Article 55

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Keeping Soil in Its Place

Perhaps the most critical stage at a construction site is when soils are exposed both during and after clearing and grading. Erosion of these exposed soils can be sharply reduced by stabilizing the soil surface with erosion controls. For many contractors, erosion control is just shorthand for hydroseeding. However, a wide range of erosion control options are available, including mulching, blankets, plastic sheeting, and sodding, among others.

In this article, the performance, costs and constraints of these often-confusing erosion control options are compared. Guidance is provided on when each method should be used or avoided. In addition, the article outlines options for effective erosion control under challenging site conditions, such as the non-growing season, steep slopes, drought, concentrated flows, stockpiles and poor soils.

Effectiveness of Erosion Controls

Four recent studies evaluated the effectiveness of 15 erosion controls (Table 1). With a few exceptions, suspended solids load reductions were on the order of 80 to 90%. This suggests that erosion controls are extremely effective, when compared to the 60 to 70% sediment removal typically reported for most sediment controls.

Benefits of Erosion Controls

Erosion controls have benefits beyond controlling erosion. First, they can improve the performance of sediment controls. Controlling erosion reduces the volume of sediment going to a sediment control device. Consequently, less treatment volume is reduced by sedimentation and "clean out" frequencies are lower. In addition, many erosion controls can lower surface runoff velocities and volumes, preventing damage of perimeter controls.

Table 1: Sediment Removal Efficiency of Surficial Erosion Controls

Erosion Prevention Techniques	Sediment Reduction (%)
Straw (1.25 tons/ ac)[1]	93.2[a]
Straw (2 tons/ ac)[2]	89.3[b]
Fiber mulches (about 1.0 tons/ac)[3]	65.0 - 97.1[b]
Fiber mulch (at least 1.0 tons/ac)[4] 3% tackifier	91.8[c]
Fiber mulch (1.25 tons/ ac)[1] fertilized, seeded	89.1[a]
Filber mulch (1.25 tons/ ac)[1] fertilized, seeded 90 gal/ac tackifier	85.9 - 99.1[a]
70% wheat straw/30% coconut fiber blanket[2]	98.7[b]
Straw blankets[3]	89.2-98.6[b]
Straw blanket[1]	92.8[a]
Curled wood fiber blanket[1]	28.8[a]
Curled wood fiber blanket[3]	93.6[b]
Curled wood fiber blanket[2]	93.5[b]
Jute mat[1]	60.6[a]
Synthetic fiber blanket[1]	71.2[a]
Nylon Monofilament blanket[2]	53.0[b]
Mixed Yard Debris (410 cy/ac)[4]	95.0[c]
Leaf Compost (410 cy/ac)[4]	85.9[c]

[a.] TSS load reduction [b.] Soil load reduction [c.] TSS event concentration reduction

[1.] 24% slope gravelly sandy loam for 13 storms over two Washington winters. (Horner *et al.*, 1990)

[2.] 9% slope silt loam soil. Subjected to 5.8", one hour simulated storm. (Harding, 1990)

[3.] 30% slope clay loam soil; subjected to 3.1", 1/2 hour simulated storm. (Wall, 1991)

[4.] 34% slope clay cap and top-soil mixed slope. Five March Oregon storms. (W+H Pacific and CH2M-Hill, 1993)

Table 2: Comparison of Erosion Control Methods

Materials Type	Cost ($/sy)	Uses	Limitations/ Disadvantages
Seeding	0.10[a]	As a permanent or temporary erosion control Established grass is the most effective erosion control.	Climate (dry or cold weather) Infertile soils (needs fertilizer, lime, etc.) Needs some other surficial cover on most slopes
Mulch	0.20-0.35[a]	As a protection for seeds Alone as a temporary erosion control	Slopes steeper than 20% for straw Slopes steeper than 40% for bark/compost Can interfere with grading operations Straw or Hay mulch needs to be secured to the soil surface
Blankets	1.00-2.00[b]	Useful on steeper slopes than mulches Protects seeds and prevents erosion	Installation is more complicated and time-consuming than for mulches
Plastic Sheeting	0.05-0.15[b]	Temporary control for very small areas	Does not allow infiltration of runoff Edges must be weighed down or runoff will flow under the sheeting Unsuitable for areas greater than 2,000 sq.ft.
Sodding	1.80[a]	Provide immediate vegetative cover Can be used in low-flow channels	Drought or poor soils can impede growth Most expensive

[a.] Costs adapted from U.S. EPA 1993. [b.] Costs based on phone survey information.

Erosion controls can actually preserve topsoil, and reduces the need for re-grading at the site because of rill and gully formation. Furthermore, erosion control reduces landscaping costs by limiting the need to import topsoil.

The comparative costs and uses of five common erosion control methods are outlined in Table 2 and are described below.

Seeding

Establishing grass cover is the perhaps the most effective erosion control method. Lee and Skogergboe (1985) found that suspended solids load decreased by 99% when biomass increases from zero to 2,464 lb/ac. Although some surficial erosion controls, such as mulch and blankets, can achieve similar removal rates, grass can provide permanent erosion control. Establishing grass cover can be challenging, however, and requirements can vary considerably from site to site. Choosing the right species and providing an adequate growing environment are critical to vegetative establishment (Table 3). Specific information varies both regionally and seasonally.

The three most common seeding methods are *broadcast seeding, hydroseeding* and *drill seeding*. In broadcast seeding, seeds are scattered on the soil surface. It is most appropriate for small areas and patching of areas where the grass is thin. In hydroseeding, seed is sprayed on the surface with a slurry of water. It is appropriate for most areas in excess of 5,000 square feet. Tackifiers, fertilizers, and fiber mulch are often added during this step. In drill seeding, a tractor-drawn implement actually injects seeds into the soil surface. Seeds are protected because they are covered by soil. This method is best suited for areas greater than two acres because it is cost prohibitive on a small scale. According to Northcutt (1993), drill seeding is about twice as expensive as broadcast seeding with mulch.

Mulching

Mulches are natural or synthetic materials spread on the soil surface to prevent erosion by intercepting and lowering the energy of falling rain. A variety of materials are available to accomplish this task, but they all operate on this same basic principle (see Table 4). The simplest way to improve the effectiveness of any mulch is to apply a thicker layer.

While compost mulch and wood chips can be useful in some circumstances, straw and fiber mulches are more commonly used, primarily because of their low cost. Both of these alternative can by very effective (Table 1). While straw mulches provide a thicker cover to protect seeds and soil, fiber mulches are easier to apply.

Straw mulch is straw spread over the soil surface to prevent erosion. It can be effective alone or in combination with seeding (see Table 1), but needs to be secured to the soil surface. When straw mulch is not properly secured or "tacked" it can slide downslope during large storms (Harding, 1990) or even be blown away. Four options to secure it are: 1) spraying a chemical tackifier, 2) using a tractor-drawn implement to "punch" the straw into the surface, 3) using a fiber mulch as a tackifier, and 4) covering the mulch with plastic netting.

Fiber mulches can be wood, paper or synthetic materials sprayed onto the soil surface. In general, wood fibers are the most effective erosion control mulches, and paper fibers should only be used for extremely short-term erosion control because they degrade quickly. Fiber mulches do not provide as

Table 3: Tips for More Effective Seeding

Choose the right species:
For temporary cover, use fast growing species such as rye.
Plant warm- or cold-season grasses behind on regional conditions.
Use drought tolerant species in dry climates.
Consider use of native species generally for increased longevity and hardiness.

Provide an adequate growing environment:
Plant dense seed cover, based on local recommendations.
Use soil test information to determine lime and fertilization requirements.
Use mulch or blanket to protect seeds from animals, dehydration, cold and erosion especially when seeds are surface applied.
Irrigate when necessary.

Practices to avoid:
Hydroseeding in arid regions; grass will be poorly established.
Seeding after the growing season ends. Instead apply a very thick mulch layer (about 4 tons/ac).

Table 4: Mulching Alternatives

Type	Description/ Uses
Straw or Hay	Straw or hay surface applied at 2 to 4 tons per acre Mechnically or chemically secured to the soil surface Provides the densest cover to protect seeds and soil
Wood Fiber	Chopped up fibers (usually wood) applied to the soil surface with a hydroseeder Tackifier is not always necessary, but can be applied with fiber, seeds and fertilizer in one step Effective erosion control, but not as dense a cover as straw mulch Best use is in combination with fast-growing seeds
Compost	Efficiency on par with wood floor Compost acts as a soil amendment Can act as a longer-term control (up to three years) Expensive compared with other mulches (about $1/ square yard)
Wood Chips	Using wood chips as a mulch Effective when applied at high levels (about 6 tons/ acre) Can actually save money if on-site materials are used Effective on up to 35% slopes

thick a cover as straw mulches and are generally more effective when used in combination with seeding. One major advantage is the ease of application: seed, water, mulch and a tackifier can all be applied on one step with a hydroseeder. Although using a tackifier is not always necessary, it can improve performance (Horner *et al.*, 1990) and only increases the cost of application by between one and two cents per square yard.

Erosion Control Blankets

Erosion control blankets are created when synthetic or organic fibers are held together with plastic netting. They are significantly more expensive than mulches, but can be used on steeper slopes than traditional mulches. Like mulch, they are most effective when combined with vegetative establishment.

While erosion control blankets can be effective, their performance varies. Some general trends are that organic materials tend to be the most effective (Harding, 1990) and that thicker materials are generally superior (Fifield, 1992), but there are exceptions to both of these rules. Information about product testing of blankets is generally lacking. One notable exception is the Texas Department of Transportation. They publish the findings of their testing program in the form of a list of acceptable and unacceptable materials for specific uses.

A recent alternative to traditional blankets is the use of spray-on blankets, which are three-dimensional matrices applied with a hydroseeder. They cost about the same amount as traditional blankets and are reported to provide similar erosion protection (Godfrey *et al.* 1994).

Plastic Sheeting

Plastic sheeting is a very simple erosion control technique, although not widely used. Plastic sheeting is only appropriate as a short-term control, and on very small areas. In order to be effective, the edges of the plastic need to be weighed down properly. Topsoil stockpiles are one example where plastic sheeting may be helpful. Since these piles are often disturbed within a few weeks, plastic sheeting, which can be frequently moved and reused, may be a good alternative.

Another synthetic erosion control technique effective in the short-term of about six months, is using *copolymers*. In this method, a synthetic material is applied in a mixture with water using a hydroseeder. The benefit of this approach is that it is effective for covering larger areas than plastic sheeting and it provides immediate cover. The best copolymers contain chemicals that increase flexibility, which prevents cracking that can cause failure. Like plastic sheeting, these semi-permeable covers also increase runoff volumes slightly.

Sodding

Sodding, another option to control erosion, is much more expensive than seeding. Sod provides immediate cover, but some evidence suggests that root establishment is shallower for seed grass than sod grass, causing higher nitrate leaching (Petrovic, 1990). The two best uses for sod are when final landscaping will include a sod lawn after construction or when immediate grass cover is needed, such as in an area of concentrated flow like a drainageway.

Choosing the Right Erosion Control

With the wide range of methods available to control erosion, choosing the right method for a specific application can be confusing. Too often, cost alone determines the erosion control method used. While cost is an important consideration, other site specific data need to be considered. Site factors related to soil quality, climate, flow velocity and construction activity can influence erosion control applicability (Table 5). Simple guidelines can dramatically improve erosion control, such as limiting planting to the growing season, and using erosion controls on slopes appropriate to their use.

In some geographic regions, effectively controlling erosion is almost always difficult. For example, the Pacific Northwest has winter conditions where vegetation cannot be established but intense rains cause a high erosion potential. Sites in this region need special "wet season" provisions such as very thick mulch cover on disturbed areas. In arid regions, establishing vegetation can be challenging for other climatic reasons. One adaptation specifically designed for these conditions is the use of "tracking." In this method, a heavy vehicle is driven perpendicular to the slope. The resulting impressions can trap limited water and organic material, increasing plant growth. Using spray-on chemicals for dust control is another important tool for erosion control in arid climates.

Closing the Window

The method of erosion control may often be less important than how quickly it is established and the extent of coverage. With most seeding operations, a window of at least two weeks exists from germination until production of a vigorous grass cover. This window may be further extended if a contractor waits a few days, weeks, or months to get started, or if the grass crop fails and needs to be restarted. During this time period, exposed soils are most vulnerable to

erosion. Although most ESC experts recognize the importance of limiting the *time* of disturbance, only 55% of the respondents to the Center's ESC write-in survey enforce time limits to vegetative establishment. Often, phrases like "as soon as practical" appear in vegetative establishment requirements. Cordova (1991) found such vague phrases to be a major stumbling block to effective ESC.

Although it is unreasonable to expect contractors to grow vegetation during a drought or outside the growing season, options are available to provide cover during this critical period. For example, a non-vegetative option such as mulch should be required outside the growing season.

Conclusion

The basic concept behind erosion control remains the same regardless of site conditions: cover the ground as quickly as possible to prevent erosion. Covering the ground with the right material quickly enough is the hard part. Establishing specific materials guidelines and time limits is necessary to provide consistent erosion control. Only by following thoughtful, region-specific guidance can soil be preserved during the critical construction period.

-DSC

Table 5: Erosion Control Options for Challenging Conditions

Condition	Suggested Options for Erosion Control
Non-Growing Season	Straw mulch (2 tons/ac) Bark/Compost mulch (4 to 6 tons/ac) Erosion control blankets Plastic sheeting
Poor Soils	Straw mulch Erosion control blankets Plastic sheeting Seeding or sodding with soil amendments, irrigation, and lime. Seeding with imported topsoil
Drought/ Arid	Straw mulch Erosion control blankets Drought tolerant seeds combined with tracking, irrigation
Steep Slopes	Erosion control blankets with seeding Compost or Bark mulch Plastic sheeting Sodding
Concentrated Flows	Erosion control blankets/ mats Sod checkdams to line channel
Frequent Disturbance	Plastic sheeting (preferred) Temporary seeding

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