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Strengthening Silt Fence

Silt fences are one of the most widely used and misused erosion and sediment control practices. Recent data suggest that they can perform well under some circumstances. In addition, their cost-effectiveness continues to make them a popular ESC technique. Unfortunately, silt fences are often used inappropriately or are improperly installed or maintained, resulting in poor performance. Simple improvements to the standard silt fence, as well as some innovative designs, can help to improve the current state of silt fences.

How, and How Well, Do They Work?

Silt fences trap sediment in construction runoff before it washes into the street, a neighboring property or, in the worst case, a nearby stream or wetland. As sediment-laden runoff flows through the silt fence, the pores in the geotextile fabric filter out sediment particles. In reality, settling is actually the most important sediment removal function of silt fences (Kouwen, 1990), since runoff is detained behind the fence, giving sediment time to settle out.

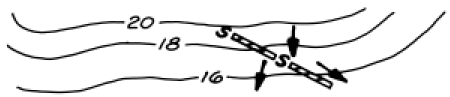
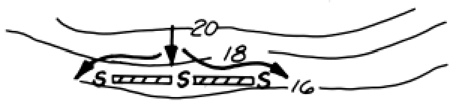
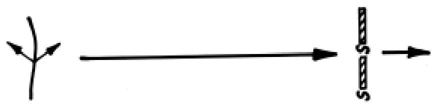
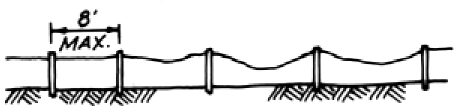
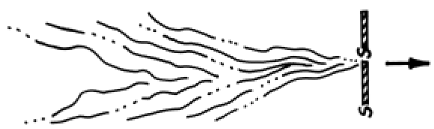
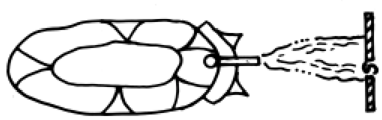
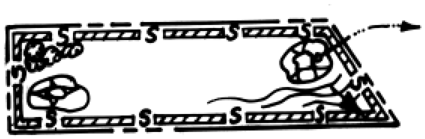
Three recent studies report sediment removal efficiencies ranging from 36 to 86% (Table 1). It is almost impossible to accurately predict the field performance of silt fences because relatively little research has been done, and the results are so variable. This being said, some useful information emerges from available data. First, these studies suggest that silt fences are more effective at removing coarser-grained materials. Conversely, silt fences are ineffective at reducing turbidity, which is disproportionately influenced by finer particles (Horner *et al*., 1990). A second finding is that silt fences are less effective on steeper slopes.

Table 1: A Summary of Recent Performance Monitoring of Silt Fences

Study	Parameter	Efficiency	Description of Study Site
W&H Pacific and CH2M-Hill (1993)	TSS Turbidity	36%[a] -4.7%[a]	Average removal efficiency for five storms in March of 1993. Plot is on the 34% slope of a landfill. Soil is clay cap mixed with topsoil. Plot of bare soil is 32' by 9'.
W&H Pacific and CH2M-Hill (1993)	TSS Turbidity	65%[a] -1.5%[a]	Same study as above, but the test site is a 42% graded embankment with thick brown clay soil.
Horner *et al.* (1990)	TSS Turbidity	86%[b] 2.9%[a]	Construction site stockpile with a 24% slope. Gravelly sandy loam soil. Thirteen storms recorded over two winters on a 36' by 9' test plot.
Wyant (1993)	TSS	75%[c]	Efficiency determined by calculating sediment in a silty soil that will not settle after 25 minutes.

a. Efficiency calculated as the average removal for all storm events
b. Efficiency in reducing total loading for all storm events
c. Theoretical maximum for silty soils based on settling rates

Table 2: Conditions that Limit the Effectiveness of Silt Fences

1		**Slope and/or Length of Slope** 5% to 10%: no more than 50 feet 10% to 20%: no more than 25 feet more than 20%: no more than 15 feet
2		Silt fence is not **aligned parallel** to slope contours
3		Edges of the silt fence are not **curved uphill,** allowing flow to bypass the fence
4		**Contributing length** to fence is greater than 100 feet
5		Fabric is not **entrenched deeply** enough to prevent undercutting
6		**Spacing between posts** is greater than eight feet
7		Fence receives **concentrated flow** without reinforcement
8		Installed **below an outlet pipe** or weir
9		Silt fence is ***upslope*** of the exposed area
10		Silt fence alignment does not consider **con-struction traffic**
11		**Sediment deposits** behind silt fence reduce capacity and increase breach potential
12		Alignment of silt fence **mirrors the property line** or limits of disturbance, but does not reflect ESC needs

Why Are They So Widely Used?

Surveys consistently report that silt fences are one of the most widely used ESC techniques (Ohrel, 1996; Johnson, 1992). Their popularity can be explained by both technical, economic and social reasons.

Silt fences can be a cost-effective ESC technique. They are inexpensive (about $3 per linear foot) and can be effective in trapping sediment when used appropriately. In addition, straw bales, their most common alternative, have been demonstrated to be almost completely ineffective. Many communities now specifically recommend that straw bales *not* be used by themselves, and some states such as North Carolina do not accept them on state projects. Consequently, silt fences are the most readily used perimeter control option in situations where other options such as diversion are not viable.

Silt fences are also popular because they have been so widely used in the past. Because developers and contractors feel they are familiar with the maintenance and installation requirements of silt fences, they can comfortably estimate the cost of using them on a project.

The visibility of silt fences is also a benefit. According to one survey respondent, they act as an "advertisement" for erosion and sediment control. In addition, this visibility sometimes makes inspection easier for both contractors and government inspectors.

What Are Their Disadvantages and Limitations?

In a recent survey of ESC experts (Brown and Caraco, 1996), almost 90% of respondents recommended silt fences with reservations. Some problems related to both installation and maintenance of silt fences are described in Table 2. In a North Carolina survey, only 58% of silt fences were installed properly and a mere 34% were maintained properly (Paterson, 1994).

Silt fences require ongoing maintenance that can cost as much as the original installation (U.S. EPA, 1993). They are often damaged by construction equipment and storm runoff. Part of the regular maintenance of silt fences includes patching or repairing broken fences. In addition, the sediment trapped behind fences can reduce the volume available to store and treat runoff.

Because silt fences are a temporary, nondurable ESC technique, installing them to prevent damage and assure treatment of runoff is challenging. High flow volumes caused by large contributing areas or high velocities resulting from concentrated flows or steep slopes can damage silt fences. This permits runoff to flow through untreated. Runoff can bypass the fence when it does not flow perpendicular to the fence. Other errors in installation, such as improperly entrenching fabric, can also cause failure.

How Can They Be Improved?

Although using silt fences effectively is challenging, some simple techniques can improve their performance (Table 3). Selecting the right materials

Table 3: Techniques and Materials to Improve Standard Silt Fences

Geotextile[1]
- Slurry flow rate lower than 0.3 cfs
- Tensile strength greater than 50 lbs/in
- Ultraviolet stability>90%
- Filtering efficiency >75%

Stakes/ Posts[2]
- Use wood stakes at least three inches in diameter or 2" X 4" and five feet tall or metal posts of 1.3 lb/ft

Installation
- Drive posts a minimum of 16" into the ground
- Embed geotextile placed in a 8"x8" trench
- Place stakes a maximum of eight feet apart, unless a wire backing is used (10 ft.)
- Maintain a ten-foot border between the silt fence and construction activity
- Install along contour lines
- Use a continuous sheet of geotextile to prevent failure at joints

Maintenance
- Check after every ½ inch storm and weekly
- Remove sediment when it reaches one half of fence height
- Patch torn fences, or replace the entire fence section when tears occur

1. MDE 1994 2. Richardson and Wyant 1987

and fence designs are only one part of improving this technique. Education and common sense also play a strong role.

Silt fence fabrics are defined by standardized parameters that indirectly determine how strong the fence is, how much flow it can withstand and what size particle it can remove. The best materials are strong fabrics with low flow-through because they offer the greatest settling time. The recommendations in Table 3 represent some minimum guidelines for what can be confusing measurements.

The other material consideration is the poles that hold the fabric in place. A simple way to improve silt fences is to use thicker, longer posts and to place them closer together. These changes decrease the chance of fence failures and sagging, but also increase costs.

One recommendation to prevent damage to silt fences from construction activity is to include a minimum of a ten- foot grass buffer between construction activity and silt fences. Although this option may not be available on all sites, it can decrease damage to silt fences where applied.

Field performance ultimately can only be improved through a combination of enforcement and education on construction sites. For example, designers and plan reviewers should carefully outline conditions where silt fences should *not* be used (Table 2) and where other structural measures should replace them.

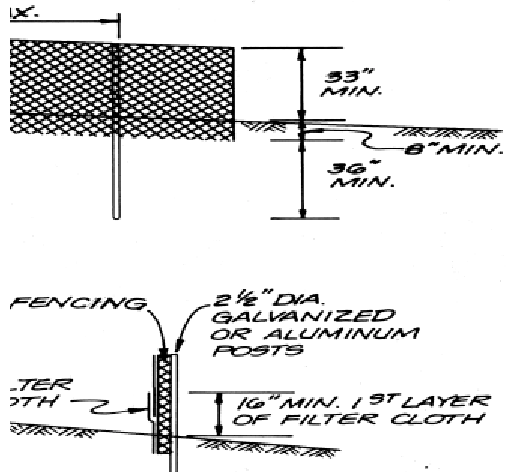
Perhaps the best way to improve silt fence performance is to practice effective erosion control. With proper erosion control, less sediment builds up behind silt fences. In addition, erosion control techniques also lower runoff volumes reducing the potential for failure.

Beyond a Standard Silt Fence

In some watersheds, it may be necessary to radically change fence design. Three innovative or alternative methods to increase silt fence efficiency are described in Table 4. They include a "super silt fence," a "bucket trap" and "silt fence anchors."

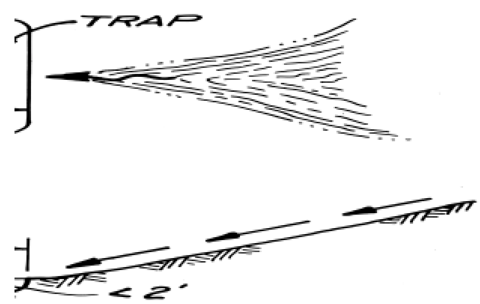
The "super silt fence" (Figure 1), developed in suburban Maryland, utilizes a chain link fence to support the geotextile material. Although super silt fences are unlikely to structurally fail, they are about three times more expensive than traditional silt fences ($9 per linear foot).

The "scoop trap" (Figure 2), also used in suburban Maryland, is a mini-sediment trap excavated with a tractor bucket placed before the silt fence at the point of concentration to provide additional ponding volume. Ordinarily, silt fences should not be applied in areas of concentrated flow. However,



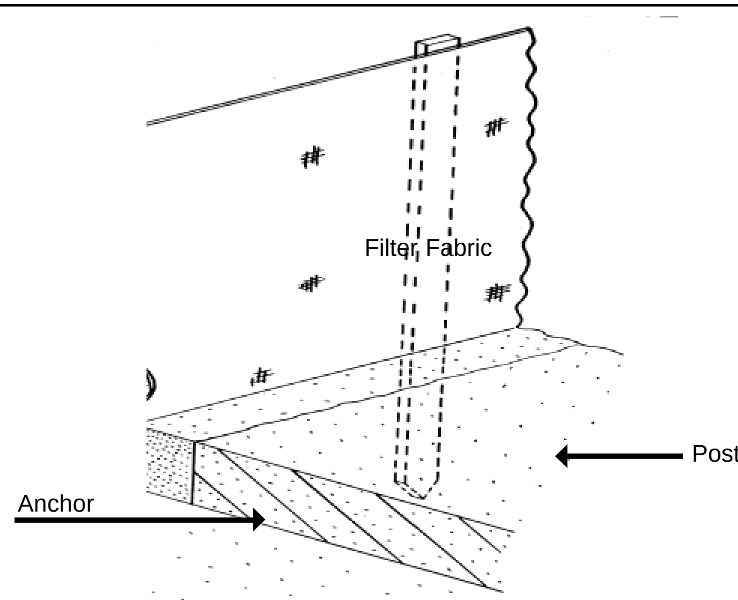
Super silt fence is a useful option in some construction sites where flow lengths or slopes are expected to be too stressful for normal silt fence.

Figure 1: Super Silt Fence



A scoop trap is a practical solution when silt fence is located at the toe of a steep slope.

Figure 2: Silt Fence with Scoop Trap



Anchors can be a remedy to prevent undercutting of silt fences, where site conditions make entrenching difficult.

Figure 3: Silt Fence Anchors

Table 4: Silt Fence Innovations	
Technique	**Description**
Super Silt Fence	Use of strong, thick geotextile backed by a chain link fence. The additional strength prevents failure.
Scoop Trap	A small sediment trap dug where flow concentrates. Provides additional detention volume.
Anchors	Plastic clips attached to the bottom of the geotextile to keep it entrenched.

at times when other preferred structural devices are not practical because of space constraints, scoop traps can be useful measures to protect the fence.

"Silt fence anchors" (Figure 3) are plastic clips that hold the fabric in the trench. The anchors are clipped to the bottom of the geotextile and then entrenched in the ground. Their purpose is to prevent fabric from being pulled out of the ground. However, these anchors have not been extensively field tested.

Conclusion

Silt fences are a deceptively simple practice. It is far too easy to draw them as a straight line on construction drawings than to construct them at the site to really stop sediment.

When silt fences are planned and installed without careful thought the results are almost always poor. Also, once installed, silt fences tend to be forgotten and are perceived as a "no maintenance" practice. In reality, most silt fences will need extensive repair to function properly. We can expect little improvement in silt fence performance as long as they are perceived as a simple, mindless practice.

—DSC

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