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**DESIGN DIVISION DRAINAGE MANUAL
REVISION 21-01**

TO: TDOT Design Division Drainage Manual Users

FROM: Jennifer Lloyd, Civil Engineering Director
Headquarters Roadway Design and Aerial Surveys Division

DATE: November 8, 2021

SUBJECT: Revision to Chapter 10 of the Design Division Drainage Manual

Chapter 10 of the Design Division Drainage Manual has been updated to show the allowable use of hydraulic erosion control products (HECP), as follows:

- 10.04.4.1 **VEGETATIVE**

Vegetative control measures, usually in the form of grasses, can play a key role in controlling erosion. These measures serve to prevent erosion by protecting soil from the impact of raindrops, holding soil particles together, and reducing the velocity of runoff. Vegetation can also help control sedimentation by working as a filter to strain out sediment, debris and other pollutants. Where vegetative measures are feasible, they are usually preferred to structural measures because they provide a relatively inexpensive and highly effective means of controlling erosion. In addition, the use of native grass species can help reduce the need for maintenance. Where possible, the ideal vegetative control measure would be to minimize the disturbed area to preserve the existing vegetation as much as possible.

It is important to establish vegetation as soon as possible on areas where a grading operation has been completed, or where a graded area is to be left inactive for more than 14 days. Significant vegetation growth becomes difficult after the topsoil has been removed from the surface by erosion. The remaining subsoil usually has very little available nitrogen for plants and minimal water holding capacity. In these conditions, root development is very weak and plant establishment becomes difficult. Thus, temporary seeding should be carried out as soon as possible and permanent seeding should be carried out only when stockpiled topsoil has been replaced on the site. On sloping sites, or in other situations where establishment might be difficult, erosion control blankets **or hydraulic erosion control products (HECP)** may be used to help hold seed and fertilizer in place and to encourage germination.

Vegetative measures usually consist of seeded grasses. In many situations, these grasses should be protected with mulch as specified in the TDOT Standard Specifications. In situations where erosive forces are expected to be somewhat greater, such as on slopes or in side ditches, erosion control blankets may be used to

protect the seed and promote growth. Turf reinforcement mats may be used in other situations where vegetated measures may need to be reinforced on a permanent basis. Section 10.08.1 provides guidance for the selection

of erosion control blankets and turf reinforcement mats and Section 5.04 provides guidance on selecting linings for ditches and other waterways.

- 10.08.1.17 **SOIL STABILIZATION**

10.08.1.17 **SOIL STABILIZATION**



Applied Soil Stabilization

Photo courtesy of Caltrans Guidance for Temporary Soil Stabilization (2003)

10.08.1.17.1 **DEFINITION AND PURPOSE**

Soil stabilization is utilized to assist in preventing erosion on seeded or unseeded exposed soils. They are usually categorized in terms of the method they use to prevent erosion:

- **Tackifiers** are used to help hold mulch in place over temporary or permanent seeding. They may also be applied directly to exposed soil as a means of dust control.
- **Hydraulic Erosion Control Products (HECP)** are manufactured, temporary degradable, pre-packaged fibrous materials that are mixed with water and hydraulically applied as a slurry designed to reduce soil erosion and assist in the establishment and growth of vegetation.
- **Bonded Fiber Matrix** consists of a layer of elongated fibers derived from wood, cotton, or other materials which are bound together by a water-resistant bonding agent or tackifier. This forms a crust on the surface which absorbs water and resists the force of raindrop impact. Seed and mulching materials are often incorporated into this measure as it is applied.
- **Soil Binders** are chemical agents which flocculate (bind together) soil particles to either form a hard surface or increase the effective soil particle size. They are typically used alone to provide surface protection for exposed soils. In most cases, they are not used in conjunction with seeding although they could be.

Several products shown on the Qualified Products List may be used for soil stabilization. However, the designer should be aware that there is considerable overlap between these products.

10.08.1.17.2 **APPROPRIATE APPLICATIONS**

Soil stabilization is applicable where assistance is needed to prevent the displacement of mulch by floatation or wind, or to provide erosion protection for graded areas which will be left idle for only a few days. Section 801.07 of the "Standard Specifications for Road and Bridge Construction" indicates part of the standard procedure for mulching is that "hay and straw mulch shall be held in place by emulsified asphalt or other commercially available tackifier." When type I or II erosion control blankets are specified in the plans the contractor may select a bonded fiber matrix from the Qualified Products List (QPL) to use in its place. Based on site conditions and engineering judgment the designer may specify a soil stabilization method in the plans.

Soil stabilization measures are effective only for raindrop impact or sheet flow and should not be applied where any type of concentrated flow would be expected. Thus, they should be applied on flat areas or on slopes up to 2H:1V. To date, research on a maximum allowable slope length is inconclusive; therefore, soil stabilization measures should be applied on slopes no more than 80 feet in length.

Tackifiers and Bonded Fiber Matrix may also be used at locations where other stabilization measures have not been effective in holding the straw in place. Using tackifiers to hold mulch in place is considered a standard procedure according to the current version of TDOT's standard specifications.

10.08.1.17.3 LIMITATIONS

Most soil stabilization measures require a 24-48 hour drying or curing time and should not be applied when there is a threat of rainfall. In addition, they should not be applied when temperatures are expected to be below approximately 40° F. This should be a consideration for projects which are expected to take place during winter months.

A number of soil stabilization measures function at least in part by forming a crust on the surface. Thus, they should not be applied in areas subject to vehicular or pedestrian traffic.

Soil stabilization measures are usually applied by spraying from a truck. Thus, they should not be specified for areas which are inaccessible to vehicular traffic. The designer should also consider the range of the pumping equipment used to apply the materials.

10.08.1.17.4 PLANNING AND DESIGN CRITERIA

Formal design is not required. In selecting the type of soil stabilization to be applied, the designer should carefully consider the soil types present at the site, the availability of water for mixing and applying the materials and the site-specific conditions which necessitate the use of soil stabilization.

Tackifiers are derived from plant-based or other organic materials. They usually consist of a combination of two or more colloidal compounds or starches, and some incorporate a flocculent such as polyacrylamide (PAM). As the name implies, these materials bind mulch to the soil surface. They also retain moisture in order to encourage the germination of grass seed, but may require reapplication as they typically remain effective for about three months.

Hydraulic Erosion Control Products (HECP) are manufactured, temporary degradable, pre-packaged fibrous materials that are mixed with water and hydraulically applied as a slurry designed to reduce soil erosion and assist in the establishment and growth of vegetation. The HECP will achieve maximum performance after a sufficient curing period, which will vary based on site specific conditions. The HECP forms a protective layer which controls erosion and allows for enhanced seed germination and accelerated growth.

- HECP Type 1 shall be installed per the table below. Shall be installed on dry soil a minimum of 48 hours prior to an anticipated rain event to allow adequate curing time. Curing times may be longer if applied when temperature is under 60 degrees F or less if applied in high temperatures. Do not use as Erosion Control Blanket or in areas of concentrated flow. Expected functional longevity based on manufacturer's estimate time period for Type 1 is 1 month.

Type 1 HECP (Maximum Uninterrupted Slope Length = 20 feet)

Slope Applicability	≤ 5:1	> 5:1 to ≤ 4:1
*Minimum Application Rate LB/ACRE	1500	2000
*Minimum Application Rate LB/UNIT	34.4	45.9

*per manufacturer recommendations

- HECP Type 2 shall be installed per the table below. Shall be installed on dry soil a minimum of 48 hours prior to an anticipated rain event to allow adequate curing time. Curing times may be longer if applied when temperature is under 60 degrees F or less if applied in high temperatures. Do not use as Erosion Control Blanket or in areas of concentrated flow. Expected functional longevity based on manufacturer’s estimate time period for Type 2 is 2 months.

Type 2 HECP (Maximum Uninterrupted Slope Length = 25 feet)

Slope Applicability	≤ 4:1	> 4:1 to ≤ 3:1
*Minimum Application Rate LB/ACRE	2500	3000
*Minimum Application Rate LB/UNIT	57.4	68.9

*per manufacturer recommendations

- HECP Type 3 shall be installed per the table below. Shall be installed on dry soil a minimum of 24 hours prior to an anticipated rain event to allow adequate curing time. Curing times may be longer if applied when temperature is under 60 degrees F or less if applied in high temperatures. Do not use in areas of concentrated flow. Can be used in place of Erosion Control Blanket Type I. Expected functional longevity based on manufacturer’s estimate time period for Type 3 is 3 months.

Type 3 (Maximum Uninterrupted Slope Length = 50 feet)

Slope Applicability	≤ 4:1	> 4:1 to < 3:1	> 3:1 to ≤ 2:1
*Minimum Application Rate LB/ACRE	2500	3000	3500
*Minimum Application Rate LB/UNIT	57.4	68.9	80.3

*per manufacturer recommendations

- HECP Type 4 shall be installed per the table below. Shall be installed on dry soil a minimum of 4-24 hours prior to an anticipated rain event to allow adequate curing time. Curing times may be longer if applied when temperature is under 60 degrees F or less if applied in high temperatures. Do not use in areas of concentrated flow. Can be used in place of Erosion Control Blanket Type II and III. Expected functional longevity based on manufacturer’s estimate time period for Type 4 is 6 months.

Type 4 (Maximum Uninterrupted Slope Length = 75 feet)

Slope Applicability	≤ 4:1	≤ 3:1	> 3:1 to ≤ 2:1	> 2:1 to ≤ 1:1
*Minimum Application Rate LB/ACRE	2500	3000	3500	4000
*Minimum Application Rate LB/UNIT	57.4	68.9	80.3	91.8

*per manufacturer recommendations

- HECP Type 5 shall be installed per the table below. Shall be installed on dry soil a minimum of 2 hours prior to an anticipated rain event to allow adequate curing time. Curing times may be longer if applied when temperature is under 60 degrees F or less if applied in high temperatures. Do not use in areas of concentrated flow. Can be

used in place of Erosion Control Blanket Type II and III. Expected functional longevity based on manufacturer's estimate time period for Type 5 is 12 months.

Type 5 (Maximum Uninterrupted Slope Length = 100 feet)

Slope Applicability	≤ 4:1	> 4:1 to ≤ 3:1	> 3:1 to ≤ 2:1	> 2:1 to ≤ 1:1	> 1:1
*Minimum Application Rate LB/ACRE	2500	3000	3500	4000	4500
*Minimum Application Rate LB/UNIT	57.4	68.9	80.3	91.8	103.3

*per manufacturer recommendations

HECP Types shall be provided as listed as approved by (ECTC) and the Department's Qualified Products List. HECP Types should not be applied when temperatures are expected to be below approximately 40° F. The necessary water needed to mix with HECP to meet the manufacturers recommendations shall not be paid for separately and shall be included in the cost of the HECP Types. HECP Types may be used as temporary mulch as directed and approved by Engineer.

Seed, fertilizer, and lime shall be either added to the HECP mix per the manufacturer's specifications and per current TDOT Standard Specifications or shall be installed on site prior to the application of the HECP Types. Seed, fertilizer, and lime will not be included in the cost of HECP but will be paid based on Standard Specifications for seeding applications.

The payment for items Hydraulic Erosion Control Product Type 1, 2, 3, 4, and 5 is full compensation for installing HECP as specified and includes furnishing, applying, and maintaining the HECP including testing and documentation of QA/QC and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item.

Bonded fiber matrix consists of fibers derived from wood, cotton or other materials that are bound by some form of tackifier agent. It is usually applied as a slurry of water, fibers, seed and fertilizer. Once dry, the matrix retains moisture to provide an environment that encourages seed germination and growth. Bonded fiber matrix is intended to be biodegradable, but will usually remain effective anywhere from 3 to 12 months, depending on the materials used.

Soil binders act by electrostatically binding to soil particles together to form either a hard shell or clumps. They can consist of various polymer compounds derived from either plant-based materials or organic chemicals, including PAM which is described in Section 10.08.1.18. These materials are short-lived and will degrade in a matter of a few weeks into environmentally harmless decay byproducts. Soil binders are rarely used on TDOT projects and require the approval of the Design Manager.

On slopes, the soil stabilization measures discussed in this section are usually applied in conjunction with Slope Surface Roughening as described in Section 10.08.1.

Soil Stabilization shall be paid for under the following item numbers:

- 209-09.16, Tackifier Powder, per Lb
- 209-09.17, Tackifier Liquid, per Gal
- 209-09.18, Soil Binder Powder, per Lb
- 209-09.19, Soil Binder Liquid, per Gal
- 801-01.40, Hydraulic Erosion Control Product (HECP) TYPE 1, Unit
- 801-01.41, Hydraulic Erosion Control Product (HECP) TYPE 2, Unit
- 801-01.42, Hydraulic Erosion Control Product (HECP) TYPE 3, Unit
- 801-01.43, Hydraulic Erosion Control Product (HECP) TYPE 4, Unit

- 801-01.44, Hydraulic Erosion Control Product (HECP) TYPE 5, Unit
- 801-01.13, Bonded Fiber Matrix Hydromulch (Without Seed), per Unit

Hydraulic Erosion Control Product (HECP) and Bonded Fiber Matrix are measured by the Unit, which corresponds to 1,000 ft².

Where Hydraulic Erosion Control Product (HECP) and Bonded Fiber Matrix are specified, pay items will also be needed for seeding (either temporary or permanent) without mulch, fertilizer and water. Where tackifiers or soil binders are specified, the additional pay items will include seeding (either temporary or permanent) with mulch, fertilizer and water.

The computation of a quantity for soil stabilization measures will usually involve consideration of the area to be seeded, the longevity of the measure, and the number of EPSC stages in the proposed project. Thus, the quantity would be computed as:

$$\text{Hydromulch (Units)} = \frac{\text{Total Area (ft}^2\text{)} \times \text{Number of Times Seeded} \times \text{Number of Applications}}{1000 (\text{ft}^2 / \text{Unit})}$$

10.08.1.17.5 EXAMPLE APPLICATION

Example 1:

Given: Due to right of way constraints, the topsoil stockpile for a proposed project must be located within 100 feet of a sediment impaired stream. Although the stockpile will be seeded and surrounded with Silt Fence with Backing, it is decided to provide an extra level of protection by specifying some form of soil stabilization. The stockpile area is to be located adjacent to the proposed roadway and cover an area 100 feet by 150 feet. It is also estimated that the stockpile will have to remain in place for 12 months.

Find: Determine the type of soil stabilization to be used and calculate the required quantity.

Solution:

Step1: Select the type of Soil Stabilization: The proposed stockpile site will be located adjacent to the proposed roadway, and be parallel to it. Thus, it will be possible to bring a spray truck to the site and reach the far side of the stockpile with the spray. Given the relative remoteness of the site, it is judged that the cost of the measure can be minimized by reducing the number of required applications. Because of its longer functional life, a bonded fiber matrix is selected for the site. Further, based on discussions with potential vendors, it is decided that a wood-based Bonded Fiber Matrix would be the most economical for this site.

Step2: Determine the quantity: Although the functional life of different types of Bonded Fiber Matrix can vary widely, it is judged that the functional life of the measure in the proposed setting will be about 6 months. Further, it is judged that the stockpile will not be affected by construction phasing. Thus, two applications of Bonded Fiber Matrix will be required.

Item Number 801-01.13, Bonded Fiber Matrix Hydromulch (Without Seed), per Unit

The quantity for this pay item may be computed as:

$$\frac{\text{Area of Seeding} \times \text{Number of Phases} \times \text{Number of Applications}}{1000 \text{ ft}^2 / \text{unit}} = \frac{(100 \times 150) \text{ ft}^2 \times 1 \times 2}{1000 \text{ ft}^2 / \text{unit}} = 30 \text{ units}$$

As described above, additional pay items for temporary seeding without mulch, water and fertilizer should also be computed for this site.

Example 2:

Given: A roadway cut slope has recently been completed, had topsoil placed and tracked in. This slope is up gradient of a wetland area that has experienced prior issues during construction. In effort to provide increase erosion control performance and enhance vegetation establishment the decision is made to use an HECP. The slope of the cut area is a 2:1 with a maximum length along the slope of 65

feet and a width along the roadway of 900 feet. It is also estimated that based on the time of year that the seed and HECP is being installed that it will need to remain effective for a minimum time frame of 3 months.

Find: Determine the type of HECP to be used and calculate the required quantity.

Solution:

Step1: Select the type of HECP: The proposed cut slope having the following parameters: 2:1 slope, 65 foot maximum slope length will require either a Type 4 HECP or Type 3 HECP with sediment tubes installed across the slope at the midpoint. The sediment tubes placed at the midpoint of the slope length would result in an uninterrupted slope length of 32.5 feet which would allow the use of HECP Type 3. However, based on the time of year that the HECP and seed is being placed it was estimated that the minimum effective time frame needed was 3 months. The manufacturers expected functional longevity for a Type 3 is 3 months and Type 4 extends to 6 months. Thus HECP Type 4 is selected due to the estimated time frame requirement and not needing to have additional measures (sediment tubes) needed in order to meet the allowable uninterrupted slope length.

Step2: Determine the quantity:

Item Number 801-01.43, Hydraulic Erosion Control Product (HECP) TYPE 4, UNIT

The quantity for this pay item may be computed as:

Area of Seeding & HECP x Number of Applications
1000ft² / unit

$$\frac{(65 \times 900) \text{ft}^2 \times 1}{1000 \text{ft}^2 / \text{unit}} = 58.5 \text{ units}$$

As described above, additional pay items for seeding without mulch, fertilizer, and lime (if needed) should also be computed for this site. All other necessary items shall be included in the cost of the HECP.

- 10.09.03 **GLOSSARY**

The following term definition was added:

HYDRAULIC EROSION CONTROL PRODUCTS - A manufactured, temporary degradable, pre-packaged fibrous material that is mixed with water and hydraulically applied as a slurry designed to reduce soil erosion and assist in the establishment and growth of vegetation.

- 10.09.05 **ABBREVIATIONS**

The following abbreviation was added:

HECP – Hydraulic Erosion Control Products

The updated Chapter 10 of the Design Division Drainage Manual is located on the web site and can be found at the following link:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/drainage_manual/DM-Chapter_10.pdf

KJL:ARH:RBB

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