6.0 BANK STABILIZATION

6.1 Description and Purpose

Bank stabilization is the vegetative or structural means used to prevent erosion or failure of any slope. The terms *erosion* and *bank failure* have different definitions, as well as different causes. Erosion occurs when soil particles at the bank's surface are carried away. It is caused by wind, water, ice, and gravity, which are caused by such things as stream currents and waves, obstacles in a stream, overbank drainage, heavy rainfall on unprotected land, freeze-thaw and dry cycles, seepage, and changes in land use. Bank failure occurs when a section of the bank slides. It is caused by increase of load on top of the bank, swelling of clays due to absorption of water, pressure of ground water from within the bank, minor movements of the soil or creep, and changes in stream channel shape.

Soft bank stabilization practices such as vegetative seeding are

- More natural appearing.
- Able to absorb energy from stream flow.
- Easy to apply.
- Less expensive.

Hard practices such as rock riprap and structures are

- Less natural in appearance.
- Likely to deflect energy of stream flow.
- More difficult to apply.
- More expensive to apply.

6.2 Importance to Maintenance & Water Quality

Stabilization of banks along roads and streams will prevent bank erosion and failure, both of which may contribute considerable amounts of sediment to surface waters. Preventing erosion and failures can also alleviate the need fro expensive road repairs that can be caused by these problems.

6.3 Vegetation - Seeding

Grass and forb seeding is the most efficient and inexpensive method to stabilize a bank and should be used wherever possible. Grass will slow the movement of water, allowing more water to seep into the ground and minimizing the impact of runoff to surface waters. Areas should be seeded **as soon as possible** after disturbance - this may even need to be done on a temporary basis.

Areas with unstable soil and steep banks may require the use of sod as opposed to seeding techniques. If sodding is necessary it should not be laid between June 10 and August 20 without irrigation in northern Michigan and similar latitudes.

- Areas to be seeded should have a maximum 2:1 slope.
- Spread at least 3 inches of topsoil over the area to be seeded and then finish grade.
- Fertilize and lime the area as needed according to the soil condition.
- Harrow or rake fertilizer and lime into the soil to a depth of two inches.
- The surface should be left rough to reduce water velocity, and to help hold seed and much.
- Select a seed mixture appropriate for site soil and drainage ("Conservation Seed Mix" is suitable for most areas).
- Whenever practical use native grasses and forbs.
- Broadcast seed evenly over the prepared area by either had broadcasting or hydroseeding. Hydroseeding is done using a truck with a mounted sprayer.
- After seeding, mulch with straw to a depth of 2 inches - this can be done by blowing it on from a truck or by hand spreading - if no mulch is to be applied, roll, rake or brush to lightly cover the seed.
- Erosion control blankets should be used on steep erodible situations nears surface water. Jute netting (COIR fiber) is preferred over any plastic 'biodegradable' nettings.

Temporary seeding: usually contains small grains, i.e. oats, barley, rye or wheat, and can contain perennial rye. This type of seeding gives a quick cover to prevent erosion during construction.

Dormant seeding: may be made in the late fall for germination in the spring. Dormant seedings must be mulched.

Long term seeding: should be done from May 1 to September 20 and must be mulched. Recommended seed mix is listed in the following table.

It is always wise to check with your local Conservation District for detailed seeding information unique to your area.

Table 6-Conservation Seed Mix
Long Term Vegetative Cover

Seed Type	Lbs/Acre	Lbs/1000 ft^2
Perennial Rye	5	0.15
Tall Fescue	20	0.5
Redtop	1	0.03
Creeping Red Fescue	20	0.5
Kentucky Bluegrass	5	0.2
Ladino Clover	0.5	0.015

6.4 Vegetation - Shrubs and Trees

Native shrubs and trees can be used to stabilize steep slopes and streambanks, create a good vegetative filter strip and create a valuable wildlife habitat. Deeply rooted woody species provide greater protection against slippage problems.

- Identify native plants in the area to determine the most suitable plants to use for stabilization.
- Commonly used stabilization plants include: native willows, dogwood and ninebark.
- Techniques for stabilizing banks with woody plants include:

6.4.1 Live Fascines/Wattles/Bundles

Live fascines, wattles and bundles are long bundles of live branches, 5 to 30 feet in length and 6 to 8 inches in diameter, tied together with growing tips oriented the same direction and tops evenly distributed through length of bundle. They can be used on steep slopes (1:1) and to protect slopes from shallow slides.

- Place in 12- to 18-inch deep trench dug along the contour of the slope, working from the base of the slope upwards.
- Secure with live stakes and dead stout stakes.
- Install bundles the same day as cut during dormant periods (spring, winter, or fall).

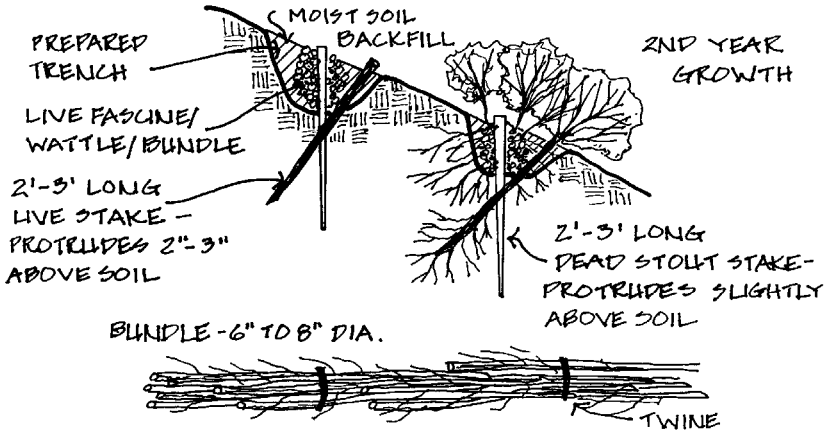

Figure 23—LIVE FASCINES/WATTLES/BUNDLES

6.4.2 Live Stakes

Live stakes are cuttings of live branches usually 1/2 to 1-1/2 inches in diameter and 2 to 3 feet long. They are an inexpensive method that can be used when time is limited and the site is relatively uncomplicated.

- Branches should be cleanly removed from stake and basal end of stake cut at an angle for easy insertion into soil\
- Stakes are tamped into the ground at right angles to the slope along the contour with buds oriented up.
- Plant in alternating grids with 2 to 4 stakes per square yard.
- Plant stakes the same day as cut during dormant periods (spring, winter, or fall).

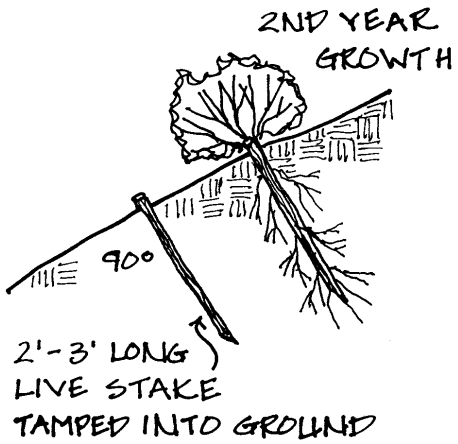

Figure 24—LIVE STAKES

6.4.3 Brushlayering

Brushlayering is the use of live branches, 1/2 to 2 inches in diameter and 3 to 4 feet long, which are placed perpendicular to the slope with growing tips outward. They are used to break up slopes into a series of shorter slopes.

- Small 2 to 3 feet wide benches, angled slightly higher at the outside, are excavated along the contour starting at the toe of the slope and working upward.
- Branch cuttings are placed on the bench in a crisscross or overlapping manner.
- Backfill on top of branches and compact.
- Plant branches the same day as cut during dormant periods (spring, winter, or fall).

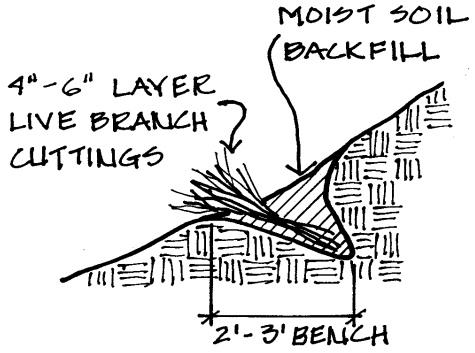

Figure 25—BRUSHLAYERING

6.4.4 Sprigs/Plugs

Sprigs or plugs are individual plant stems with roots. They can be seedlings or rooted cuttings. Rooted shrubs from a nursery may be used and are more reliable, but more expensive. Sprigs/plugs are often used on filled slopes in conjunction with fiber rolls.

- Place in hole that is dug large enough to accommodate the roots and tamp soil down around the plant.
- Plant in alternating grids with plants 1/2 to 1 yard or meter apart.

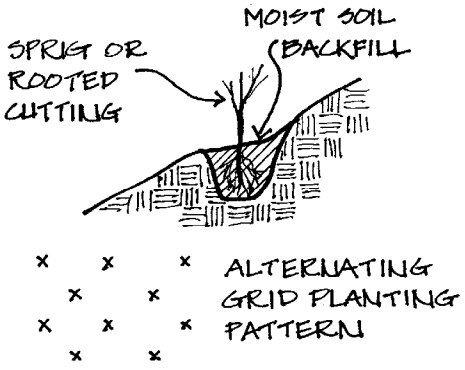

Figure 26—SPRIGS/PLUGS

6.5 Grading Techniques

Banks should be graded to a maximum 2:1 slope.

6.5.1 Terracing

Benches can be constructed on slopes that are excessively steep and long to provide near level areas that intercept and divert water.

- Backslope terrace inwards toward the slope to intercept water and prevent erosion of terrace.

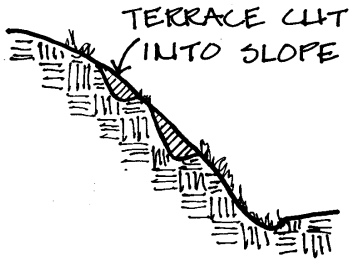

Figure 27—TERRACING

6.5.2 Counterweights

A level bench and stable slope can be added next to a steep failing bank to hold the bank up and prevent continued sliding.

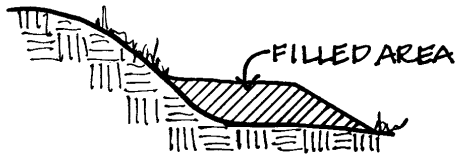

Figure 28—COUNTERWEIGHT

6.5.3 Cut and/or Fill

The removal or addition of soil to the bank to create the desired 2:1 or flatter slope, often times removing less stable soils and replacing them in the process of regrading the slope.

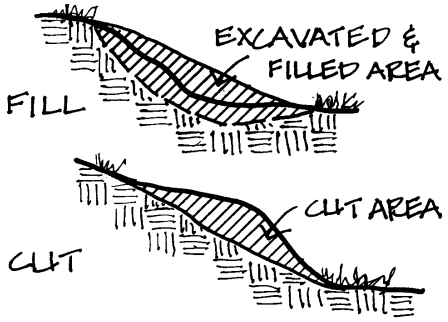

Figure 29—CUT AND/OR FILL

6.5.4 Notching or Keying

A V or trapezoid shaped cut is made in the existing ground to help further stabilize fill added to smooth the slope.

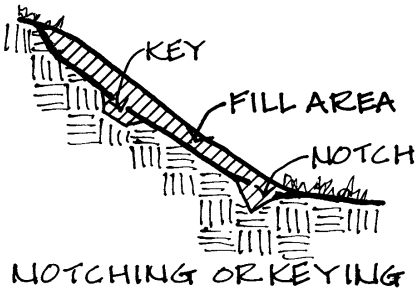

Figure 30—NOTCHING OR KEYING

6.6 Structures - Walls

6.6.1 Gabions

Gabions are wire mesh rectangular boxes filled with stone and used as a retaining wall. Gabions are permeable, allowing water to seep through and aiding in the removal of sediments. They can be stacked or terraced, and can be combined with woody vegetative stabilizers to improve their appearance.

- Gabions can be costly.
- Can be used in unstable flows.
- Live stakes or other **bioengineering** material can be used with them.

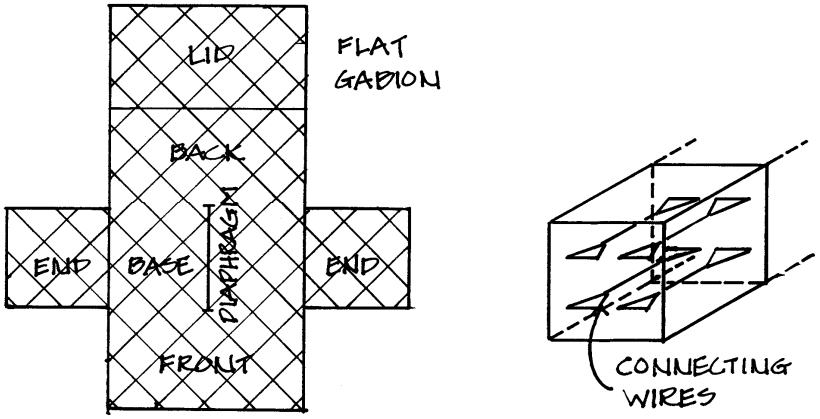

Figure 31—GABIONS

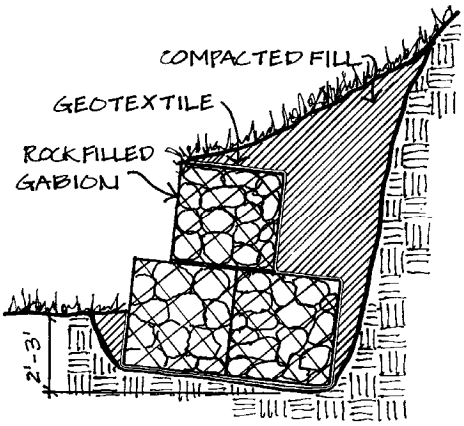

Figure 32—GABION WALL

6.6.2 Log or Timber cribs

Log or timber cribs are made of logs or treated timber filled with soil and used as retaining walls. Live branches can be planted in the crib to assist with stabilization.

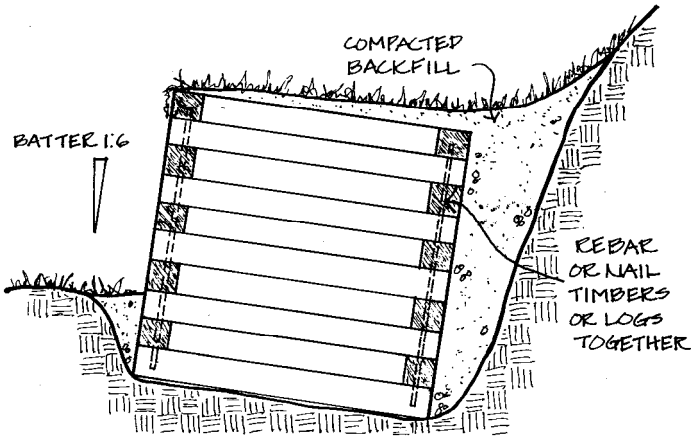

Figure 33—LOG OR TIMBER CRIB

6.7 Structures - Revetment Systems

6.7.1 Riprap

Riprap can be carefully placed on bank slopes and stream edges where vegetation does not adequately prevent soil loss to reduce erosion and filter sediment. It is used on very steep slopes, at sharp turns in streams, and where a bridge or culvert restricts water flow.

- Size of riprap is dependent on quantity and velocity of water flow.
- Riprap should be placed at an elevation equal to the 10-year storm elevation, or the annual high water line, or the top of slope.
- Use graded riprap so that smaller stones will fill in the gaps between the larger stones.
- Place appropriate geotextile properly with <u>all</u> edges 'toed in' so that water does not flow under the geotextile.

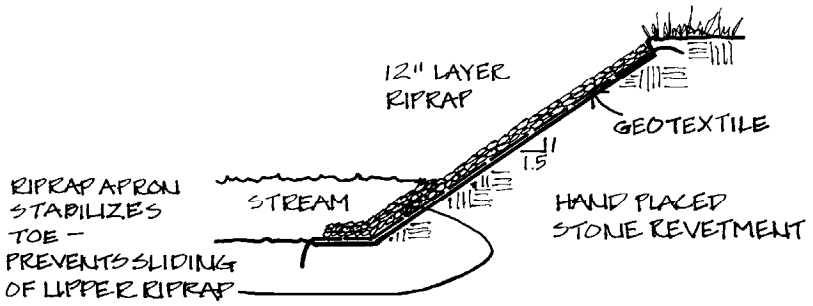

Figure 34—RIPRAP REVETMENT

6.7.2 Full Tree Revetment

Tree revetments are used in place of, or in conjunction with, rock riprap to reduce the amount of rock needed and for economic purposes. In remote areas not readily accessible to heavy equipment, tree revetment use is desirable. Often trees are available near streambanks where rock or access to equipment and rock are not.

- Install trees as parallel as possible to the bank.
- Optimal stabilization is accomplished with lush coniferous trees having total heights ranging from 12' to 20', and crown widths of 5' to 8'. Red or white pine will be used.
- Trees should be staggered and overlapped 30-50%.
- Galvanized cable of 3/16 inch diameter should be utilized to anchor trees.
- All cable should be taut and concealed.
- Earth anchors should be driven to a minimum depth of 4' below existing grade.
- Follow manufacturer's recommendations for setting anchors and cable.

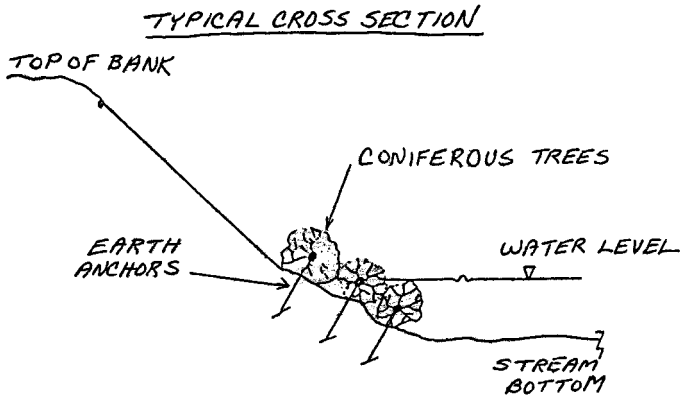

Figure 35—FULL TREE REVETMENT

6.8 Combinations

Also called bioengineering, vegetative and structural components can be combined to form a system used to stabilize steep banks. They are used when one component will not provide the necessary slope protection and stabilization. Combination or bioengineering techniques include:

6.8.1 Rock Riprap

Rock Riprap placed around cribwalls or gabions held to secure in less stable flow conditions; they also improve wildlife habitat.

6.8.2 Live Cribwalls

A log or timber crib is combined with live branches, as used in brushlayering. Timbers provide structural support while plants take root, but use half as much wood as in a timber or log crib, making it less expensive. They may also be constructed in a step fashion, creating planting areas. Use at the base of a slope where a low wall, not higher than 6 feet, is required.

- Place logs or timbers in an alternating manner leaving space for live branch cuttings.
- Branch cuttings should be long enough to reach the undisturbed soil at the back of the crib.
- Cover each layer of branches with a layer of compacted soil.

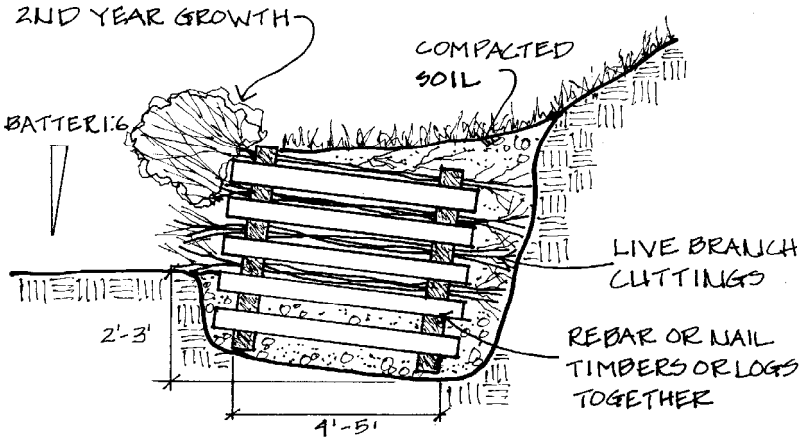

Figure 36—LIVE CRIBWALL

6.8.3 Vegetated Gabion

A gabion wall is combined with live branches, as used in brushlayering. Live branches root into gabions and slope, binding the gabions to the slope, and provide aesthetic enhancement to the gabion wall. Use at the base of a slope where a low wall, not higher than 5 feet is required.

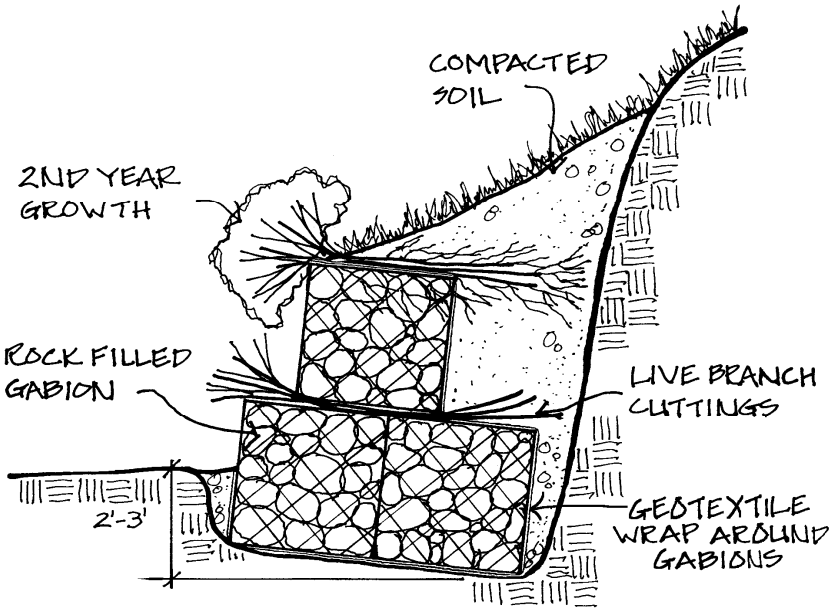

Figure 37—VEGETATED GABION WALL

6.8.4 Vegetated Rock Wall

A combination of rocks and live branches, as used in brush layering. It provides a well drained base for the wall. Use at the base of a slope where a low wall, not higher than 5 feet, is required.

- Excavate a minimum amount of slope behind the wall.
- Place rocks with long axis slanting inward toward the slope.
- Backfill between each layer of rocks and place live branch cuttings on backfill.
- Cover with soil and compact.

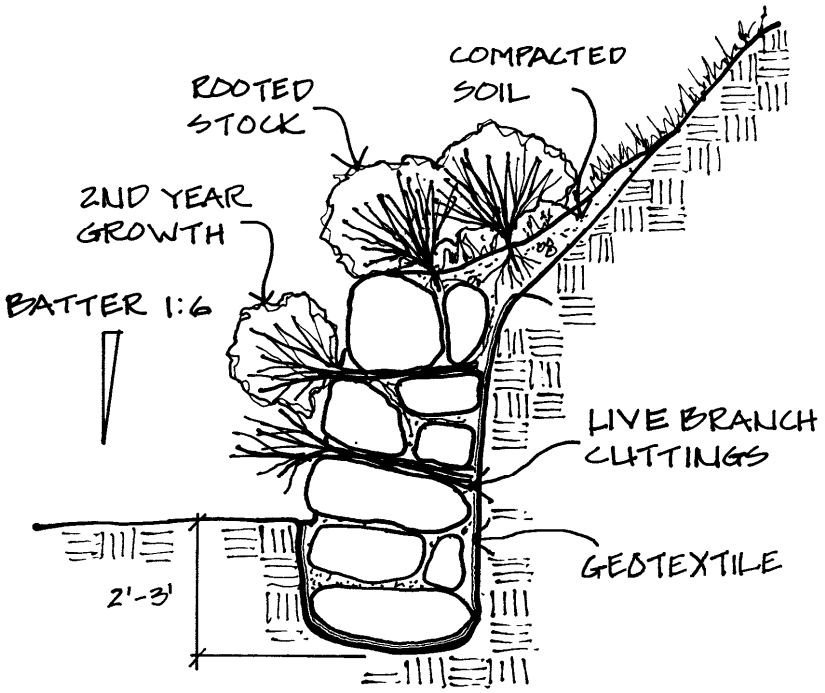

Figure 38—VEGETATED ROCK WALL

6.8.5 Vegetated Riprap/Joint Planting

Combines riprap revetment with the tamping of live stakes between the joints or open spaces in the rocks. Roots improve drainage and create a mat that binds and reinforces the soil, preventing washouts and loss of fines between and below the rocks.

- Live stakes must be long enough to extend well into soil below rock surface.

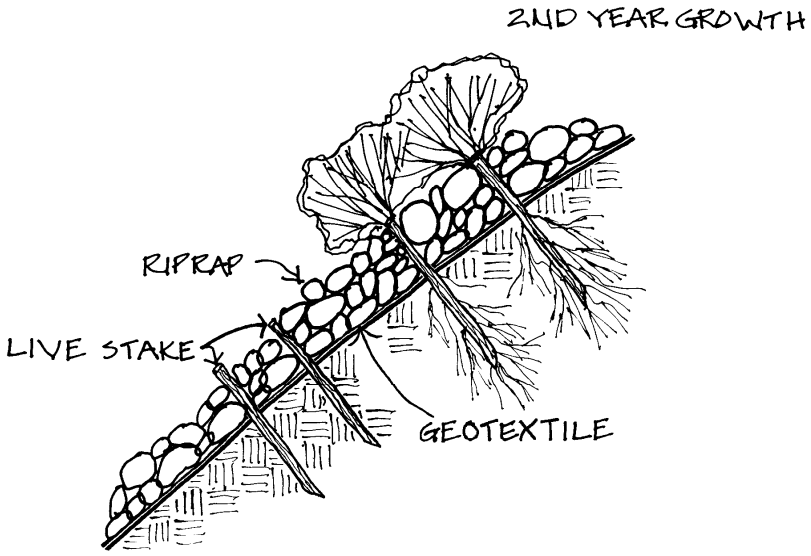

Figure 39—VEGETATED RIPRAP

6.9 Mats & Blankets

Mats and blankets are used to prevent erosion on a temporary basis on steep slopes, in ditches with high water velocities, and other areas prone to erosion. Types of mats and blankets include:

6.9.1 Jute Matting

is a strong, natural fiber woven into an open 1-inch square weave mesh.

- Spread over seeded and mulched areas to hold in place.
- Bury up-slope end of each section in a 6-inch vertical slot, backfill and tamp.
- Overlap each down-slope section with 12 inches of mat.
- Overlap side-by-side sections by 4 inches.
- Securely anchor mat with stakes and staples.
- Jute matting is generally preferred over other types of mats and blankets.

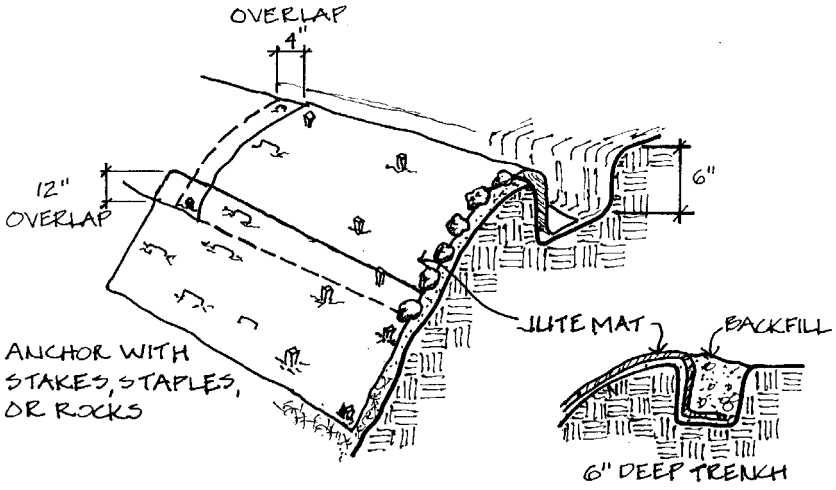

Figure 40—JUTE MATTING

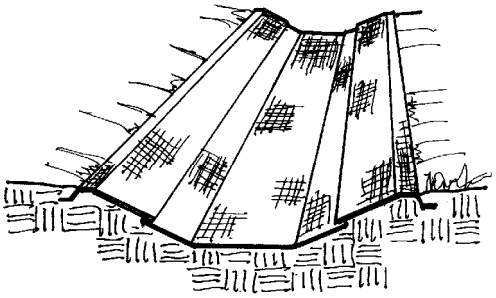

Figure 41—DITCH INSTALLATION

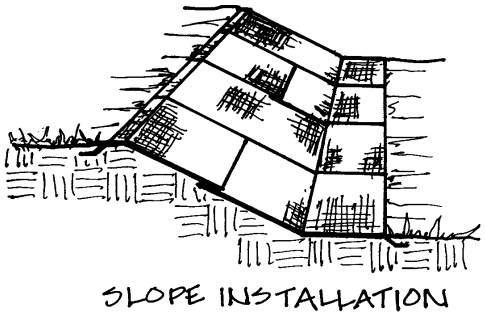

Figure 42—SLOPE INSTALLATION

6.9.2 Wood Excelsior Blanket

Wood excelsior blanket is a machine produced mat of 6-inch long curled wood excelsior entwined with a photodegradable plastic mesh.

- Ends of sections should be tightly butted but not overlapped.
- No need to mulch when using a wood excelsior blanket.
- Installation is otherwise similar to jute mat.

6.9.3 Mulch Blanket

Straw, coconut, or wood fibers sandwiched between photodegradable plastic. Use in areas where it is difficult to hold mulch in place and there is erosion potential until vegetation is established.

- Place after area has been seeded.
- Place lengthwise along direction of the slope and secure with staples.

6.10 Geotextiles

Geotextiles are permeable natural or synthetic materials used for silt fences, channel linings, road base stabilizers, and prior to the placement of riprap or aggregate. They help to prevent the migration of finer soil particles and are used to trap sediments.

- Installation technique is dependent upon use.