Bowling Green, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-06

Activity: Bank Stabilization (BS)

BS

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
50-70% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◈ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Bank stabilization is used to reduce erosion from stream banks by providing protective cover through the use of vegetation and other methods.

Suitable Applications

- Bank stabilization practices are used for stream banks susceptible to erosion, locations with high flow rate that are subject to produce erosion, and/or actively eroding stream banks.
- Due to the nature of these practices additional permitting through the state of other agencies may be required.
- Bank stabilization practices should be designed by a Professional Engineer licensed in the Commonwealth of Kentucky.

Approach

- Structural measures such as retaining walls, gabions, rip-rap or interlocking blocks.

Structural practices are used for projects in which a quick stabilization of stream banks is required. Generally speaking, these practices are more costly than bioengineer solutions. However, they usually require less maintenance than bioengineering measures.

- Bioengineering methods

Bioengineering methods are commonly used for this purpose,. These methods generally take longer to establish stabilization. However, they can be quite effective and economical to implement. As with any vegetative practice, careful selection of materials, installation, and maintenance is necessary to be effective.

Approach (Continued)

Several methods of Bioengineering solution are listed as follows:

- Live Stake

Live stakes are the insertion of live, rootable vegetative cuttings into the ground. Live stakes are an appropriate technique for repair of small earth slumps that are frequently wet. Or they can be used to supplement other types of bank stabilization plantings. Live stakes can also be installed through existing riprap or other aggregate materials, allowing a stabilized riprap location to eventually have natural vegetation.

Live stakes are usually 0.5 to 1.5 inches in diameter and approximately 2 to 3 feet in length. Typical spacing is 2 to 3 feet apart. The basal end (or root) is cut to an angled point for easy insertion. The top should be cut square. Willow branches have historically been specified for use as live stakes and are well-suited to the purpose. Other types of tree branches may be selected, depending on soil type and available moisture conditions, such as ash, alder, elm or dogwood.

Gently tamp the live stake into the ground at right angles to the slope. Approximately 80 percent of the live stake length should be installed into the ground. Pack soil firmly around live stake after installation. Do not split the stakes during installation; stakes that split should be removed and replaced. An iron bar can be helpful in establishing a pilot hole for the live stake.

- Live Fascine

A fascine is defined as a bundle of sticks or branches, tied together and used for a definite purpose such as preparing a primitive house, fort, or other structure. A live fascine is defined as a bundle containing live branch cuttings bound together into sausage-like structures, and then placed to provide slope stability or prevent erosion.

Live branch cuttings should be from species that easily root and have long, straight branches. Cuttings are tied together to form live fascine bundles that vary in length from 5 to 30 feet, depending on site conditions and limitations in handling. The completed bundles should be 6 to 8 inches in diameter, with all of the growing tips oriented in the same direction. Stagger the cuttings in the bundles so that tops are evenly distributed throughout the length of the uniformly sized live fascine.

Both live stakes and dead stakes are used to install fascine bundles. Stakes should be at least 2.5 feet long on cut slopes and at least 3 feet long on fill slopes. Dead stakes can be constructed from untreated 2x4 lumber with a minimum length of 2.5 feet. A diagonal cut across the 2x4 lumber will assist in creating stakes quickly.

Prepare the live fascine bundles and live stakes immediately before installation.
Begin at the base of the slope and work upwards. Dig a trench along a level contour just deep enough to contain the live fascine bundle. A typical trench size is 12 to 18 inches across and also 6 to 8 inches deep. Place the live fascine bundle into the trench.

Drive dead stakes directly through the bundle every 2 to 3 feet to securely fasten it. Extra stakes should be used at connections and overlaps. Leave the top of stakes flush with the installed bundle. Live stakes are generally installed on the downslope side of the bundle. Drive the live stakes below and against the bundle between the previously installed dead stout stakes. The live stakes should protrude 2 to 3 inches above the top of the live fascine. Place moist soil along the sides of the live fascine. The top of the fascine should be slightly visible when the installation is completed as shown in Figure SMP-06-01.

Approach (Continued)

Place straw or similar mulching material between rows. Slopes steeper than 3:1 may need erosion control matting or some type of mesh to prevent erosion. Recommended maximum slope lengths for live fascine bundles are:

Slope (H:V)	Maximum slope length
1 : 1 to 1.5 : 1	15 feet
1.5 : 1 to 2 : 1	20 feet
2 : 1 to 2.5 : 1	30 feet
2.5 : 1 to 3 : 1	40 feet
3 : 1 and flatter	50 feet

A willow mattress (also called a brush mattress) is similar to a fascine roll. Willow branches and cuttings are formed into a layered arrangement approximately 4 to 6 inches thick and then tied with twine or string. Excavate an anchor trench along the bottom of the willow mattress to a depth of 3 inches, to prevent downhill sliding. Loosen the subgrade soil throughout the mattress installation location; add lime and slow-release fertilizer as needed. A willow mattress is anchored onto a slope by using dead stout stakes and twine. Place 4 to 6 inches of fertile soil upon the willow mattress and tamp firmly.

- Branchpacking

Branchpacking consists of alternating layers of live branch cuttings and compacted backfill to create bank stabilization vegetation. It is often used to repair small localized slumps, gully washouts, or other small areas where the slope needs to be stabilized. Branchpacking can also be adapted as a method for planting an entire slope (see description below for brushlayering).

Live branch cuttings may range from 1/2 inch to 2 inches in diameter. Cuttings should be long enough to touch the undisturbed soil at the back of the trench. Wooden stakes (typically made from 2x4 lumber, untreated) are 5 feet or longer, depending on the depth of the hole and field conditions. Starting at the lowest point, drive the wooden stakes vertically 3 to 4 feet into the ground, at a typical spacing of 1 to 2 feet apart.

Place a 6-inch layer of live branch cuttings in the bottom of the hole or trench, between the vertical stakes and perpendicular to the slope face (as shown in Figure SMP-06-02). Cuttings should be placed in a crisscross configuration with the growing tips generally oriented toward the slope face. Most branch basal ends should touch the back of the hole or slope. Each layer of branches is followed by a layer of compacted soil, typically 6 to 8 inches thick, to ensure soil contact with the branch cuttings. Final grade should match the existing slope, and branches should protrude slightly from the filled face. The soil should be moist so that the live branch cuttings do not dry out.

Branchpacking may not be effective in slumped areas or gullies which are greater than 5 feet wide. Examine the slope closely to determine the cause of slumped areas and gullies. Wet soils, inadequate drainage, excessive stormwater runoff or other site conditions may require additional solutions.

Approach (Continued)

Brushlayering is a variation of branchpacking suitable for gentle slopes with only a moderate potential for erosion. The live branch cuttings are oriented perpendicular (up and down) to the slope level contours, installed in a trench or cut slope, and then covered with soil as before. The difference is that the soil for each downhill trench comes from the next excavated trench immediately uphill. The presence of branch cuttings in the soil will limit the amount of compaction that can be obtained on a slope, so that additional erosion control measures may be necessary. Straw mulch, temporary seeding, jute mesh and erosion control mats may be necessary, particularly for slopes steeper than 3:1. Avoid slopes steeper than 2:1 and generally limit slope lengths to 20 feet or less.

- Vegetative Crib Walls

A crib wall is a hollow, box-like, interlocking arrangement of structural members to create a retaining wall. A retaining wall is an engineered structure, with calculated loads and stresses used for the material selection and design. Crib walls made from prefabricated metal or reinforced concrete beams can be designed as very tall retaining walls that can handle large surcharge loads and traffic impacts; these types of crib walls must be designed by a professional engineer. Crib walls are filled with compacted soil or gravel, with provisions for subsurface drainage.

Adding vegetation may or may not affect structural stability of a retaining wall in the future. It would certainly affect large structural crib walls, but should not impact small crib walls such as the type shown in Figure SMP-06-03 for a relatively short height using untreated logs or timber. The structure is filled with suitable backfill material and layers of live branch cuttings which will root inside the crib structure and extend upward into the slope or outward into the wall face. This technique is appropriate at the base of a slope where a low wall may be required to stabilize the toe.

Live branch cuttings should be long enough to reach the back of the wooden crib structure. Logs or timbers are usually 6 inches in diameter or thickness. Large nails or rebar are required to secure the logs or timbers together. Place foundation of wall 2 to 3 feet below grade, as shown on Figure SMP-06-03.

Place the first course of logs or timbers at the front and back of the excavated foundation, approximately 4 to 5 feet apart. Place the second course of logs or timbers at right angles (perpendicular to the slope) on top of the previous course to overhang the front and back of the previous course by 3 to 6 inches. Repeat course in same manner and nail to the preceding course with nails or reinforcement bars. When the crib wall structure reaches the existing ground elevation, place live branch cuttings on the backfill perpendicular to the slope. Then cover the branch cuttings using fertile soil as backfill and compact firmly.

Installation Procedures

- Groove or stair step cut grading is recommended for slopes steeper than 3:1 (H:V)
- To control erosion vegetation and simple retaining structures should be considered
- Retaining structure must meet two minimums: pressure beneath the base must not exceed the allowable soil pressure; structure should possess adequate strength under loaded conditions.
- Cribwall structures consisting of vegetative matters are called “live” cribwall.
- Cribwall structures should start 2-3 feet below ground elevation at the lowest point of the slope to stabilize the structure.
- The first course of reinforcement should start 4-5 feet apart and parallel to the slope

Installation Procedures (cont'd)

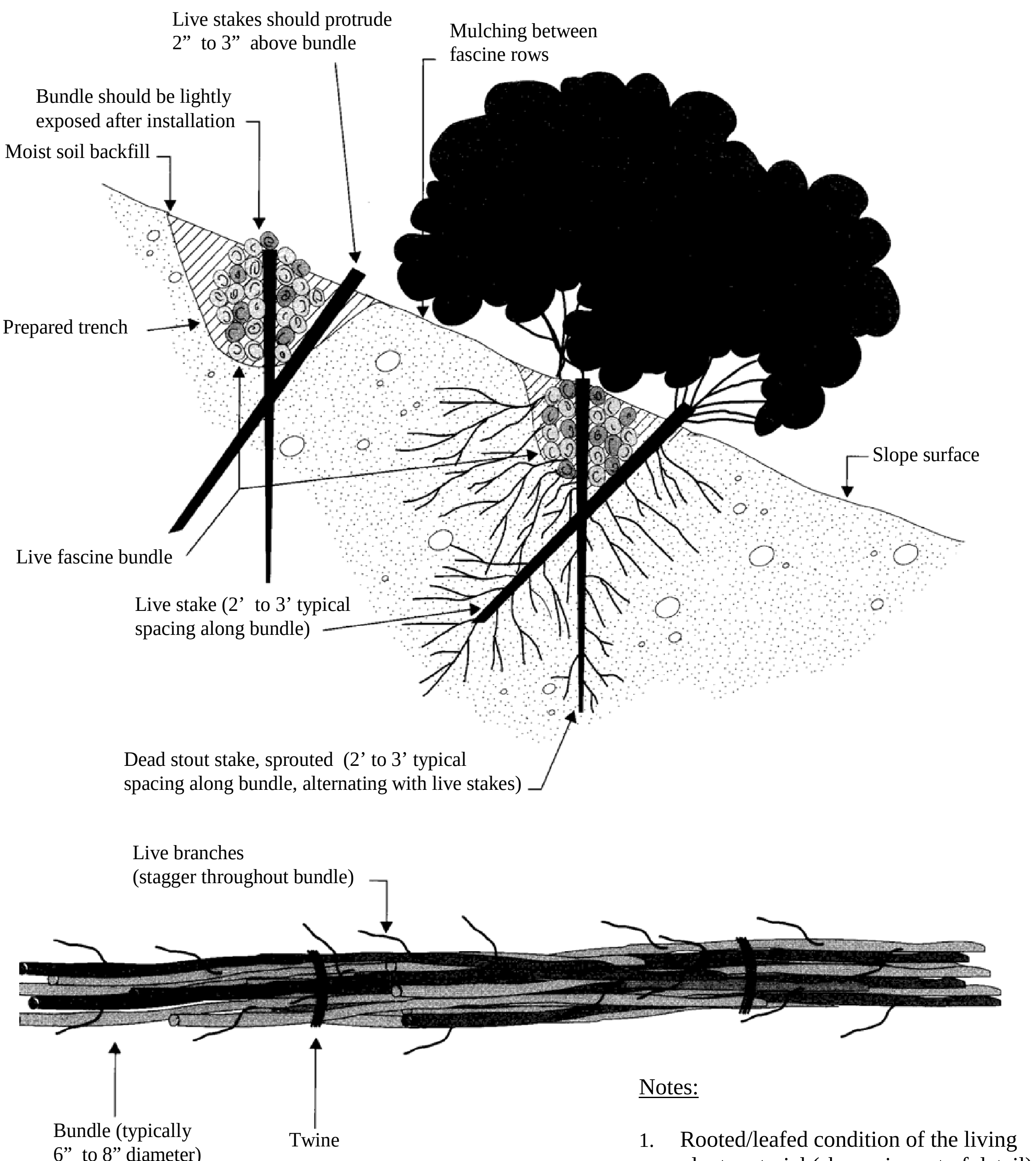
- Other courses of reinforcement will follow the same pattern as the first and second course while being fastened with nails, bars, or bands to the previous course.
- Rock Gabions follows the same procedures for foundation stabilization as Cribwall.
- The back of the foundation should be exhumed slightly deeper than the front to add stability.
- Fabricated wire baskets should be placed at the bottom of the exhumed site prior to rock filling. Rock filling should be between and behind the basket wire.
- Continue filling area with wire baskets and rock fill until desired height is reached.
- ALL structure construction must be performed by a Licensed Professional Engineer.

Maintenance

- Inspect structure before and after rainfalls.
- Make repairs when necessary.

Inspection Checklist

- [ ] Licensed Professional Engineer's stamp is clearly placed on plans in order to construct the appropriate retention structure.
- [ ] Changes to site conditions have been transmitted for review by the Project Engineer.



NOT TO SCALE

Notes:

1. Rooted/leafed condition of the living plant material (shown in part of detail) is not representative of the time of installation.
2. Use a combination of live stakes and dead stakes to anchor fascine bundles.

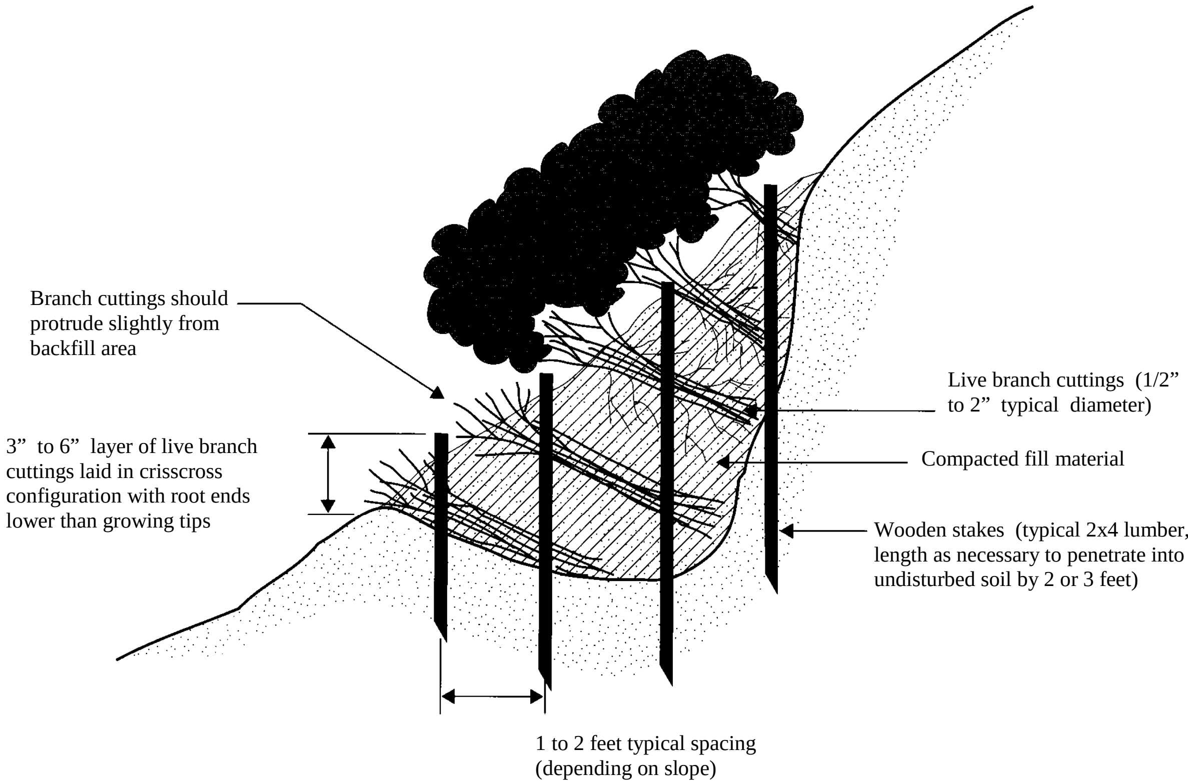
Figure SMP-06-01
Live Fascine Details

Source: Knoxville BMP Manual

Notes:

1. Rooted/leafed condition of the living plant material (shown in part of detail) is not representative of the time of installation.

2. Branchpacking locations are typically for small repairs of a slope or gully. Carefully examine site conditions to

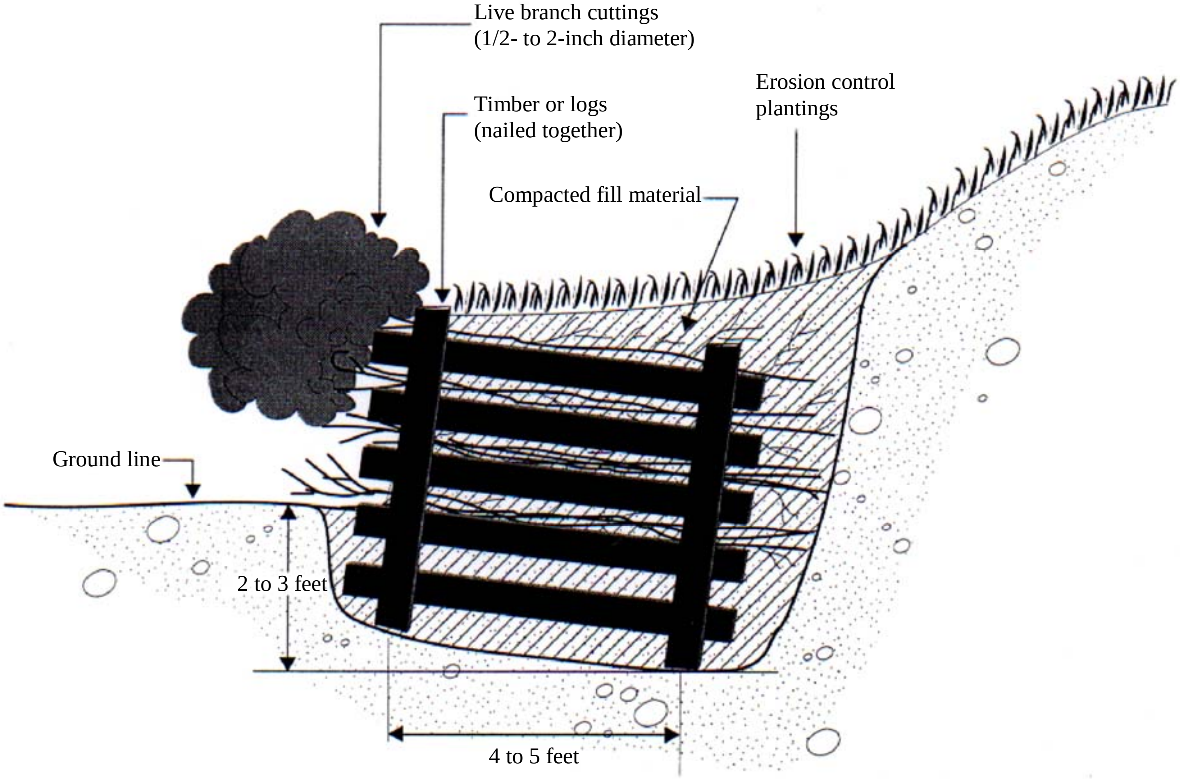


NOT TO SCALE

Figure SMP-06-02
Branchpacking Details

Source: Knoxville BMP Manual

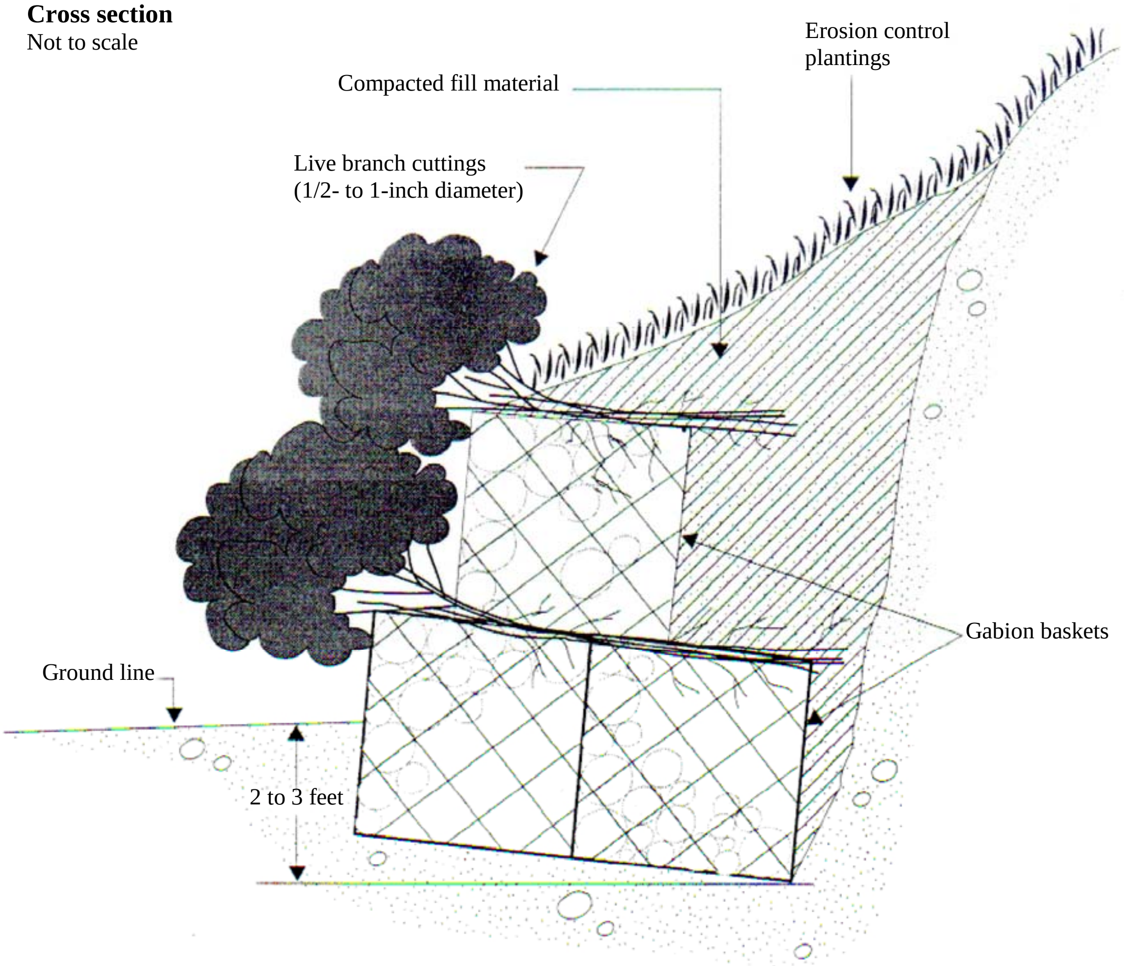
Cross section
Not to scale



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

Figure SMP-06-03
Vegetated Crib Wall

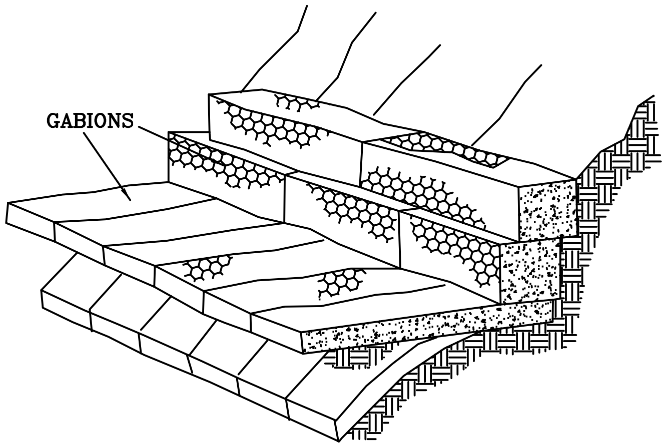
Source: Knoxville BMP Manual



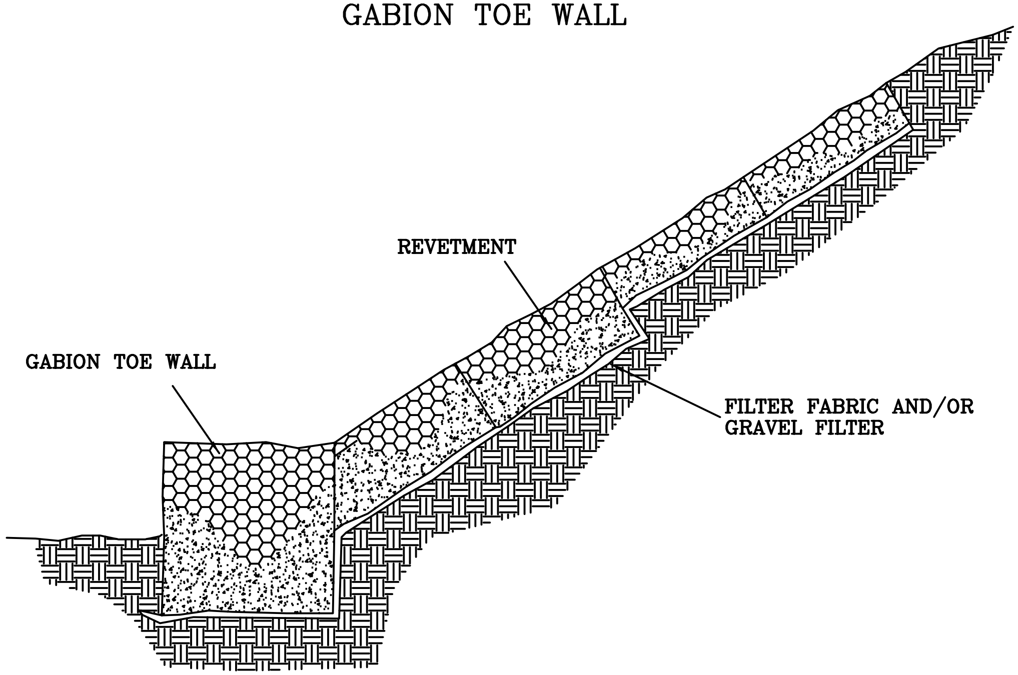
Note:
Rooted/leafed condition of the living plant material is not representative of the time of installation.

Figure SMP-06-04
Vegetated Rock Gabions

Source: Knoxville BMP Manual



GABION TOE WALL



GABION REVETMENT

SOURCE: TDEC

City of Bowling Green
Public Works Planning and Design
1011 College Street
Bowling Green, Kentucky 42101

GABIONS

STANDARD DRAWING NO. SMP-06-01

APPROVED BY: ____________________ ________
DIRECTOR OF ENGINEERING DATE

CONDITIONS:

The practice is applicable wherever slope steepness or erosion potential exceeds the management capacity of less complicated applications. Gabions are typically a permanent or semi-permanent slope and/or soil stabilization application. Typical installations include:

- Retaining walls
- Bridge abutments and wing walls
- Culvert headwalls and outlet aprons
- Shore and beach protection
- Check dams
- Bio-Engineering Sollutions

DESIGN CRITERIA:

Professionals familiar with the use of gabions should prepare construction plans and drawings. Erosion and sediment control construction plans should ensure that foundations are properly prepared to receive gab ions; that the gabion structure is securely "keyed" into the foundations and abutment surfaces; and that the rock used is durable and adequately sized to be retained in the baskets. See Figure 1 for a typical gabion installation.

CONSTRUCTION SPECIFICATIONS:

Filling: The gabion is usually filled with 4 - 8 inch pieces of stone (clean; without fines), preferably placed by hand, but sometimes dumped mechanically, into the basket. Hand packing allows the complete filling of the basket; allowing the basket to gain strength and maintain its integrity. The filled gabion then becomes a large, flexible, and permeable building block from which a broad range of structures may be built. This is done by setting and wiring individual, empty baskets together in courses and filling them in place. The manufacturer should provide installation details.

Geotextiles: It is recommended that geotextiles be used behind all gabion structures. If there is seepage from the excavated soil face, the appropriate geotextile should be selected to prevent the build-up of hydrostatic pressure behind the geotextile. Improper geotextile selection may result in failure of the structure or piping and erosion around the structure.

Corrosion Resistance of Gabions: The wire mesh or welded wire used in gabions is heavily galvanized. For highly corrosive conditions, a pvc (polyvinyl chloride) coating must be used over the galvanizing. Such treatment is an economical solution to deterioration of the wire near the ocean; in some industrial areas; and/or in polluted streams. However, extra care should be taken during construction and installation because the corrosion resistance of the baskets is compromised if the pvc coating is chipped off. Baskets manufactured completely of plastic are also available. However, estimated required wire strength should be considered in the selection of wire versus plastic.

Permeability: If properly designed and constructed, hydrostatic pressure does not develop behind a gabion wall. The wall is pervious to water and stabilizes a slope by the combined action of draining and retaining. Drainage is accomplished by gravity and by evaporation as the porous structure permits active air circulation through it. Moreover, as plant growth invades the structure, transpiration further assists in removing moisture from the backfill.

INSPECTION:

Inspect for signs of undercutting or excessive erosion at transition areas, and around or under the structure. Inspections should be made before anticipated storm events (or series of storm events such as intermittent showers over one or more days) and within 24 hours after the end of a storm event of 0.5 inches or greater, and at least once every fourteen calendar days. Where sites have been finally or temporarily stabilized, such inspection may be conducted only once per month.

Source: TDEC

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City of Bowling Green

Public Works Planning and Design
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Bowling Green, Kentucky 42101

GABIONS

STANDARD DRAWING NO. SMP-06-02

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