DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

CECW-EG

ETL 1110-2-286

Technical Letter
No. 1110-2-286

25 July 1984

Engineering and Design
USE OF GEOTEXTILES* UNDER RIPRAP

Distribution Restriction Statement

Approved for public release; distribution is unlimited.

DAEN-ECE-G

DEPARTMENT OF THE ARMY
U. S. Army Corps of Engineers
Washington, D. C. 20314

Engineer Technical
Letter No. 1110-2-286

25 July 1984

Engineering and Design
USE OF GEOTEXTILES* UNDER RIPRAP

1. Purpose. This ETL provides information on experiences with geotextiles under riprap on the Tennessee-Tombigbee Waterway.

2. Applicability. This ETL applies to all HQUSACE/OCE elements and field operating activities having civil works responsibilities.

3. Reference. CW-02215, Plastic Filter Fabric.

4. Background. Geotextiles have been used extensively throughout the 234-mile Tennessee-Tombigbee Waterway, primarily to replace multi-layered graded filter systems under the riprap. During the past ten years, the Mobile and Nashville Districts have had considerable experience in placing geotextiles under riprap. Over 4,000,000 square yards of geotextile will have been placed by the conclusion of the Tennessee-Tombigbee Project. Problems were encountered with clogging, tearing, or puncturing of the geotextile and erosion undermining the geotextile. Proper control of both surface and groundwater and close inspection during construction proved to be essential.

5. General.

a. The majority of the riprap had a top size of 300-400 pounds with a W50 of 90-100 pounds. It was placed on slopes of 1V:2H, 2V:5H, and 1V:3H. The types of geotextiles used are listed in Table 1 (see Inclosure 1). Only limited use was made of nonwoven geotextile.

b. Over 2,500,000 square yards of geotextile was placed in the Divide Cut by the Nashville District, with woven geotextile used almost exclusively. The design called for the riprap to be placed directly on the geotextile, which resulted in some tearing or puncturing. The type of equipment and the skill of the operator directly influenced the amount of damage. Close inspection during construction and insistence upon a very low drop height of the stone reduced, but did not totally eliminate damage.

*Geotextiles as used here refers to any permeable textile used in a geotechnical application as an integral part of a man-made project. Geotextiles have been called filter cloths, filter geotextiles, civil engineering geotextiles, etc. Geomembrane, a related term, is normally used for impermeable materials.

c. A 6-inch bedding layer was used between the riprap and geotextile by the Mobile District on their portion of the waterway, for the sole purpose of protecting the textile from tearing or puncturing. Both natural sand and crushed rock were used successfully. When available on site, natural sand was cheaper than the crushed rock. In some cases rain and surface runoff washed the sand from under the riprap, resulting in the riprap being deposited directly on the geotextile. When this occurred, and if the slope material directly under the textile was loose or soft enough to allow the riprap to settle, this settling tightened the geotextile to the point of puncturing or tearing. The crushed rock bedding did not wash out and continued to protect the geotextile from puncturing or tearing by the riprap.

d. The monofilament flat yarn geotextile tended to creep more and was not as durable as the textile consisting of spun yarn in one direction and monofilament flat yarn in the other. Tears in the woven geotextiles tended to elongate and spread, whereas the characteristics of the nonwoven geotextile tended to prevent a puncture from lengthening. Some small sections of nonwoven geotextiles were tested. The lighter weights were cost competitive but not durable; the heavier geotextiles were durable but not cost competitive.

6. Clogging. Many of the slopes that received riprap consisted of fine and silty fine sands. Early contracts specified an equivalent opening size (EOS) ranging from 70-100, primarily because of these fine sands. The EOS proved to be too small as clogging occurred. In some cases, piezometers measured a head buildup of several feet behind the geotextile. After changing to an EOS of 30-70, the clogging was decreased, though not entirely eliminated.

7. Slope Preparation. Specifications generally stated the grading tolerances of slopes to receive geotextile. In addition to meeting the grading tolerances, the slopes needed to be checked for soft spots. Wet, unstable slopes made the proper placement of the textile difficult, while well prepared slopes greatly aided the proper placement of the geotextile.

8. Placement of Geotextile.

a. The geotextile was sewn and overlapped as specified in Guide Specification CW-02215. The textile was placed in runs from top of slope to toe, with the downstream edge of the upstream run overlapping the upstream edge of the downstream run. Equipment was not allowed on unprotected geotextile.

b. Guide specification CW-02215, "Plastic Filter Fabric", dated November 1977, required the geotextile to be pinned. Both the Nashville and Mobile Districts found that pinning the geotextile tended to make the textile stretch tight as the riprap was placed, making the textile much more susceptible to puncturing or tearing. Eliminating the pinning greatly reduced the damage, but the geotextile tended to creep down the slope, conforming to the prepared slope and to the riprap itself. However, temporarily pinning the geotextile to help hold it in place until the bedding layer was placed was found to be beneficial. These pins were removed as the bedding layer was placed on the geotextile. Upon inspection after placement of the bedding layer, the geotextile had folded accordion-like down the slope, conforming with the slope surface. To compensate for this "folding" the length of installed geotextile had to be 10-15 percent longer than the slope being covered. There was more creep experienced when the riprap was placed directly on the textile than when a protective bedding layer was used.

c. Placing the upper end of the geotextile in a trench at the top of slope was found to be a good practice to help control surface runoff. However, if the trench was backfilled before the bedding or riprap was placed, the geotextile was stretched tight and became more susceptible to puncturing and tearing.

d. Many geotextiles were sensitive to sunlight, which meant close coordination was required for the entire construction process in order to reduce exposure.

9. Bedding Layer.

a. A bedding layer between the riprap and geotextile protected the geotextile during placement of the riprap. Both sand and/or graded crushed rock were used successfully, but the latter provided better protection. Where a protective bedding layer was used, the rate of stone placement was higher and the damage to the textile less. The preferred placement of the bedding was from the bottom of the slope upward and laterally using light pressure dozers (such as wide-track D-5) for spreading without damaging the geotextile. Sharp turns with even light equipment caused geotextile damage.

b. Heavy equipment was not allowed on the riprap without a bedding layer being used as this would have damaged the geotextile. Rearrangement of the previously placed riprap by backhoes and gradalls also caused geotextile damage. The extra precautions and restrictions required when the protective bedding was not used generally slowed the production rate to the extent that the cost of the protective bedding was offset.

10. Equipment. Many types of equipment were used to place riprap with varying success in preventing damage to the geotextile. Placing riprap directly on the geotextile proved to be extremely sensitive to the equipment and skill of the operator. The mechanically-articulated "claw" or "orange peel" worked best in placing the riprap directly on the geotextile. Conventional backhoes did not work very well because the downward pressure of the bucket could not be controlled. Better results were obtained in placing the riprap with the equipment positioned at the top of the slope because the operator had a better view of the work area. When a protective bedding was placed over the geotextile, very good results were obtained with equipment such as skip pans and backhoes. On two jobs, satisfactory results were obtained by winching trucks, loaded with riprap, down slopes covered with a crushed stone protective layer; then final spreading of the riprap was done by a backhoe or gradall. For the large "Divide Cut Section," over 900,000 tons

of riprap were successfully placed directly on the geotextile with a specially designed and fabricated riprap placement machine.

11. Surface Water. Failure to properly handle surface water resulted in many failures. The concept of sheet runoff was used in design but this proved to be inapplicable since the runoff tended to create channels in the highly erodible soils and undermine the geotextile. The geotextile was either clogged, of too low a permeability, or not in contact with the soil, causing the water to percolate down the slope under the geotextile instead of up through the textile and then down the slope on top of the textile. Any punctures or tears in the textile allowed the trapped water to exit and carry materials with it. Slumps or depressions in the riprap resulted. and in cases of heavy or prolonged rainfall, a complete washout and failure occurred. Burying the geotextile 2-3 feet deep in a trench at the top of slope after riprap placement helped greatly to control erosion, but it was not a complete solution (Figure 1). Modifying berm slopes and stabilizing berms with small rock were also tried and met with varied success (Figures 2 & 3). Collector systems for the runoff proved to be the best and most reliable overall solution but were expensive. Various combinations of ditches, paved channels, and pipes were used successfully. Figure 4 shows a typical collector system. See Inclosure 1 for Figures 1 thru 5.

12. Groundwater. Groundwater seeping out of cut slopes also presented problems. Coupled with the highly erodible and horizontally laminated soils, the groundwater seepage eroded the slopes badly and created soft unstable areas. Extensive slope preparation was required to correct the erosion problem. Interceptor trench drains parallel to the waterway center-line were required to stabilize the slopes before the geotextile and riprap could be placed. These drains were installed as determined in the field, with as many as six lines of drains needed on a single slope. Figure 5 is a typical section of these drains.

13. Points of Contract. For more detailed information contact Ray Gustin, Mobile District, 205-690-2685 and Ben Couch, Nashville District, 615-251-5693.

FOR THE COMMANDER:

1 Incl
as

WILLIAM N. McCORMICK, JR.
Chief, Engineering Division
Directorate of Engineering and
Construction

TABLE 1

Geotextiles Used On The

Tennessee - Tombigbee Waterway

Manufacturer	Product Name	EOS	District
Advance Construction Specialties	Adva-Filt	70-100	ORN, SAM
Amoco Geotextiles Co.	Propex M-1195	70	ORN
Bradley Materials Co.	EPR 323	70-100	ORN, SAM
Bradley Materials Co.	Filter Weave Tenn-Tom	30-70	ORN, SAM
Carthage Mills	Poly-Filter X	70	ORN, SAM
Carthage Mills	Poly-Filter GB	40	SAM
Laurel Plastics	Type 1 Erosion Control Cloth	70-100	ORN, SAM
Laurel Plastics	Type 2 Erosion Control Cloth	40	SAM
Dupont	Typar	N/A	ORN
Monsanto	Bidim	N/A	ORN

Inclosure 1

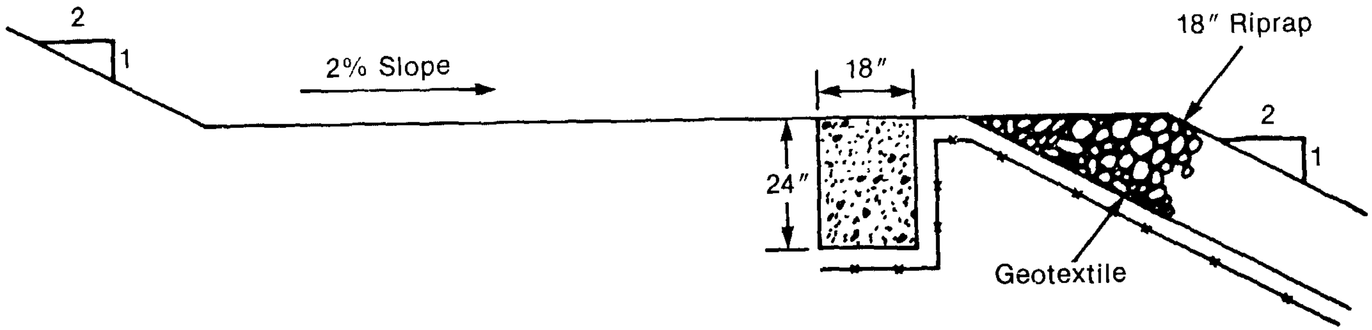

FIGURE 1. Entrenched Geotextile at Top of Slope.

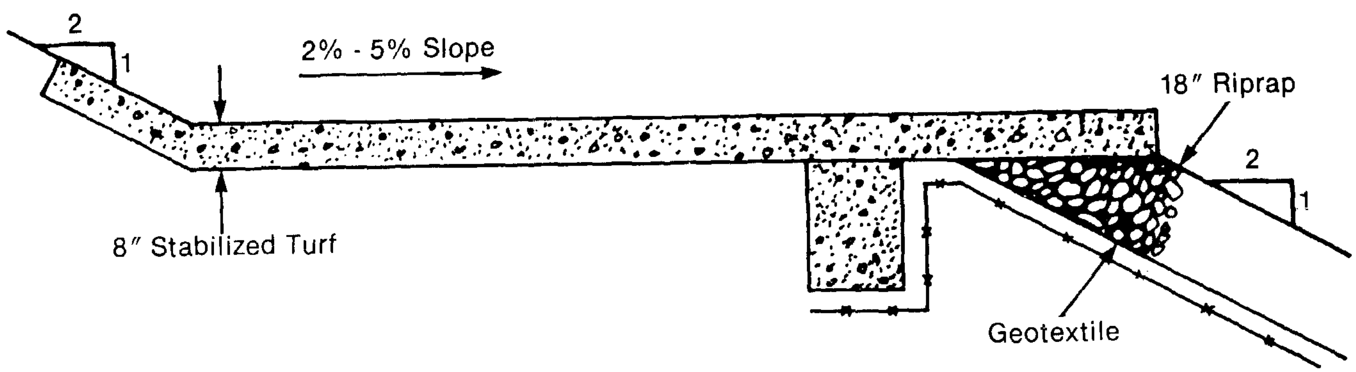

Figure 2. Stabilized Berm of Variable Slope Extending Over Riprap Combined with Entrenched Geotextile.

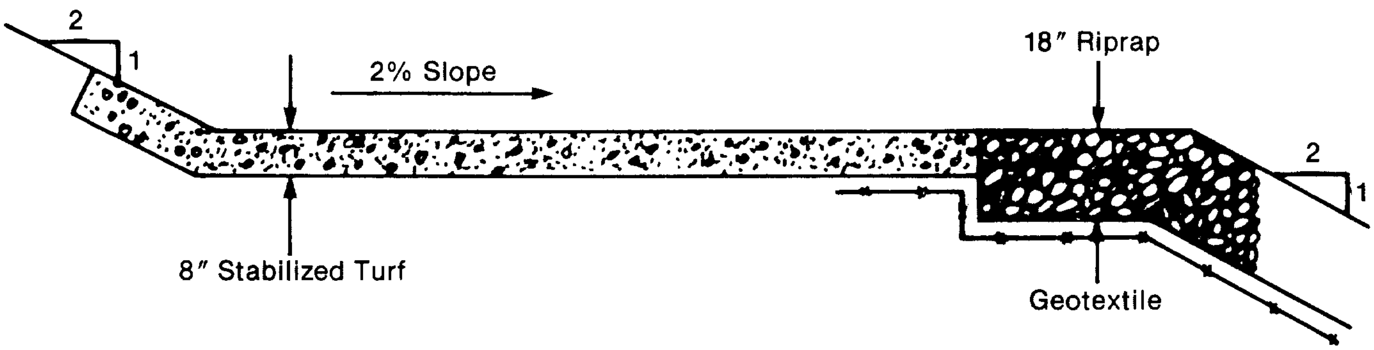

FIGURE 3. Stabilized Berm with Riprap Extended and No Entrenched Geotextile.

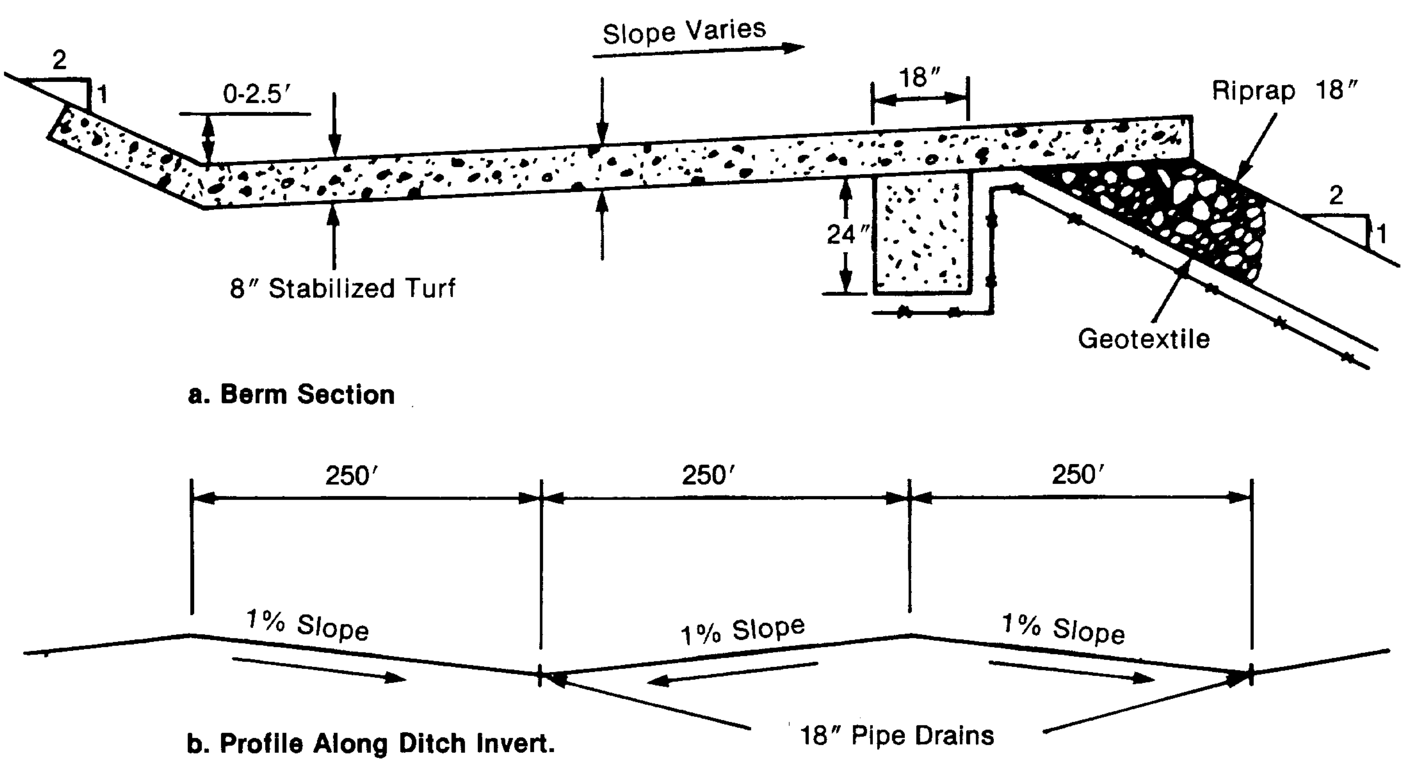

FIGURE 4. Typical Surface Water Collector System.

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

CECW-EG

ETL 1110-2-286

Technical Letter
No. 1110-2-286

25 July 1984

Engineering and Design
USE OF GEOTEXTILES* UNDER RIPRAP

Distribution Restriction Statement

Approved for public release; distribution is unlimited.

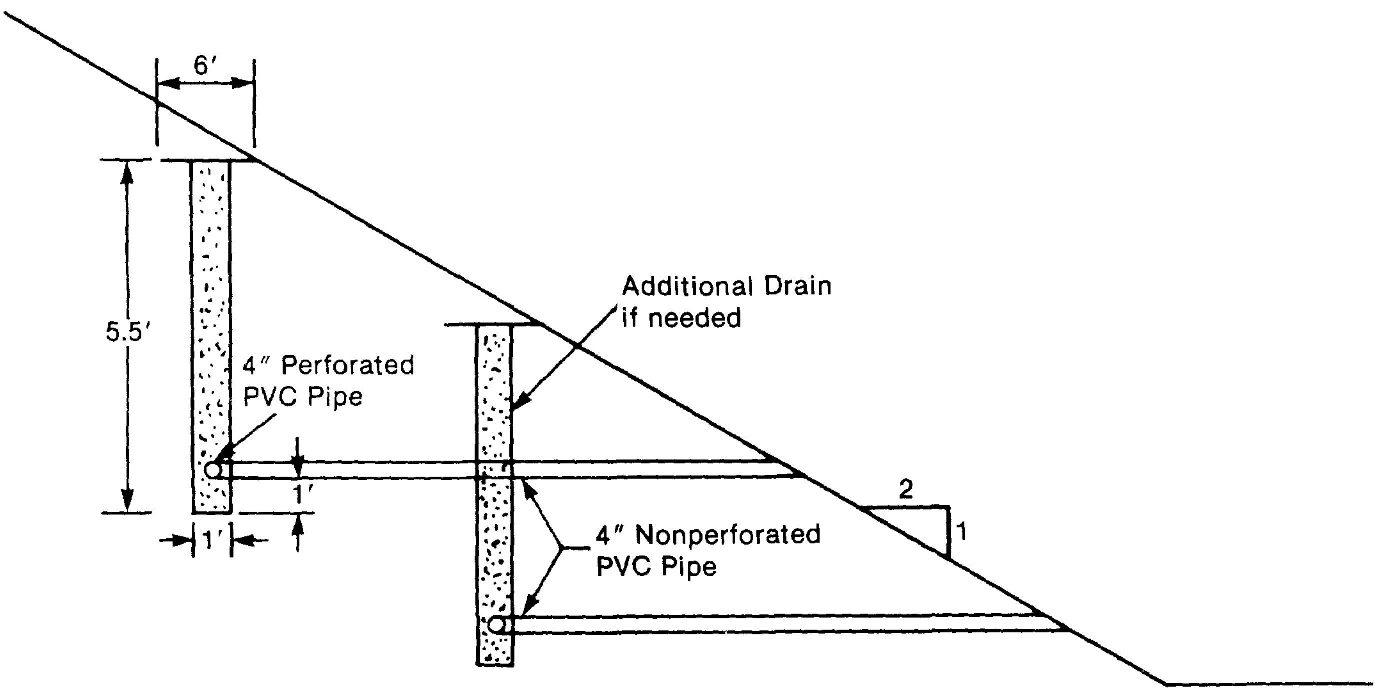

FIGURE 5. Typical Lateral Drains for Groundwater Seepage Control.