Workshop Bio for A.L. Riley:

Dr. Ann Riley recently retired as the Watershed and River Restoration Advisor for the San Francisco Bay Regional Water Quality Control Board. She is one of the founders of the California Watershed Coalition, on the advisory board of the California Urban Streams Partnership and was instrumental in organizing California's urban streams movement through the Urban Creeks Council starting in 1982. She established the California Dept of Water Resources Urban Streams Restoration Program in 1984. She participated in the development of a national network of urban waterway citizen organizations in the 1990's, the Coalition to Restore Urban Waters. She is author two books: Restoring Streams In Cities and Restoring Neighborhood Streams. The watershed council she was instrumental in creating, the Wildcat-San Pablo Creeks Watershed Council, Richmond, California and her non-profit won the California Governor's Economic and Environmental Leadership Award in 2003. She is also a recipient of the Salmonid Restoration Federation's Nat Bingham Restorationist of the Year Award. Her Ph.D. from the University of California, Berkeley under Dr. Luna Leopold specialized in floodplain and river management. She is an urban farmer, a chickens and bee keeper and produces award winning home brew.

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Common Reasons for Success and Failure

For Successful Bioengineering:

- Plant material collected after it is has gone dormant
- Careful transport to the site
- Material planted the same day it is collected
- Plant material soaked in water first
- System watered in immediately after installation, unless site is already wet.
- Plant material not allowed to dry out in first year after installation
- Good coverage and tamping of soil around plant material for good material-soil contact

Common Reasons for Failure:

- All of the above are not practiced
- Material is planted in the active channel and drowns
- Too much of the stake or pole is planted above the ground level and not enough buried below the surface. Site conditions or presence of irrigation systems determine depth of planting.
- Stakes or poles are planted upside down
- Systems are planted too high on the project cross-section and don't get enough moisture
- Planting is not dense enough and understory plants expire from too much sun and stress
- Stakes or poles were damaged by mallots when planted
- Plants are trampled because protective fencing not installed
- The plant species are not located correctly on the channel cross-section

Please Do Not Engage in Chaparral Gardening on Creeks
If you are planting species such as ceanothus, manzanita, artemesia, flannel bush, etc. they will be short- lived and suffer in a wetland environment they did not evolve in.

Installing Soil Bioengineering: How to Succeed

Posts and Stakes

Soil bioengineering is not difficult if you follow these suggestions and installation steps. Not knowing the following can easily lead to project failures, but following these suggestions will mean you will most likely succeed in a planting that will help stabilize streambanks quickly, inexpensively and naturally.

Plant Collection

Soil bioengineering typically uses willow and or cottonwood plant material which will root if planted in soil using a cutting taken from a tree branch. When cutting a branch off a tree to use it for plant material use a saw or loppers and make a point or angled cut . This will help you remember later which part of the branch was facing down toward the trunk or roots of the plant when you start cutting up the branches into smaller pieces.

If you are transporting the collected plant material from another site cover the material in the back of a truck with a tarp or some other cover so the material doesn't dry out during the drive.

Collect the material after it has gone dormant, when the leaves have died and fallen off in the fall. In Northern California this dormancy typically happens around mid to late November. Collecting green material with leaves on will greatly lower the odds of the cuttings and posts to survive and re-root. If you must use the plant material before it has gone dormant, water the plantings frequently to keep the soil very moist around the planted systems until the first rains can take over the irrigation.

Use the plant material within two days of collection if possible. If there needs to be a longer interval between collection and use, prepare the material as stakes and posts and put the butt(rooting ends) ends into buckets with water or the stream , to keep the material hydrated before use. Some practitioners like to hydrate the material this way before use to increase growing rates and survival.

Plant Preparation

Soil bioengineering uses basically three sizes of material cut from tree branches: 1.The small "whips" that are flexible and compose the ends of the branches; 2.) the stake sizes which are branches from 1-2 inches wide and about .5 to 2 feet long; Posts (sometimes referred to as poles)which are about 3 - 5inches thick and 2-10 feet long. The preparation stage of the project cuts up the willow or cottonwood branches into three separate piles representing these three sizes. It is particularly important to put a

point on the end of the plant material which is facing downward towards the roots as you are cutting up the material . Why this is important ? One of the most common reasons for project failure is planting stakes or posts with the wrong end in the soil. If the tip of the cut material facing up is planted down in the soil it won't grow roots. It is also helpful for driving the stake or post into the ground if it has a pointed tip.

Plant Installation

Make a planting hole

Installation is best done if a planting hole is prepared first using a piece of rebar or construction stake. Use a mallet to drive the rebar into the ground to make a planting hole. A common mistake: hammering the stake in too far so you can't get it out! Wiggle the rebar around as you hammer it in so that you will make a larger hole and be assured you can pull it out.

A frequent question is : How deep should I plant a stake or a post? The answer, generally, is as deep as you can. The more the plant material is below ground the more it will grow roots to support the sprouting top. Many publications recommend that 2/3 of the material is below ground. For dry sites plant at as much of the material below ground as you can and leave just a few budding nodes above the soil line to start growing when it warms in Spring. If the site is moist or has some shade you can get an "instant" tree by planting several feet of post above ground (4-6 feet) with less below ground for rooting. It's best to irrigate the site if you only have 30% of the plant below ground.

If the soil is dry and hard, pour water from a bucket onto the planting area. Allow the water to seep in and soften the soil, then pound the rebar in to make the planting hole. Pour water into the hole as it gets deeper.

Installing the Material

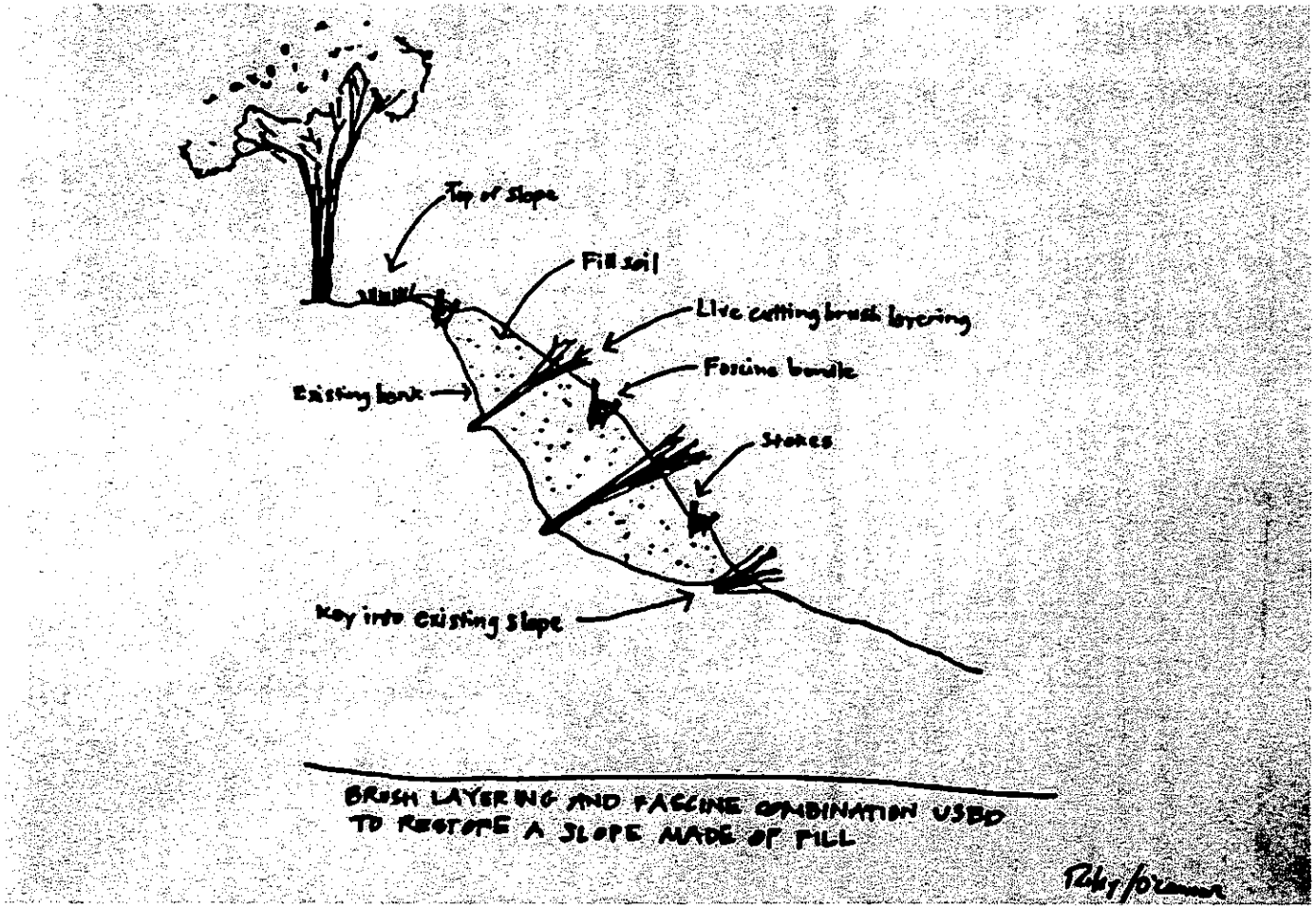
Put a 2x 4 inch board on top of the plant material to be planted and then hammer the wood on top of the stake or post using a mallet. A conventional hammer is typically too light a tool for the job. Try to avoid damaging the top of the stake or post in this process. After planting the posts or stakes cut off any damaged tops with loppers or a saw . This reduces unnecessary water loss from the plant material.

The most important step is to tamp the soil tightly around the plant material. Air left around the stake or post will stop successful rooting .Pour more water from your bucket around the new planting as the last step. Press the soil around the material again with your feet. You're done!

Caring for the plantings

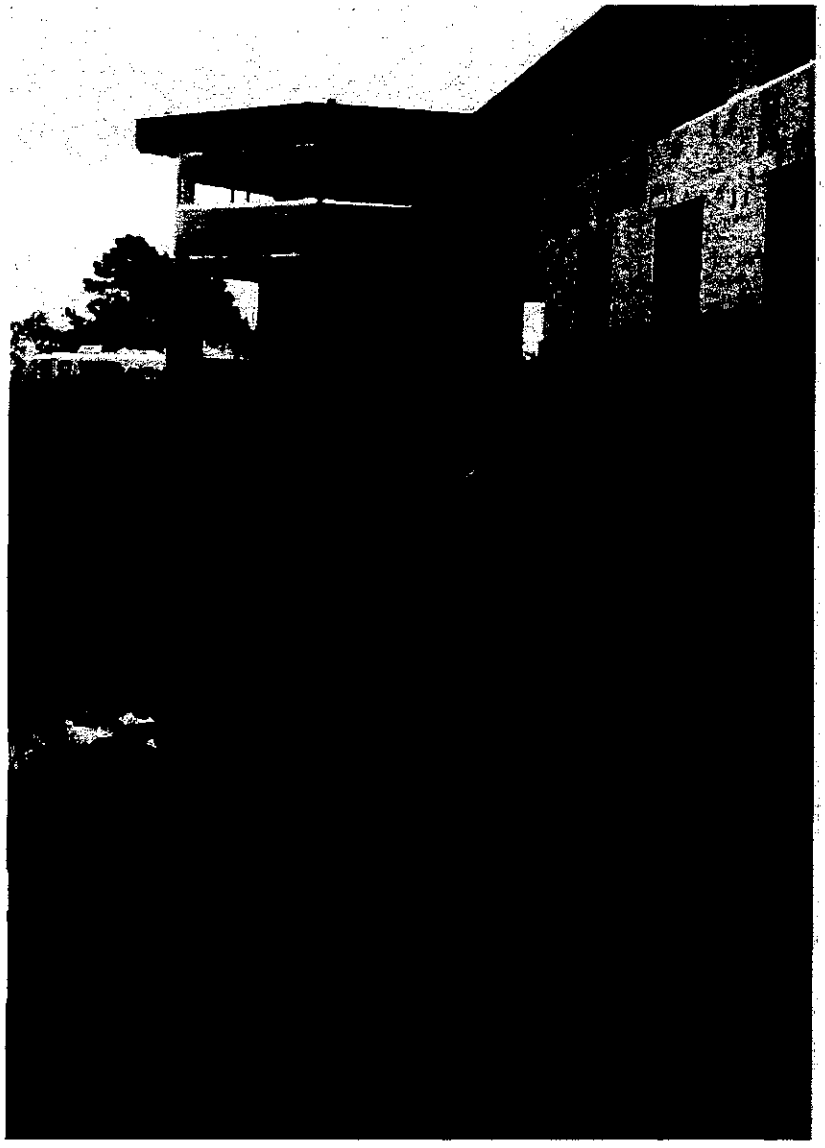
If the planting site doesn't receive expected rainfall , irrigate the plantings if the soil starts to become hard and dry. Some sites need to be protected from deer or beaver grazing the new sprouts. Put wire cages around the plants to protect them if this is an issue.

Installing brush layering: Which way is up?



- Rooting ends must be pushed into undisturbed native soil
- Growing tips should extend up to 2-3 feet beyond the fill soil.

Useful Installation Tips

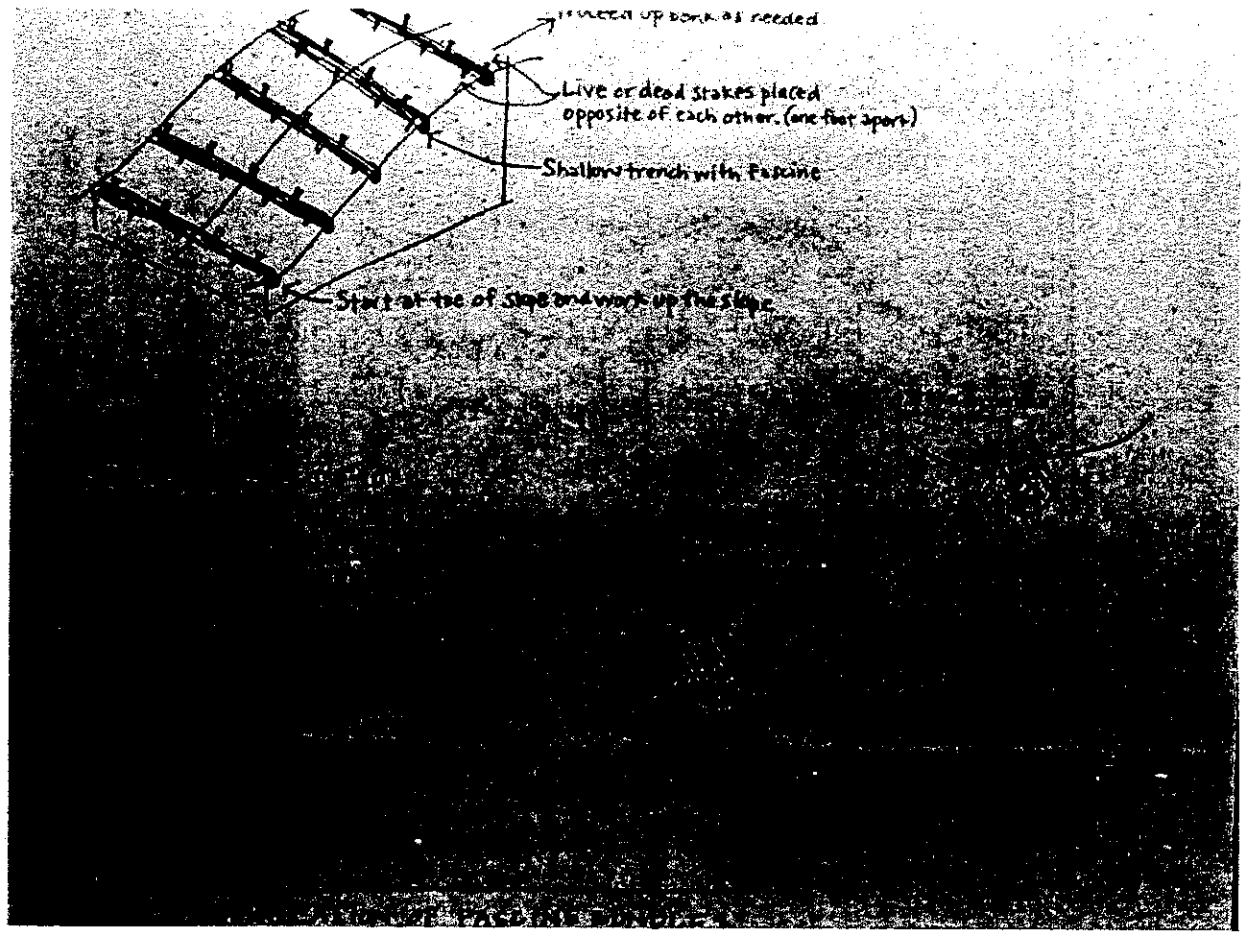


- Terrace Grading is effective for brush layering
- Soil will be tamped into the brush
- Brush layering can be installed with or without fabric.
- The use of fabric can create "pillows" of secured soil between the brush layers

5

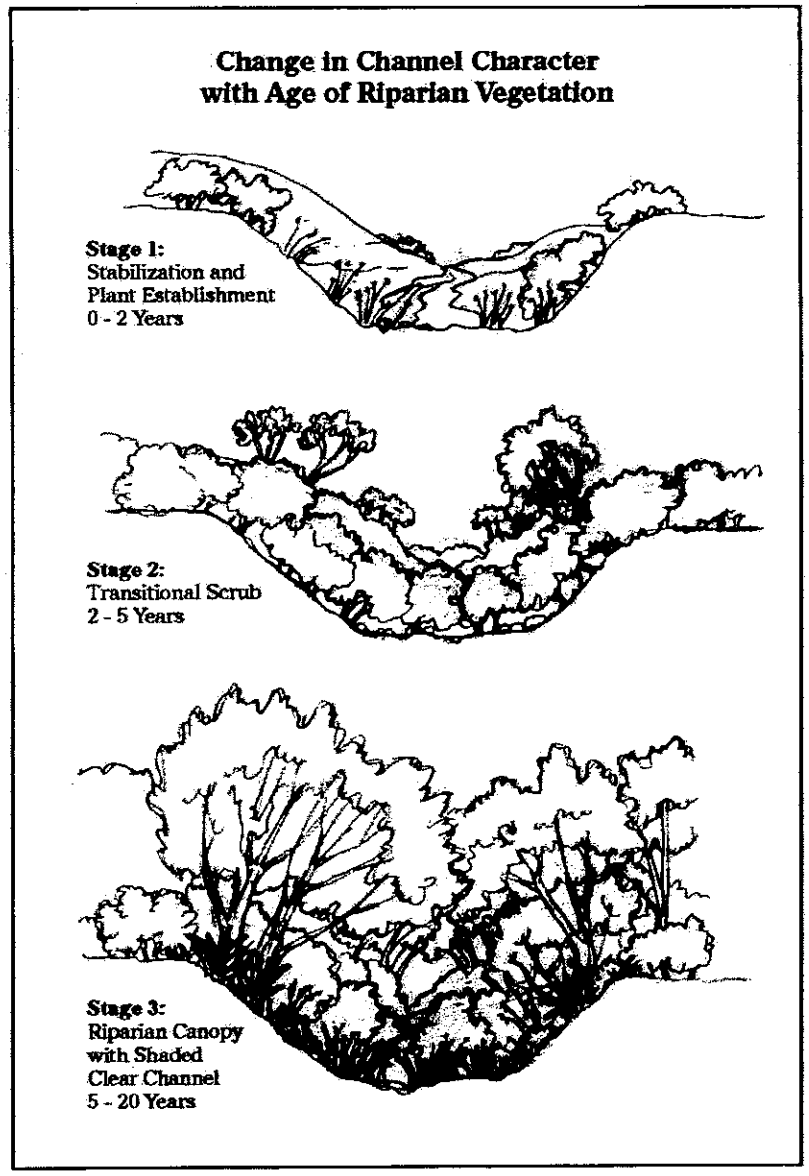
Location, Location, Location

- It is important to plant fascines on the contour.
- Planting on the contour prevents fascines from directing water downhill and causing gullying
- Stakes help keep fascines from heaving up or washing out.



Stages of Development: Post Restoration

- Soil Bio-engineering first grows in very bushy.
- It should grow into three different layers, and be pruned at shoulder height at various intervals if necessary for sight lines.
- In streams with fish, a brushy layer needs to be on the bank, near the water
- Other canopy species, such as alders, maples, ash, box elder, oak, and buckeyes can be added.



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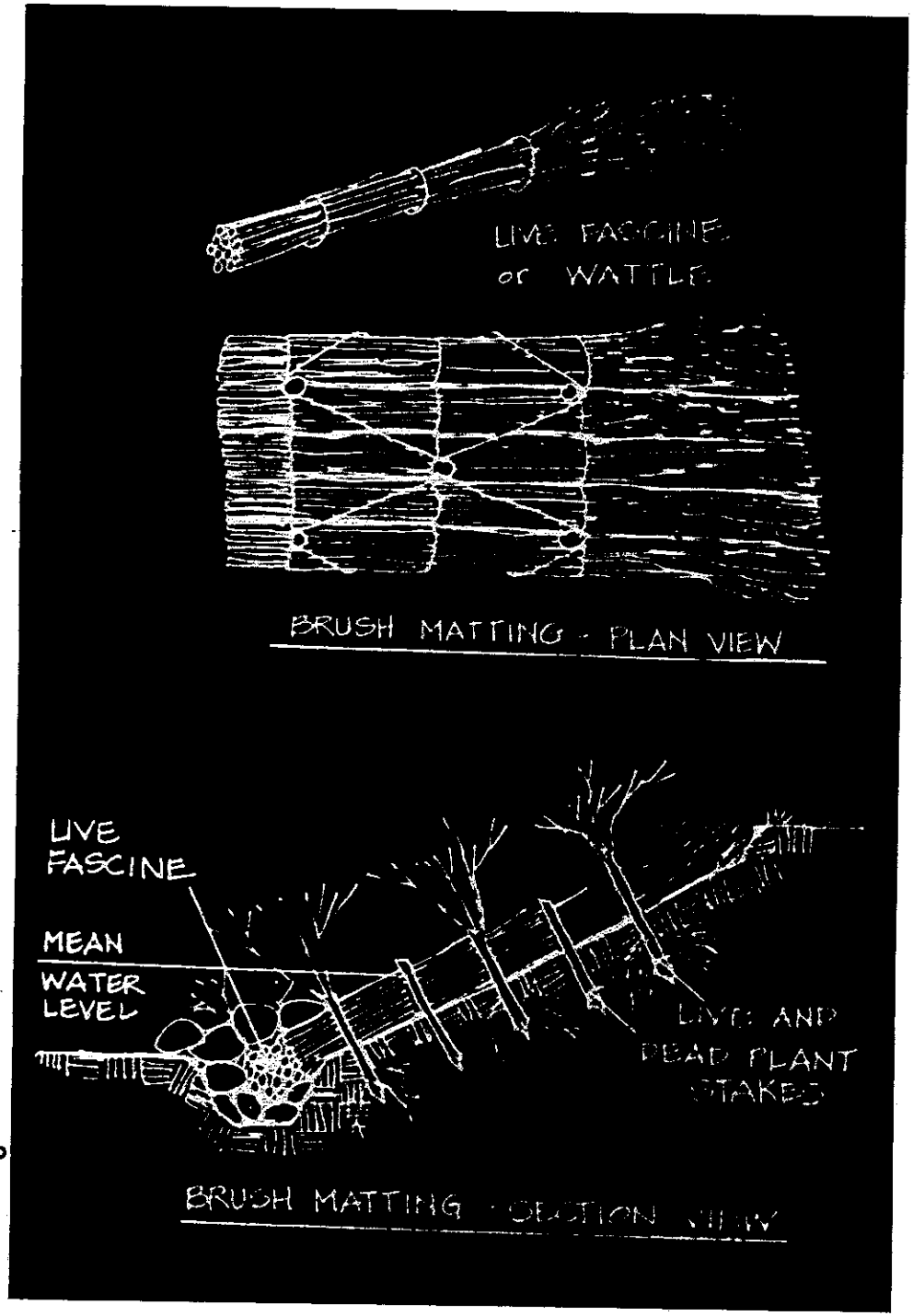


← Aberdeen Idaho guy... made a GIS guide

Be Creative!

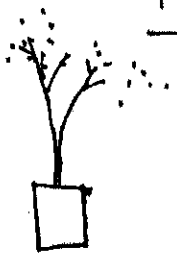
1 yd³ Willow roots = 26 miles stretched out

← Biotechnical & Soil Bioengineering + Bank Stabilization

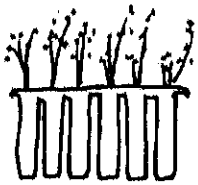
- Sometimes, the best solution combines multiple soil-bioengineering systems together. → tensile strength willow root > concrete
- For example: combine Fascines, willow posts and brush matting to make a dynamic bank stabilizer.

(4) Unrelated... add [illegible] to resume such as DNA extraction in Bird lab, Yosemite ecology, soil bioengineering

REVEGETATION MATERIALS


Container stock


Tubes

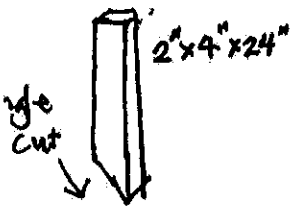

Liners


Poles


Cuttings

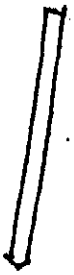

Bare Root Stock

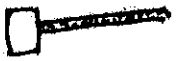
BASIC MATERIALS AND TOOLS

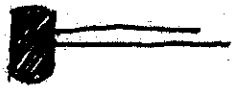


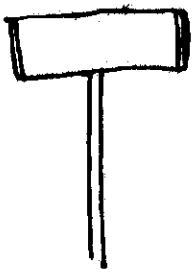
Stakes

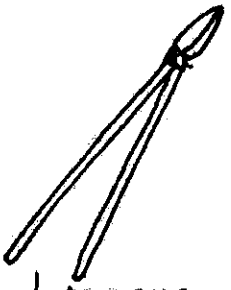

Rebar


Construction Stake


Hand mallet

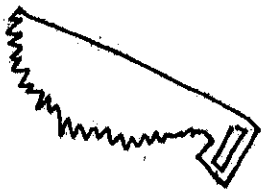

Rubber mallet


Sledge hammer

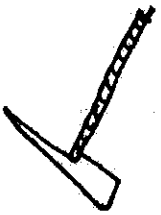

Loppers


Shovel (trenching)


Hand pruners


Hand saw


Shovel


Mattocks or pick


Poison Ivy/oak Repellant


String

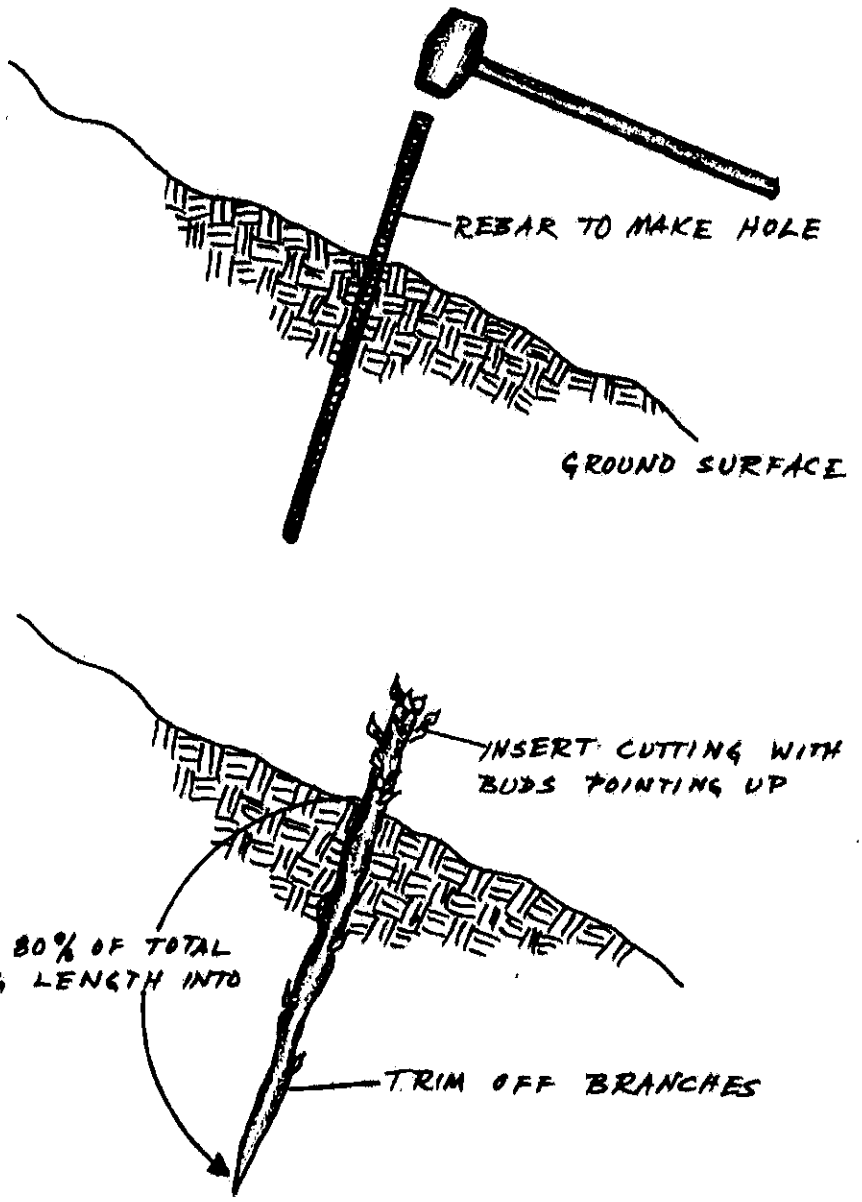

Wire


GLOVES

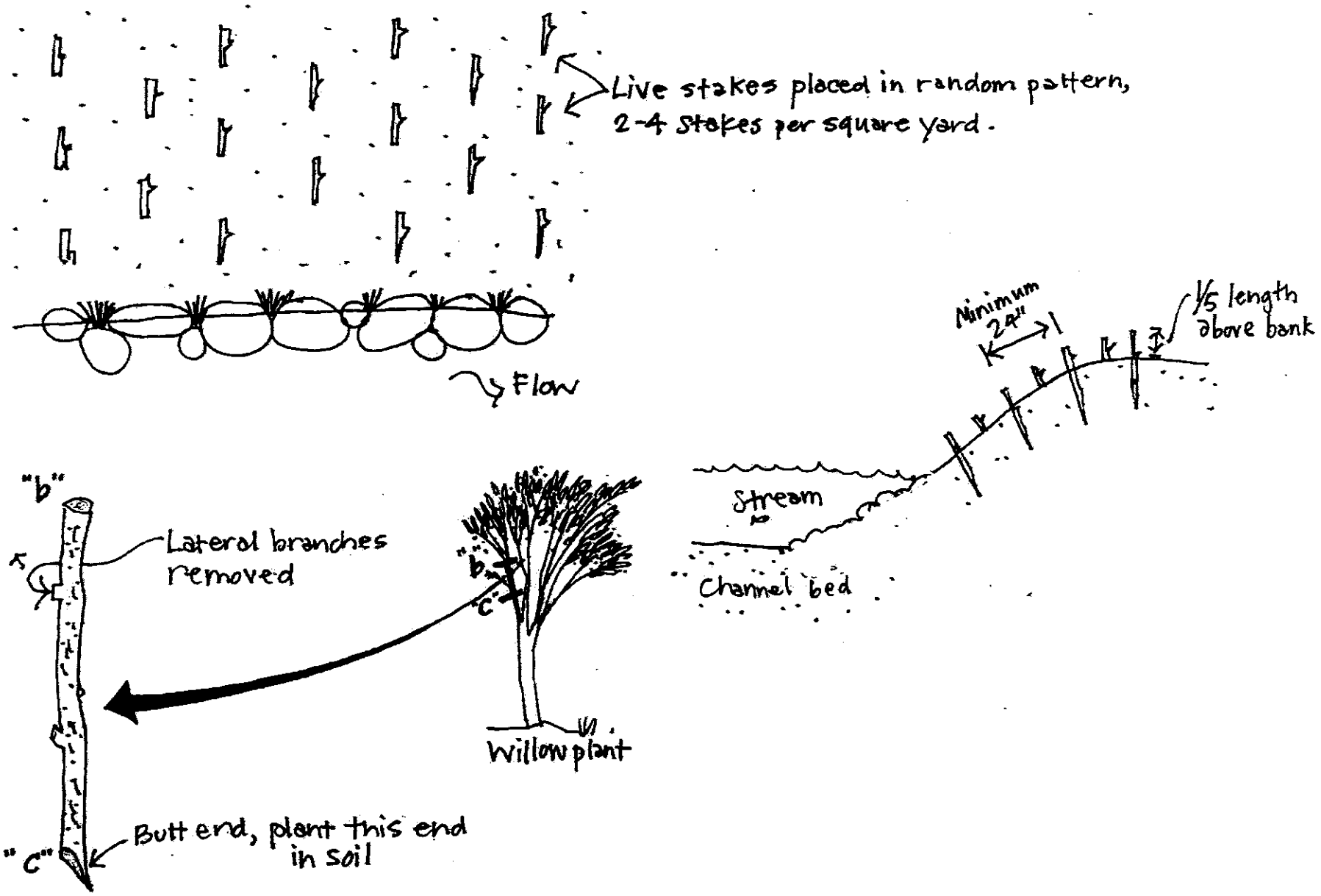
Riley/O'Connor

CUTTINGS

DETAIL FOR PLANTING CUTTINGS



HAMMERED REBAR OR STAKE CAN BE USED TO MAKE A HOLE. THE MOST DESIRABLE WIDTH OF THE CUTTING IS DETERMINED BY THE SPECIES; THE DEPTH OF INSTALLATION IS DETERMINED BY SITE CONDITIONS. TAMP THE LIVE CUTTING CAREFULLY SO AS NOT TO DAMAGE IT.

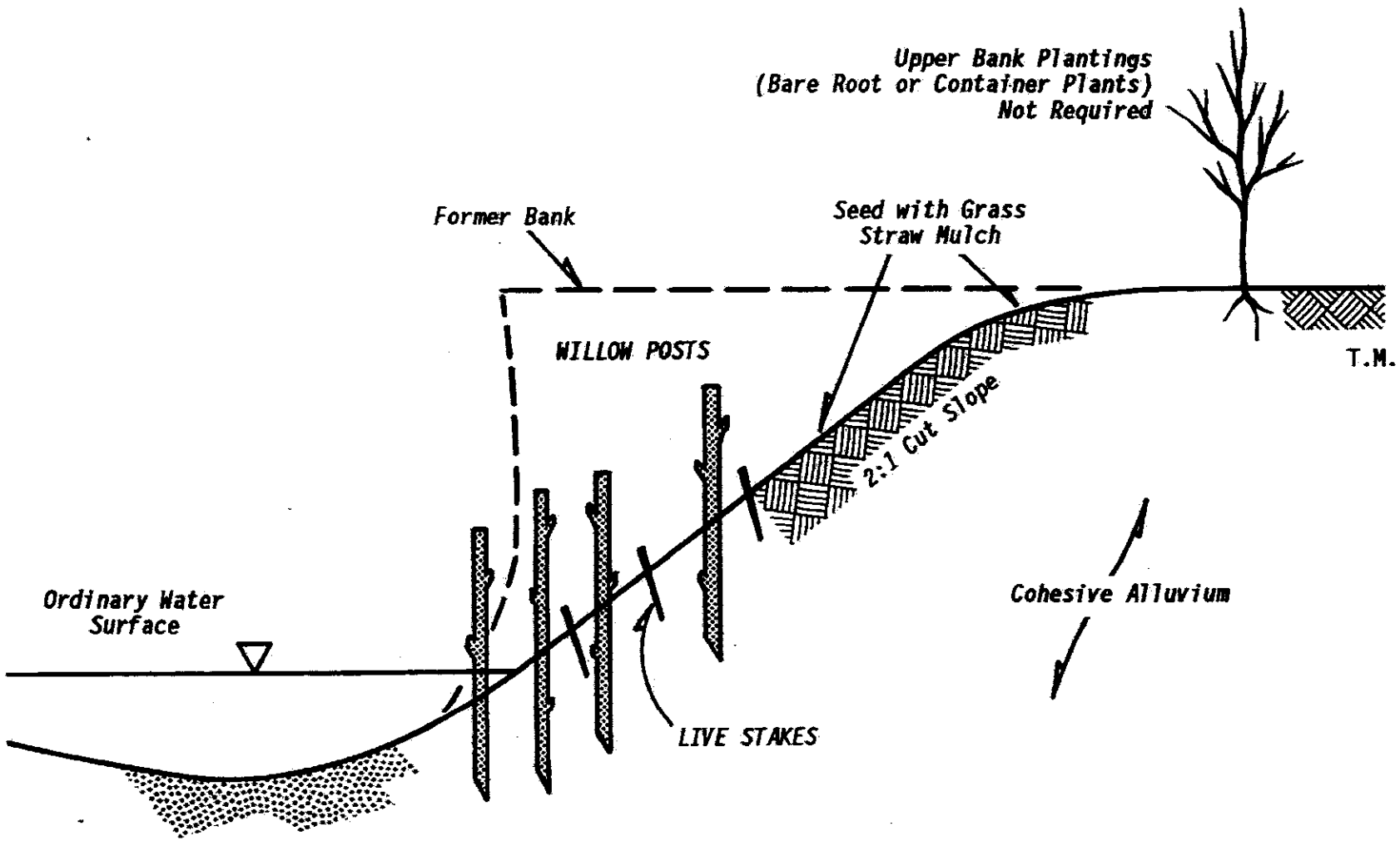


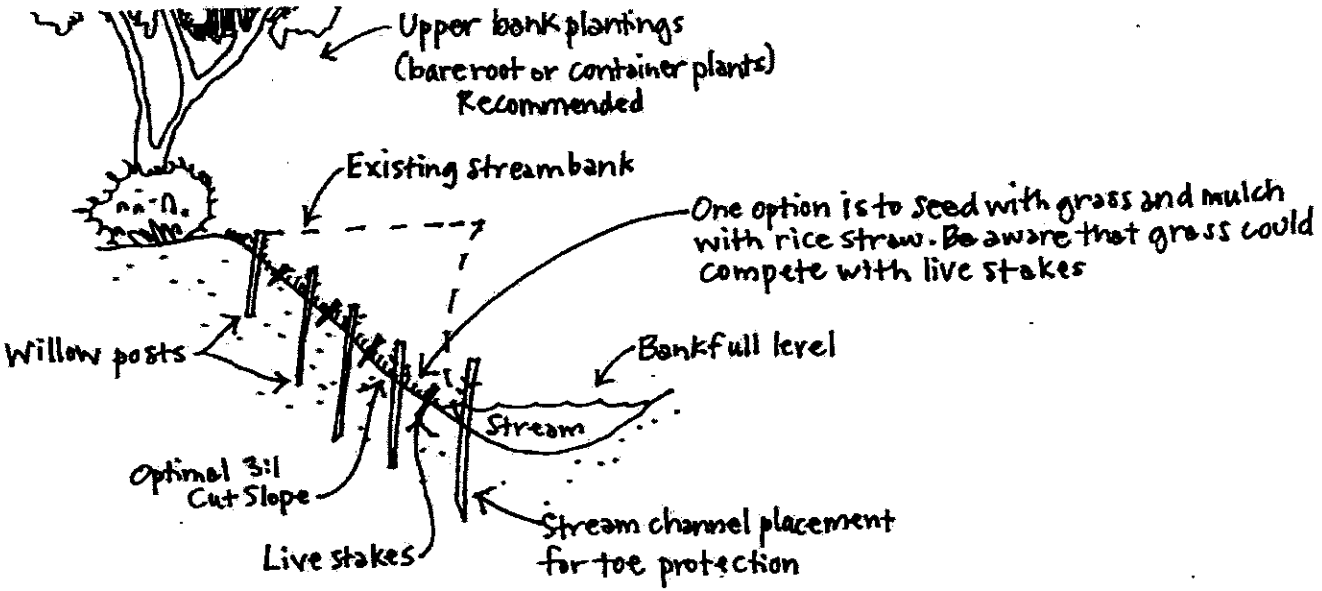
LIVE STAKE DETAIL
FROM WILLOW CUTTING

Riley/Ocanna

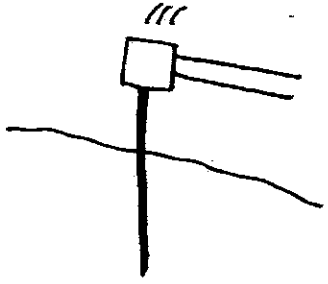
INSTALLATION OF LIVE STAKES SHOWN WITH AN OPTIONAL

WILLOW POST TREATMENT FOR COHESIVE BANKS

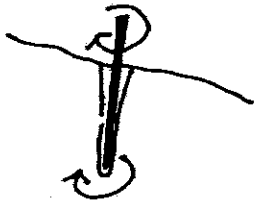




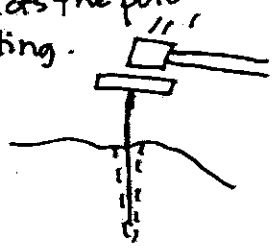
1. Using a substantial sledge hammer and a construction stake (metal pole with a point) make a planting hole.



2. Wiggle stake loose after every few blows of the hammer so you will be able to remove the stake after making as deep a hole as you can.

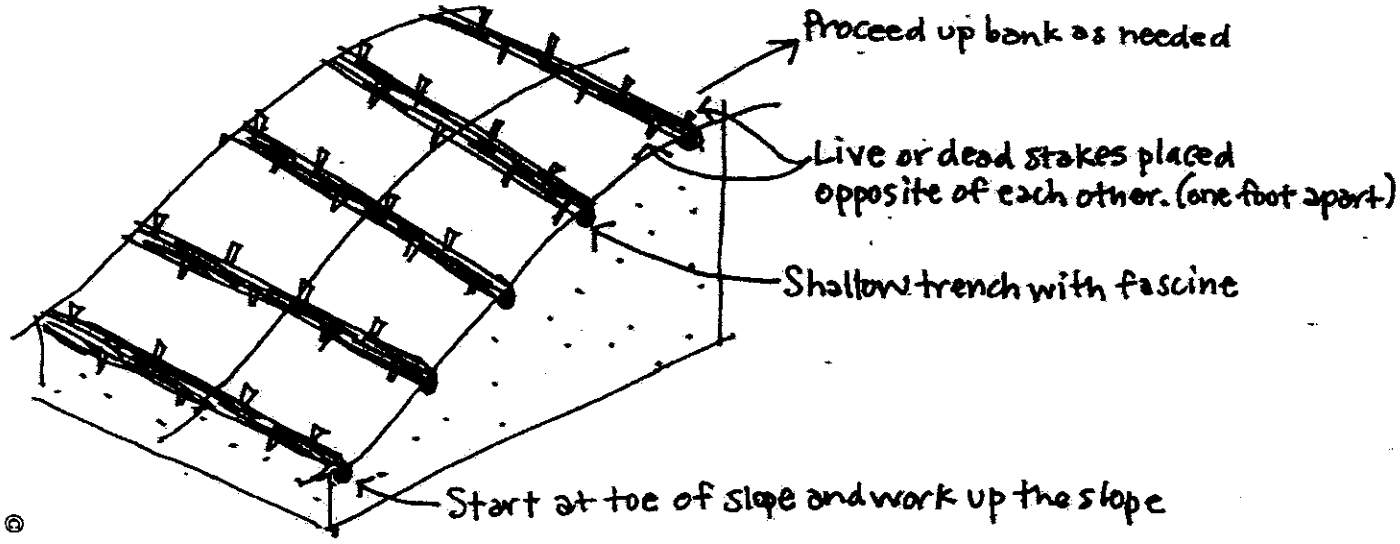


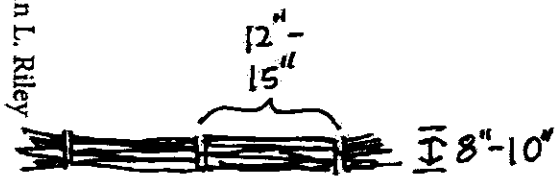
3. Place live pole in hole started by stake. Place a board on top of the pole and then hammer the live pole in. The board protects the pole from splitting.



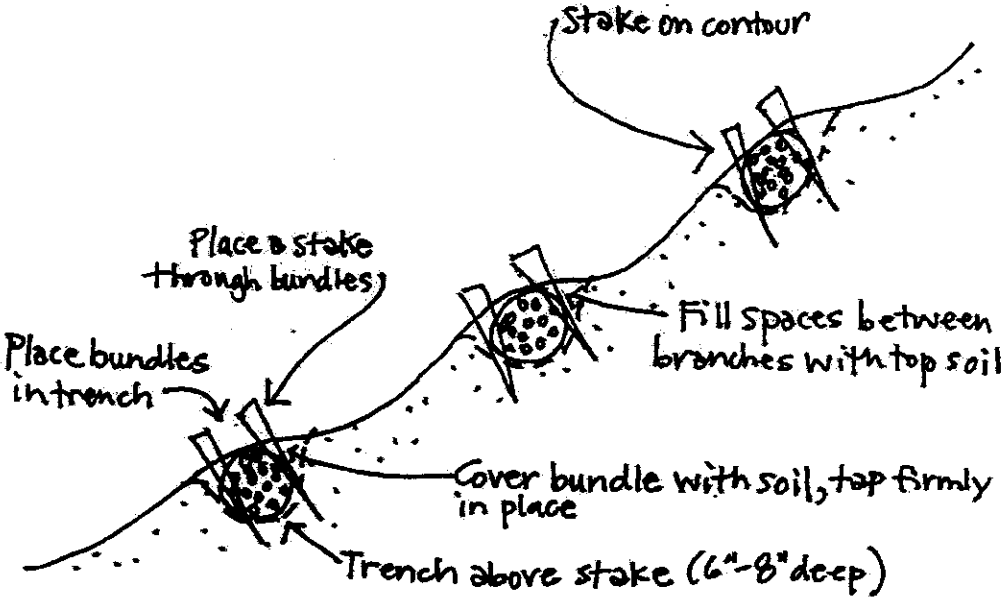
POLE CUTTING TREATMENT FOR STREAM BANKS
(Willows or Cottonwoods recommended)

Riley/O'Connor

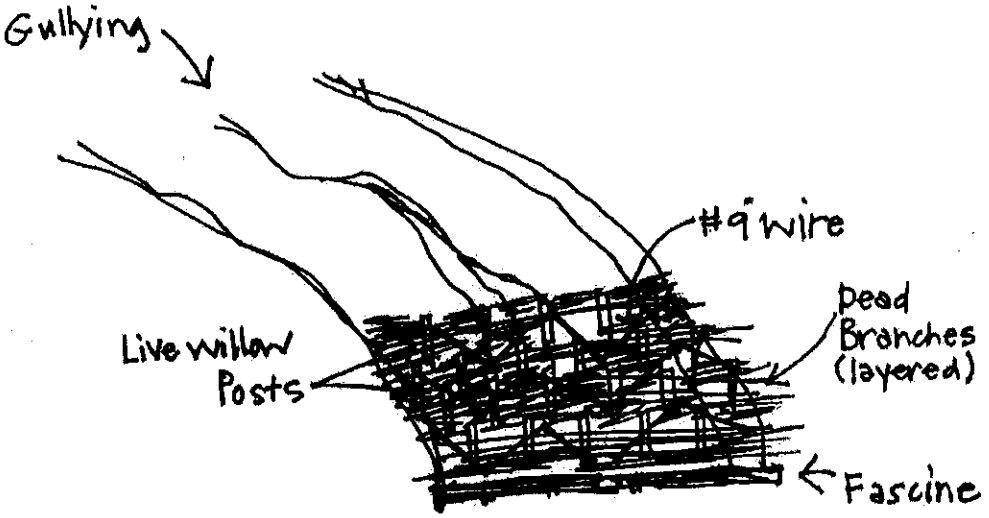


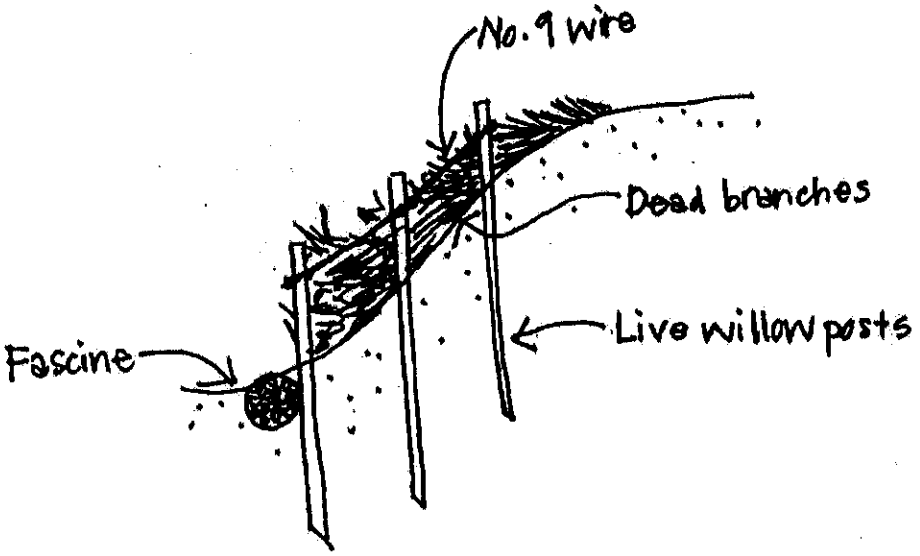


Prepare wattling, cigar-shaped bundles of live brush with butts alternating. The wattles are 8"-10" in diameter, tied 2"-15" on center. Species which root easily are preferred.



FASCINE BUNDLE (WATTLE)





Riley/O'Conn

BRUSH MATS - DEAD MATERIAL

(1.) LAYER BRUSH

(2.) ADD LAYERS OF BRUSH - ALTERNATE BRUSH BUTTS

(3.) WIRE THE BRUSH DOWN

(4.) TAP DOWN STAKES TO TIGHTEN

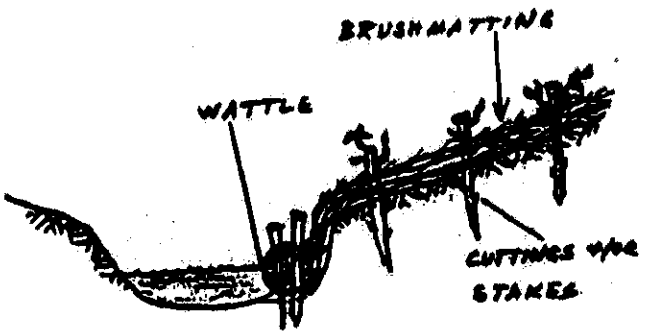
BRUSHMATTING AND WATTLE (FASCINE) COMBINATION TO STABILIZE A STREAM BANK:

— STEPS FOR CONSTRUCTION:

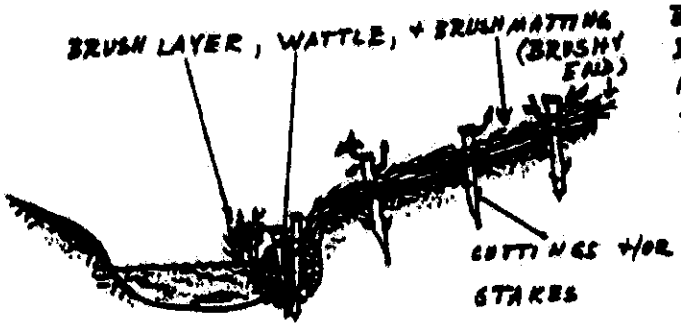
1. RESLOPE BANK

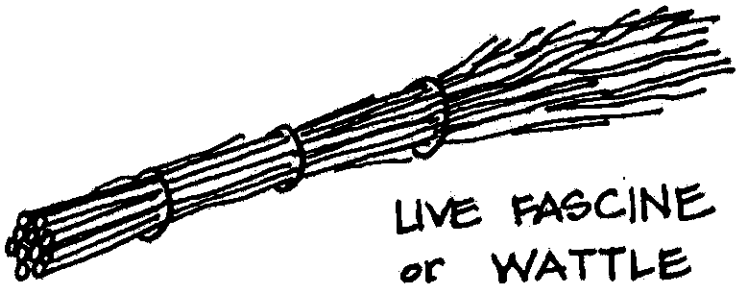
2. DIG A SHALLOW DITCH AND PLACE A WATTLE BUNDLE AT THE TOE OF THE BANK. PLACE IT WHERE IT WILL BE ABOUT HALF SUBMERGED DURING LOW FLOW PERIODS.

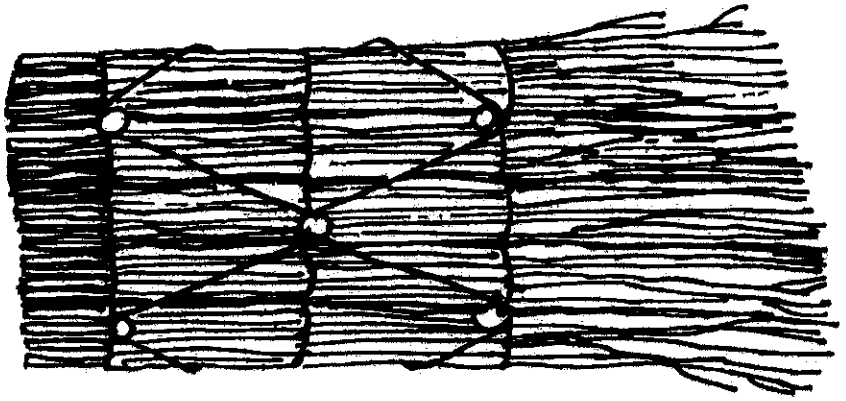
3. BURY THE BUTT END OF LIVE BRUSH UNDER THE WATTLE SO THAT THE WATTLE HELPS ANCHOR AND PROTECT THE BRUSH. STAKE THE BRUSH WITH LIVE CUTTINGS.



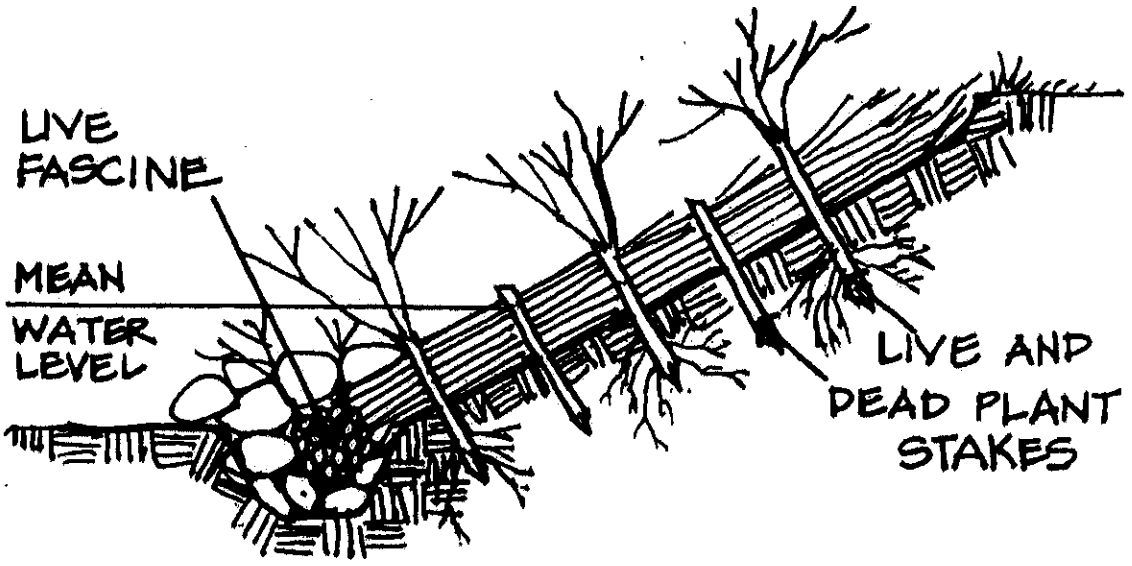
4. ANOTHER VARIATION USES A LAYER OF BRUSH THAT IS BURIED UNDER THE WATTLE BUNDLE TO PROTECT IT FROM HIGH VELOCITY FLOWS. THE BRANCHES OF THE BRUSH LAYERING HELPS SLOW THE VELOCITY OF THE WATER AGAINST THE BANK.





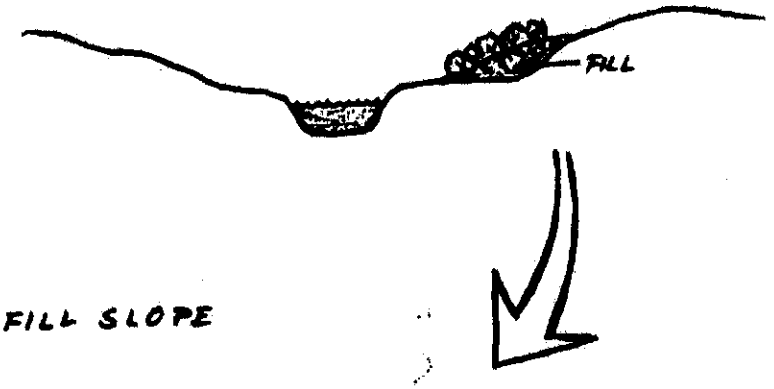


BRUSH MATTING - PLAN VIEW

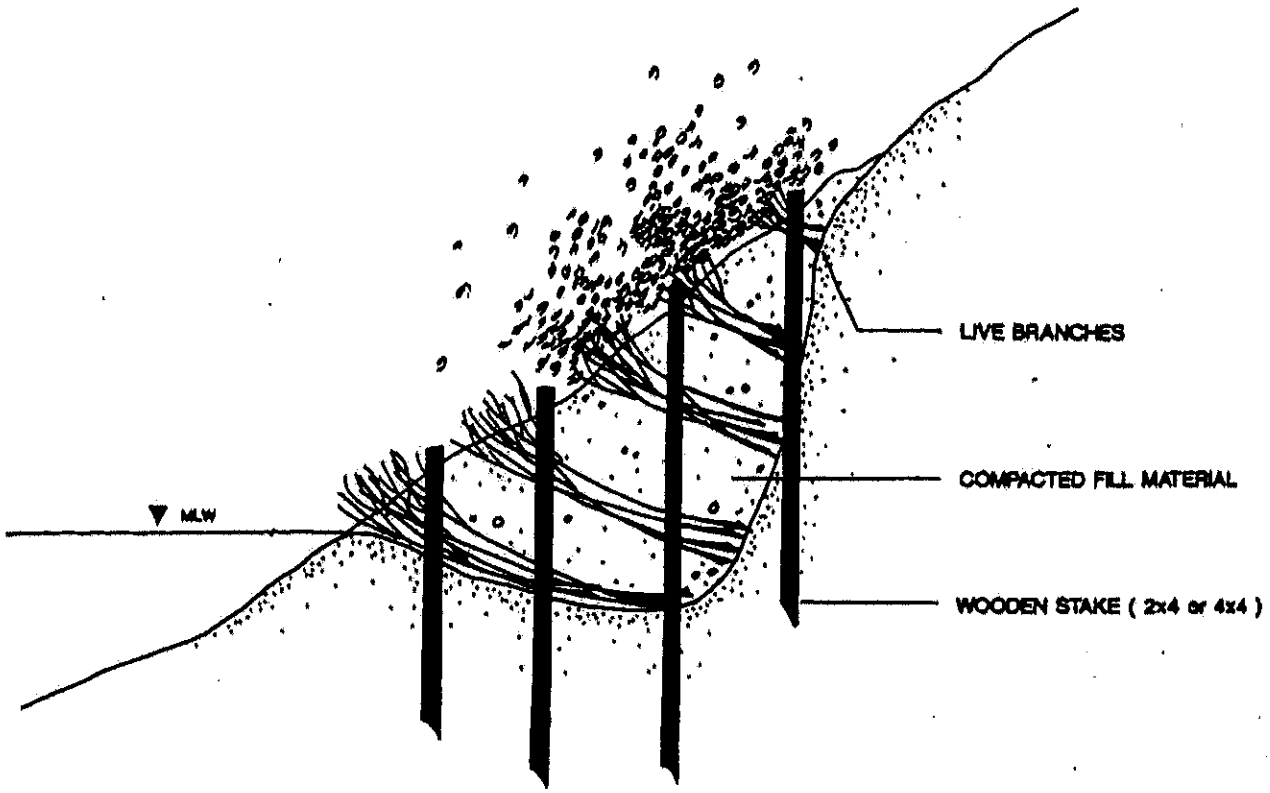


BRUSH MATTING - SECTION VIEW

BRUSHLAYERING:



FILL SLOPE



SECTION

NOTE:
Rooted/leafed condition of the living plant material is not representative at the time of installation.

Robbin B. Sotir & Associates

Not To Scale

Figure 12 Illustration of a branchpacking installation.

Riparian planting zones

Success of streambank soil bioengineering treatments depends on the initial establishment and long-term development of riparian plant species. The success of the plants, in turn, depends on numerous factors including:

- species selected
- procurement methods
- installation and handling techniques
- time of year
- soil compaction
- soil type
- nutrients
- salinity
- ice
- sediment
- debris load
- flooding
- accessibility to water
- drought
- hydrology
- climate
- location relative to the stream

USEFUL STREAM RESTORATION DOCUMENTS FOR MORE INFORMATION

1. Stream Corridor Restoration: Principles, Processes, and Practices
    - NRCS/USDA, 1998
2. Stability Thresholds for Stream Restoration Materials
    - Craig Fischenich, 2001
3. Bioengineering for Streambank Erosion Control
    - U.S. Army Corps of Engineers; Hollis H. Allen, James R. Leech, 1997
4. Stream Management
    - U.S. Army Corps of Engineers; J. Craig Fischenich and Hollis Allen, 2000
5. The self-organization of step-pools in mountain streams
    - Anne Chin, Jonathan D. Phillips, 2006
6. Environmentally Sensitive Channel- and Bank-Protection Measures
    - National Cooperative Highway Research Program, 2005
7. Biotechnical Slope Protection and Erosion Control
    - Donald H. Gray, Andrew T. Leiser, 1982
8. The Practical Streambank Bioengineering Guide
    - Gary Bentrup, J. Chris Hoag, 1998
9. Soil Bioengineering for Upland Slope Protection and Erosion Reduction [Ch. 18]
    - Engineering Field Handbook; USDA Soil Conservation Service, 1992
10. Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection
    - H.M. Schiechtl, R. Stern, 1997
11. Biotechnical and Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control
    - Donald H. Gray, Robbin B. Sotir, 1996
12. Restoring Streams in Cities: A Guide for Planners, Policymakers and Citizens
    - Ann L. Riley, 1998
13. Restoring Neighborhood Streams: Planning, Design and Construction
    - Ann L. Riley, 2016

PERMITS FREQUENTLY USED FOR SMALL SCALE STREAM PROJECTS

SF Bay Regional Water Board

1. Rapid Permit Checklist – Stream Channels and Floodplains
    - For individual section 401 water quality certification
2. General 401 Water Quality Certification Order for Small Habitat Restoration Projects
    - Order for Clean Water Act Section 401

U.S. Army Corps of Engineers

3. Nationwide Permit 27- Aquatic Habitat Restoration, Enhancement, and Establishment Activities

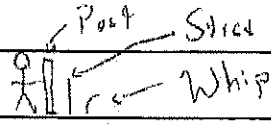
California Department of Fish and Wildlife (CDFW)

4. Notification of Lake or Streambed Alteration Fish and Game Code Section 1601

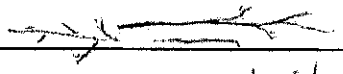
(4) • Land acknowledgement! Do HW on Hawaiian history & indigenous peoples

NOTES

12. A.R.: • willow post, Rip-Rap substitute



1. Facing: • alternate apical direction in bundle



• 3-4 twine holds

• ends: should be approx. "symmetrical", to look fit each other well