

*This guide specification has been prepared by Propex Operating Company, LLC (Propex) to assist design professionals in the preparation of a specification section covering the use of Vegetated Shoreline Defense Systems for constructing stream and pond banks. It may be used as the basis for developing either a project specification or an office master specification. Since it has been prepared according to the principles established in the Manual of Practice published by The Construction Specifications Institute (CSI) including the use of section numbers and titles from the 2011 Edition of MasterFormat, this guide specification may be used in conjunction with most commercially available master specifications sections with minor editing.*

*The following should be noted in using this guide specification:*

- *Optional text requiring a selection by the user is enclosed within brackets, e.g.: “Section [01 33 00] [\_\_\_\_].”*
- *Items requiring user input are enclosed within brackets, e.g.: “Section [\_\_\_\_ - \_\_\_\_].”*
- *Optional paragraphs are separated by an “OR” statement, e.g.:*

*\*\*\*\* OR \*\*\*\**

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## **1 GENERAL**

### **1.1 SUMMARY**

- A. The work for this section shall consist of furnishing all materials, equipment, and labor necessary for the installation of a Vegetated Shoreline Defense Systems for constructing stream and pond banks.

### **1.2 RELATED SECTIONS**

*Edit the following paragraphs to coordinate with other sections of the Project Manual.*

- A. SECTION [01 33 00 SUBMITTAL PROCEDURES] [\_\_\_\_ - \_\_\_\_]

- B. SECTION [31 00 00 EARTHWORK] [\_\_\_\_ - \_\_\_\_]
- C. SECTION [31 05 19 GEOTEXTILE] [\_\_\_\_ - \_\_\_\_]
- D. SECTION [31 25 00 EROSION AND SEDIMENTATION CONTROLS] [\_\_\_\_ - \_\_\_\_]
- E. SECTION [32 92 19 SEEDING AND SODDING] [\_\_\_\_ - \_\_\_\_]

### 1.3 UNIT PRICES

*Include the following article only for unit price contracts or lump sum contract with unit price adjustments. Delete for lump sum contracts.*

- A. Method of Measurement: By the linear meter (or linear foot - as indicated in contract documents) of stream or pond bank including seams, overlaps, and wastage.
- B. Basis of Payment: By the linear meter (or linear foot - as indicated in contract documents) of stream or pond bank installed.

### 1.4 REFERENCES

*The following article assumes that the date of each reference standard will be the latest edition as of the date of the project specification. This provision must be defined in Division 1; coordinate with Division 1 statements.*

- A. American Society for Testing and Materials (ASTM):
  - 1. A 366 – Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled.
  - 2. A 1023 – Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes.
  - 3. B 85 – Standard Specification for Aluminum-Alloy Die Castings.
  - 4. B 240-10 – Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloys in Ingot Form for Foundry and Die Castings.
  - 5. D 1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
  - 6. D 4354 – Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing.
  - 7. D 4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.

8. D 4439 – Standard Terminology for Geosynthetics.
9. D-4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
10. D-4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles
11. D-4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
12. D-4751 – Standard Test Methods for Determining Apparent Opening Size of a Geotextile
13. D 4759 – Standard Practice for Determining the Specification Conformance of Geosynthetics.
14. D 4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
15. D-5199 – Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
16. D-5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
17. D-6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
18. D 6524 – Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats (TRMs).
19. D 6525 – Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.
20. D 6567 – Standard Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP).
21. D 6575 – Standard Test Method for Determining Stiffness of Geosynthetics Used as Turf Reinforcement Mats (TRMs).
22. D 6818 – Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products.
23. E8/E8M – Standard Test Methods for Tension Testing of Metallic Materials
24. MIL-STD-810 Method 501.5 – High Temperature
25. MIL-STD-810 Method 502.5 – Low Temperature

26. MIL-STD-810 Method 504.1 – Contamination by Fluids

27. MIL-STD-810 Method 510.5 – Sand and Dust

B. Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP).

C. International Standards Organization (ISO) 9001:2008 - Quality System Certification.

#### 1.5 DEFINITIONS

A. *Certificate of Compliance (COC)*: An official document certified by an authorized representative within the manufacturer's company that the manufactured synthetic turf reinforcement mat product(s) meet designated property values as manufactured in a facility having achieved ISO 9001:2008 certification, and tested in accordance with GAI-LAP procedures.

B. *Internal Bracing*: Bracing members designed to interlace through the HPTRM and provide internal support during construction and through the project design life.

C. *High Performance Turf Reinforcement Mat (HPTRM)*: A long-term, non-degradable RECP composed of UV-stabilized, non-degradable, synthetic fibers, nettings and/or filaments processed into three-dimensional reinforcement matrices designed for permanent and critical hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature natural vegetation. HPTRMs provide sufficient thickness, strength and void space to permit soil filling and/or retention and the development of vegetation within the matrix. The HPTRM MARV tensile strength per ASTM D-6818 is 3000 lbs/ft in the weakest principle direction.

D. *Manufacturer*: Entity that produces synthetic turf reinforcement mats through a process directly utilizing obtained raw materials, in a facility owned and operated by said entity, using equipment and assemblies owned and operated by said entity, subject to a certified Manufacturing Quality Control (MQC) Program. Upon completion of production, the manufacturer may sell the turf reinforcement mat product(s) directly to the customer, or through a vendor entity.

E. *Manufacturing Quality Control (MQC) Program*: A certified and documented program initiated and operated by the manufacturer that outlines the operational techniques and activities which sustain a quality of the synthetic turf reinforcement mat product(s) that will satisfy given needs.

F. *Minimum Average Roll Value (MARV)*: Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

G. *Engineered Wrap-Face Vegetated Solution*: A reinforced-earth wall and/or steepened slope system that provides permanent erosion protection and is comprised of consecutive layers of soil-filled wraps using an HPTRM and fiber-composite internal bracing.

H. *Rolled Erosion Control Product (RECP)*: A temporary degradable or long-term non-degradable material manufactured or fabricated into rolls designed to reduce soil erosion and assist in the growth, establishment and protection of vegetation.

- I. *Securing Pin*: A device designed to temporarily hold the HPTRM in place while either vegetation establishes, or the installation of the HPTRM occurs. The securing pin offers no long term value to permanent tie-down of the HPTRM in an armoring solution.
- J. *Trilobal Monofilament Yarn*: A multi-dimensional polymer fiber consisting of a minimum of three points, providing increased surface area and grooves/channels along the fiber to capture additional moisture and sediment to enhance vegetative growth.
- K. *Typical Roll Value*: Property value calculated from average or mean obtained from test data.
- L. *Vendor*: An entity that provides synthetic turf reinforcement mat product(s) to a customer, on behalf of an independent manufacturer. A vendor does not manufacture the actual synthetic turf reinforcement mat product(s), and therefore is not subject to provisions of a certified MQC Program.

## 1.6 SUBMITTALS

*Edit the following to coordinate with Division 1.*

- A. Submit under provisions of Section [01 33 00] [\_\_\_\_]:
  - 1. Certification:
    - a) The Contractor shall provide the Engineer a certificate of conformance stating the name of the HPTRM manufacturer, product name, style, chemical compositions of filaments or yarns and other pertinent information to fully describe the HPTRM.
    - b) The Manufacturer is responsible for establishing and maintaining a Quality Control Program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available prior to the approval of the armoring solution for use on the project.
    - c) The manufacturer's Certificate of Compliance (COC) shall state that the furnished HPTRM meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. The certificate shall be attested to by a person having legal authority to bind the Manufacturer.
    - d) The Contractor shall establish and maintain a quality control procedure to assure compliance of the armoring solution with the requirements of the specification. Documentation describing the quality control procedure shall be provided to the Engineer.
  - 2. Manufacturing Quality Control (MQC) test results shall be provided by the manufacturer for the HPTRM component of the armoring solution prior to installation during the duration of the project as material is delivered to the jobsite.
  - 3. Independent Performance Test Results shall be provided upon request.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. HPTRM labeling, shipment and storage shall follow ASTM D 4873.
- B. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.
- C. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
- D. Each HPTRM roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants. (This will be waived for HPTRMs having a 90% retention of strength after 6000 hours of exposure per ASTM D-4355.)
- E. The protective wrapping shall be maintained during periods of shipment and storage.
- F. During storage, HPTRM rolls shall be elevated off the ground and adequately covered to protect them from the following: Site construction damage, extended exposure to ultraviolet (UV) radiation, precipitation, chemicals that are strong acids or strong bases, flames, sparks, temperatures in excess of 71 deg C (160 deg F)m and any other environmental condition that might damage the HPTRM.

1.8 QUALITY ASSURANCE SAMPLING, TESTING, AND ACCEPTANCE

- A. HPTRM shall be subject to sampling and testing to verify conformance with this specification. Sampling for testing shall be in accordance with ASTM D 4354.
- B. Acceptance shall be in accordance with ASTM D 4759 based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications and testing of quality control samples obtained using Procedure B of ASTM D 4354.
- C. Quality Assurance Sampling and Testing will be waived for ISO 9001:2008 Certified Manufacturing Facilities. Documentation of ISO 9001:2008 Certification shall be provided upon request.

**2 PRODUCTS**

2.1 MANUFACTURERS

- A. All components of the Vegetated Shoreline Defense System shall be furnished by a single manufacturer as a complete system.
- B. Approved Vegetated Shoreline Defense System Manufacturers:
  - 1. Propex Operating Company, LLC  
4019 Industry Drive  
Chattanooga, TN 37416  
(800) 621-1273
- C. Alternate Vegetated Shoreline Defense System Manufacturers:
  - 1. Any alternate products seeking approval must be submitted to the Engineer 10 days prior to the bid date. For acceptance on this project, any alternates seeking approval must meet the

requirements outlined in this document. The alternate’s product specifications and a product sample must be submitted to the Engineer for approval.

2. All product manufacturers seeking approval on this project must have local representation within the state in which the project is bidding. Manufacturers seeking approval must also have a manufacturer’s representative present at the prebid meeting.

**2.2 MATERIALS**

A. **VEGETATED SHORELINE DEFENSE SYSTEM:** A system constructed of rigid cells armored with a High Performance Turf Reinforcement Mat (HPTRM) and internally lined with high durability nonwoven geotextile. The HPTRM is fastened to the rigid cells to provide a flexible exterior, control erosion, and improve system durability and forms pockets that can be filled with mulch or other media to promote and sustain vegetation. The durable geotextile lining allows the rigid cell to be filled with earth, sand, gravel, crushed rock and other granular material. Engineered Earth Anchors can also be utilized with the system to provide additional resistance to lateral earth pressures.

B. **HPTRM:**

1. Three-dimensional, lofty woven polypropylene HPTRM specially designed for erosion control applications on levees, steep slopes, and vegetated waterways.
2. Matrix composed of Trilobal monofilament yarns woven into uniform configuration of resilient pyramid-like projections that minimize watering requirements while enhancing vegetation establishment.
3. Must be a homogeneous matrix, and not comprised of layers, composites, or discontinuous materials, or otherwise loosely held together by stitched or glued netting.
4. The woven matrix of Trilobal yarns must be heat-set to improve interlock and minimize yarn displacement around anchors and pins, which also results in greater flexibility for improved conformance to uneven surfaces.
5. Material is to exhibit very high interlock and reinforcement capacity with both soil and root systems and demonstrate high tensile modulus.
6. The HPTRM should meet the following values:

<b>Property</b>	<b>Test Method</b>	<b>Test Parameters</b>	<b>Units</b>	<b>Property Requirement</b>
Thickness <sup>1</sup>	ASTM D-6525	Minimum	mm (in)	10.2 (0.40)
Light Penetration <sup>1</sup> (% Passing)	ASTM D-6567	Maximum	percent	10
Tensile Strength <sup>1</sup>	ASTM D-6818	Minimum	kN/m (lb/ft)	58.4 x 43.8 (4,000 x 3,000)
Tensile Elongation <sup>1</sup>	ASTM D-6818	Maximum	percent	40 x 35
Resiliency <sup>1</sup>	ASTM D-6524	Minimum	percent	80
Flexibility <sup>2,3</sup>	ASTM D-6575	Maximum	mg-cm (in-lb)	615,000 (0.534)

UV Resistance <sup>2</sup>	ASTM D-4355	Minimum	percent	90 at 3,000 hrs <sup>4</sup> 90 at 6,000 hrs
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Note:

1. Minimum Average Roll Value (MARV).
  2. Typical Value.
  3. A smaller value for flexibility denotes a more flexible material.
  4. Third party / Independent Testing values must be provided showing UV resistance testing for two consecutive years including most recent year.
7. Performance Properties:
- a) Flume Testing: In a vegetated state, the HPTRM must demonstrate acceptable performance (as defined by the Engineer) when subjected to at least 0.5 hrs of continuous flow producing the following conditions.
    - 1) Permissible velocity: 7.6 m/sec (25 ft/sec)
    - 2) Permissible tractive force (shear stress): 0.766 kPa (16 psf)
    - 3) Performance may be demonstrated by:
      - i. Flume testing at an independent facility under conditions similar to this project provided that the manufacturer can demonstrate that the material tested is functionally equivalent to the material being supplied. This may be demonstrated by providing index property test results (listed in 2.2.A.4) from a GAI-LAP accredited laboratory for both the tested and supplied materials.
      - ii. A documented case history of successful performance (as defined by the Engineer) at an installation similar to this project where (documented) hydraulic forces met or exceeded the requirements listed above provided that the manufacturer can demonstrate that the case history material is functionally equivalent to the material being supplied. This may be demonstrated by providing index property test results (listed in 2.2.A.4) from a GAI-LAP accredited laboratory for both the case history and supplied materials.
  - b) Wave Overtopping Testing: In a vegetated state, the HPTRM must demonstrate acceptable performance (as defined by the Engineer) when subjected to wave overtopping simulations, performed by Colorado State University (CSU), and authorized and directed by the U.S. Army Corps of Engineers (USACE).
    - 1) A single test shall be defined as one wave overtopping simulation down the flume on one set of trays (linear and angled sections) for 3 equivalent test hours at 4.0 cfs/ft. Passing this wave overtopping test is defined as surviving the 3 equivalent test hours without visible damage.
    - 2) Failure is defined by (0.06 m) 0.2 ft. or more of soil/grass erosion over a (0.37 m<sup>2</sup>) 4 ft<sup>2</sup> area.
    - 3) Each type of HPTRM armoring product shall be subject to 1 wave overtopping test on each tray set at 4.0 cfs/ft for the duration equivalent to 3 test hours (~6 elapsed hours).



- c) **Functional Longevity:** In addition to the UV resistance per ASTM D-4355 stated above, the HPTRM must have a documented installation showing a minimum retained tensile strength of 70% per ASTM D-6818 after a minimum of 10 years of exposure to a minimum solar radiation of 21.70 MJ/m<sup>2</sup>-day.
8. **Manufacturing Quality Control:** Testing shall be performed at a laboratory accredited by GAI-LAP for tests required for the HPTRM, at frequency exceeding ASTM D-4354, with following minimum acceptable testing frequency:

<b>Property</b>	<b>Test Frequency m<sup>2</sup> (yd<sup>2</sup>)</b>
Thickness	1/12,291 (1/14,700)
Light Penetration (% Passing)	1/12,291 (1/14,700)
Tensile Strength	1/12,291 (1/14,700)
Tensile Elongation	1/12,291 (1/14,700)
Resiliency	1/12,291 (1/14,700)
Flexibility	1/12,291 (1/14,700)
UV Resistance	Annually

**C. Geotextile Lining**

1. The geotextile construction shall be a nonwoven, staple fiber, needlepunched, polypropylene geotextile; the fibers are needled together to form a stable network that retains dimensional stability relative to each other.
2. The geotextile should be resistant to UV degradation and biological and chemical environments normally encountered in soils.
3. The geotextile lining should meet the following values:

<b>Property</b>	<b>Test Method</b>	<b>Test Parameters</b>	<b>Units</b>	<b>Property Requirement</b>
Mass Per Unit Area	ASTM D-5261	Minimum	oz/yd <sup>2</sup> (g/m <sup>2</sup> )	6.5 (220)
Thickness	ASTM D-5199	Minimum	mils (mm)	57 (1.37)
Color	Visual	-	-	Tan
Grab Tensile Strength	ASTM D-4632	Minimum	lbs (N)	210 (934)
Grab Tensile Elongation	ASTM D-4632	Minimum	percent	80
Trapezoidal Tear	ASTM D-4533	Minimum	lbs (N)	80 (356)
CBR Puncture	ASTM D-6241	Minimum	lbs (N)	550 (2447)
Apparent Opening Size (AOS)	ASTM D-4751	Maximum	in	0.004 - 0.007

			(mm)	(0.11 - 0.18)
Permittivity	ASTM D-4491	Minimum	sec <sup>-1</sup>	1.1
UV Resistance	ASTM D-4355	Minimum	percent	80 at 1000 hrs
Chemical Exposure (Diesel fuel and deicing fluid)	MIL-STD-810 Method 504.1	Minimum	percent	90
Acid and Alkali Exposure (Sulfuric Acid)	MIL-STD-810 Method 504.1	Minimum	percent	90
Acid and Alkali Exposure (Calcium Hydroxide)	MIL-STD-810 Method 504.1	Minimum	percent	80
High Temperature Exposure	MIL-STD-810 Method 501.5	Minimum	percent	90
Low Temperature Exposure	MIL-STD-810 Method 502.5	Minimum	percent	90
Blowing Sand Abrasion	MIL-STD-810 Method 510.5	Minimum	percent	85
Burn Propagation when filled	-	Minimum	-	No Flame Spread

D. Rigid Cell:

1. The rigid cell should meet the following values:

Property	Test Method	Units	Property Requirement
Ultimate Tensile Strength	ASTM E8/E8M	psi (Mpa)	99,350 (685)
Ultimate Tensile Elongation	ASTM E8/E8M	percent	7
Weld Shear Strength	ASTM E8/E8M	percent	70
Rigid Cell Dimensions	-	ft (m)	4 x 3 x 15 1.2 x 0.9 x 4.5
Wire Diameter	-	inches (mm)	0.157 (4)

E. Engineered Earth Anchor:

1. Anchors with a minimum drive depth specified by the design engineer are used to provide for structural slope stability reinforcement as shown in the drawings.
2. The anchor components shall be made of materials suitable to resist corrosion and UV degradation particularly at the soil/air interface.
3. The load bearing plate shall be of sufficient size to resist forces acted upon by the tensioned anchor.
4. Anchors shall meet the following requirements:

Component	Standard(s)	Material Composition	Physical Properties
Anchor Head	Zinc Alloy (ZA 2) ASTM B-240-10	5.0 in. x 1.62 in. x 1.23 in. (L x W x H)	Corrosion resistant pressure die cast zinc alloy.
Lower Termination	Aluminum ferrule MS51844	Length: 17.46mm (11/16") Wall Thickness: 9.53mm(3/8")	N/A
Cable Tendon	Zinc-Aluminum Coated Carbon Steel ASTM A-1023	4mm (5/32") diameter 1x19 strand Zinc-Aluminum Wire Tendon 6FT	Corrosion resistant zinc-aluminum coated cable.

Top Accessory Bearing Plate	Mild Steel Zinc Plated ASTM A366 Plastisol Coating	Diameter: 108mm (6.29in) Thickness: 3.25mm (0.125in)	Corrosion resistant zinc plated steel. Coated with Plastisol.
Top Termination	Zinc Alloy ZA 2 ASTM B-240-10	Diameter: 35mm (1.37x1.37in) Thickness: 2.5mm (0.1in)	Corrosion resistant pressure die cast zinc alloy. Utilizing a multiple point of contact ceramic roller & directional locking device.

5. Performance

Performance Property	Value
Anchor & Cable Assembly Ultimate Strength*	11.57 kN (2.6 Kips)
Anchor Weight	0.182 kg (0.401 lbs)
Anchor Head Bearing Area	3,871 mm <sup>2</sup> (6.0 in <sup>2</sup> )

\* Anchor performance is a function of in situ soil strength and therefore the load range in this specification should be regarded as a guide only. Site specific soil conditions shall be evaluated by a licensed geotechnical engineer to determine the anchor type, depth, and pattern to resist slope instability. Pre-construction pull tests may be recommended.

**3 EXECUTION**

**3.1 SUBGRADE PREPARATION**

- A. Excavate a shallow, level trench at least 0.9 m (3 ft.) wide and 15 to 23 cm (6 to 9 in) deep below finished grade using an excavator with smooth bucket to reduce disturbance at the defined subgrade elevation.
- B. The cut-slope excavation width shall not exceed the lines and grades shown on the Plans, and care shall be taken to avoid encroachment near bordering properties.
- C. Deleterious material (overly wet soil, uncontrolled loose fill, construction debris, organics, etc.) encountered during this excavation shall be over-excavated, removed, and replaced with compacted granular fill or approved backfill soil. Compact the subgrade as specified by the Engineer.
- D. If specified by the engineer, a perforated drainage pipe shall be installed at the back of the trench and connected to a prescribed outlet for draining groundwater.
- E. Granular soil is defined as:
  - 1. Classified as GM, GW, SM, SW, GW-GM, SW-SM referencing the USCS (Unified Soil Classification System).
  - 2. Contains maximum particle size of 3.8 cm (1-1/2 in) and less than 12 percent fines passing 0.074 mm (No. 200 sieve).
  - 3. Inert earth material with less than 3 percent organics or other deleterious substances (wood, metal, plastic, waste, etc).

OR

4. Meets the untreated base grading requirements for 3.8 cm (1-1/2 in) maximum nominal size crushed aggregate per typical state construction standards.
- B. For clay subgrade soils, line the trench with GEOTEX<sup>®</sup> 801 nonwoven geotextile. Place a 10 cm (4 in) thick loose lift of granular soil on top of the filter fabric and compact it to at least 90 percent of the specified modified Procter dry density per ASTM D 1557. Smooth the surface of the compacted soil to provide a level pad needed for the first unit.

3.2 INSTALLATION

- A. Install the Vegetated Shoreline Defense System at elevation and alignment indicated.
- B. Starting with the lowest portion of the alignment, lower the first unit onto the foundation layer and expand into place. At each terminus of this lowest section of the alignment, curve the turn the unit into the slope so the ends of this run can be buried.
- C. Gradual curves can be created due to the system flexibility. Curving is done during setup and all curved units must be set out and joined before filling. Each of the 4.6 m (15 ft) long units can be curved a maximum of 30 cm (12 in) from the tangent line set by the previous unit. Tighter concave or convex curves can be achieved as shown below.
- D. Concave curves are formed by removing a single rear facing panels and creating a triangular unit.
1. Begin the process by removing the spirals on each side of the panel and cut along the geotextile inside the unit, just under the row of staples.
  2. Remove the rigid cell panel and reapply the spirals at each corner to secure the internal panels.
  3. Overlap the corner spirals and insert the joining pins in order to complete the triangular cell.
  4. Zip-tie the excess geotextile liner to the rigid cell panel to keep it out of the way during filling.
- E. Convex curves are formed by removing a single front facing panel and creating a triangular unit.
1. Begin the process by cutting the exterior HPTRM down the middle of the cell to expose the rigid cell panel and geotextile lining.
  2. Remove the spirals on each side of the panel and cut along the geotextile inside the unit, just under the row of staples.
  3. Remove the rigid cell panel and reapply the spirals at each corner to secure the internal panels.
  4. Overlap the corner spirals and insert the joining pins in order to complete the triangular cell.
  5. Zip-tie the excess geotextile liner to the rigid cell panel to keep it out of the way during filling.
  6. Shingle the exterior HPTRM in the direction of flow and trim excess material in order to maintain a 15 cm (6 in) overlap.
  7. Using stainless steel hog rings, secure the overlap to the rigid cell, leaving a minimum of 7.5 cm (3 in) beyond the hog rings.
- F. If required, Engineered Earth Anchors can be utilized with the system to provide additional resistance to lateral movement.
1. With the unit set in place and expanded, prior to infilling of the cells mark the location of anchors on the slope behind the units.
  2. Anchor locations should align with the intermediate dividing walls of the unit. Do now place anchors in alignment with rear facing panels.

3. Drive anchor horizontally into rear excavation at the marked locations. Remove anchor drive rod and set anchor. Remove anchor top plate and locking mechanism from anchor cable.
  4. With units aligned per the design, cut a hole in the geotextile liner near the intermediate dividing wall to allow the anchor cable to be routed from the rear of the unit to the inside of the unit.
  5. Connect the anchor cable to the unit by reconnecting the anchor top plate and locking mechanism to the anchor cable on the inside of the unit.
- G. Place a 15 cm (6 in) thick fill material approved by the Engineer within the units. Check and adjust the units to ensure a level placement. If joining the units together in series, do not fill the end cell more than 15 cm (6 in) prior to joining units.
- H. Install remaining fill in lifts no more than 0.6 m (2 ft). Fill the units and backfill behind the units simultaneously so as to balance the earth pressures. When normal water levels are present, face units should be filled with granular, self-consolidating material. Compact infill and backfill to the specified modified Proctor dry density per the Engineer's recommendation, but never less than 87% of the maximum dry density per ASTM 1557.
- I. For vegetation establishment on the face of the units, fill the pocket between the HPTRM and the cell with seed and growth media. This can consist of 50% topsoil, 50% hardwood mulch, and seed in accordance with Section [32 92 19 SEEDING AND SODDING] [\_\_\_\_\_ - \_\_\_\_\_]. Place a minimum of 2 cm (1 in) of topsoil/mulch/seed mix on the top of the filled unit.
- J. Pull the remaining portion of the HPTRM tightly across the top of the filled unit. Fasten the HPTRM top cover to the back of the unit walls as well as the intermediate walls with stainless steel hog rings. Turn down excess HPTRM along the back side of the unit prior to placing fill behind unit.
- K. Units can be joined by connecting the spirals from one unit to another.
1. Align the units, overlapping the spirals and insert the joining pin to permanently attached to each other.
  2. When joining facing units, the HPTRM is to be spliced together. Shingle the exterior HPTRM in the direction of flow and trim excess material in order to maintain a 15 cm (6 in) overlap. Using stainless steel hog rings, secure the overlap to the rigid cell, leaving a minimum of 7.5 cm (3 in) beyond the hog rings.
- L. Repeat Steps A. through K. for each subsequent unit. Incorporate a setback with unit to provide the desired overall slope angle.

**END OF SECTION**