolated sections of high quality habitat, although the reach is generally low quality habitat due to confinement from bank stabilization treatments and non-vegetated banks.

The most common problem in Reach 2 is failure of existing gabion bank protection (often without space for regrading behind them), over-hardened banks, inappropriate protection and emergency riprap placed at unstable angles and/ or undercut. A significant amount of existing bank protection features are unstable and may require repair or replacement in the near future.

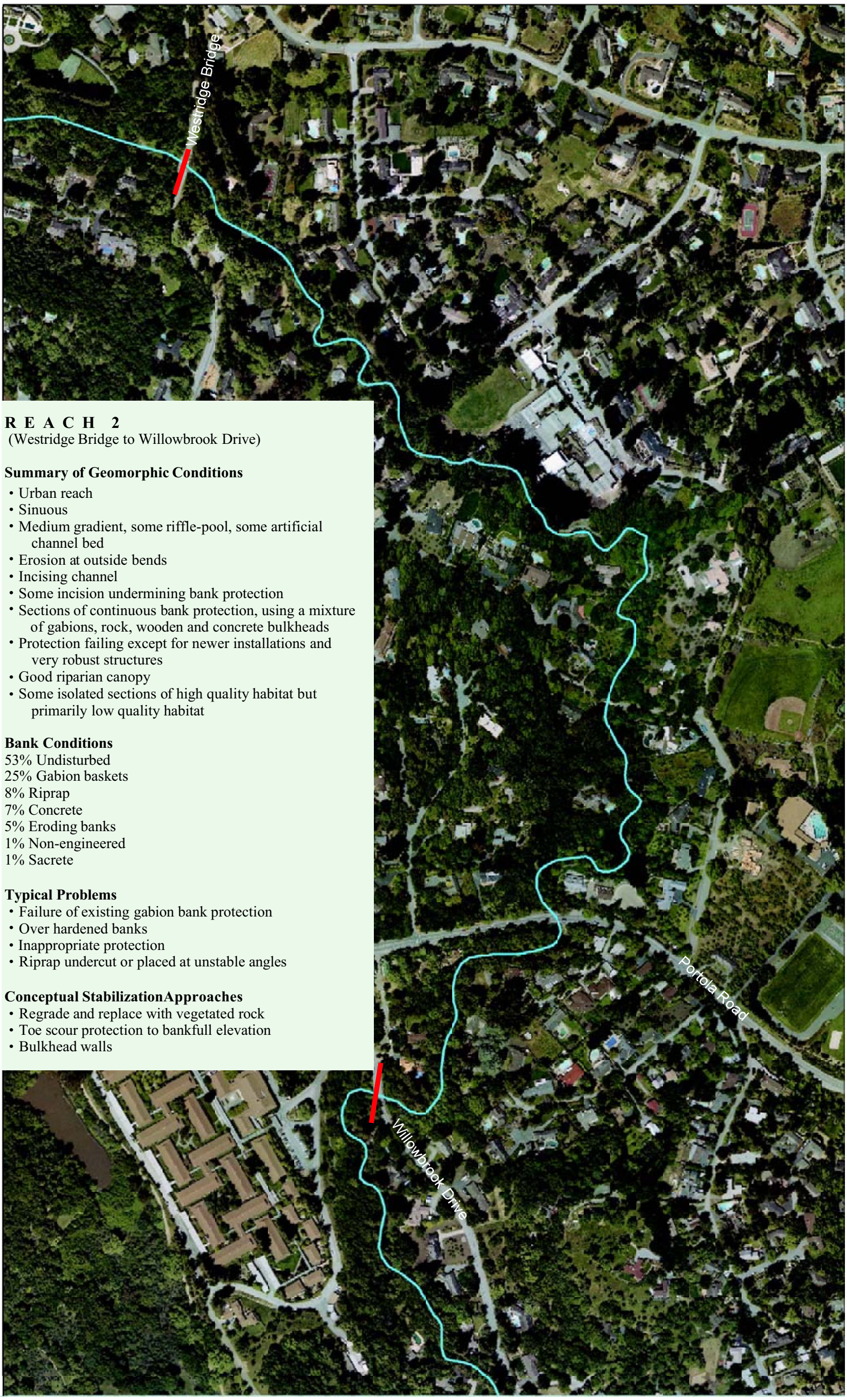
- Reach 3 **(Willowbrook Drive to headwaters)**

Reach 3 is upstream of the more densely developed reach and has a more natural character. It is slightly steeper than downstream, with the channel transitioning from a riffle-pool to a step-pool form higher in the reach. The straight sections of Reach 3 have some very high quality habitat and stable channels. On the meander bends there are many sections with **impinging** flows and bank erosion. The channel is incising locally by approximately 1 to 2 ft.

The channel continues to be dominated by mostly shallow riffles and a few pools (1-2 feet deep). The main difference is there are fewer steep banks and less "engineered" bank stabilization structures although the actual gradient of the creek increases through Reach 3. Aquatic vegetation increases slightly in Reach 3 most likely due to the reduced canopy cover allowing sunlight to reach the creek

The most common problem in Reach 3 is failure of existing gabion bank protection, emergency riprap placed at unstable angles or undercut, erosion of unprotected outside bends.

Blank Page



R E A C H 2
(Westridge Bridge to Willowbrook Drive)

Summary of Geomorphic Conditions

- Urban reach
- Sinuous
- Medium gradient, some riffle-pool, some artificial channel bed
- Erosion at outside bends
- Incising channel
- Some incision undermining bank protection
- Sections of continuous bank protection, using a mixture of gabions, rock, wooden and concrete bulkheads
- Protection failing except for newer installations and very robust structures
- Good riparian canopy
- Some isolated sections of high quality habitat but primarily low quality habitat

Bank Conditions

53% Undisturbed
25% Gabion baskets
8% Riprap
7% Concrete
5% Eroding banks
1% Non-engineered
1% Sacrete

Typical Problems

- Failure of existing gabion bank protection
- Over hardened banks
- Inappropriate protection
- Riprap undercut or placed at unstable angles

Conceptual StabilizationApproaches

- Regrade and replace with vegetated rock
- Toe scour protection to bankfull elevation
- Bulkhead walls

N

0 500 1,000
f e e t

figure 4

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Reach 2 - Geomorphic Conditions & Conceptual Approaches

Project # 1698/reach2.cdr

PWA

Blank Page



R E A C H 3

(Willowbrook Drive to headwaters)

Summary of Geomorphic Conditions

- Upstream of dense urban reach
- High gradient riffle-pool and transition to step-pool channel
- Bends are sharp and eroding, flows are impinged on banks
- Isolated eroding banks
- Channel is incising locally by 1-2 ft
- High quality habitat with good pools and riparian vegetation in places

Bank Conditions

77% Undisturbed
11% Concrete blocks
3.5% Eroding banks
4% Riprap
1.5% Sacrete
2% Gabion baskets
1% Non-engineered

Typical Problem

- Failure of existing gabion bank protection
- Emergency riprap placed at unstable angles
- Riprap undercut
- Erosion of unprotected outside bends

Conceptual Stabilization Approaches

- Toe scour protection to bankfull elevation
- Regrade bank to 3:1 or flatter
- Biotechnical stabilization on bank

N

0 500 1,000

f e e t

figure 5

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Reach 3 - Geomorphic Conditions & Conceptual Approaches

Project # 1 698/reach3.cdr

PWA

Blank Page

4.4 Reach 4/ The Headwaters

In addition to the more detailed survey of four miles of Corte Madera Creek, the team undertook a reconnaissance level survey of an additional two miles from Portola Road to the boundary of Windy Hill Open Space above the confluence of Rengstorff and Coal Creeks. This survey provides a better understanding of the Corte Madera Creek watershed setting and condition. In this reach the creek is relatively undisturbed, except for rock protection associated with Alpine Road. The creek becomes gradually steeper upstream of Reach 3, with more step-pool sections and fewer stretches of riffle-pool channel. Reach 4 is characterized by significant sections of high quality habitat. There is a large amount of bank erosion on outside bends, as would be expected with a steep headwater creek in a seismically active area.

The gradient of the creek continues to increase upstream. The channel is relatively confined due to the steepness of the surrounding environment. The creek banks are mostly natural with a few "engineered" fixes (wood and concrete retention walls) associated with stabilizing the adjacent Alpine Road.

4.5 Existing Bank Stabilization Treatments

Inappropriate bank stabilization can contribute to the problems observed along Corte Madera Creek. For example, smooth un-vegetated bank stabilization treatments such as concrete or wooden bulkheads reduce the amount of friction on flowing water compared with natural banks, which are irregular and rough. As a result, flows tend to accelerate as they pass along these armored sections of creek. Increased flow velocities and depths increase **shear stress**, which can lead to **downcutting** and **scour** along the bank protection itself, or increased erosive force expressed on the next bank downstream.

Another typical bank armoring approach is building out into the creek channel to reinforce an eroded bank, for example by dumping large rock over the bank. Building into the creek reduces its cross section area, limits **conveyance** and increases flow velocity. This typically leads to more downstream erosion, bed scour that undercuts the original bank protection, and the need for additional bank and erosion protection. Inappropriate erosion protection can lead to a bank stabilization 'arms race' with stabilization/ hardening of one reach leading to more erosion on another reach, leading to still more erosion protection and so on. Eventually the whole creek becomes armored, significantly reducing habitat, recreational and aesthetic values, and natural function. These conditions are observed throughout the study area.

Descriptions of typical problems and inappropriate bank protection methods observed along Reaches 1, 2 and 3 of the Corte Madera Creek study area are found below.

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Typical Problems Reach 1, 2 and 3

Miscellaneous/ Ad Hoc Stabilization:
- Non-engineered or Dumped Rock, Construction Debris, Tires

What is the problem?

Non-engineered, dumped rock and construction debris used to address bank erosion (particularly under emergency conditions) is a typical response to erosion that has occurred throughout Corte Madera Creek. These responses often provide temporary stabilization, but can create problems that require additional action later. Dumped rock and debris comes to rest at a very steep angle reflecting the eroded condition it is intended to protect. Incision/ down-cutting of the creek channel (which is inevitable in Corte Madera Creek) undercuts the rock layer, causing the rocks to fall into the channel. This eventually leaves the bank unprotected and the scattered rocks can confine flow and lead to concentrated/ redirected flows and ultimately increased scour potential.

Due to imprecise placement and installation techniques, dumped materials tend to narrow and confine the creek channel increasing local flow velocities, water surface elevations and shear stress. Dumped materials are rarely keyed into the channel bed and banks increasing the likelihood of wash out and failure. In addition, undercut materials may expose unsightly and potentially hazardous **geotextile** filter fabrics. Finally, these materials limit the establishment of vegetation, especially native trees which help to stabilize the bank and provide important shade and habitat conditions.

Similarly old tires anchored with pipes and metal stakes dumped on creek banks in response to erosion have limited value as bank protection and compromise riparian habitat quality significantly. Scour and erosion can be exacerbated around and under the tire structures intended to armor creek banks. As they decompose, tires introduce hazardous chemicals into the creek compromising water quality. In general, non-engineered structures are liable to break apart, leaving the affected bank susceptible to further erosion and subsequent material dispersal.



Tires as Bank Armor



Ad Hoc Materials as Bank Armor

Location: Reach 1, 2 and 3

Typical Issues
- Confine channel and lead to concentrated / redirected flows
- Exacerbate scour and destabilizing forces
- Limited life span
- Constrict conveyance and channel capacity
- Degrade habitat values and water quality

Preferred Stabilization Approaches
- Vegetated Rock
- Biotechnical Stabilization

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Typical Problems Reach 1, 2 and 3

Sacrete/ Concrete Walls

What is the problem?

Sacrete/ concrete walls are single purpose armoring approaches to bank protection that are relatively common along certain sections of Corte Madera Creek. Sacrete can be described as informal placement of bags of concrete stacked together to form a contiguous hardened bank over an area of erosion or instability. Concrete walls are hard structures constructed along banks and at some locations within the creek channel. Some concrete walls are unreinforced structures poured in place directly onto affected bank areas while others are significant structural elements built on creek banks in response to erosion.



Concrete and Sacrete BankArmor

Sacrete and concrete walls can be effective responses for bank protection, but can significantly and negatively influence creek flows and function. Hard, smooth bank protection such as sacrete and concrete walls reduce friction and can increase erosion further downstream as a result of accelerating flows. Many secrete and concrete wall installations observed on Corte Madera Creek are not adequately keyed into the channel and have been undermined. Concrete bank protection effectively limits vegetation establishment.

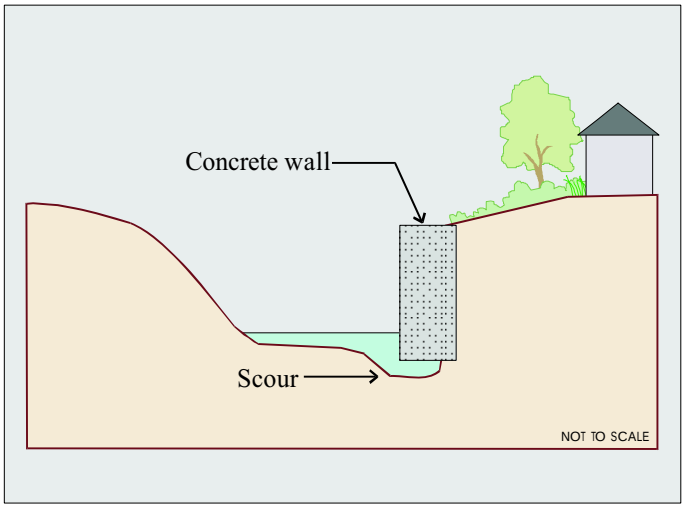
Location: Reach 2 and 3

Typical Issues

- Accelerate flows
- Increase shear stresses downstream
- Increase scour potential locally
- Susceptible to scour and flanking
- Limited vegetation establishment

Stabilization Approaches

- Vegetated rock
- Bulkhead wall
- Biotechnical stabilization



Typical Section

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Typical Problems Reach 1, 2 and 3

Failing Gabions (constrained and unconstrained sites)

What is the problem?

Gabions are large wire baskets filled with rock to create a hardened bank. The gabion baskets are often placed along the channel in front of eroding bank sections. The baskets can be stacked on top of each other to achieve almost vertical conditions. Along Corte Madera Creek gabions often have been placed on the channel bed and in many cases extend the entire vertical limit of the affected bank.

In high-energy creeks such as Corte Madera Creek, gabion baskets have a relatively limited design life, typically not more than fifteen years, and often less. Gabions fail for three primary reasons:

- The creek channel erodes and undercuts the structure, causing it to sag and eventually fail
- The bank slumps behind the structure, causing it to fail
- The steel basket rusts or is worn away by material in the creek, causing the rock inside to fall into the creek



Existing Conditions - Gabions

The first situation occurs when the channel incises downwards, as is happening along sections of Corte Madera Creek particularly on the apex of outside bends. Channels incise for many reasons, including the presence of faults, removal of vegetation and trees from the watershed, and human encroachment on the channel (narrowing/ constriction). Failing bank protection is a particular problem when buildings or desirable mature trees limit the amount of space for bank grading.

Location

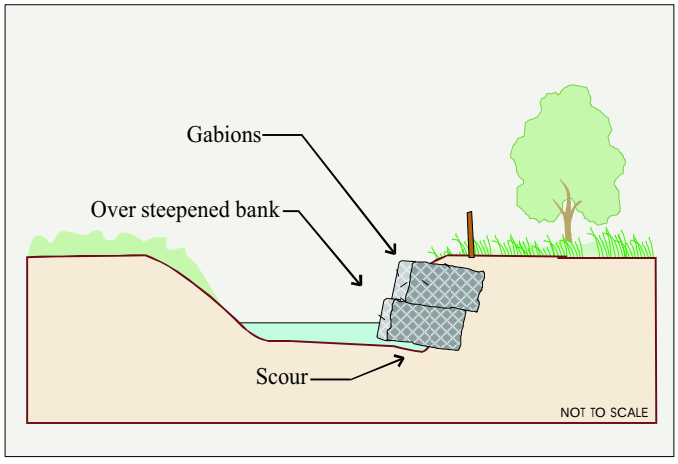
Reach 2 and 3

Typical Issues

- Limited structural life span, 10 to 15 years
- Accelerate flows
- Increase shear stresses downstream
- Limited scour protection
- Limit vegetation
- Require costly replacement

Preferred Stabilization Approaches

- Bulkhead wall with biotechnical stabilization
- Vegetated rock with biotechnical stabilization



Typical Section

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Typical Problems Reach 1, 2 and 3

Eroding Unprotected Bends

What is the problem?

Where Corte Madera Creek encounters unprotected and unstable bends, flows can undercut the banks, causing slumps and scour, potentially compromising residences, facilities and riparian vegetation. Much of this erosion is natural in the creek, and can be seen in the relatively undisturbed headwaters along Alpine Road in addition to areas within Reach 1. However, this kind of erosion is often exacerbated by a pattern of bank hardening and channel confinement (narrowing), which can be seen in the more urbanized sections of the creek. Eroding banks can fail due to geotechnical and hydraulic forces or a combination.*

Areas of unprotected eroding banks occur throughout the project study area. These areas vary widely in terms of severity and rate of erosion, threat to property and infrastructure, bank height, and existing vegetation. All of these factors must be considered in analyzing, designing and implementing appropriate bank stabilization projects. In some less constrained locations (Reach 1 in particular), although the erosion is very visible it does not represent a direct threat to most property. Eroding banks over 8 feet in height typically present more serious constraints and problems. Analysis and understanding of destabilizing forces will typically lead to better stabilization solutions.

* Banks will often erode until more stable bank angles and channel dimensions are achieved.



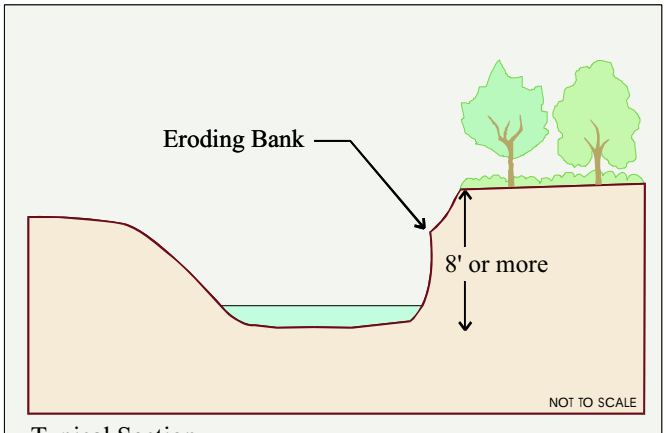
Location: Reaches 1 and 3

Typical Issues

- Threaten property
- Significant sediment delivery
- Limited vegetation
- Perceived problem

Preferred Stabilization Approaches

- Biotechnical Stabilization
- Vegetated Rock
- Do Nothing/ 'Patience' where appropriate



Typical Section

Blank Page

Corte Madera Creek
Bank Stabilization & Revegetation Report

Typical Problems Reach 1, 2 and 3

Poor Vegetation/ Limited Habitat (Stable Channel)

What is the problem?

Many bank sections along Corte Madera Creek are relatively stable, but have limited or degraded habitat value due to extensive establishment of invasive exotic tree and plant species. Many native trees and plants that have adapted to climatic and physical conditions within riparian corridors can be particularly valuable for improved soil stabilization and habitat values.

Non-native tree and plant species have colonized and established throughout the creek corridor. Many of these species can "out-compete" local native species thus reducing overall diversity. By limiting native species along the creek, non-natives contribute to long-term channel instability and compromise important species diversity.



Non-native or limited vegetation reduces potential habitat values

Location

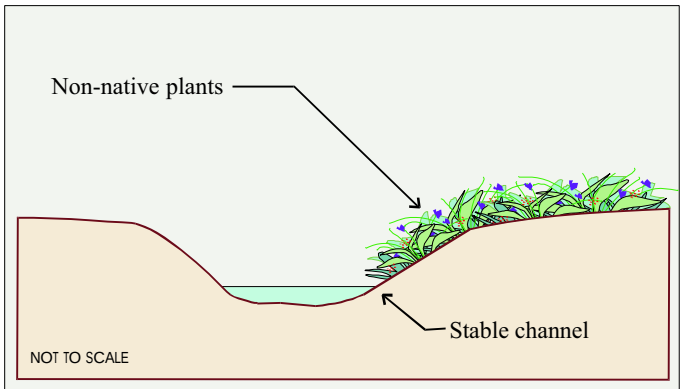
Reaches 1 and 3 (Predominantly)

Typical Issues

- Limited soil stabilization
- Limited vegetation diversity
- Degraded habitat value: cover, refuge, foraging opportunities

Stabilization/ Enhancement Approaches

- Non-native tree and plant species removal
- Bioengineering/ Planting
- Planting native riparian species



Stable channel with undesirable vegetation (limited habitat value)

Typical Section

Blank Page

4.6 Existing Biotic Conditions of Corte Madera Creek

Biotic values of these reaches were assessed during the site visits, and additional background information, from a variety of sources, was reviewed. These sources included the California Natural Diversity Database (CNDDB 2004), and information on wildlife occurrences in Searsville Lake and San Francisquito Creek from a series of reports prepared by the Center for Conservation Biology at Stanford University.

4.6.1 Fish and Wildlife of Corte Madera Creek

Corte Madera Creek provides excellent habitat for a variety of wildlife species especially birds. As mentioned above, riparian areas in California provide oases of habitat for a number of bird, mammal, fish, and amphibian species. The fact that the riparian habitat here is contiguous with substantial wildlife upstream and downstream of the project area increases its value to wildlife, as it allows it to serve as a movement corridor, providing continuous cover and foraging habitat for species moving through the area

The most common fish in Corte Madera Creek is probably the rainbow trout (*Onchorynchus mykiss*). This native salmonid is common in streams throughout California. Where no migration barriers exist between streams and the ocean, this same species migrates to the ocean, and is considered the steelhead, a species listed as Threatened under the federal Endangered Species Act. However, in streams such as Corte Madera Creek, where barriers exist (in this case, the dam at Searsville Lake), rainbow trout are resident year-round having no access to the ocean. Migration patterns above Searsville Dam are also affected by barriers and rainbow trout in these reaches are often restricted to particular areas of the creek. A study conducted in 2001 (Stoecker) identified migration barriers to rainbow trout in Corte Madera Creek and proposed possible actions to improve fish passage (Appendix A - References). While larger trout are less common, small young-of-the-year trout can often be seen in pools in Corte Madera Creek. Other native fishes in Corte Madera Creek may include threespine stickleback (*Gasterosteus aculeatus*) and California roach (*Lavinia symmetricus*). These native fishes are threatened by competition and predation from non-native fishes, such as green sunfish (*Lepomis microlophus*), and crayfish (*Procambarus clarkii*) which are abundant in Searsville Lake, and likely also occur in Corte Madera Creek.

Aquatic habitat in Corte Madera Creek is also important for native amphibian species such as the California newt (*Taricha torosa*). During spring, adult newts emerge from moist leaf litter and similar moist habitats and breed in pools in Corte Madera Creek. Larvae develop here, and during summer months when pool levels are low, larvae are often visible in isolated pools. Newts are also at risk of predation by non-native crayfish. Other common salamanders, such as the ensatina (*Ensatina eschscholtzii*) and arboreal salamander (*Aneides lugubris*), are less dependent on the creek. Arboreal salamanders are common in oak woodland habitats, and because they can climb, are often seen around houses locally. Corte Madera Creek also provides potential habitat for the federally-

listed threatened California red-legged frog. No protocol level surveys for red-legged frog were done as part of this survey although the potential for their occurrence is discussed further in the Special-Status Species section of this report.



California newts can be seen after the first fall rains.

Invertebrates

A variety of invertebrate species thrive in Corte Madera Creek, and provide food for fish and amphibians. The most visible of these invertebrates are water striders (family *Gerridae*). These insects use surface tension to walk on the surface of the water, where they scavenge and prey on other small insects.



Water striders leaving tell-tale shadows in Corte Madera Creek.

Numerous aquatic insect species, such as mayflies, stoneflies and caddisflies spend the early stages of their life cycle (the larval stage) in streams on and under the cobbles at the bottom of stream channels. A high abundance of caddisfly larvae were observed in Corte Madera Creek and are an indicator of good water quality.



Aquatic invertebrates, such as the small caddisfly larvae on these rocks in Corte Madera Creek, provide food for fishes.

Banana slugs (*Ariolimax columbianus*) are another highly visible invertebrate common in wet habitats in the Santa Cruz Mountains.



Banana slugs live in moist habitats in the Santa Cruz Mountains.

Terrestrial Animals

Terrestrial animals that use Corte Madera Creek and adjacent riparian habitat include the desert cottontail rabbit (*Sylvilagus audubonii*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), fox squirrel (*Sciurus niger*), California mouse (*Peromyscus californicus*), deer mouse (*Peromyscus maniculatus*), and western fence lizard (*Sceloporus occidentalis*). Black-tailed deer (*Odocoileus hemionus*) regularly use the creek for drinking water. Domestic cats (pets) (*Felis domesticus*) may also occur in the riparian corridor, and may prey on native wildlife. Several species of bats are also likely to forage over the riparian corridor, which provides great habitat for their insect prey. The most common of these are the Yuma myotis (*Myotis yumanensis*), and the big brown bat (*Eptesicus fuscus*).



A black-tailed deer doe and fawn pausing to drink at Corte Madera Creek (Reach 2).

Birds

As mentioned previously, riparian habitats in California are particularly important for birds. Neotropical migrants (birds that breed in North America and migrate to Central or South America during winter), rely heavily on insect prey in riparian corridors on the west coast to fuel up for migration. Several neotropical migrants breed in the riparian corridor of Corte Madera Creek, including the Wilson's Warbler (*Wilsonia pusilla*), Warbling Vireo (*Vireo gilvus*), Swainson's Thrush (*Catharus ustulatus*), and Black-headed Grosbeak (*Pheucticus melanocephalus*). Other bird species use Corte Madera Creek year-round, or only during the non-breeding season. These species include the Steller's Jay (*Cyanocitta stelleri*), California Towhee (*Pipilo crissalis*), Bewick's Wren (*Thryomanes bewickii*), Yellow-rumped Warbler (*Dendroica coronata*), and Townsend's Warbler (*Dendroica townsendi*). Portions of the Corte Madera Creek riparian corridor support large trees with cavities large enough for birds to nest in. Here, cavity nesting birds such as Downy Woodpecker (*Picoides pubescens*), Chestnut-backed Chickadee (*Poecile rufescens*), and Tree Swallows (*Tachycineta bicolor*) nest.

4.6.2 Habitat Descriptions

The following are descriptions of the aquatic and riparian vegetation habitat types present in each of the four reaches.

- Reach 1 **(257 Mapache Drive to Westridge Bridge): Unique and important biological resource.**

Reach 1 supports some of the highest quality riparian habitat of any of the creeks along the east side of the Santa Cruz Mountain foothills. The riparian corridor in many areas is more than 200 feet wide and has 100% canopy cover. Its large size and complex multi-canopied structure with few non-native plant species make this a unique and critically important biological resource. The overstory vegetation is dominated by large, mature tree species including black cottonwood (*Populus trichocarpa*), box elder (*Acer negundo*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*), white alder (*Alnus rhombifolia*), California buckeye (*Aesculus californica*), blue elderberry (*Sambucus mexicana*), and coast live oak (*Quercus agrifolia*). The midstory vegetation is composed of dogwood (*Cornus glabrata*), snowberry (*Symphoricarpos albus*), elk clover (*Aralia californica*), mugwort (*Artemesia douglasiana*), poison oak (*Toxicodendron diversilobum*), and California blackberry (*Rubus ursinus*). Understory vegetation is mostly Western colt's foot (*Petasites frigidus* var. *palmatus*), American stinging nettle (*Urtica dioica* ssp. *gracilis*), horsetail (*Equisetum sp.*), hairy honeysuckle (*Lonicera hispidula*) and a variety of ferns, sedges and rushes.

This reach is dominated by native vegetation with a relatively low percentage of non-native species. However, some non-native, invasive pest plants such as cape ivy (*Senecio mikanioides*), periwinkle (*Vinca major*), English ivy (*Hedera helix*), French broom (*Cytisus monspessulanus*), pampas grass (*Cortedaria selloana*), poison hemlock (*Conium maculatum*), privet (*Ligustrum vulgare*) and St. Johnswort (*Hypericum sp.*) are present. Many of these species, especially cape ivy, periwinkle, English ivy and St. Johnswort form monocultures that are spreading horizontally and degrade the riparian habitat by reducing the diversity and cover of native riparian shrub species. This reduces the habitat value for wildlife species, especially birds that depend on riparian habitat.

The extensive riparian vegetation here provides habitat for a considerable diversity and abundance of wildlife. The creek provides habitat for rainbow trout, California newts, and other fish and amphibians. The wide riparian corridor supports the greatest diversity of bird species within the study area. Neotropical migrants breed and forage here, and larger trees may support nesting raptors. Overall, Reach 1 provides excellent wildlife habitat.

- Reach 2 **(Westridge Drive to Willowbrook Drive): Reduced diversity and abundance of wildlife species.**

In general, the riparian corridor is narrower in Reach 2 compared to Reach 1, ranging from approximately 40 – 100 feet wide. There are fewer large trees than in Reach 1 resulting in slightly lower canopy cover (approximately 80%). The tree species are generally the same as in Reach 1 with the addition of coast redwood (*Sequoia sempervirens*), bigleaf maple (*Acer macrophyllum*), black walnut (*Juglans californica*), and California bay (*Umbellularia californica*). The mid-story is generally a similar mix as in Reach 1 with a few different species such as, coyote brush (*Baccharis pilularis*), mulefat (*Baccharis salicifolia*) and flowering currant (*Ribes glutinosum*). Ground cover is sparser than in Reach 1, but supports the same species with a few additional ferns. The percentage of invasive, pest plants, such as English ivy is greater than that present in Reach 1. The banks in these areas are relatively low gradient and present good opportunities to improve the riparian habitat by removal of invasive species like ivy and replanting with natives riparian under-story species.



Riparian habitat in Reach 2 with the under-story converted from native plant species to a monoculture of invasive English ivy.

Wildlife use of Reach 2 is likely to be similar to that in Reach 1, although the narrower riparian corridor, increased abundance of non-native vegetation and bank stabilization features in Reach 2 probably results in a reduction in both diversity and abundance of wildlife species. Again, the riparian corridor supports many bird species, including Steller's Jays, Downy Woodpeckers, and migrants such as Black-headed Grosbeaks. The low flow of summer water in the creek is more continuous here, and may support a greater diversity of fishes than reach 1.

- Reach 3 **(Willowbrook Drive to Hamms Gulch): Potential for revegetation with native species.**

The riparian corridor continues to narrow through Reach 3 with an average width of approximately 50 feet and approximately 75% canopy cover. The over-story vegetation is similar to that found in Reach 2 with the addition of Pacific madrone (*Arbutus menziesii*). The mid-story vegetation is the same as in Reach 1 with the addition of toyon (*Heteromeles arbutifolia*). The under-story vegetation through Reach 3 is dominated by the same mix of native species that are present in Reaches 1 and 2. There are a few areas that have been invaded by non-native plants such as Himalayan blackberry (*Rubus discolor*) and French broom, but they are isolated patches. These patches present good opportunities to improve the riparian habitat for plants and wildlife by removing these non-native, invasive species and replanting with native shrub and under-story plants.

Wildlife use of Reach 3 is likely to be generally similar to Reach 2. Additional oaks present here provide food for a number of species that feed on acorns, including Acorn Woodpeckers (*Melanerpes formicivorus*), Band-tailed Pigeons (*Columba fasciata*), and fox squirrels.



- Reach 4/ The Headwaters: **Connection between wildlands and lower reaches.**

The riparian corridor in Reach 4 shifts to a much more "coastal mountain" character with redwood, Douglas fir (*Psuedotsuga menziesii*), bigleaf maple and California bay dominating the landscape. While willows and alders persist in some density immediately adjacent to the channel. The canopy is very dense and there is a sparse under-story dominated by natives including California blackberry, poison oak, and a variety of fern species.

Here, the sparser under-story likely corresponds to a lower abundance and diversity of wildlife species. Moving upstream into the Santa Cruz Mountains, the wildlife community becomes more similar to that found in mixed evergreen forests. Here, bird diversity is fairly low, including species such as the Steller's Jay, Common Raven (*Corvus corax*), Winter Wren (*Troglodytes troglodytes*), Pacific Slope Flycatcher (*Empidonax difficilis*), and Black-throated Gray Warbler (*Dendroica nigrescens*). This habitat supports few large mammals, although the connectivity with large expanses of undeveloped habitat in the Santa Cruz Mountains means that mountain lions (*Felis concolor*) could occasionally occur here. Banana slugs are common here during winter.

4.7 Special-Status Species

4.7.1 Regulatory Overview

Populations of several plant and animal species in California are at risk of extinction, in most cases as a result of loss of habitat to human development and competition with non-native species inadvertently introduced locally by humans. The species at greatest risk of extinction are listed by the federal government as Endangered or Threatened under the **Federal Endangered Species Act** (FESA) of 1972, and the California Endangered Species Act (CESA) of 1973. These species are protected, and humans are prohibited from killing, harming, or disturbing them. The FESA requires project proponents to Consult with the U.S. Fish and Wildlife Service or NOAA Fisheries Service for projects that could affect federally-listed threatened or endangered species. Through this protection, and other management efforts such as habitat restoration, most species listed under the FESA and CESA are expected to recover and be "de-listed". Other species that do not yet warrant listing under the FESA or CESA, but may have declining or at-risk populations are listed on several other "special-status species" lists, including the California Department of Fish and Game list of special-status species, and lists produced by the California Native Plant Society. These other special-status species do not receive the same level of protection as species listed under the FESA and CESA. However, they must be specifically addressed by projects subject to the California Environmental Quality Act (CEQA), a requirement that should prevent these species from declining to levels at which they need to be listed. It should also be noted that all native bird species are protected (from any type of disturbance, but particularly while nesting) under the federal Migratory Bird Treaty Act of 1897.

No wildlife species listed under the FESA or CESA are known to occur on Corte Madera Creek, although federally-listed threatened species, the **California red-legged frog** (*Rana aurora draytonii*) could potentially occur here. The California red-legged frog, the largest native frog in the state, was once common throughout the coast ranges and the foothills of the Sierra Nevada, where it achieved fame in Mark Twain's "Celebrated Jumping Frog of Calaveras County." Over the last century however, much of the habitat for this species has been lost to development, and remaining populations have been decimated by non-native predators, especially bullfrogs (*Rana catesbeiana*). Red-legged frogs still occur throughout the San Francisco Peninsula, in stock ponds, slow-moving streams, and other wetland habitats. Red-legged frogs require year-round water, and typically breed only on ponds or pools more than two or three feet deep. Adults are mainly nocturnal, and may use woody debris and overhanging vegetation for cover during the day. Pools within Corte Madera Creek could provide habitat for this species. Surveys have not been conducted in the study area, but surveys conducted by the Center for Conservation Biology at Stanford University in San Francisquito Creek, downstream from Searsville Lake, resulted in numerous sightings of California red-legged frogs. Bullfrogs and non-native largemouth bass (*Micropterus salmoides*) in Searsville Lake have likely decimated red-legged frog populations within and immediately adjacent to the lake. The Stanford studies showed that abundance of red-legged frogs increased with distance downstream from Searsville Lake. It is not known whether red-legged frogs occur in Corte Madera Creek although the habitat present is suitable; we would consider it likely that they could occur here.



California red-legged frogs occur nearby, and may occur in Corte Madera Creek.

One other federally-listed wildlife species (listed as threatened), the **San Francisco garter snake** (*Thamnophis sirtalis tetrataenia*), occurs in the vicinity of Corte Madera Creek. The San Francisco garter snake is very rare, occurring almost exclusively in San Mateo County. These colorful snakes live on the margins of ponds where substantial frog populations provide abundant prey. They occur in the vicinity of Crystal Springs Reservoir, and intergrades of this subspecies and another subspecies of garter snake (*T. sirtalis infernalis*) occur at Jasper Ridge, at Stanford University. However, San Francisco Garter snakes have not been reported from Searsville Lake or Corte Madera Creek, and probably do not occur in the study area.

A variety of other special-status wildlife species (listed as Species of Special Concern by the California Department of Fish and Game) may occur in the riparian corridor of Corte Madera Creek. **Foothill yellow-legged frogs** (*Rana boylii*) are closely related to red-legged frogs, but typically occur in rocky streams, as opposed to ponds. This species occurs in other streams in the Santa Cruz Mountains, and could occur in Corte Madera Creek. **Cooper's Hawks** (*Accipiter cooperii*) and **Sharp-shinned Hawks** (*Accipiter striatus*) are small agile hawks that feed primarily on smaller songbirds, which they catch in flight. These hawk species nest and forage in densely wooded habitats, and may nest in the riparian corridor of Corte Madera Creek. **California Yellow Warblers** (*Dendroica petechia brewsteri*), small neotropical migrant songbirds, may also nest in riparian vegetation along Corte Madera Creek, particularly in the abundant willows at the downstream end of the study area.

Western pond turtles (*Emmys marmorata*) historically occurred at Searsville Lake, but apparently no longer occur here. This species is not expected to occur in Corte Madera Creek (there are no recent records in the CNDDB database), but the potential for occurrence exists because suitable habitat is present in the study area. Special-status mammal species that may occur locally include the two species of bats and the **San Francisco dusky-footed woodrats** (*Neotoma fuscipes annectens*). **Pallid bats** (*Antrozous pallidus*) likely forage over the Corte Madera Creek riparian corridor, and may roost in larger trees and under bridges here. **Townsend's big-eared bats** (*Corynorhinus townsendii*) roost in caverns, such as caves, but may forage occasionally over Corte Madera Creek. The San Francisco dusky-footed woodrat, a California Species of Special Concern, can be distinguished from common non-native rats (*Rattus* spp.) by its tail; woodrats have fur on their tails and non-native rats do not. Woodrats build large, conical nests of sticks, and live in a variety of wooded habitats on the San Francisco Peninsula. Dense riparian vegetation, such as that along portions of Corte Madera Creek, provides suitable habitat for woodrats. In addition, other special-status species, including birds such as the **Merlin** (*Falco columbarius*), **Vaux's Swift** (*Chaetura vauxi*), are likely to pass through and forage within the study area, but are not likely to breed within the study area.

Although no plant species listed as threatened or endangered under the FESA or CESA are known to occur in the Corte Madera Creek watershed, the California Department of Fish and Game's California Natural Diversity Data Base shows one plant species of special concern that occurs along Corte

Madera Creek. **Western leatherwood** (*Dirca occidentalis*) has been documented just upstream of Searsville Lake along Reach 1 and within the upper section of Reach 3 and 4. The California Native Plant Society has listed Western leatherwood as a species of special concern in California.

SECTION 5 – Conceptual Restoration Approaches and Permitting

5.1 Introduction

The Conceptual Restoration Approaches outlined in the Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection report provide an outline for property owners and stakeholders to use for planning, design, permitting and construction of future stabilization and revegetation projects on Corte Madera Creek. The Conceptual Approaches emphasize limiting structural or hard approaches or adapting them to integrate roughness and revegetation components. The conceptual approaches are based on findings of the geomorphic assessment and vegetation surveys conducted to support the report. The approaches are compatible with the existing conditions and function of Corte Madera Creek. The geomorphic and habitat conditions of Corte Madera Creek are described in detail in Section 4 - Corte Madera Creek Watershed.

In this section we describe the development of bank stabilization alternatives recommended for the entire study area of the creek. The preferred situations and most appropriate locations for application of each of the conceptual approaches as well as general costs and benefits are provided. The approaches are based on the defined project goals.

5.2 Methods

The approaches range from complete removal and replacement of bank protection features to revegetation using native species. Where bank erosion and site constraints are more severe, a more limited set of approaches apply that tend to be more structural, and provide less habitat. Several of the preferred stabilization and revegetation approaches are appropriate to all three reaches of the study area.

Given the degraded and developed character certain sections of the creek corridor, there are many constraints to bank stabilization and enhancement of riparian habitat. As such, the critical goals of the stabilization approaches within the Citizens' Guide include:

- To increase the overall stability of the creek, or at least to avoid localized solutions that unintentionally reduce the stability of neighboring reaches.
- To provide alternatives for bank stabilization and protection that improve creek function and habitat values.
- To enhance and increase native vegetation – extents and diversity. This will also support the improvement of habitat values and long-term bank stability.
- To describe preferred conceptual approaches for property protection that are consistent with local and regulatory agency priorities and jurisdictions
- To include a range of cost effective solutions that can be implemented throughout the reach.

5.3 How to Protect Creek Banks?

When done thoughtfully, stabilizing an eroding creek bank can protect the property and improve the creek resource. Preferred approaches will not increase erosion risk for neighbors up and downstream and are based on the existing physical processes and support creek habitats. Three key questions are critical when considering stabilization of an eroding bank

1. Bearing in mind the cost and process associated with undertaking a bank stabilization project, the first is to ask 'is this protection necessary?' If erosion directly threatens a residence it is clearly necessary to prevent the bank from undermining the structure. On the other hand if the creek bank is slowly eroding the edge of a garden it may be preferable to monitor the condition for several seasons before deciding whether and what level of intervention is appropriate. Often where the total bank height is low (eight feet or less) bank erosion may be temporary or even reverse itself, as part of the **'dynamic equilibrium'** of the creek. This is particularly likely if property is on the inside of a bend. In this case, planting riparian vegetation along the edge of the creek may be more effective than using rock or hard structures. Unnecessary bank armoring protection is expensive and can make other sections of the creek less stable by increasing and transferring erosive forces downstream.

2. Second, if protection is determined to be necessary, the approach for bank stabilization and protection should address creek dynamics, bank stability and riparian habitat enhancement. As a general rule the most effective way to stabilize a bank is to regrade it to a flatter, more stable angle and cover it with a rough and resistant material. In some cases this material may be native vegetation, which both reinforces the soil and reduces flow velocities. Where erosion is more of a problem or the site is more constrained the preferred approach is typically to regrade the slope to a stable angle (2:1) and place vegetated rock revetment at the toe of slope. The engineered rock section should extend to the **bankfull** elevation on the bank at a minimum, and should be placed with native riparian branch cuttings (willows) integrated into the rock layer (Vegetated Rock).

   When significant constraints exist (e.g. a threatened structure within a few feet of the top of bank) that prevent or limit bank grading, the solutions are limited to constructing retaining walls in the lower sections of the channel. Footings for walls (or any structural element) constructed in the active channel must be keyed into the channel bed to address potential scour. It is preferable to utilize construction materials or approaches that 'roughen' the surface of the walls to prevent creek flows from accelerating along the smooth bank and increasing erosion potential elsewhere downstream.

   Durability of materials used in bank stabilization efforts is also important. For example, most construction debris is not heavy enough to withstand the flows found in Corte Madera Creek and will simply wash away and fill the creek downstream with unsightly and

potentially hazardous material. Even rock filled gabions, though very strong when constructed, only have a design life of approximately 15 years in creeks, as the wire baskets degrade (rust) and rupture.

Bank treatments must also plan for and accommodate dynamic conditions in the creek. Corte Madera Creek is incising in locations, and even robust bank treatments can be undercut as a result. Keying the bank protection into the bed of the creek to the anticipated scour depth can prevent undercutting and destabilization.

Some bank erosion is natural, and slowly eroding banks that have diverse native vegetation cover represent valuable riparian habitat. Bank conditions like this are not necessarily a problem. The presence of structures, utilities or other infrastructure close to the top of bank may guide specific stabilization requirements and approaches. Where erosion is not directly threatening property and the banks are lower (less than eight feet high) no treatment may be required beyond planting and/ or maintaining native vegetation. Where erosion occurs on a higher bank behind a yard or away from structures, the preferred approach may be to terrace or regrade the bank to a stable angle **(3:1)** and stabilize/ plant the bank face to provide erosion resistance and improve riparian habitat. It is typically beneficial to plant native riparian trees (for example willows, alders or dogwood). These species will help to anchor and stabilize soils, slow erosion, and provide valuable riparian habitat.

3. Finally, any bank protection approach selected should not make the erosion problem worse for other property owners and should enhance the creek environment.

Some typical guidelines for bank stabilization approaches include:

- Do not reduce the width of the creek, as this will almost certainly cause erosion in the bed, on the opposite bank, and downstream.
- Do not reduce the length of the creek (by straightening a bend for example). This action will steepen the bed profile, increasing erosion locally, and on the next bend downstream.
- Where possible, combine grading activities to flatten bank angle and using a mixture of biotechnical methods such as brush mats and willow planting.
- Where rock is required, place rock (mechanically or by hand) rather than by dumping. Dumped rock generally forms an unsustainably steep angle, which eventually collapses and rolls rock into the creek.
- Limit the upper vertical extent of placed rock for structural and erosion protection requirements on the bank slope to maximize plantable areas. Key rock into the bed several feet to prevent undercutting.
- Utilize rock sizes based on calculations of flow force and resistance.

- Integrate native trees such as willow and alder with the engineered rock bank protection. Integrated planting has several benefits:

1. Roots anchor the soil beneath the rock, providing a living support system that increases the strength of the bank protection over time;
2. Vegetation slows water velocities, reducing erosion both at the bank and downstream, and;
3. Trees provide shaded cover for the creek, improving habitat conditions.

5.4 Conceptual Restoration Approaches

Six conceptual restoration approaches are described in the report. The approaches outlined include:

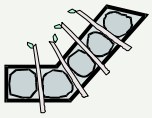
- Vegetated Rock
- Bulkhead Wall (Rock)
- Grade Control Structure (GCS)
- Biotechnical Stabilization
- Bioengineering Stabilization/ Planting
- Native Planting – Stable Channel

Descriptions of the conceptual stabilization approaches for multi-objective bank stabilization and revegetation efforts within the Corte Madera Creek study area are found below.

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Conceptual Stabilization Approaches Key

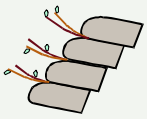
Key



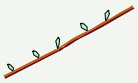
Vegetated rock protection
- bankfull elevation
- toe & scour protection



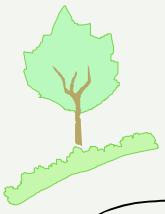
Bulkhead wall (rock)
- bankfull elevation
- toe & scour protection



Biotechnical stabilization
- vegetated soil lifts (VSL)
- brush mat with vegetated rock toe

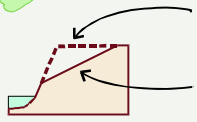


Bioengineering stabilization (live plant materials)
- brush mat
- live pole planting
- biodegradable fabrics



Native tree planting

Native shrub planting



Existing (eroding) bank

Regrade banks

Potential Cost (relative)	Potential Ecological Benefit (relative)
high	high
med	med
low	low

Note: Relative cost and ecological benefit of each conceptual stabilization approach is measured against the entire set of potential approaches presented in the report. Many factors influence cost including source and extent of erosion, access, technical assistance, and permitting. Potential ecological benefits are measured primarily on revegetation potential and soil stabilization factors.

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Conceptual Stabilization Approaches

Vegetated Rock

What is the solution?

Vegetated rock is the installation of large rock to armor and protect the channel bank toe. Live pole cuttings of native riparian tree species (Alder and Willow,) typically are built into the rock section and ultimately establish and grow into the bank. The rock provides structural stabilization to the creek channel while the trees will enhance soil stabilization and habitat qualities as they establish. Vegetated rock is effective in increasing channel roughness, slowing flow velocities and reducing shear stresses. Vegetated rock can be integrated with biotechnical / bioengineering approaches and should be used for toe protection.

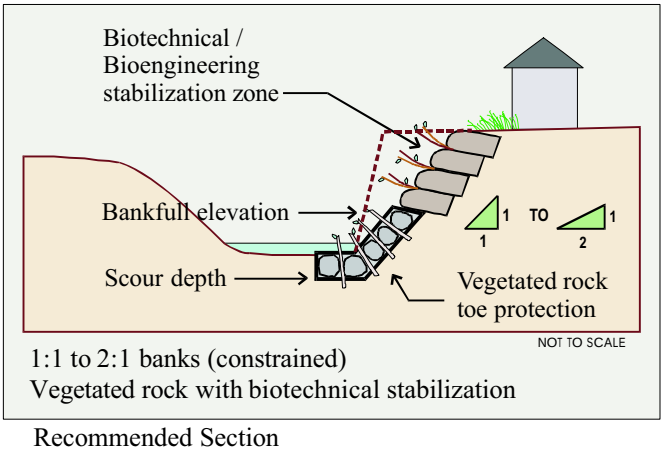
The design and installation of vegetated rock requires technical engineering analysis and design. Implementation of vegetated rock requires grading of the affected bank to key the structure into the channel and banks. The rock section must be designed to accommodate predicted scour to protect the installation from under-cutting and should be designed to the bankfull elevation. On the bank, the scour depth varies from site to site, but is usually at least 3-4 ft*.

Sequence of Installation

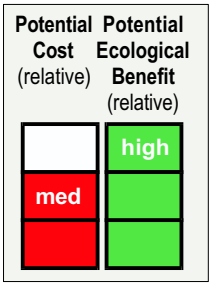
1. Remove old or failing bank protection
2. Regrade the bank slope to a stable slope or subgrade for biotechnical applications. (2:1 or flatter where possible)
3. Install vegetated rock section in lower channel bank
4. Install biotechnical (VSL) or bioengineering/ planting stabilization in upper channel bank

Benefits

- Flexible long-term stabilization approach
- Can be used in high energy constrained locations
- Stabilizes & armors toe of bank to bankfull elevation
- Increases channel area
- Maximizes bank area for biotechnical and bioengineering / planting approaches
- Reduces flow velocities and shear stresses
  Improves native vegetation cover



Recommended Section



*Analysis of potential hydraulic and shear stress forces as well as acceptable risk should inform design conditions.

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Conceptual Stabilization Approaches

Bulkhead Wall (Rock)

What is the solution?

Bulkhead walls are robust structural walls that resist significant hydraulic and sheer stress forces to protect and retain creek banks. Bulkhead walls are most appropriate in situations where severe topographic constraints / steep banks exist that prevent or limit bank grading. Bulkhead walls may also be the preferred solution where structures, infrastructure and facilities are present and potentially threatened. The vertical extent of the bulkhead retaining walls in the lower sections of the channel should be defined by the bankfull water surface elevation to maximize areas for active planting of vegetation above the wall. Analysis of potential hydraulic and shear stress forces as well as acceptable risk should inform design conditions.

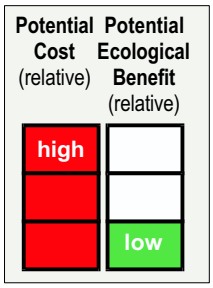
Footings for walls constructed in the active channel must be keyed into the channel bed to address potential scour and prevent undercutting. It is preferable to utilize construction materials or approaches that 'roughen' the surface of the walls to prevent creek flows from accelerating along the smooth bank and increasing erosion potential elsewhere downstream.

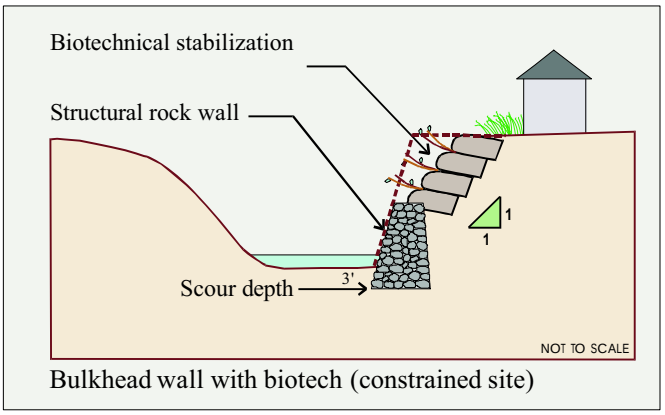
Sequence of Installation

1. Remove old or failing bank protection (if present)
2. Install bulkhead wall in lower section of channel bank to bankfull elevation (or higher if necessary)
3. Regrade the bank slope above bulkhead wall to a stable slope or as subgrade for biotechnical applications. (2:1 or flatter where possible)
4. Install biotechnical (VSL) or bioengineering/ planting stabilization on upper channel bank

Benefits

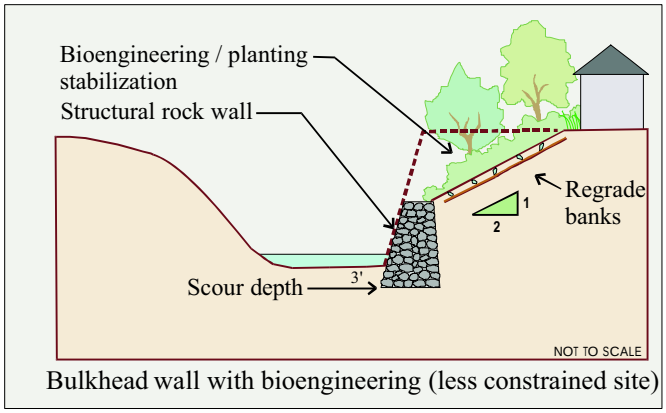
- Reliable long-term stabilization approach
- Can be used in high energy, constrained locations
- Stabilizes and armors toe of bank
- Maximizes available channel area
- Maximizes bank area for biotechnical and bioengineering/planting approaches
- Reduces flow velocities and shear stresses
- Improves potential for native vegetation cover at top of bank





Bulkhead wall with biotech (constrained site)

Recommended Section



Bulkhead wall with bioengineering (less constrained site)

Recommended Section

NOT FOR CONSTRUCTION

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

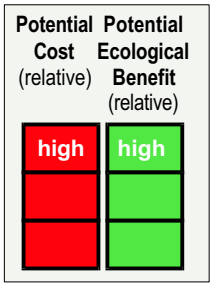
Conceptual Stabilization Approaches

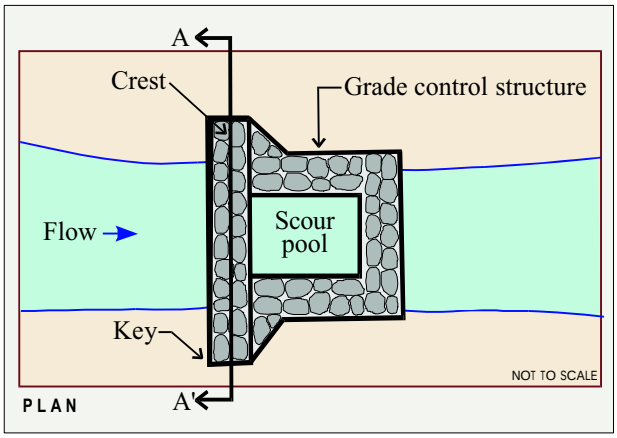
Grade Control Structure (GCS)

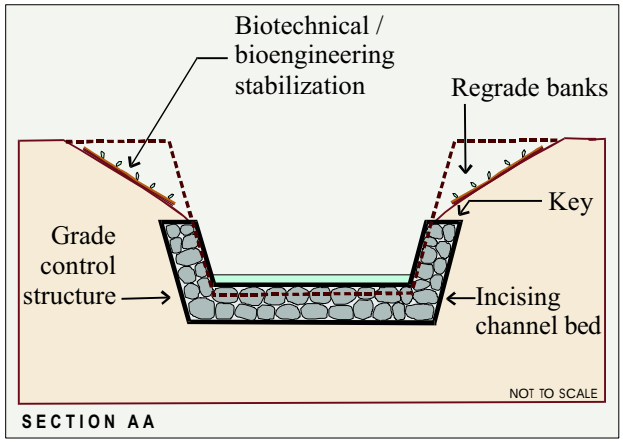
What is the solution?

Grade control structures are structures utilized for longitudinal channel stabilization and are typically constructed from rock, concrete or large wood elements. The structures are intended to address incision and channel profile instability by controlling and stabilizing bed materials upstream of the structure. Grade control structures are built across the entire channel and must be keyed into channel banks and bed to prevent scour and flanking. In high energy creeks like Corte Madera Creek grade control structures should address energy dissipation, incision and existing and potential habitat quality. Grade control structures can help to stabilize channel banks by raising bed levels and limiting potential of undercut banks.

Grade control structures are typically built at locations where head-cuts or channel incision are evident. These structures can have profound hydraulic affects and must be considered and designed carefully. Grade control structures in Corte Madera Creek must be constructed of materials that can resist the extreme hydraulic environment and remain stable. In this case large rock or structural concrete weirs may be the preferred materials. Grade control structures should be constructed in straight sections of the creek channel and generally should not be built on channel bends. Grade control structures must be designed on a reach scale to properly locate the top and toe of structures.







Sequence of Installation

1. Identify appropriate location for grade control structure
2. Install grade control structure
3. Install biotechnical (VSL) or bioengineering/ planting stabilization around edges of grade control structure

Benefits

- Reliable long-term stabilization approach
- Can be used in high energy, constrained locations
- Raises or stabilizes channel bed elevation
- Stabilizes local bank conditions
- Mitigates flow velocities and dissipates energy

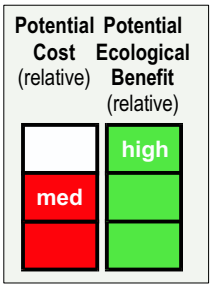
Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Conceptual Stabilization Approaches

Biotechnical Stabilization:

- Vegetated Soil Lifts (VSL), Brush Mat with Vegetated Rock



What is the solution?

Biotechnical bank stabilization applications are measures that utilize structural or hard materials in combination with living plant elements. Biotechnical applications rely on structural materials for short-term protection while integral live cuttings establish and root throughout the creek bank. As the live materials establish, the roots provide long-term stabilization to the soils, the vegetation reduces flow velocities and sheer stresses on the bank surface and provides improved habitat.

Biotechnical stabilization applications can be utilized in areas that are not exposed to more significant flow conditions. Biotechnical stabilization measures employed in lower channel areas must be keyed into the adjacent bank and channel. Vegetated soil lifts (VSL) is a robust stabilization approach that involves the construction of engineered soil lifts wrapped in woven biodegradable erosion control fabrics inter-planted with live cuttings (willow, alder and dogwood). VSL can be utilized with a variety of structural toe protection approaches and in some situations can be used independently to reconstruct entire sections of bank. Brush mat with rock toe protection is another effective biotechnical stabilization that involves installation of live plant materials (willow) on the affected bank. The willow material is anchored to the bank using stakes, biodegradable fabrics and rock revetment at the toe.*

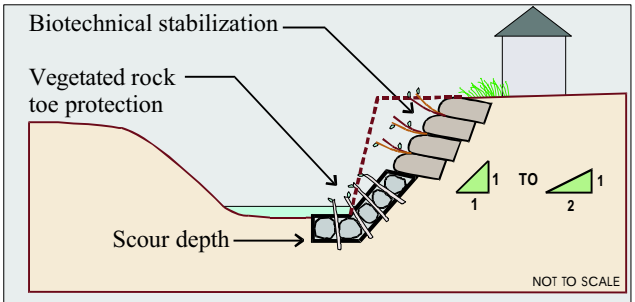
Sequence of Installation

1. Remove old or failing bank protection. (if present)
2. Regrade the bank slope to a stable slope or subgrade for biotechnical applications. (2:1 or flatter where possible)
3. Install toe protection if proscribed and as appropriate.
4. Install biotechnical stabilization on channel bank.

Benefits

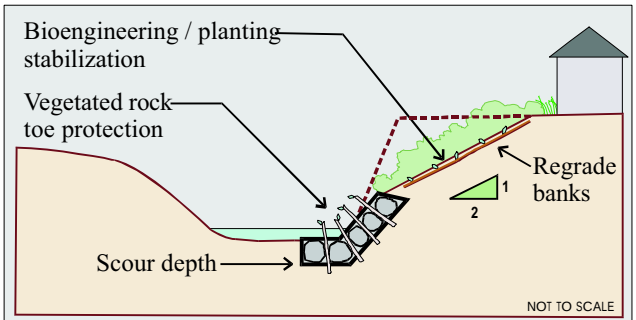
- Reliable long-term stabilization approach
- Can be used in many locations
- Stabilizes and armors toe of bank to bankfull elevation
- Maximizes channel area
- Maximizes bank area for biotechnical and bioengineering/planting approaches
- Reduces flow velocities and shear stresses
- Improves potential for native vegetation cover

*Maintenance, such as irrigation, to support plant / tree establishment should be planned for and undertaken.



1:1 to 2:1 banks (constrained)
Vegetated rock with biotechnical stabilization

Recommended Section



2:1 or flatter banks (unconstrained)
Vegetated rock with bioengineering and / or planting

Recommended Section

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Conceptual Restoration Approaches: Reach 1, 2, and 3

Bioengineering Stabilization/ Planting

What is the solution?

Bioengineering bank stabilization applications are measures that utilize living plant materials, dead brush and biodegradable erosion control fabrics. Bioengineering applications rely on the establishment of the live plant materials throughout the creek bank. As the live materials establish, the roots provide long-term stabilization to the soils, the vegetation reduces flow velocities and shear stresses on the bank surface and provide improved habitat.

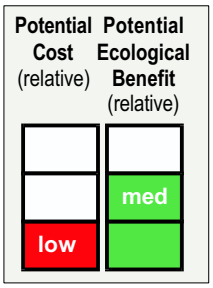
Bioengineering stabilization applications can be utilized in areas that are exposed to less significant flow and shear stress conditions. Bioengineering applications often include preparation of bank slopes through grading. Bioengineering approaches can range from live pole cuttings (willow, alder and dogwood) planted in the bank to more complex structures involving the placement of dead brush and fabrics in addition to the live plant material. Maintenance, such as irrigation, to support plant / tree establishment should be planned for and undertaken.

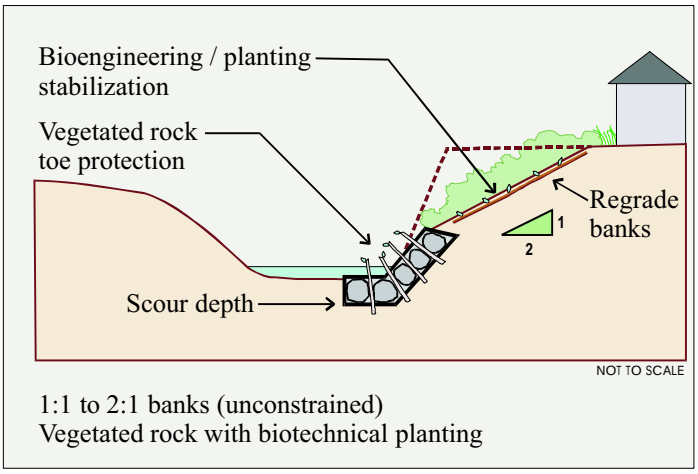
Sequence of Installation

1. Remove old or failing bank protection (if present).
2. Regrade the bank slope to a stable slope or subgrade for biotechnical applications. (2:1 or flatter where possible)
3. Install bioengineering stabilization on channel bank.
4. Install planting and seeding.

Benefits

- Supplements and enhances other bank stabilization applications
- Stabilizes bank soils
- Reduces flow velocities and shear stresses
- Improves potential for native vegetation cover
- Improves habitat qualities





Recommended Section

Blank Page

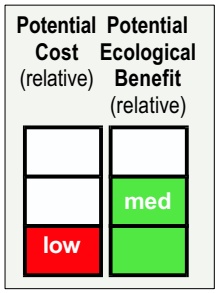
Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Conceptual Stabilization Approaches

Native Planting - Stable Channel

What is the solution?

Planting for bank stabilization utilizes the installation of container plants, cuttings and seed to establish vegetation. Successful planting on stable channel areas may require site preparation such as non-native exotic plant removal, grading / soil preparation and vegetation management. Planting can supplement and enhance other structural and biotechnical approaches for bank stabilization. Native Willow, Alder and Dogwood species have been used successfully as cuttings in riparian settings



Planting of native riparian species in stable channel areas can further enhance channel stability and improve habitat qualities over the long term. It is important to select an appropriate mix of tree and plant species to establish a variety of habitat elements and soil stablization properties. Establishing native trees and plants in stable channel areas can be a proactive and cost effective measure for long term creek stability and provide important long-term benefits to the creek system.

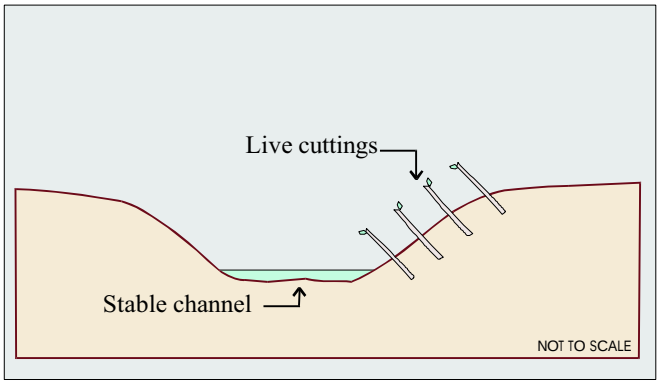
Many properties along Corte Madera Creek could better integrate the creek corridor and appropriate plantings with residential yard areas. Property owners should consider the use of native plants in projects adjacent to the creek. Maintenance, such as irrigation, to support plant / tree establishment should be planned for and undertaken.

Sequence of Installation

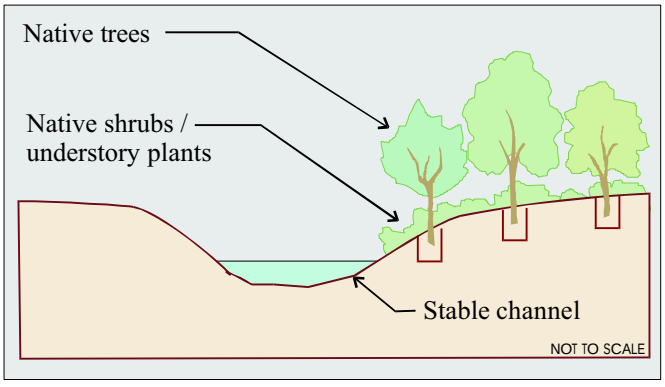
1. Remove non-native exotic species
2. Prepare site and/ or bank soils
3. Install planting and seeding.

Benefits

- Supplements and enhances other bank stabilization measures
- Stabilizes bank soils
- Reduces local flow velocities and shear stresses
- Improves potential for diverse native vegetation cover
- Improves habitat quality



Cuttings will establish and grow into trees



Stable channel native revegetation (enhanced habitat value)

Blank Page

5.5 Undertaking a Stabilization Project

Bank restoration and stabilization approaches in the Citizens' Guide are outlined at a conceptual level and are not prescribed for specific locations nor are they intended for construction. Site and project specific analyses will be required for a property owner intending to plan and undertake a stabilization or revegetation project. The development of a sufficiently detailed project design will involve a team of professional consultants including a licensed professional civil engineer, geomorphologist, biologist, and geotechnical engineer. Consultation with appropriate experts can help to develop a project approach that addresses erosion in the most effective, timely, sustainable and cost effective manner.

Refer to flow chart on following page.

Any proposed project is subject to review and approval from a set of local and state agencies and potential federal jurisdictions. See the Section 5.6 – Permitting for more detailed information.

Blank Page

Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection

Undertaking a Stabilization Project (in Sequence)

1. IDENTIFY PROBLEM AND PROJECT LOCATION



2. Consult with Town
   - Identify Resources and existing information
   - Project Approach
   - Opportunities & Constraints



3. Consult with Professional Expertise
   - Engineering & Design
   - Geomorphology
   - Permitting

4. Undertake Technical Analysis (as appropriate)
   - Hydrology & Hydraulics
   - Geomorphology
   - Biology
   - Geotechnical & Soils
   - Engineering





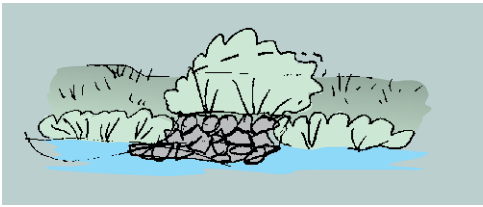
5. Develop Stabilization Design

* Define design for cost and feasibility by referring to technical analyzes

6. Permitting
   - CA Dept of Fish & Game
   - US Army Corps of Engineers
   - RWQCB
   - Town of Portola Valley

7. Contracting
   - Restoration Experience

8. Construction & Monitoring



Blank Page

5.6 Permitting

Various State and Federal environmental regulations require the acquisition of permits prior to implementation of stabilization projects that could affect regulated habitats (such as riparian areas and wetlands) and/or protected wildlife species. Implementation of a bank stabilization or revegetation project within the bed and banks of Corte Madera Creek would likely require a Streambed Alteration Permit ("1601-1603 permit") from the California Department of Fish and Game (CDFG), a Section 401 Water Quality Certification from the Regional Water Quality Control Board (RWQCB), a Section 404 Permit from the U.S. Army Corps of Engineers (USACE), and a Section 7 Consultation with the U.S. Fish and Wildlife Service (USFWS) for the California red-legged frog. The following table summarizes the jurisdictional area, permit type and the average duration for receipt of a permit from each of these agencies.

Table 1. Regulatory Agencies and Permits for Creek Related Projects

Agency	Jurisdiction	Permit Type	Duration for Receipt of Permit Following Application
California Department of Fish and Game	Stream bed and banks	Streambed Alteration Agreement (Sections 1600-1603)	60-90 days
Regional Water Quality Control Board	Streambed below ordinary high water and wetlands	Clean Water Act Section 401 Water Quality Certification/Water Discharge Requirement	3-4 months
United States Army Corps of Engineers	Streambed below ordinary high water and wetlands	Clean Water Act Section 404 (Nationwide or Individual Permit)	Nationwide = 3-6 months Individual = 6-9 months
United States Fish and Wildlife Service	Anywhere a special-status species may be impacted	Endangered Species Act Section 7 Consultation (Informal Consultation = Letter of Concurrence or Formal Consultation = Biological Opinion)	Informal = 2-4 months Formal = 6-12 months

The types of activities typical to most stabilization and some revegetation projects for which permits are required include, but are not limited to, the following:

- Grading, excavation, placement of fill
- Placement of materials (erosion control blankets, rock revetment, boulders, logs, drain outfalls, fences, etc.)
- Removal or planting of vegetation
- Use of herbicides or pesticides
- Diversion, dewatering, or damming of stream flow
- Disturbance of wildlife

The CDFG Streambed Alteration Agreement would be necessary for any project that affects the bed and/or banks of the creek. A 1601 permit application would be filed by a public agency while private individuals would file a 1603 application.

A USACE Section 404 permit application would be necessary for any project that disturbs the creek bed below ordinary high water (approximately the 2-year flood water level) or any area designated as wetlands. Depending on the nature of the project either a Nationwide or Individual permit application would need to be submitted. Nationwide permits are more streamlined and for projects that result in minimal impacts while individual permits are more elaborate and address more complex impacts. For example, USACE Nationwide permit #13 is for bank stabilization projects, however, these projects must meet a number of limiting conditions to qualify**.**

The guidelines for a RWQCB Section 401 Water Quality Certification are the same as for the USACE Section 404 permit. In addition, for any work above the ordinary high water mark or in a wetland a Water Discharge Requirement (WDR) may be needed.

A Section 7 Conference/Consultation with the USFWS may be necessary whenever a project has the potential to impact a federally-listed special-status wildlife species, such as the California red-legged frog. There are two types of Section 7 Consultations, formal and informal. A Formal Section 7 Consultation requires the preparation of a Biological Assessment on the projects effects on the listed species and proposes measures to avoid, minimize and mitigate the negative effects. The formal consultation concludes with the USFWS issuance of a Biological Opinion. The Biological Opinion typically includes an incidental take statement, essentially permitting a certain amount of "take" (death of species) as well as Terms and Conditions to protect the listed species. An Informal Section 7 Consultation applies to projects that are unlikely to adversely affect the federally-listed species. If the USFWS agrees they issue a Letter of Concurrence, however an informal consultation does not provide "take" authorization.

While the permitting process seems burdensome for certain projects it is important to remember that the real reason for the laws and guidelines from the regulatory agencies is the proper management, protection and preservation of our natural resources. In the long run it is more beneficial to the local ecosystem for projects to go through the proper permitting process which includes input from biologists, environmental planners, regulatory specialists, etc. so that projects are designed to avoid and/or minimize impacts to regulated habitats and special-status species to the greatest extent possible.

Due to the multiple agencies and jurisdictions many property owners may find the project permitting process to be very daunting. Given the amount of time and energy typically associated with permit acquisition it is often much more cost effective and efficient to coordinate the permitting effort with the support of an experienced professional consultant who is familiar with the priorities and submittals required to support the process.

5.7 Recommended Trees and Plants for Corte Madera Creek

There are many benefits to using California native plants either to integrate into bank stabilization structures or for landscaping property along or within the riparian corridor. The integration of residential gardens and the riparian corridor thorough the installation of native plants can be a very effective approach defining a buffer or transitional zone along the creek. Property owners are encouraged to view the creek corridor and native trees and plants as resources for planning landscape and property improvement efforts. California native plants are adapted to the local climate, soils, topography, etc. and require much less maintenance and irrigation than most traditional horticultural landscaping plants. Additionally, native plants provide food and shelter for local wildlife. Plant material that originates in, and is native to, the geographic region in which it is to be used is generally the most appropriate. These are referred to as local "ecotypes". Using local ecotypes has many added benefits, such as:

1. **Ensuring the greatest success in landscaping efforts.**
   In general, the more closely you match the environmental conditions of the source of your plant material to that of the planting site, the better it will grow.

2. **Helping to preserve the genetic diversity and integrity of native plants.**
   A common concern today for plant ecologists is the preservation not only of a diversity of species, but also of the genetic diversity within each species. Native species vary genetically in their adaptation to the particular localities and environmental conditions under which they grow. You can help preserve the local ecotypes in your area by using them in your landscaping.

There are many nurseries that sell local California native plants and some can collect and propagate local ecotypes from the Corte Madera Creek watershed for interested property owners.

Tables 2 and 3 list recommended tree and plant species for use in bank stabilization and landscaping/ gardening applications.

Table 2. Recommended Plant Species for Revegetation on Corte Madera Creek: Reaches 1 - 3

Common Name	Scientific Name	Creek Bank Location	
		Floodplain/ Lower bank	Upper bank/ Top of bank
Trees:			
Red willow *	*Salix laevigata*	X	
Arroyo willow *	*Salix lasiolepis*	X	
Black cottonwood [1,*]	*Populus balsamifera*	X	
White alder	*Alnus rhombifolia*	X	
Box elder	*Acer negundo*	X	X
Bigleaf maple [2,3]	*Acer macrophyllum*	X	X
Coast redwood [2,3]	*Sequoia sempervirens*	X	X
California bay [2,3]	*Umbellularia californica*	X	X
Coast live oak	*Quercus agrifolia*		X
California buckeye	*Aesculus californica*		X
Blue elderberry	*Sambucus mexicana*		X
Shrubs:			
Brown dogwood	*Cornus glabrata*	X	
Mulefat *	*Baccharis salicifolia*	X	
Elk clover	*Aralia californica*	X	
Thimbleberry [3]	*Rubus parviflorus*	X	
California blackberry *	*Rubus ursinus*	X	X
Mugwort	*Artemesia douglasiana*	X	X
Snowberry	*Symphoricarpos albus*	X	X
Coyote brush [2,3]	*Baccharis pilularis*		X
Toyon [3]	*Heteromeles arbutifolia*		X
California wild rose *	*Rosa californica*		X

[1] Species more suitable for Reach 1

[2] Species more suitable for Reach 2

[3] Species more suitable for Reach 3

* Species commonly used in bioengineering/ biotechnical soil stabilization applications.

Table 3. Recommended Plant Species for Revegetation on Corte Madera Creek: Reach 4 (Headwaters/ Upper Watershed)

Common Name	Scientific Name	Creek Bank Location	
		Floodplain/ Lower bank	Upper bank/ Top of bank
Trees:			
Coast redwood	*Sequoia sempervirens*	X	X
Douglas fir	*Pseudotsuga menziesii*	X	X
Bigleaf maple	*Acer macrophyllum*	X	X
California bay	*Umbellularia californica*	X	X
Red willow *	*Salix laevigata*	X	
White alder *	*Alnus rhombifolia*	X	
Shrubs:			
California blackberry *	*Rubus ursinus*	X	X
Giant chain fern	*Woodwardia fimbriata*	X	
Western sword fern	*Polystichum munitum*	X	X
Thimbleberry	*Rubus parviflorus*	X	
Huckleberry	*Vaccinium ovatum*		X
California wild lilac	*Ceanothus thyrsiflorus*		X

* Species commonly used in bioengineering/ biotechnical soil stabilization applications.

5.8 Non-Native/ Undesirable Plant Species on Corte Madera Creek

Invasive non-native plants are a serious threat to the riparian ecosystems of the United States and compete with or exclude many native plant and animal species. People often introduce invasive, non-native plants both unknowingly and accidentally through landscaping. These species tend to spread aggressively and can reproduce rapidly. Their rate of growth allows them to overwhelm and displace existing native plants by reducing the availability of light, water, nutrients and space. In addition, they can reduce biodiversity, alter hydrology, soil chemistry and erodability, change fire intensity and frequency, interfere with natural succession, compete with native plants for pollinators, and replace diverse communities with single species monocultures. Some non-native plants can even hybridize with genetically similar native plant species resulting in the dilution of the genetic composition of native species populations. The proliferation of invasive, non-native plants also results in the loss of habitat and food sources for native wildlife species.

These species spread quickly due to the absence of their home-range predators and diseases, aggressive growth habits, abundant pollen and seed production and seed that remains viable for long

periods in the soil. Often there is a lack of organisms adapted to eating or competing with the invasive plant in the ecosystem that is being invaded.

Some of the most abundant and problematic invasive, non-native plants of riparian ecosystems of the San Francisco Bay Area are shown in the table below.

Table 4. Common Invasive, Non-native plant species of the San Francisco Bay Area

Common Name	Scientific Name
French broom*	*Genista monspessulana*
Scotch broom	*Cytisus scoparius*
Himalayan blackberry*	*Rubus discolor*
Cape ivy*	*Senecio mikanioides*
English ivy*	*Hedera helix*
Periwinkle*	*Vinca major*
Pampas grass*	*Cortedaria selloana*
Giant reed	*Arundo donax*
Poison hemlock*	*Conium maculatum*
Wild fennel	*Foeniculum vulgare*
St. John's wort*	*Hypericum sp.*
Blue gum	*Eucalyptus globulus*
Tree-of-heaven	*Ailanthus altissima*

*Observed in Reaches 1-4 of Corte Madera Creek

Planting of invasive species listed above should be avoided in and adjacent to Corte Madera Creek. In addition, there are numerous opportunities to enhance the riparian habitat along Corte Madera Creek by removing invasive understory species and revegetating the understory with native shrubs and grasses.

For additional resources and information regarding encouraged native and discouraged non-native plant species in the Town of Portola Valley refer to the Design Guidelines – Town of Portola Valley (Revised September 2003). This document is available at the Town Planning Office.

Blank Page

SECTION 6 - Creek Walks

Four Creek Walks were organized by the Town and supported by the project team to introduce the Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report to interested community members. These coordinated sessions, hosted by Town residents who live along Corte Madera Creek, focused on bringing small groups of interested creek-side property owners and Town staff together for presentations of the overall project approach and methodology as well as discussion of issues and concerns regarding a diversity of topics relating to Corte Madera Creek. The walks were held within each of the three primary study reaches within the project area, and each included a visit to the creek for a question and answer session with the technical members of the team.

The Creek Walks were intended to encourage input and solicit feedback from stakeholders in order to establish understanding, interest and support for the Citizens' Guide. Early in the project, the team members determined that an engaged, participatory process, targeted at the stakeholders most impacted by Corte Madera Creek, would provide valuable input to the project.

During the Walks the team presented an overall summary of physical and biological processes that influence erosion conditions within the Corte Madera Creek watershed. In addition to the existing conditions, typical problems, issues and recommendations associated with bank stabilization and revegetation on the creek were also presented.

The Creek Walks became productive venues for the Town, JPA and project team to introduce the Citizens' Guide. The events allowed for broad and enthusiastic discussion of elements presented in the study as well as exchange of ideas and experiences between the attendees. Turnout and participation in each of the events was generally limited to neighbors who lived near the host residence. Summaries of input from each of the Creek Walks are provided below:

Reach 1

The Creek Walk for Reach 1 was held on April 21, 2005. Specific topics of interest explored during the walk included permitting, emergency protocols and the desire for 'pilot' or reference projects in the Town. Several attendees communicated their concern and frustration around the project permitting process and the irony that the process may actually discourage well-intentioned property owners from undertaking beneficial projects. The sense was that people who chose to implement responsive, creek sensitive projects are often 'penalized' by regulatory agencies. The project team members acknowledged this concern and worked to clarify the groups' understanding of regulatory priorities and recommendations to facilitate the project planning, design and implementation process.

The group discussed some of the typical problems that have been associated with bank stabilization measures undertaken under flood conditions/ emergency permits. Although the Citizens' Guide does not provide specific guidance on erosion control and bank stabilization activities under emergency situations the group discussed potential collaborative and regulatory opportunities that could improve coordination between the residents and Town.

The attendees were interested in seeing example projects that could be used as references by property owners to better understand potential approaches for bank stabilization projects. The group discussed the value of 'pilot' or demonstration projects to help develop understanding and confidence in the approaches outlined in the Citizens' Guide. Team members pointed out that several example projects are presented in the appendices of the Citizens' Guide.

During the visit to the creek the group noted the wide riparian corridor and coinciding native tree canopy. Project team members and Town staff also facilitated discussion of a failing bank protection (gabion) structure and alternative approaches for bank stabilization and property protection. The team members outlined the types of technical analyses and expertise that are typically required to develop understanding of geomorphic and hydraulic conditions at a given site. The group discussed the role of woody debris within the creek corridor and specifically considered potential management practices that allow for woody debris accumulations for habitat values while accommodating flood protection goals.

Reach 2

Two Creek Walks were held in Reach 2 due to the high level of community interest. The first Walk, held on April 26, 2005, had a large turnout and the group was particularly engaged in discussions focused on specific types of bank protection measures, fish populations and creek management responsibilities. There was interest in the different characteristics and function of specific bank protection structures. The team members discussed how bank roughness can influence flow velocity and shear stress conditions and in turn erosion of the creek bed and banks. In particular, the group reviewed the integration of native vegetation as a way of improving upon structural stabilization solutions. The group's discussion also focused on the consideration and design of transitional features for all bank stabilization measures such as scour protection, cut-off features and critical water surface elevations. The natural resources (plant and animal communities) of Corte Madera Creek were identified as community assets. There was interest in native fish populations and potential actions to improve aquatic habitats.

During the visit to the creek the group observed the destabilization of a rock revetment structure, native riparian tree establishment and multi-stage channel features. Team members emphasized the relationship between flow conditions (velocity, direction, water depth) and determination of appropriate bank stabilization measures. The group discussed the preferred approach to limit the use of more structural stabilization approaches (vegetated rock, gabions, bulkhead walls) based on shear stress analyses and the presence of residences, utilities and/or other threatened property. In particular, the team members presented the benefit of using structural responses in the lower sections of the channel to maximize plantable areas in the upper bank that are typically less susceptible to erosive forces. Project team members and Town staff also facilitated discussion of approaches for retrofitting existing structures with native plantings to improve long-term stability and habitat values. The group

discussed the role of woody debris within the creek corridor and specifically considered potential management practices that allow for woody debris accumulations for habitat values while accommodating flood protection goals. Additionally, the attendees discussed ideas for neighborhood coordination and potential protocols for public input to the project planning process. There was considerable interest in understanding and discussing how one property owner's project may impact erosion and property protection requirements downstream.

The second Walk was held on May 14, 2005. Key issues that were raised during this Walk included a desire to coordinate bank stabilization and revegetation efforts to protect property and improve the Creek's function and health. Several attendees presented their concern regarding site specific projects that fail to consider impacts to the creek system as a whole and adjacent property owners. Interestingly, one attendee visiting from Los Altos shared their experience with channelized, eroding and degraded sections of Adobe Creek and in particular stressed the need and value of residents working together to develop comprehensive solutions for creek restoration. There was an emphasis on the social aspects of creek restoration work and a recognition that committed groups of people can influence decision-making and improve planning for property protection and environmental enhancement efforts. Given this discussion, the group appreciated the relative health, beauty and quality of Corte Madera Creek and hoped to explore future creek protection planning and coordination as a group with the Town.

Reach 3

The Creek Walk for Reach 3 was held on April 21, 2005. Specific topics explored by the attending group during the Walk included discussion of creek history and processes, opportunities and benefits of integrating garden areas with the adjacent riparian corridor and the desire for 'pilot' or reference projects in the Town. There was significant interest in and support for the Citizens' Guide as well as the surveys that were undertaken to support the project. Many attendees of the Reach 3 Walk shared their recollections of their experiences with Corte Madera Creek. There was particular interest in the history of human development and recreation, fish populations and flooding on the creek.

Like the attendees in the Reach 1 Creek Walk this group was also interested in seeing example projects that could be used as references by property owners to better understand potential approaches for bank stabilization projects. The group discussed the value of 'pilot' or demonstration projects to help develop understanding and confidence in the approaches outlined in the Citizens' Guide. Team members referred the attendees to the example projects presented in the appendices of the Citizens' Guide.

During the visit to the creek the group focused on recommendations and activities that property owners can undertake to integrate their garden areas with the adjacent riparian corridor. Some of the benefits of this approach include non-native vegetation management, native planting/revegetation, habitat enhancement and aesthetic improvements. Attendees discussed use of herbicides along the

creek and concerns regarding potential infiltration and contamination of the creek (the application of herbicides and pesticides is a regulated activity). Additionally, the attendees discussed ideas for neighborhood coordination and potential protocols for public input to the project planning process. There was considerable interest in understanding and discussing how one property owner's project may impact erosion and property protection requirements downstream.

SECTION 7 - Next Steps

The Town and JPA intend to maintain the initiative and interest around the Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report through several coordinated activities. Opportunities for outreach and education with the Town staff and residents through presentations of the Citizens' Guide and its objectives should be identified and pursued. The Maintaining Corte Madera Creek: A Citizens' Guide to Creek-Side Property Protection report is intended to initiate and establish a supportive and collaborative framework to encourage multi-objective bank stabilization ongoing efforts between the Town and community. Effective and comprehensive change and improvement in bank protection and stabilization activities, both public and private, will be supported by the provision and availability of appropriate information and resources. The project team has identified a number of potential actions for further consideration going forward. These are listed below:

- Undertake and coordinate a local 'Creek Awareness Campaign'.
- Sponsor additional Creek Walks to build interest and awareness of the Citizens' Guide and commitment to desirable creek-side property protection activities.
- Establish stronger partnership, coordination and collaboration between the Town of Portola Valley, its residents and other organizations such as the school district, watershed protection groups and neighboring municipalities.
- Post and provide the Citizen's Guide on the Town of Portola Valley's webpage. Make the report easily available to Town staff and residents via the Internet.
- Identify and develop 'pilot projects' to demonstrate preferred stabilization and revegetation techniques, and include monitoring to track success. These could be collaborative efforts led or sponsored by the Town of Portola Valley. Potential projects should be located in visible areas where typical project conditions and constraints are similar to those encountered by the Town's citizens.
- Develop and advertise standard protocols to improve Town and property owner coordination in the event of emergency and/ or flood conditions.
- Develop a Corte Madera Creek stabilization and enhancement master plan for the 6-mile study area or individual study reaches to identify key erosion issues and causes as well as specific recommended stabilization measures. Additionally, a master plan could determine where reach scale grade control is required vs. individual bank protection schemes. This plan would effectively separate out regional vs. homeowner scale projects.
- Develop a GIS database to present existing conditions along Corte Madera Creek and the Conceptual Restoration Approaches for recommended bank stabilization activities.
- Produce and display posters, brochures and handouts based on the Citizens' Guide to Creek-Side Property Protection.

Appendices

Appendix A

References

Appendices

1. Cotton Shires & Associates, Inc. Consulting Engineers and Geologists. August 2001. Engineering Geologic Reconnaissance Map (5 Sheets): Lower Corte Madera Creek, Portola Valley, California.

2. Design Guidelines – Town of Portola Valley (July 1989, revised September 2003). Developed under direction of the Architectural and Site Control Commission. Prepared by William Spangle and Associates, Inc. City and Regional Planners.

3. Fee, C., A. E. Launer, and S. Rottenborn. 1996. Biotic assessment of upper Searsville Lake and the lower floodplain of Corte Madera Creek. Unpublished report, Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA.

4. Launer, A.E., and G.W. Holtgrieve. 2000. Fishes and amphibians of the San Francisquito Creek and Matadero Creek Watersheds, Stanford University: Report on 1998 & 1999 field activities. Unpublished report, Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA.

5. Launer, A.E., and D. Spain. 1998. Biotic resources of the San Francisquito Creek Watershed: Report on1997 field activities associated with streambed alteration agreement #934-96. Unpublished report, Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA.

6. Launer, A.E., and G.W. Holtgrieve. 2000. Fishes and amphibians of the San Francisquito Creek and Matadero Creek Watersheds, Stanford University: Report on 1998 & 1999 field activities. Unpublished report, Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA.

7. Fee, C., A.E. Launer, and S. Rottenborn. 1996. Biotic assessment of upper Searsville Lake and the lower floodplain of Corte Madera Creek. Unpublished report, Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA.

8. Stoecker, Matt. 2001. Adapted from: Barriers/Impediments to Steelhead Migration in San Francisquito Creek Watershed. Steelhead Technical Task Force. San Francisquito Creek Watershed Council.

Appendix B

Example Creek Bank Stabilization, Enhancement and Revegetation Projects

Appendices

1. Sycamore Creek, Danville, California-

Creek bank restoration project that involved reconstruction of eroded and instable banks at several different locations along Sycamore Creek in Danville, California. Some areas of bank restoration activities were constrained by Sycamore Valley Road, a recreational pathway and significant mature native trees. The methods used to restore the bank areas included:

- Vegetated Rock
- Vegetated Soil Lifts (VSL)
- Biotechnical structures (brush mats) and native revegetation
- Bank grading: lay back banks to 2:1 and 3:1 slopes as well as establish terrace features

2. Corte Madera Creek, Portola Valley, California

Local creek bank restoration project associated with a vehicular and pedestrian bridge project located in Reach 3 of the *Maintaining Corte Madera Creek: A Citizen's Guide to Creek-Side Property Protection* study area. Goals for the project included bank reconstruction for long term stability, improved geomorphic function and habitat enhancement. The methods used to restore the bank areas included:

- Vegetated Rock
- Rootwads/ Large Woody Debris
- Vegetated Soil Lifts (VSL)
- Native revegetation for habitat values and diversity

3. Glen Echo Creek, Oakland, California

The project involved comprehensive creek bank restoration efforts integrated with a multi-use public pathway within a constrained site in the City of Oakland. Severely eroded and actively failing banks were successfully reconstructed utilizing the following methods:

- Vegetated Rock
- Vegetated Soil Lifts (VSL)
- Native revegetation
- Strategic bank grading: lay back banks to 2:1 and 3:1 slopes as well as establish terrace features

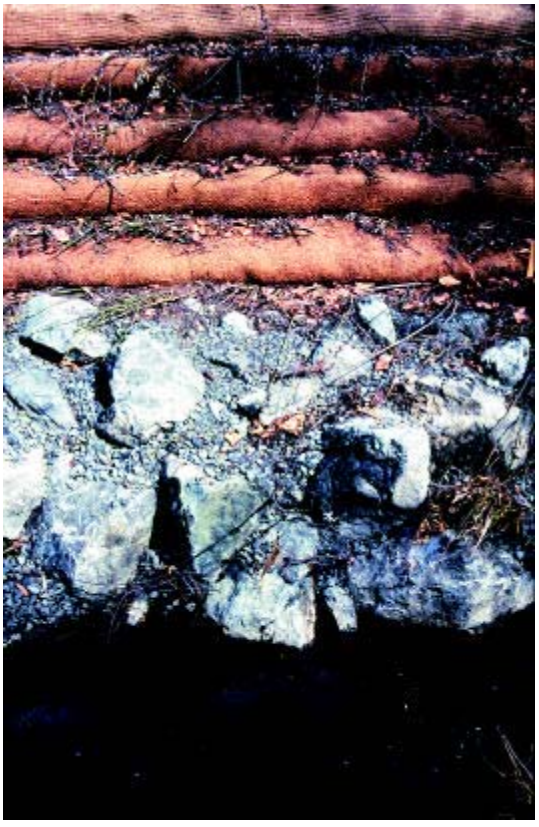
4. Georgia Lane - Corte Madera Creek, Portola Valley, California

The project involved comprehensive creek stabilization integrated with a native revegetation efforts. Channel bed incision and bank erosion were addressed utilizing the following methods:

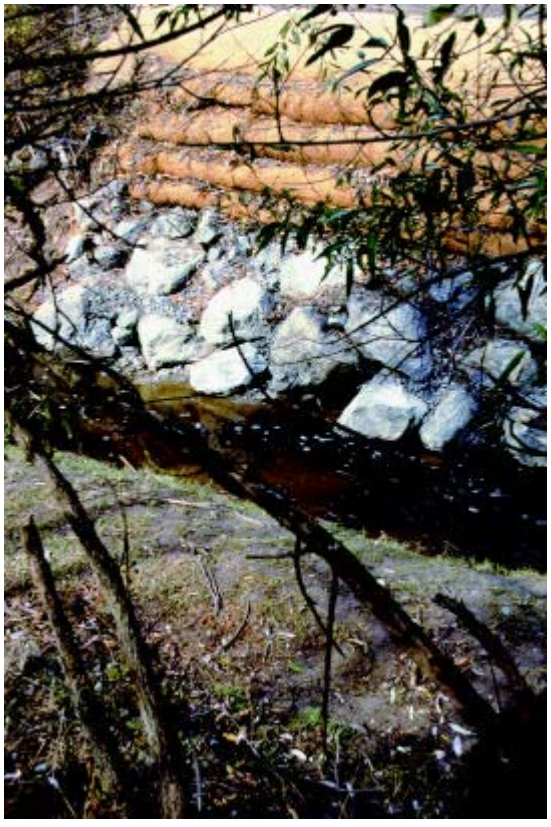
- Step-pool/ grade control structures
- Vegetated Rock



Detail, vegetated soil lifts



12” VSL lifts with 3’ vegetated rock
January 2001



January 2001

Examples of Vegetated Soil Lifts with Vegetated Revetment

Sycamore Creek, Danville, California, 2000

PWA

Blank Page



Construction completed, November 2000



Construction completed, November 2000



Project establishment, January 2001



Project establishment, October 2001

Examples of Vegetated Soil Lifts with Vegetated Rock

Corte Madera Creek, Portola Valley, California, 2000

Blank Page

PWA
PROJECT SUMMARY

Glen Echo Creek Restoration

Oakland, California

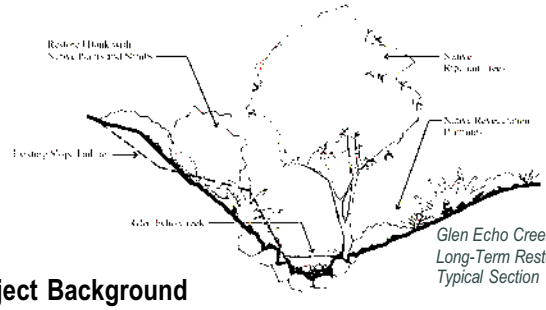
Alameda County Technical Assistance

Philip Williams & Associates (PWA) provided Technical Assistance to the Alameda County Public Works Agency (ACPWA) for creek restoration, bank stabilization and habitat enhancement efforts on Glen Echo Creek in Oakland, Alameda County, California. Our involvement in this project focused primarily on supporting ACPWA in the assessment of existing conceptual bank stabilization alternatives (developed by the ACPWA). PWA proposed and developed an alternative approach for restoration activities on Glen Echo Creek, leading to a preferred alternative and construction documents. In addition, we helped to successfully re-engage the public and establish support for the project through participatory meetings and presentations.



Glen Echo Creek vegetated soil lift (VSL) construction, October 2003

The project scope includes comprehensive bank restoration in addition to strategic native revegetation along the creek. The bank restoration approach, as developed by PWA, reconstructs eroded banks using biotechnical engineering applications/vegetated soil lifts to stabilize soils, improve local fluvial geomorphic processes and maximize plantable areas. Our specific services include project plan reviews, technical recommendations and support to identify appropriate design approaches, production of design documents (biotechnical engineering and planting plans, specifications and cost estimates), in addition to project management and coordination with the ACPWA, the City of Oakland and other project consultants. We supported project permitting with regulatory agencies including the California Department of Fish & Game, US Army Corps of Engineers and Regional Water Quality Control Board through coordinated site visits and project documentation. PWA also provided construction support services during the implementation of the creek restoration projects in Fall 2003.



Glen Echo Creek Long-Term Restoration Vision Typical Section

Project Background

- Actively eroding creek banks due to run-off and creek flows characterized by limited native vegetation, damaged walls, and compromised habitat and aesthetic values.
- Coordinated and committed effort led by the ACPWA including conceptual alternatives, public outreach, participation and input.
- PWA staff worked closely with the ACPWA, the City of Oakland, regulatory agencies and the community to define and reiterate project objectives for creek bank restoration, flood flow conveyance, and habitat enhancement, as well as visual and physical integration with the park.



Glen Echo Creek Restoration, January 2004

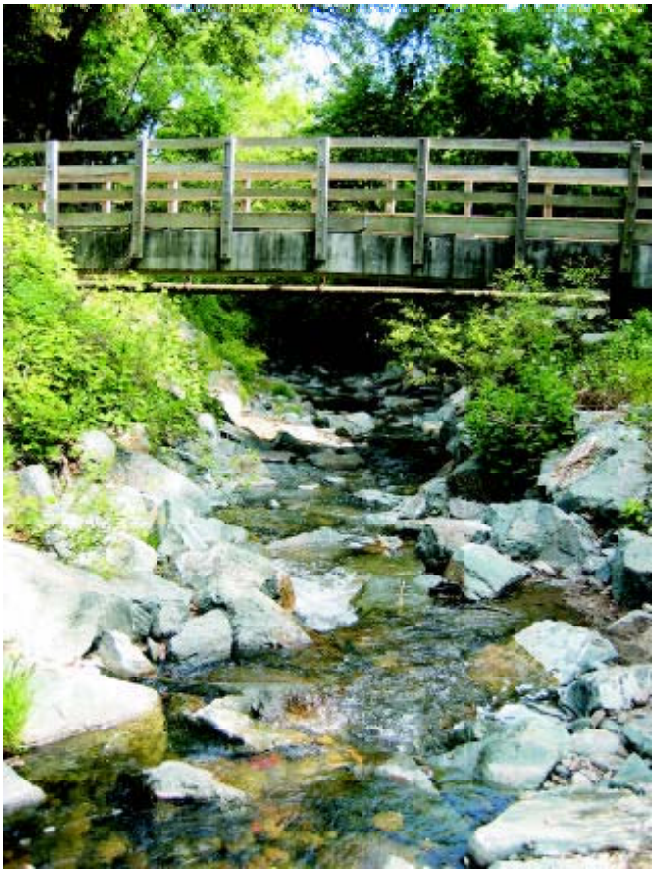
Key Project Elements

- Strong collaborative relationship with the ACPWA.
- Restoration and stabilization of approximately 200 linear feet of creek channel and banks at two distinct locations.
- Developed through an integrated engineering and geomorphic analysis, leading to a functional, effective and buildable project.
- Biotechnical streambank stabilization and native species revegetation plans to improve and diversify riparian and aquatic habitat.
- Public involvement including facilitation, presentation and coordination of the project with engaged and active community group (PANIL).
- Multi-use recreational pedestrian and bicycle trail paralleling the creek to connect the popular route between Monte Vista Avenue and Montell Street to the neighborhoods and active commercial area nearby.

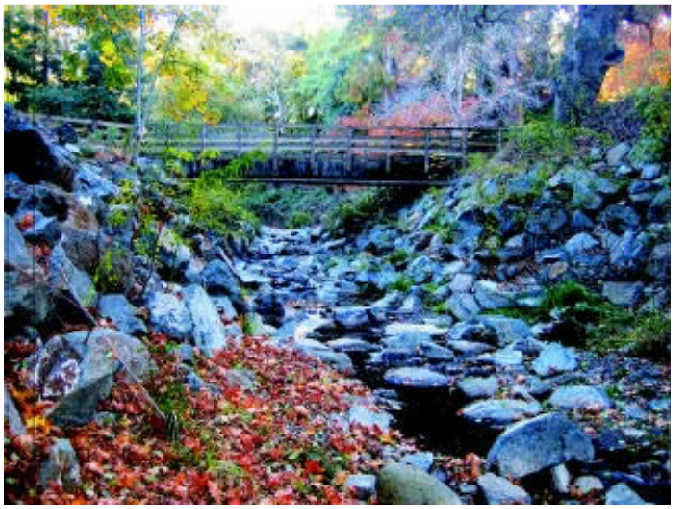
Client: *Alameda County Public Works Agency (LSA Associates)*
Project location: *Alameda County, California*
Period of Performance: *2002 – 2003*

PHILIP WILLIAMS & ASSOCIATES
CONSULTANTS IN HYDROLOGY

Blank Page



Series of Step-pool / Grade Control Structures, 2004



Grade Control Structures integrated with Vegetated Rock - note vegetation establishment, 2004



Detail, step-pool feature

Examples of Step-pool / Grade Control Structures

Georgia Lane - Corte Madera Creek, Portola Valley, California

PWA

Blank Page

Appendix C

Creek Walk Materials

1. Invite 1: Reaches 1, 2 and 3
2. Invite 2: Reach 2
3. Creek-Side Property Owners' Interactive Questionnaire

Blank Page

Announcing Portola Valley Creek Walks!



Join your creekside neighbors, Town staff, San Francisquito Creek Joint Powers Authority, H.T. Harvey & Associates, and Philip Williams & Associates on an exciting afternoon at Corte Madera Creek.

Come share your experience and learn about our Creek's watershed, sources of erosion, methods for bank stabilization, ways to improve creek habitats and much more!

Choose to attend any or all of the following meetings:

- **Thursday, April 21 at 2:00 p.m.**
  155 Mapache Drive

- **Thursday, April 21 at 4:00 p.m.**
  295 Willowbrook Drive

- **Tuesday, April 26 at 5:00 p.m.**
  341 Grove Drive

Blank Page

Portola Valley Creek Walk



Join your creekside neighbors, Town staff, San Francisquito Creek Joint Powers Authority, H.T. Harvey & Associates, and Philip Williams & Associates on an exciting morning at Corte Madera Creek.

Come share your experience and learn about our Creek's watershed, sources of erosion, methods for bank stabilization, ways to improve creek habitats and much more!

Saturday, May 14 at 10:00 a.m.
Home of Ken Rosen & Larisa Fong
1285 Westridge Drive

If you would like to attend, please contact Leslie Lambert at Town Hall, 851-1700 ext. 12

Blank Page

Maintaining Corte Madera Creek:
A Citizens' Guide to Creek-Side Property Protection

Creek-side Property Owners' Interactive Questionnaire

1. What watershed do you live in?

2. How often do you visit the creek on your property? Elsewhere?

3. Is the creek a valuable resource to you?

4. How high does the water get during large storms?

5. What changes have you observed to the creek channel/vegetation after large storms?

6. Has the nature or character of the creek changed in your memory?

7. Do you think your reach of the creek is healthy?

8. Is your creek bank eroding?

9. Do you keep a collection of photographs of the creek? Keep a photo journal of the creek.

10. Are you concerned that your bank is eroding? If so, what do you plan to do about it?

11. Can you identify 5 native plants and trees on your property? How old are they? Are more growing in along the creek?

12. What types of animals use your creek? Fish? Amphibians? Birds?

13. Did you know that Corte Madera Creek provides habitat for the endangered California red-legged frog-the largest native frog in California?

14. Have you noticed a difference in the birds that nest and forage along the creek versus in the landscaped areas?

15. How do you use your creek?

16. Creeks can be a fun place for kids to learn about nature. What do the neighborhood kids think of the creek? Do parents support the neighborhood children exploring the creek?

Blank Page