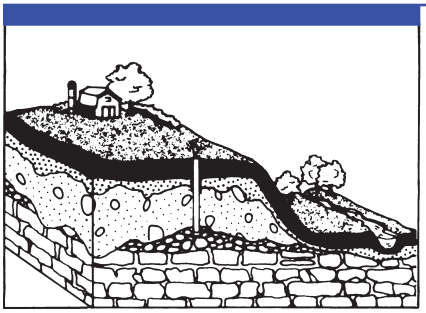

Soil Facts

Mulch Options for Erosion Control on Construction Sites

Contractors are required to use mulch on construction sites to help reduce erosion and allow newly planted seed to become established. A protective mulch application that covers at least 75 percent of the soil surface helps prevent seeds from washing away, provides a better environment for germination, and slows runoff on slopes. Mulches used for ground cover vary in cost, application procedures, and appropriate conditions of use. Three basic classes of mulch include loose mulch, erosion control blankets (ECBs), and hydraulically-applied mulches (hydromulches).

Groundcover Types

Loose Mulch

Straw is usually the least expensive mulch available, with a cost as low as $0.09 per square yard. Straw mulch with seed, lime, and fertilizer ranges from $0.31 to $1.00 per square yard. Large areas can be covered with straw using commercial blowers, which break up straw bales and blow the straw onto the soil (Figure 1). Applying straw by hand is also effective but is more expensive due to labor costs. Straw mulch is applied at a rate of about 1 to 2 tons per acre on slopes of less than 2:1 and lasts about three months, usually enough time to establish permanent, stabilizing vegetation.

Because straw is lightweight, it is easily blown away. Tackifiers or "crimping" help reduce this problem. Common tackifiers applied on the straw include:

- *Emulsified asphalt*, once a common tackifier because of its excellent adhesive properties, is toxic to both plants and animals. Prohibited in some states and all national parks,

Figure 1. Applying straw with a blower pulled by a straw supply truck.

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emulsified asphalt is currently allowed in North Carolina and is usually applied at a rate of 12 ounces per square yard.

- *Wood and paper fiber hydromulches* are natural tackifiers that are used at a rate of 125 to 750 pounds per acre. They are less toxic than asphalt and are more visually appealing when applied.
- *Guar- and starch-based tackifiers* are two natural products usually applied at 100 to 200 pounds per acre. Starch-based tackifiers, unlike guar, contain 7 to 8 percent natural nitrogen and have a high moisture retention capability, both of which help establish permanent vegetation.

Although the use of tackifiers in conjunction with straw mulch is the most common practice to prevent displacement, using heavy equipment or hand tools to "crimp" or "punch" straw into the soil may be sufficient when the soil is not too sandy. Ideally, some straw is partially buried during crimping, which holds it in place and may increase infiltration rates.

Straw has a relatively high rate of failure compared to other erosion control options. Main causes of failure include insufficient coverage during application, use on slopes that are excessively steep or long, or insufficient application of tackifier. However, when properly applied on acceptable slopes, straw can be an inexpensive and effective mulch for erosion control. The growth of vegetation in strawed areas is similar to that of other mulch types. These pros and cons are summarized in Table 1 below.

Other loose materials used for ground covers include compost and wood chips. **Compost** is made from a wide variety of organic materials, including animal manure, crop residue, municipal waste, biosolids, and yard waste. As a result, it can be highly variable in its properties. For example, the carbon to nitrogen ratio (C:N) of manure ranges from 3 to 56, while the C:N ratio of some crop residues may be more than 1,000. Materials with high C:N ratios can stunt or kill seedlings through microbially-mediated depletion of nitrogen and other nutrients from the root zone.

Compost is generally applied as a 1- to 2-inch layer on top of prepared soil with seed, fertilizer, and lime previously applied. On steep slopes (2:1 or steeper), up to 4 inches of compost may be applied. Some professional compost applicators include seed in the compost, which is recommended if more than 2 inches of compost is applied. Studies have shown that compost can be an appropriate ground cover for establishing grass on low to moderate slopes, but compost is often more expensive than other erosion control options.

Wood chips, or shredded woody materials, are often generated during the clearing stage of construction when trees are shredded using large tub grinders. Such materials are ideal for landscaping around established vegetation or large plants, but they should be applied only where no permanent vegetation is planned. Similarly, wood chips should not be incorporated into the soil where permanent vegetation is planned. Typical ground covers such as grass have difficulty growing through woody material because as this high-carbon material decomposes, it removes plant nutrients from the soil (through microbial processes), resulting in low soil fertility.

Table 1. Pros and cons of using straw mulch for erosion control.

Pros	Cons
Inexpensive	Not as effective in preventing soil loss as more expensive erosion control options
Quick and easy to apply by blower	May be displaced by wind
Good grass growth	May introduce weed seeds
No water needed for application	Fines from blower drift long distances in wind

Erosion Control Blankets

Erosion control blankets (ECBs) vary widely in composition, price, and circumstances of appropriate use. In general, ECBs are more expensive to purchase and more time- and labor-intensive to install compared to straw mulch, but are comparable to hydromulching.

When selecting an appropriate ECB, important considerations are the slope ratio, duration of use, cost, and effectiveness compared to other viable options. The main types of ECBs, and guidelines for use, are summarized in Table 2.

Despite the variety of ECB selections, the general method of installation is similar. The first step is proper slope preparation, including application of lime, fertilizer, and seed. The soil surface should be uniformly graded and without rocks, large roots, or other materials that could prevent good soil-blanket contact. After slope preparation, the top edge of a roll is "trenched in" or staked into the ground 6 inches deep and buried, then rolled over itself down-slope (Figure 2).

When laying out the ECB after trenching, adjacent rolls should overlap by 3 inches on the sides and 18 inches down-slope. Rolls are secured to the ground with lawn staples at a density of 1.5 staples per square yard as defined by the Erosion Control Technology Council. Staples are generally put a foot across the top and every 3 feet along the sides on both overlapping and non-overlapping portions. Staples should also be installed down the middle of the roll in a diamond or square pattern.

When installing ECBs, good contact with the soil surface is important to reduce soil bridging and washouts under the ECB. Correct installation—making sure the blanket is flush with the soil surface—is important for long-term erosion control and the vegetative establishment.

Hydromulches

Like ECBs, there are many types of hydromulches available for erosion control. The selection of a hydromulch for a par-

Table 2. Types and circumstances for using sod and erosion control blankets, arranged from most expensive (top) to least expensive (bottom). Adapted from Erosion Control Technology Council, 2002. Longevity estimates from Erosion Control Technology Council, 2002. Ranking based on cost estimates from Daillaire (2002) and Missoula Technology Development Center (2006).

Slope Ratio	Material	Longevity	Notes
≤ 3:1	sod	> 36 months	Most expensive to purchase and install, but quickly increases property value and does not introduce weeds. Poor survival in sandy soils and steep slopes. Must select appropriate turfgrass species. Irrigation required.
≤ 1:1	synthetic turf reinforcement mat / geotextile fiber	> 36 months	Expensive but effective for high-velocity flows in channels. Good for steep slopes. Heavy.
≤ 1:1	double-net coconut blanket	≤ 36 months	Good moisture absorption but poor moisture retention. Can handle high flow.
≤ 1:1	double-net straw/coconut blanket	≤ 24 months	Good for steep areas with medium runoff. May import weed seed.
≤ 1:1	double- or triple-net excelsior	≤ 36 months	No introduction of weed seeds. Netting may entangle wildlife and last years.
≤ 2:1	double-net straw blanket	≤ 12 months	Lightweight and fast to degrade. May import weed seed.
≤ 3:1	single-net excelsior	12-24 months	No introduction of weed seeds. Netting may entangle wildlife or may be removed.
≤ 3:1	net-free excelsior	12-24 months	Does not entangle wildlife or introduce weed seeds. 100% biodegradable.
≤ 3:1	single-net straw blanket	≤ 12 months	Lightweight and fast to degrade. May import weed seed.

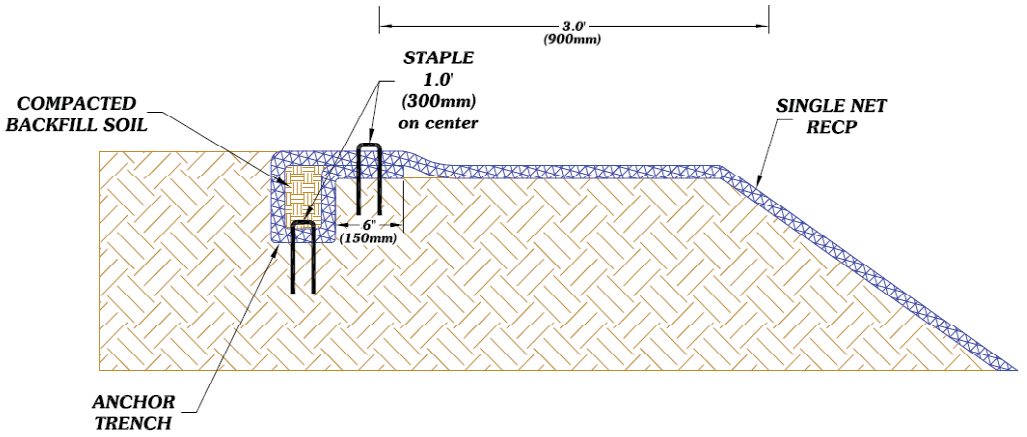

Figure 2. Trenching in an ECB to avoid undercutting near the top of a slope. Adapted from L. Honnigford, Erosion Control Technology Council, 2007.

ticular purpose depends on the slope and soil type where the mulch is being applied, the price of mulch application, and the effectiveness of a particular mulch type under a unique set of circumstances. The wide variety of hydromulches allows the applicator to select the optimum mulch for a job, although the number of choices can also make it difficult to select the best mulch.

Unlike straw and ECBs, hydromulching requires specialized equipment, including a water tank with a mixer and a high-powered pump to apply the mixture to a slope. A water source near the site where the mulch is being applied is also needed. A pond or large stream may be suitable for tank filling, or a permit can be obtained to fill the tank from fire hydrants. The amount of water needed is based on the manufacturer's recommended amount of material in the tank and the recommended application rate. A sample calculation follows, as well as a table of water needs for different combinations (Table 3).

Unlike erosion control blankets, hydromulch application does not require advance site preparation or direct access to the slope, making it suitable for large slopes (Figure 3). In addition, hydromulch does not contain netting that could entangle wildlife or degrade slowly.

Lime, seed, and fertilizer are sometimes mixed with the mulch, but avoid this mix

if possible. Lime and fertilizer can harm the seed when left in the tank for too long and are actually much more effective when incorporated into the soil prior to seeding and mulching. Seed applied with the mulch may land on the mulch surface, where it is unlikely to survive. Hydromulch is best applied after liming, fertilization, and seeding.

When applying hydromulch, follow the manufacturer's directions for rate and method of application. The rate of hydromulch depends on the slope where it is being applied. Mulch can be applied at a known rate by calibrating the spray hose, but many applicators prefer to apply the mulch by "eyeballing" it until coverage is sufficient. Regardless of the application method, the mulch should be applied from both the top and bottom of a slope to ensure uniform coverage. Several basic types of hydromulches are discussed in Table 4, along with notes concerning application and appropriate circumstances of use.

Hydromulching cost varies with the type of mulch selected, the application equipment, water availability, and area size. The least expensive products are paper based, while the most expensive are bonded fiber matrix products. Application costs can range from $0.41 to $1.15 per square yard, not including seed,

Amount of hydromulch to mix in tank: 40 pounds of mulch per 100 gallons of water
Application rate: 3,000 pounds of mulch per acre
Water needed: 3,000 pounds of mulch per acre * (100 gallons of water / 40 pounds of mulch) = 7,500 gallons per acre

Table 3. Volume of water needed for various mixing rates and application rates of hydromulch.

Mulch Mix Rate (lb per 100 gallons)	Application Rate (lb per acre)	Water Needed (gallons per acre)
40	3,000	7,500
40	4,000	10,000
50	3,000	6,000
50	4,000	8,000
60	3,000	5,000
60	4,000	6,700

Figure 3. Hydromulching a large slope. This process should be repeated from the bottom of the slope. Note the berm at the top of the slope to prevent runoff from the upper areas from running onto the slope.

Table 4. Various types of hydromulches, adapted from Erosion Control Technology Center descriptions.

Slope Ratio	Material	Rate (lbs per ac)	Description
≤ 2:1	Stabilized mulch matrix	1,500-2,500	Organic fibers with soil flocculants or cross-linked hydro-colloidal polymers or tackifiers. Used to provide erosion control and facilitate vegetative establishment on moderate slopes. Designed to be functional for a minimum of 3 months.
≤ 2:1	Bonded fiber matrix	3,000-4,000	Organic fibers and cross-linked insoluble hydro-colloidal tackifiers. Used to provide erosion control and facilitate vegetative establishment on steep slopes. Designed to be functional for a minimum of 6 months. May need 24 h cure time.
≤ 2.5:1	Fiber reinforced matrix	3,000-4,500	Organic defibrated fibers, cross-linked insoluble hydro-colloidal tackifiers, and reinforcing natural or synthetic fibers. Used to provide erosion control and facilitate vegetative establishment on very steep slopes. Designed to be functional for a minimum of 12 months.
≤ 6:1	Hydraulic mulch	1,500	Paper, wood or natural fibers that may or may not contain tackifiers. Used to facilitate vegetative establishment on mild slopes. Designed to be functional for up to 3 months.

fertilizer, or lime. As a general rule, the more expensive hydromulches, such as bonded fiber matrices, tend to offer better protection against erosion, but actual results are site-specific.

Summary

Regardless of the type of erosion control measure used, the long-term efficacy of the ground cover depends on proper slope preparation and correct installation. Considerations for proper slope preparation include filling any existing rills or gullies and applying the appropriate amounts of lime, fertilizer, and the correct seed mixture. Seeding blends and guidelines depend on the geographic location, slope, soil condition, and time planting. For North Carolina, good resources to find this information are the *North Carolina Erosion and Sediment Control Planning and Design Manual* (http://www.dlr.enr.state.nc.us/pages/publications.html#eslinks) and the North Carolina Department of Transportation Web site (http://www.ncdot.org/doh/operations/dp%5Fchief%5Feng/roadside/soil%5Fwater/special_provisions/).

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Prepared by
Deanna Babcock,
Extension Associate
and
Richard A. McLaughlin,
Associate Professor and Soil Extension Specialist
Department of Soil Science, North Carolina State University

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