Chapter 2
Findings/Conclusions

Findings/Conclusions from Field Visits

The field visits were very informative in pointing out the problems with silt fence usage. Unfortunately, during the period of this study construction activity was at a low; however, there were opportunities to observe several of sites with different drainage areas, terrains, ages of installation, and level of on-going construction activity.

Several of the problems observed can be addressed through better design guidance, such as better positioning of the fence. On several sites, there was bare soil between the fence and the location it was supposed to protect. On one site, a fence was placed across a roadside ditch, creating the potential for street flooding if the fence stands and the water in the ditch back up. On another site, short lengths of fence were erected on a hillside in locations where they would not provide additional protection, and could potentially worsen erosion by concentrating flows.

Existing guidance documents address the issue of where to position the fence for best protection and to avoid increasing off-site damage (Smolen et al., 1988). However, it appears that problems with positioning a silt fence result from a lack of knowledge in the user community about the guidance available. Better efforts on the part of regulating agencies to inform users about the guidance available should lead to more effective use of silt fences. A complete solution to the problem of poor positioning will also require a thorough review of erosion control plans submitted with applications for building permits and more aggressive inspection and enforcement once a site is in operation.

Follow-up inspection and enforcement is equally important as a complement to good designs. For example, one problem consistently observed was failure to anchor the toe in the manner recommended in almost every set of guidelines evaluated, including the EPA's menu of BMPs (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/site_30.cfm). A silt fence is frequently sold pre-attached to the posts, and a practice of taking the loose end (that is supposed to be buried in a toe trench) and simply laying it flat along the ground and covering it with a thin layer of soil was observed on a number of sites. While there were locations where this method of installation had not failed, it is obvious that a heavy rain shortly after installation could easily wash away the piled up soil and result in no anchoring of the toe. Again, guidance and standards are available, but it appears that the user community is either unaware or unwilling to use proper methods and inspection and enforcement of regulations is frequently not pursued. In this case, a lack of willingness to follow the recommended method is understandable, since it is clearly more costly to dig a trench, line the trench with the toe, and cover and tamp the backfill than it is to throw soil on a flap of fabric. For now, better education, inspection, and enforcement will improve this problem. Ultimately, however, contractors will only be willing to anchor the toe correctly if there is a mechanized or otherwise quick and cost-effective means of doing so. Supporting development of such a system and promoting its use should be a priority for regulatory agencies.

Fence failures due to damaged posts and fabric were also observed, which is largely a maintenance issue. However, use of the design aid developed as part of this project can help users to determine if their fence will be subjected to depths or volumes of water that are likely to be damaging. In general, a freeboard of 0.5 ft of fence above the predicted depth of flow or impounding is recommended, and the design aid can be used to predict the peak depth.

Many of the problems observed during the site visits, particularly failure to repair broken or overturned posts or damaged fence, are primarily solved through better inspection and enforcement. For remote areas that may not be visited too often, the design aid can be used to estimate the accumulated depth of sediment resulting from a typical storm and provide an indication as to how often the site should be checked for problems. If there is a nearby national weather service rain gage or some local weather station to provide inches of rainfall, each storm can be inputted into the design aid after it occurs and a running tabulation of the predicted sediment accumulation created.

Findings/Conclusions from Simulated Field Testing

Failure of the toe trench was observed in eight simulations. The erodibility of the soil was a major factor in this, with six of the eight failures occurring with the loam soil. The secondary factor was the slope, with the other two failures occurring with red clay at a 13.5% slope. The volume of soil in the toe trench was approximately 10 ft^3. Almost all the failures occurred when the net erosion, i.e., discharge from the toe trench in excess of the incoming sediment load, reached 25% of that toe trench volume.

Half of the simulations had net erosion and half had net deposition. Again, the soil type and slope along the toe were the controlling factors. Net deposition occurred for all soil types at the 1% slope. Net deposition is beneficial in that it helps protect against toe failure due to scour and represents sediment that is prevented from leaving the site.

Regardless of whether there was net erosion or deposition, there was always significant sediment discharge at the downstream end of the toe. This sediment needs to be prevented from flowing off-site. One way to contain this sediment is to extend the silt fence upslope at the ends of the toe. It is desirable to have an extension at both ends, unless the slope along the toe is relatively steep. Based on several design aid simulations, it appears that an extension of 10 to 20 ft will be sufficient in most cases. The actual length required is determined from the peak depth and the slopes along the toe and toward the fence.

Soil type was also a factor in net deposition. With the very erosion-resistant black clay, there was net deposition in five or six tests, with a small amount (about 0.25 ft^3) of net erosion during one steep slope test. For sandy loam and loam, there was net erosion for both the moderate and steep slopes.

In almost all the simulations, a first-flush effect of concentration peaking during the first 15 to 20 min of runoff was observed. Therefore, the most downstream damage is apt to occur immediately following the initiation of runoff. This points out again the importance of not discharging the flow along the toe trench directly into a stream or other sensitive area. If the area for an impoundment or sediment trap is limited, means of capturing, at a minimum, the first 15 to 20 min of discharge should be developed.

The accumulation of sediment in sags in the fence can be beneficial up to a point by creating flat areas where more deposition is likely. The accumulation of sediment will eventually become a problem either by causing collapse of the fence under the loading or reducing the height so the overtopping becomes likely. The design aid can help in determining when there is too much sediment and when clean-out is needed. During the field tests, an apparent equilibrium was observed with incoming and discharged sediment loads approaching each other. The design aid can be used to determine if the soil/slope combination is one that will result in equilibrium under a given rainfall, thereby making the duration of rainfall much less of an issue.

The field test site usually became saturated and depressions filled in a short time – typically less than 15 min - giving a constant rate of runoff, usually slightly less than the rate of rainfall. This indicates that the National Resources Conservation Service (NRCS) curve number method for generating runoff is valid for construction sites, as the volume of runoff converges to a constant value under an input of steady rainfall.

In summary, a number of the observations and results from the construction site visits and simulated field studies confirmed the validity of the recommendations contained in the numerous guidance documents.