Stormwater Best Management Practice

Silt Fences

Minimum Measure: Construction Site Stormwater Runoff Control
Subcategory: Sediment Control

Purpose and Description

The purpose of a silt fence is to retain the soil on disturbed land (Figure 1), such as a construction site, until the activities disturbing the land are sufficiently completed to allow revegetation and permanent soil stabilization to begin. Keeping the soil on a construction site, rather than letting it be washed off into natural water bodies (e.g., streams, rivers, ponds, lakes, estuaries) prevents the degradation of aquatic habitats and siltation of harbor channels. And preventing soil from washing onto roads, which readily transport it to storm sewers, avoids having sewers clogged with sediment. The cost of installing silt fences on a watershed's construction sites is considerably less than the costs associated with losing aquatic species, dredging navigation channels, and cleaning sediment out of municipal storm sewers.

A silt fence is a temporary sediment barrier made of porous fabric. It's held up by wooden or metal posts driven into the ground, so it's inexpensive and relatively easy to remove. The fabric ponds sediment-laden stormwater, causing sediment to be retained by the settling processes. A single 100-foot run of silt fence may hold 50 tons of sediment in place. Most construction sites today do have silt fences. However, many do not work effectively because they are not well designed, installed, or maintained. The focus of this fact sheet is—how to make silt fences work.

Design

The three principal aspects of silt fence design are: proper placement of fencing, adequate amount of fencing, and appropriate materials.

Proper Placement of Fencing

Placement is important because where a fence starts, runs, and ends is critical to its effectiveness. Improper

Figure 1. A silt fence at the perimeter of a construction site.
Photo Credit: USEPA/Wikimedia

placement can make the fence a complete waste of money. Construction staff should analyze the construction site's contours to determine the proper placement.

Figure 2. Create manageable sediment storage areas.

Staff should segment the site into manageable sediment storage areas for using multiple silt fence runs. The drainage area above any fence should usually not exceed a quarter of an acre. Water flowing over the top of a fence during a normal rainfall indicates the drainage area is too large. An equation for calculating the maximum drainage area length above a silt fence, measured perpendicular to the fence, is given in Fifield (2011). Construction staff should avoid long

Figure 3. Water should not flow over the filter fabric during a normal rainfall

runs of silt fence because they concentrate the water in a small area where it will easily overflow the fence. The lowest point of the fence in Figure 4 is indicated by a red arrow. Water is directed to this low point by both long runs of fence on either side of the arrow. Most of the water overflows the fence at this low point and little sediment is trapped for such a long fence.

Figure 4. Avoid long runs of silt fence

Construction staff should use J-hooks as shown in Figures 5 and 6, which have ends turning up the slope to break up long fence runs and provide multiple storage areas that work like mini-retention areas. If the fence doesn't create a ponding condition, it will not work well. The silt fence in Figure 7 doesn't pond water or retain sediment. Stormwater will run around the fence carrying sediment to the street, which will transport the water and its sediment load to the storm sewer inlet.

Figure 5. Use J-hook fences to break up long fence runs

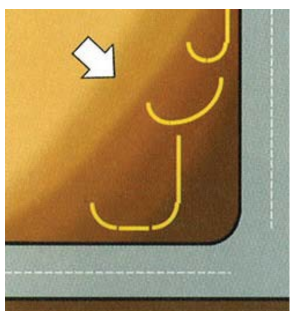

Figure 6. J-hook silt fences provide multiple storage

Figure 7. This silt fence doesn't work

Water flowing around the ends of a silt fence will cause additional erosion and defeat its purpose. Construction staff should ensure that the bottom of each end of the fence is higher than the top of the middle of the fence (Figure 8). This ensures that during an unusually heavy rain, water will flow over the top rather than around either end of the fence. Only fine suspended material will spill over the top, which is not as harmful as having erosion at the ends. When there is a long steep slope, construction staff should install one fence near the head of the slope to reduce the volume and velocity of water flowing down the slope, and another fence 6-10 feet from the toe of the slope to create a sediment storage area near the bottom. A common misconception is that only steep slopes cause a stormwater management concern. However, steep slopes may have a relatively small water collection area. The total drainage area of a gentle slope, if large (Figure 10), can be more important than its slope in determining sediment loss. A silt fence should not be placed in a channel with continuous flow (channels in Figures 8 and 9 don't have a continuous flow), nor across a narrow or steep-sided channel. However, when necessary a silt fence can be placed parallel to the channel to retain sediment before it enters the watercourse.

Figure 8. Proper installation, bottom of both ends are above the top of the middle.

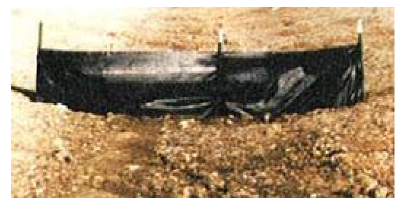

Figure 9. Poor installation, water can flow around the ends causing additional erosion

Figure 10. Gentle slopes may require a silt fence

Paved streets are major conduits of stormwater and silt, and they drain to storm sewer inlets. The best solution is to retain as much sediment as possible before it reaches paved surfaces. Construction staff should install a silt fence at the inlet side of a storm sewer or culvert, rather than at the discharge where there is greater velocity and less storage area. Streets cut in the grade, but not yet paved, are also prime erosion conduits. If the streets are not going to be paved right away, they need a containment barrier such as a silt fence. Finally, as a construction site's dynamics change, construction staff should adjust the silt fence layout to maintain its effectiveness.

Silt fences are a “last line of defense” sediment control practice (U.S. EPA, 2007), and designers and contractors should always consider diverting sediment-laden stormwater to a sediment detention pond or other primary sediment control practice in conjunction with the use of silt fences. If the site can provide a large enough area, this is usually the most effective and economical best management practice for retaining sediments.

Adequate Amount of Fencing

Silt fences are typically perimeter control practices or the last line of defense for discharge points like storm drains. As such, the amount of silt fence needed at a site depends on the site’s configuration, or more specifically, the configuration of the contributing area that is subject to erosion. Still, it is important to not overload a silt fence. A reasonable rule-of -thumb for the proper amount of silt fence is—at least 100 feet of silt fence per 10,000 square feet of disturbed area. Soil type, slope, slope length, rainfall, and site configuration are all important elements in determining the adequate silt fence protection for a site, and to what extent it fits the 100 feet per 10,000 square feet rule-of-thumb. If the amount of fencing provides the volume of storage needed, then over-flowing the silt fence runs will be minimized. This is the basic test; if fences are over-flowing after a moderate rainfall event, construction staff should probably increase the amount of fencing to avoid undercutting, washouts, and fence failures.

Appropriate Materials

There are different types of porous fabrics available (e.g., woven, non-woven, mono-filament) as well as different types of posts (e.g. wooden or metal) available to support the silt fence. Proper installation methods are more important than the fabric or post type for overall effectiveness. However, a lightweight fabric tends to tear where it is attached to the posts. Posts should hold the fabric up and support the horizontal load of retained water and sediment. Hardwood posts (2 inches by 2 inches) are potentially strong enough to support the loads but are difficult to drive into the ground more than 6-8 inches. To hold 2 feet of sediment and water, construction staff should drive the posts 2 feet into the ground. Steel posts are best because staff can drive them into compacted soil to a depth of 2 feet. Staff should space the support posts 3-4 feet apart where water may run over the top of the fence, 5 feet in most other areas, and 6-7 feet where there isn’t a considerable horizontal load. Improper post depth and spacing is often the cause of sagging fabric and falling posts. A more robust wire or chain link supported silt fence is needed to withstand heavy rain events or sediment loading. However, this may double the cost of a silt fence installation and entails disposing of more material when the fence is removed. Construction staff can usually obviate the need for a wire or chain link reinforced fence by installing silt fencing with five interacting features: (1) proper placement based on the site’s contours, (2) adequate amount of fencing without long runs, (3) heavy porous filter fabric, (4) metal posts with proper depth and spacing, and (5) tight soil compaction on both sides of the silt fence.

Figure 11. Chain link supported silt fence

Silt Fence Installation

Two approaches that construction staff commonly use for installing silt fences are the static slicing method and the trenching method.

Static Slicing Method

The static slicing machine pulls a narrow blade through the ground to create a slit 12 inches deep, and simultaneously inserts the silt fence fabric into this slit behind the blade. The blade is designed to slightly disrupt soil upward next to the slit and to minimize horizontal compaction, thereby creating an optimum condition for compacting the soil vertically on both sides of the fabric. Construction staff compact soil by rolling a tractor wheel along both sides of the slit in the ground 2 to 4 times to achieve nearly the same or greater compaction as the original undisturbed soil. This vertical compaction reduces the air spaces between soil particles, which minimizes infiltration. Without this compaction infiltration can saturate the soil, and water may find a pathway under the fence. When a silt fence is holding back several tons of accumulated water and sediment, it needs to be supported by posts that are driven 2 feet into well compacted soil. To complete installation, construction staff should drive in the posts and attach the fabric to the posts.

Figure 12. Static slicing machine

Figure 13. Tractor wheel compacting the soil

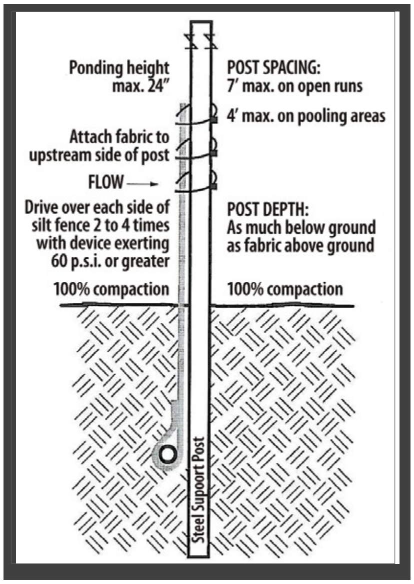

Figure 14. Silt fence installation using the static slicing method

Trenching Method

Trenching machines have been used for over twenty-five years to dig a trench for burying part of the filter fabric underground. Usually the trench is about 6 inches wide with a 6-inch excavation. Its walls are often more curved than vertical, so they don't provide as much support for the posts and fabric. Turning the trencher is necessary to maneuver around obstacles, follow terrain contours or property lines, and install upturns or J-hooks. However, trenchers can't turn without making a wider excavation, and this results in poorer soil compaction, which allows infiltration along the underground portion of the fence. This infiltration leads to water seeking pathways under the fence, which causes subsequent soil erosion and retained sediment washout under the fence. The white line on the fence in Figure 16 and red arrow both mark the previous sediment level before the washout. Post setting and fabric installation often precede compaction, which make effective compaction more difficult to achieve. EPA supported an independent technology evaluation (ASCE 2001), which compared three progressively better variations of the trenching method with the static slicing method. The static slicing method performed better than the two lower performance levels of the trenching method and was as good or better than the trenching method's highest performance level. The best trenching method typically required nearly triple the time and effort to achieve results comparable to the static slicing method.

Figure 15. Trenchers make a wider excavation at turns.

Figure 16. Poor compaction has resulted in infiltration and water flowing under this silt fence causing retained sediment washout.

Proper Attachment

Regardless of the installation method, it is critical for construction staff to properly attach the fabric to the posts to combine the strength of the fabric and support posts into a unified structure. The silt fence should be able to support 24 inches of sediment and water. For steel posts, construction staff should use three plastic ties per post (50-pound test strength), located in the top 8 inches of the fabric, with each tie hung on a post nipple, placed diagonally to attach as many vertical and horizontal threads as possible. For wooden posts, staff should use several staples per post, with a wood lath to overlay the fabric.

Silt Fence Applications

When staff place silt fences around the perimeter of a stockpile or a construction site, the conventional silt fence design and materials discussed previously may not be sufficient.

Stockpile example. A stockpile of dirt and large rocks is shown in Figures 17 and 18 with a silt fence protecting the downgradient area of its perimeter. By only protecting the downgradient area, the silt fence will allow access of the stockpile from the upgradient side without having to remove it. Rocks that roll down the pile would likely damage a conventional silt fence. The bottom of the porous fabric is held firmly against both the ground and base of precast concrete, highway, barriers by light-colored stones. An alternative installation would for construction staff to rest the concrete barriers directly on the bottom edge of the filter fabric, which would extend under the barriers about 10 inches, so the barriers' weight will press the fabric against the ground to prevent washout. Water passing through the silt fence (red arrow in Figure 18) flows to a storm sewer culvert inlet, which is surrounded by a fabric silt fence (yellow arrows in Figures 17 and 18) that reduces the stormwater's velocity and allows settling before the water is discharged to a creek.

Figure 17. Back of silt fence on part of the stockpile's perimeter.

Figure 18. Front of silt fence on part of stockpile's perimeter.

Bridge abutment example. While constructing a bridge over a river between two lakes, construction staff needed an excavation on the riverbank to pour footings for the bridge abutment. Design engineers created the silt fence along the excavation's perimeter, composed of concrete highway barriers with orange filter fabric, to prevent stormwater from washing excavated soil into the river and to fend off the river during high flows. A portion of the orange filter fabric that has blown away from the concrete barriers shows the need for construction staff to overlap and reinforce the joints where two sections of filter fabric are attached.

Figure 19. Silt fence for bridge abutment excavation.

Highway example. Because of the proximity of a construction site to a highway, a concrete barrier was required by Minnesota's DOT to protect the highway and an underground fiber optic cable next to the highway from construction activities. Construction staff used the concrete barrier to support a silt fence along the perimeter of a large amount of dirt that was stock piled before being used for fill at a different location.

Figure 20. Silt fence protecting a highway and underground fiber optics cable.

Lake shore example. Workers are restoring the lake's shoreline with plant plugs and seeding it with native plant species. Staff are using a plywood,

Figure 21. Silt fence protecting a lake shore.

perimeter, silt fence to trap sediment from a construction site on the right-side of the picture, protect the lake shore from boat-wake erosion, and prevent geese from eating the seeds and young plants. Staff will remove this fencing when 70% vegetative cover is achieved.

Inspection and Maintenance

Construction staff should inspect silt fences routinely and after precipitation events to determine whether they need maintenance because they are full (Figure 22) or damaged by construction equipment. The ASTM silt fence specification (ASTM 2003) recommends that staff remove sediment deposits from behind the fence when they reach half the height of the fence or install a second fence.

Figure 22. A silt fence full of sediment that needs maintenance.

However, there are several problems associated with cleaning out silt fences. Once the fabric is clogged with sediment, it can no longer drain slowly and function as originally designed. The result is normally a low volume sediment basin because the cleaning process doesn't unclog the fabric. The soil is normally very wet behind a silt fence, inhibiting the use of equipment needed to move it. Construction staff typically use a backhoe, but if the sediment is removed, what is to be done with it during construction? Another solution is to leave the sediment in place where it is stable and build a new silt fence above or below it to collect additional sediment as shown in Figure 23. The proper maintenance may be site specific, e.g. small construction sites might not have sufficient space for another silt fence. Construction staff should maintain adequate access to the sediment control devices so inspections and maintenance can be performed.

Figure 23. New silt fence below the old fence

Permanent Soil Stabilization

When construction staff have sufficiently completed the land disturbing activities to allow permanent soil stabilization on the site, they should remove the silt fences and sediment basins. The fabric and damaged posts go to the landfill. Steel posts and some of the wooden posts can be reused. Then, staff spread the sediment over the site to provide fertile soil, and the area can be seeded and mulched to support revegetation.

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

References

American Society of Civil Engineers (ASCE). (2001). Environmental Technology Verification Report for Installation of Silt Fence Using the Tommy Static Slicing Method, CERF Report #40565. Washington, DC: American Society of Civil Engineers.

ASTM International. (2003). Standard Practice for Silt Fence Installation, D 6462-03(2008). West Conshohocken, PA: American Society of Testing Materials International.

Fifield, Jerald S. (2011). Designing and Reviewing Effective Sediment and Erosion Control Plans, 3rd Edition. Santa Barbara, CA: Forester Press.

U.S. Environmental Protection Agency (U.S. EPA) (2007). Developing Your Stormwater Pollution Prevention Plan, EPA 833-R-06-004. Washington: EPA. Available from EPA hardcopy 800-490-9198.

Photograph Credits

Figure 1: U.S. EPA/Wikimedia

Figures 2–10, 12-16, 22, 23: Thomas Carpenter, CPESC, Carpenter Erosion Control

Figure 11: Pete Schumann, Fairfax County, Virginia, Department of Public Works and Environmental Services

Figures 17–21: Dwayne Stenlund, CPESC, Minnesota Department of Transportation

Disclaimer

This fact sheet is intended to be used for informational purposes only. These examples and references are not intended to be comprehensive and do not preclude the use of other technically sound practices. State or local requirements may apply.