4.2.6.6 Rolled Erosion Control Products

Source: TDEC

Definition and Purpose

Rolled erosion control products (RECPs) are natural or synthetic woven, sewn, bonded, or manufactured coverings designed to prevent erosion and promote vegetation growth. RECPs include turf reinforcement mats (TRMs) and erosion control blankets (ECBs) that are fabricated into rolls for ease of installation. While both TRMs and ECBs stabilize soils, prevent erosion, and promote vegetation growth they are implemented in different settings due to their differences in material composition and intended longevity.

ECBs are temporary coverings designed to protect bare soil and support the initial establishment of vegetation. They are composed of natural or polymer fibers held together by biodegradable or photodegradable netting. ECBs shield the soil from raindrop impact and wind erosion while promoting moisture retention, reducing soil crusting, and facilitating vegetation growth until plant roots and top growth can sustain long-term soil protection.

Turf reinforcement mats are permanent, non-degradable products engineered to provide long-term erosion protection and structural support for vegetation. TRMs are composed of synthetic, UV-stabilized fibers, filaments, and netting that form a three-dimensional matrix designed to reinforce vegetation by increasing its resistance to hydraulic forces.

Appropriate Applications

RECPs are used to stabilize soil, prevent erosion, and support vegetation establishment in areas where traditional mulching or seeding alone may not be sufficient (USEPA, 2021). Their application depends on site-specific factors such as slope steepness, expected runoff velocity, shear stress, and the need for temporary versus permanent erosion protection.

ECBs are most effective on disturbed areas where vegetation is being established, particularly on slopes 3H:1V or greater and in sheet flow conditions. They are commonly applied on cut or fill slopes, where rapid vegetation growth is necessary to prevent erosion, and over bare soil areas where construction has temporarily ceased (MCPA, 2023a). They help reduce seed loss due to wind, runoff, and wildlife.

TRMs are commonly used on excessively long slopes and steep slopes and in channels where flow velocities exceed erosion resistance capabilities of vegetated liners during the design storm (TDOT). TRMs can also be applied along shorelines, at culvert outlets, and in areas prone to scour. Their ability to reinforce vegetation and withstand high shear stresses makes them suitable for areas where natural vegetation alone would be insufficient for long-term stabilization (MCPA, 2023b). Their flexible nature allows them to conform to changing channel shapes due to settlement or erosion, making them a cost-effective and ideal alternative to Hard Armoring (Section 4.2.6.4).

Limitations and Maintenance

RECPs require thorough site preparation before installation. The subsurface must be smooth and free of debris, large rocks, sticks, and trash, to ensure proper soil contact. Improper staking, shingling, or anchoring, can lead to sagging, lifting, detachment, or displacement of the RECP, thereby reducing its effectiveness (MCPA, 2023a,b). RECPs should be inspected routinely and after large storm events for erosion, washouts, and undermining. Any damage must be repaired by reinstalling or patching affected sections with the same material and reinforcing the anchoring system. In cases where erosion occurs underneath the RECP, the underlying drainage issue must be corrected before reinstalling the new material.

ECBs, being more temporary, are prone to wind displacement, and in areas with intense storms, they may require additional anchoring or tackifiers to remain in place. Additionally, bulging may occur when seedlings emerge beneath improperly staked or loosely placed ECBs, reducing mat-soil contact. Because of the relatively greater density of TRMs, they can require longer growing periods for the establishment of vegetation as compared to ECBs.

Synthetic RECPs may be a source of environmental microplastics and lead to wildlife entanglements. Use of plastic-free, netless, and natural materials, whenever possible, is recommended.

Planning and Design Considerations
There are five types of RECPs and are categorized based on their functional longevity and physical properties. Types 1 - 4 are ECBs and offer protection ranging from three months to 36 months. Type 5 products are TRMs and are designed for long-term erosion control and provide significantly higher shear stress resistance. Manufacturers may refer to RECPs as TRMs and ECBs or by their type. When used in channels, formal design of RECPs is required since analysis of channels are necessary to determine the anticipated maximum shear stresses along the face of the ditch (TDOT). Use the methodologies presented in Channel and Swale Stabilization (Section 4.2.6.1) to calculate the design velocity and shear stress within the channel and ensure the selected RECP can withstand those forces (Table 4.2.6.6-A). The Manning's n coefficient of RECPs can vary by material and depth of flow, but typically range from 0.02 and 0.04 (NCDEQ, 2013). Defer to manufacturer specifications for Manning's n values when provided.

The effectiveness of RECPs in erosion control (generally on slopes) can be evaluated using RUSLE2 (Eqn 11) as presented in Section 2.2. A key parameter in this assessment is the C-factor, which quantifies the reduction in soil loss due to the erosion control system compared to bare soil conditions (NCDEQ, 2013). The designer may need to conduct soil tests, consult external sources, or use the freely available RUSLE2 model from USDA-ARS to obtain pre-protected C-factors. Because RECPs are made from different materials (Table 4.2.6.6-A), they exhibit varying levels of cost and effectiveness. When examining erosion by itself, the P-factor in Eqn 11 is often considered to be one, indicating no treatment practices. However, through the use of EPSC measures, implementing a P-factor less than one, which reflects the effectiveness of EPSC measures in removing sediment from runoff (NCDEQ, 2013) may be necessary. Like the C-factor, extra effort may be required for accurate P-factor enumeration. Designers are encouraged to use the RULSE2 model from USDA-ARS.

Table 4.2.6.6-A: Classification and specifications for rolled erosion control products. Defer to manufacturer specifications when provided. Source: ECTC (2025).

RECP and Longevity	Type	Product	C-Factor	Material Thickness (in)	Permissible Shear Stress - Vegetated (lb/ft^2)	Permissible Shear Stress - Unvegetated (lb/ft^2)	Maximum Slope Gradient (H:V)
ECB 3 months	1a	Netting or open weave textile	≤ 0.10	≥ 0.03	1	-	5:1
	1b	Netless ECB	≤ 0.10	≥ 0.3	1	-	3:1
	1c	Single-net ECB	≤ 0.15	0.25 - 0.50	1.5	-	3:1
	1d	Double-net ECB	≤ 0.20	0.25 - 0.50	1.75	-	2:1
ECB 12 months	2a	Netting or open weave textile	≤ 0.10	≥ 0.03	1	-	5:1
	2b	Netless ECB	≤ 0.10	≥ 0.3	1	-	3:1
	2c	Single-net ECB	≤ 0.15	0.25 - 0.50	1.5	-	3:1
	2d	Double-net ECB	≤ 0.20	0.25 - 0.50	1.75	-	2:1
ECB 24 months	3a	Open weave textile	≤ 0.10	0.20 - 0.40	2	-	2:1
	3b	ECB	≤ 0.25	0.25 - 0.50	2	-	1.5:1
ECB 36 months	4a	Open weave textile	≤ 0.25	0.20 - 0.40	2.25	-	1:1
	4b	ECB	≤ 0.25	0.20 - 0.50	2.25	-	1:1
TRM Permanent	5a	TRM	-	≥ 0.25	6	2	1:1
	5b	TRM	-	≥ 0.25	8	2	1:1
	5c	TRM	-	≥ 0.25	10	2	0.5:1
	5d	TRM	-	≥ 0.25	12	2	0.5:1
	5e	TRM	-	≥ 0.25	12	2	0.5:1
	5f	High Performance TRM	-	≥ 0.25	14	2	0.5:1

Proper installation of RECPs is essential to ensure their effectiveness in soil stabilization and vegetation growth. The installation process begins with thorough site preparation, which includes grading the surface to create a smooth and loose substrate. All rocks, roots, dirt clods, and debris must be removed to ensure direct contact between the RECP and the soil. If seeding is required before installation, the soil should be prepared by loosening the top two to three inches, incorporating soil amendments like lime and fertilizer (see Section 4.2.6.11), and ensuring even distribution of the seed. In some cases, mulch or a soil-filled matrix may be required before laying the RECP. The surface must be stable and properly compacted to facilitate long-term vegetation establishment (ALSWCC, 2018).

In sloped areas, lay the RECP two to three feet beyond the top of the slope and anchored the ends in an excavated trench at least six inches deep and six inches wide. The material is then pinned at one-foot intervals, backfilled, and compacted to secure the top edge. As the RECP is unrolled down the slope, it must maintain continuous contact with the soil, air pockets or loose areas could lead to failure. Adjacent rolls should overlap by at least two inches, with a secure pinning pattern of staples or stakes placed per manufacturer specifications or every three feet if unspecified. Steeper slopes may require additional anchoring to prevent displacement. Extend the RECP two to three feet beyond the toe of the slope and entrench and anchor the ends at least four inches into the soil and staple at one-foot intervals. Installation details are provided in Figure 4.2.6.6-A.

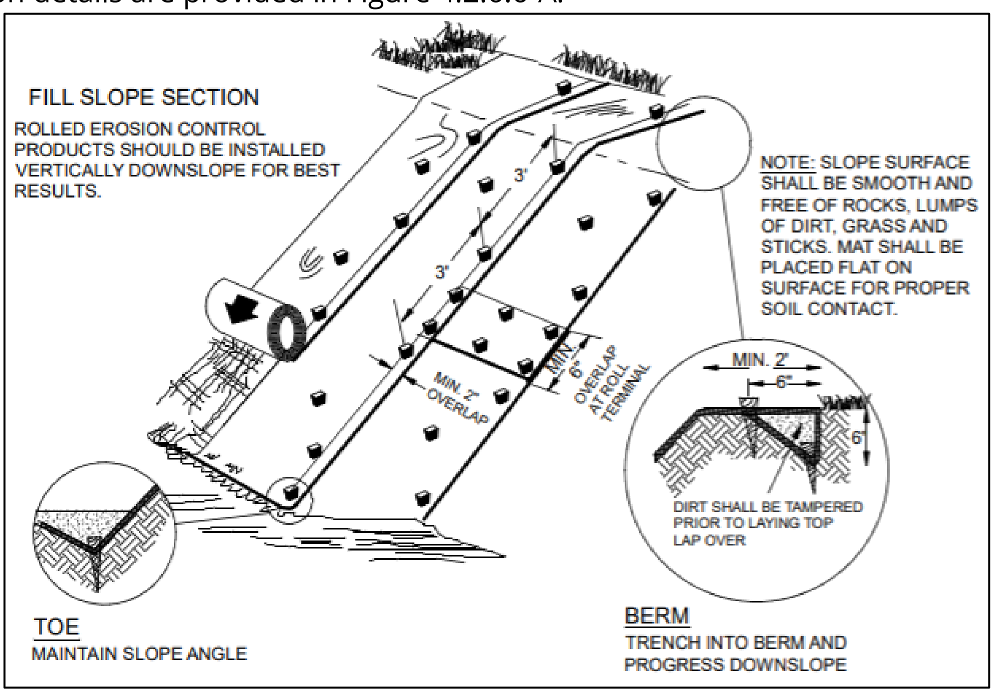

Figure 4.2.6.6-A: Installation details for rolled erosion control products along slopes. Adapted from VDEQ (2024).

In channels RECPs are installed using one of two primary methods, depending on the product specifications and site conditions. In one approach, RECPs are applied directly over a freshly seeded surface, allowing vegetation to establish through mat openings over time. Alternatively, RECPs may be installed first, followed by a topdressing of fine soil and seed to promote immediate rooting within the mat structure. Regardless of method, proper surface preparation is essential, including seeding (if required), grading, and moisture control. RECPs should be unrolled from upslope to downslope, maintaining close contact with the soil and avoiding any stretching or wrinkling. Overlaps should be a minimum of four to six inches in the flow direction and two to four inches laterally. Furthermore, lateral overlaps are to be avoided along the channel bottom; thus, the center of the RECP should align with the centerline of the channel. RECPs must be anchored at least six inches deep at the top and bottom of slopes, and intermittent check slots should be placed at roughly 25 foot intervals along the channel (Figure 4.2.6.6-B). On slopes and in high-velocity flow areas, anchor spacing should be no greater than one and a half to three feet, with longer stakes or staples used in loose or saturated soils. Mat edges and ends should be secured within dedicated anchor slots and backfilled to prevent undermining. Where seeding after installation is specified, a dry, fine-textured topsoil (such as sandy clay loam) should be lightly spread to fill mat voids without covering the entire surface. Final grading and topsoil spreading should be performed using light, rubber-tired equipment to avoid displacement. All disturbed areas must be promptly repaired, and RECPs should be inspected to ensure continuous ground contact, secure anchorage, and adequate coverage, especially at overlaps and terminal points. Defer to manufacturer of ECTC (2025) installation specifications whenever possible.

Metal stakes, wooden stakes, triangular wooden stakes, or U-shaped wire staples can be used to anchor RECPs. It is recommended to use natural materials that will degrade overtime and not need to be picked up once their use is complete. Further, the use of natural materials limits anthropogenic pollutants introduced into the environment. When using metal stakes, use 11 gauge staples that are at minimum six inches in length and one inch in width. Use stakes at least 3/16 inch in diameter with a one and a half inch diameter head. These sizes help ensure effective anchoring (KTC, 2015; NCDEQ, 2013). If maintenance issue persist, consider larger anchoring mechanisms installed more frequently.

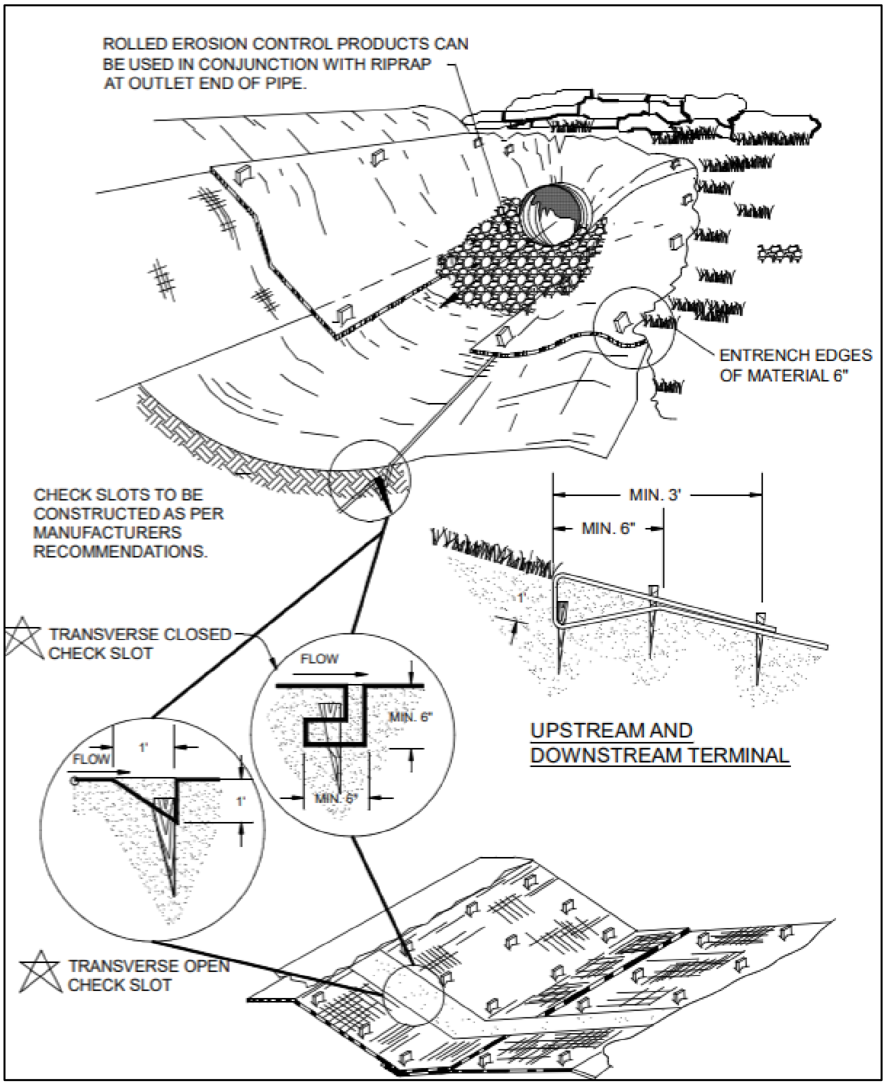

Figure 4.2.6.6-B: Installation details for rolled erosion control products in channels. Adapted from VDEQ (2024).

As mentioned earlier in the manual, there is a growing ambition for using plastic-free materials and environmentally-safe EPSC measures on construction sites (USEPA, 2022). This is particularly true for RECPs, which have the greatest potential to cause wildlife entanglement among EPSC measures, and a high potential for introducing microplastics into the environment (Whitman et al., 2025). Various DOTs (Colorado, Georgia, Minnesota, North Carolina, Vermont, and Washington State) have adopted plastic-free and wildlife-friendly (typically netless) RECPs made from materials such as wood fibers, coconut coir, cotton based products, natural fibers, and jute that have been visually observed to perform as well as or better than their synthetic counterparts in terms of erosion prevention. TRM matting composed of nylon is a good alternative to polypropylene as it is more resistant to degradation, thereby limiting microplastic (Theisen & Deem, 2025).

Example Application
For channel lining, refer to the example(s) in Section 4.2.6.1.

-Example courtesy of TDOT-

Given:

A 450-foot section of a roadway relocation project in Knox County will require a large cut in a hill adjacent to the site. The soils are silty clay loam. As currently proposed, the slope will be 85 feet high and at a 2H:1V grade. Due to the length and grade of this slope and the condition that the construction site drains to an Exceptional Tennessee Water, there is concern that it be stabilized against erosion as quickly as possible.

Determine:

An appropriate erosion control blanket for the cut slope.

Solution:

Based on the design criteria, a Type 1d, 2d, 3, or 4 would be a suitable ECB for the cut slope. However, given the sensitive nature of the receiving waterway, it is decided to take the additional step of evaluating the potential for erosion from the cut slopes using RUSLE2 (Eqn 9).

Step 1 – Determine the soil loss from the slope if it were not stabilized: Use USDA-NRCS documentation and tables or the freely available software to identify the necessary parameters in RUSLE2. The parameters for a bare soil cut slope are listed with the corresponding reference table from TDOT:

- The R-factor for Knox Co. is 180 [ft × tonf × in × $(ac \times hr \times yr)^{-1}$] (Table 10A-1);
- Silt clay loam soils yield a K-factor of 0.32 [ton × ac × hr × (hundreds of ac × ft × tonf × $in)^{-1}$] (Table 10-2);
- The slope length can be calculated by the square root of the sum of the squared slope height (85 ft) and the square slope width. The slope width is 2 × 85 = 170 ft since the slope is a 2H:1V ratio. Thus, the slope length is 190.1 ft. Interpolation of LS-factor tables yield a value of 15.48 (unitless) (Table 10A-2);
- The C-factor for bare soil is 1.0 (unitless) (table 10-3); and
- Finally, a P-factor value of 1.3 (unitless) is selected based on the worst case assumption of a compacted smooth surface scraped with bulldozer up and down slope (Table 10-4).

Given these parameters, the average annual soil loss for a bare slope is computed as:

$$A = R \times K \times LS \times C \times P$$

$$A = 180 \times 0.32 \times 15.48 \times 1 \times 1.3 = 1{,}159 \text{ tons / acre / year}$$

The total surface area of the cut slope is 450 ft × 190.1 ft = 85545 ft^2 = 1.96 acres. Thus, the annual soil loss from the cut slope with bare soil would be 2,276 tons per year.

Step 2 – Determine the effect of covering the slope with an ECB: Use USDA-NRCS documentation and tables or the freely available software to identify the necessary parameters in RUSLE2. A Type 3a ECB is initially selected, yielding a C-factor of 0.10 (Table 4.2.6.10-A). Use manufacturer specifications for product details if provided. Herein, assume the P-factor does not change due to implementation of other EPSC measures. Utilizing the same procedures as *Step 1*, the annual sediment load is 227 tons per year.

Step 3 – Use local regulations, engineering judgement, or further knowledge to assess if the ECB provides adequate protection: Herein, no details are provided regarding the pre-development state of the site. Therefore, a comparison between the sediment yield with an ECB and a pre-development sediment yield cannot be made. The annual sediment load is reduced substantially compared to the cut slope without protection; however, a sediment load of 227 tons per year is likely too great for an ETW. Other ECBs suitable for design slope yield larger C-factors, thus an ECB is not suitable for the constraints on this construction site. However, the designer may consider changing the slope of the cut if space permits which would yield a change in the LS-factor and which ECBs are suitable for use.

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