



**SPECIAL PROVISIONS
FOR
VEGETATIVE FACED REINFORCED EARTH WALLS**

**Webster County
TAP-R-C094(123)--8T-94**

**Effective Date
October 19, 2021**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

PART 1 - GENERAL

1.01 SUMMARY

The work for this special provision shall consist of furnishing all materials, equipment, and labor necessary for the installation of an Engineered Vegetated faced reinforced earth walls and steepened slopes.

1.02 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 pounds per foot 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% 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.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Conference: Prior to installation of the system and associated Work, meet with the Contractor, reinforced-earth walls and steepened slope system installer and their field supervisor, manufacturer's technical representative, the Engineer, and other entities concerned with the reinforced-earth walls and steepened slope system performance.
 - 1. Provide at least 72 hours advance notice to participants prior to convening preinstallation conference.
 - 2. Introduce and provide a roster of individuals in attendance with contact information.
 - 3. The preinstallation conference agenda will include, but is not limited to the review of:
 - a. Required submittals both completed and yet to be completed.
 - b. The sequence of installation and the construction schedule.
 - c. Coordination with other trades.
 - d. Details, materials and methods of installation.
 - 1) Review requirements for substrate conditions, special details, if any, installation procedures.
 - 2) Installation layout, procedures, means and methods.
 - e. Mock-up requirements.
- B. Sequencing and Scheduling:
 - 1. General: Prior to beginning Work of this Section, prepare a detailed schedule of the Work involved for coordination with other trades.
 - 2. Schedule utility installations prior to beginning Work of this Section.
 - 3. Where possible, schedule the installation of the system after the area is no longer required for use by other trades and Work. Where necessary to prevent damage, protect installed system if Work must occur over or adjacent to the installed Vegetated faced reinforced earth walls and steepened slopes system.

1.04 SUBMITTALS

- A. Certification:
 1. 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.
 2. The manufacturer is responsible for establishing and maintaining a MQC 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.
 3. The manufacturer's 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.
 4. 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.
- B. 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.
- C. Independent Performance Test Results shall be provided upon request.

1.05 QUALITY ASSURANCE

- A. Obtain necessary permits/approvals from these authorities.
- B. Manufacturer Qualifications:
 1. 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.
 2. 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.
 3. 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.
- C. Installer Qualifications: A qualified installer with not less than 5 years of successful experience installing soil cell systems or related products and materials, and whose work has resulted in successful installation of underground piping, chambers and vault structures, planting soils, and planter drainage systems of a similar scope and scale in dense urban areas.
- D. Installer's Field Supervisor: A full-time supervisor employed by the installer with not less than 5 years of successful experience similar to that of the installer and present at the Project site when Work is in progress. Utilize the same field supervisor throughout the Project, unless a substitution is submitted to and approved in writing by the Engineer.
- E. Mock-Up: Prior to the installation of the Vegetated faced reinforced earth walls and steepened slopes system, construct a mock-up of the complete installation at the Project site in the presence of the Engineer.
 1. Size and Extent: Minimum of 100 square feet in area and including the complete Engineered Wrap-Face Vegetated Solution for constructing reinforced-earth walls and steepened slopes system installation with subbase, aggregate subbase, drainage installation, soil cell decks, posts, and bases, base course aggregate, geotextile, geogrid, backfill, planting soil, and necessary accessories.
 2. The mock-up area may remain as part of the installed Work at the end of the Project provided that it remains undamaged and meets the requirements of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

1. HPTRM labeling, shipment and storage shall follow ASTM D 4873.
2. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.
3. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
4. 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.)
5. The protective wrapping shall be maintained during periods of shipment and storage.
6. 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 160°F and any other environmental condition that might damage the HPTRM.

1.07 FIELD CONDITIONS

Existing Conditions: Do not proceed with Work when subgrades, soils and planting soils are in a wet, muddy or frozen condition. Refer to the project geotechnical report for other recommendations and requirements.

1.08 WARRANTY

Manufacturer warrants to the original purchaser of its Vegetated faced reinforced earth walls and steepened slopes product that such product will be free from defects in materials and workmanship, and perform to manufacturer's written specifications for the warranted product, when installed and used as specifically provided in the product's installation guidelines for a period of 20 years from the date of purchase. This warranty does not cover wear from normal use, or damage caused by abuse, mishandling, alterations, improper installation and/or assembly, accident, misuse, or lack of reasonable care of the product. This warranty does not apply to events and conditions beyond manufacturer's control, such as ground subsidence or settlement, earthquakes and other natural events, acts of third parties, and/or Acts of God. If this warranty is breached, manufacturer will provide a replacement product. Incurred costs, such as labor for removal of the original product, installation of replacement product, and the cost of incidental or other materials or expenses are not covered under this warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Obtain all vegetated faced reinforced earth walls and steepened slopes assembly components from single supplier to ensure complete system warrantee.
- B. Provide Vegetated faced reinforced earth walls and steepened slopes assemblies by one of the following manufacturers, or approved equal:
 1. Propex Global (www.propexglobal.com)
 2. Earth Wall Products (www.earthwallproducts.com)
 3. Tensar Corp (www.tensarcorp.com)

2.02 DESCRIPTION

- A. The term Vegetated faced reinforced earth walls and steepened slopes shall be used to refer to all assembly components required to furnish and install walls in locations identified in the contract documents.
- B. Vegetated faced reinforced earth walls and steepened slopes shall be designed for the purpose of providing stormwater management.

2.03 MATERIALS FOR VEGETATIVE FACED REINFORCED EARTHAN WALLS

- A. 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:

Property	Test Method	Test Parameters	Units	Property Requirement
Thickness ¹	ASTM D-6525	Minimum	in	0.40
Light Penetration ¹ (% Passing)	ASTM D-6567	Maximum	percent	10
Tensile Strength ¹	ASTM D-6818	Minimum	lb/ft	4000 x 3000
Tensile Elongation ¹	ASTM D-6818	Maximum	percent	40 x 35
Resiliency ¹	ASTM D-6524	Minimum	percent	80
Flexibility ^{2,3}	ASTM D-6575	Maximum	in-lb	0.534
UV Resistance ²	ASTM D-4355	Minimum	percent	90 at 3000 hrs ⁴ 90 at 6000 hrs

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 hours of continuous flow producing the following conditions.
 - 1) Permissible velocity: 25 feet per second
 - 2) Permissible tractive force (shear stress): 16 pounds per square foot
 - 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 per foot. Passing this wave overtopping test is defined as surviving the 3 equivalent test hours without visible damage.
 - 2) Failure is defined by 0.2 feet. or more of soil/grass erosion over a 4 square foot area.
 - 3) Each type of HPTRM armoring product shall be subject to 1 wave overtopping test on each tray set at 4.0 cfs per foot 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/m²-day.
8. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GALAP for tests required for the HPTRM, at frequency exceeding ASTM D 4354, with following minimum acceptable testing frequency:

Property	Test Frequency (yd ²)
Thickness	1/14,700
Light Penetration (% Passing)	1/14,700
Tensile Strength	1/14,700
Tensile Elongation	1/14,700
Resiliency	1/14,700
Flexibility	1/14,700
UV Resistance	Annually

B. Internal Bracing and Securing:

1. The internal brace assembly comprises three nonmetallic polymer bars specially designed, whereby two of the bars are threaded through the pyramidal projections of the HPTRM to form a semi-rigid base and upright member, which both are then connected using the third bar as a transverse member. These braces shall be installed for each lift at a horizontal spacing along the wall not to exceed 27 inches. For curved wall applications, this spacing typically ranges from 21 to 24 inches.
2. Wood or plastic stakes, or steel pins are used to pin-down the geotextile near the back of the reinforcement zone to hold the geotextile taut while aligning the wall face and placing soil backfill. These are installed as needed along the HPTRM, but at a frequency no less than one per 6 lineal feet. The stakes or pins shall be long 9 to 12 inches and shall be approved by the Engineer before installation.

PART 3 - EXECUTION

3.01 EXAMINATION

Examine the conditions under which the Vegetated faced reinforced earth walls and steepened slopes are to be installed.

- A. Carefully check and verify dimensions, quantities, and grade elevations.
- B. Carefully examine the Plans to become familiar with the existing underground conditions before digging. Verify the location of aboveground and underground utility lines, infrastructure, other improvements, and existing trees, shrubs, and plants to remain including their root system.
- C. Notify the Contractor and the Engineer in writing in the event of conflict between existing and new improvements, of discrepancies, and other conditions detrimental to proper and timely completion of the installation.
- D. Obtain written approval of changes to the Work prior to proceeding. Proceed with installation only after changes have been made and unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Take proper precautions as necessary to avoid damage to existing improvements and plantings.
- B. Prior to the start of Work, layout and stake the limits of excavation and horizontal and vertical control points sufficient to install the complete Vegetated faced reinforced earth walls and steepened slopes system.
- C. Coordinate installation with other trades that may impact the completion of the Work.

3.03 TEMPORARY PROTECTION

Protect open excavations and Vegetated faced reinforced earth walls and steepened slopes system from access and damage both when Work is in progress and following completion, mark top and toe of slopes with highly visible construction tape, fencing, or other means until related construction is complete.

3.04 SUBGRADE PREPARATION

- A. Excavate a shallow, level trench at least 4.3 feet wide and 6 to 9 inches 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. As necessary, to account for grade variations along the wall base line, the trench shall have level sections separated by 12 inch steps to allow for grade alignment with the 12 inch wrapped lifts.
- 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. A perforated drainage pipe shall be installed at the back of the trench and connected to a manufacture prescribed and Owner approved outlet site for draining groundwater. A chimney drain shall be installed when required by the manufacture or required by the Engineer.
- E. Granular soil is defined as: Classified as GM, GW, SM, SW, GW-GM, SW-SM referencing the USCS (Unified Soil Classification System).
- F. Contains maximum particle size of 1 1/2 inches and less than 12% fines passing (No. 200 sieve)
- G. Inert earth material with less than 3% organics or other deleterious substances (wood, metal, plastic, waste, etc).

OR

- H. Meets the untreated base grading requirements for 1 1/2 inches maximum nominal size crushed aggregate per typical state construction standards.
- I. For clay subgrade soils, line the trench with nonwoven geotextile. Place a 4 inch thick loose lift of granular soil on top of the filter fabric and compact it to at least 90% of the specified modified Proctor dry density per ASTM D 1557. Smooth the surface of the compacted soil to provide a level pad needed for the first layer of HPTRM.

3.05 INSTALLATION

- A. Install the armoring solution at elevation and alignment indicated.
- B. Starting with the lowest portion of the wall alignment, roll out the first layer of the HPTRM along the trench line, with the inboard 4 feet of the 8.5 foot wide roll laid along the trench footprint. At each terminus of this lowest section of the wall alignment, curve the wall face slightly into the slope so the ends of this run can be buried, leaving no HPTRM edges exposed at the ground surface. Concave curves in the wall are formed by cutting and overlapping the fabric in the 4 foot backfill zone; convex curves are formed by spreading the fabric.
- C. Weave the bottom and upright internal bracing components (bars) through the interior pyramidal projections of the HPTRM toward the 4 foot fold line, being sure to catch 4 to 8 yarns with the bracing bar at each pyramid. Fold the fabric and stand-up the face, then connect the bars using a T-slot at the 4 foot fold line. While holding the face near vertical, connect those two bars with the third bar, aligned transverse to the other two using two T-slots. Do not allow the vertical face segment to lay down prior to installing this transverse bar, because the vertical bar likely will be damaged and require replacement. Install these braces at a maximum uniform spacing of 27 inches along the wall face; a lesser spacing of 24 inches may be desirable for tighter face liners. Loose fabric at the outboard side is laid out away from the backfill area.
- D. Pull the fabric fairly taut in both directions, then drive stakes or pins long 9 to 12 inches along the edges of the 4 foot backfill zone to hold the fabric in place for subsequent soil backfilling at a frequency no less than one pin per 6.5 to 10 lineal feet. Exercise extreme caution when driving or operating equipment across this HPTRM, as sudden turns or braking may deform or damage the HPTRM, or pull the wall face out of proper alignment.
- E. Place a 7 to 8 inch thick loose lift of backfill soil approved by the Engineer along the 4 foot backfill zone using hand shovels to place soil around the braces first, and then filling the space in-between braces along the face. Compact the soil lift 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.
 - 1. The internal-braced design of the geosynthetic wrap allows mechanical compaction of the backfill zone immediately adjacent to the face without the use of temporary bracing and without the use of external support at the wall face.
 - 2. Vibratory plate compactors should not be used within 3 inches of the face; ramming compactors ("jumping jack" style) should not be used within 12 inches of the face.
- F. Place a second lift of backfill soil along the backfill zone and compact it to bring the total height up to 12 inches at the wall face even with the top of the internal braces, and approximately 11 inches in the area back from the face..
- G. Fold the 3.5 foot outboard portion of the HPTRM wrap layer back over the backfill zone, stretch it taut to remove wrinkles, and pin it down. Spread approximately 1 inch of fine backfill soil with no coarse gravel or larger particles evenly across the fabric in preparation for the next wrapped lift.
- H. To splice onto the end of a HPTRM roll (previous roll), install a brace at 1.5 feet from the end of the roll. For the new roll to be added, insert a brace close to the roll end, then slide the new roll end into the previous roll end until the new roll end abuts against the final brace of the previous roll. After placing and compacting backfill, fold the top wrap back over the fill and stretch taut to provide an end-to-end overlap of 1.5 feet.

- I. Repeat Steps A. through H. for each subsequent backfill lift. Incorporate a setback with each lift to provide the desired overall slope angle.
- J. To form a curve in the wall alignment, cut the fabric laydown flaps perpendicular to the wall face and then: a) spread the fabric at the cuts to form a concave face curve, or b) overlap the fabric at the cuts to form a convex face curve. Add an additional brace within the curve if needed.
- K. For taller walls, the geosynthetic-reinforced zone behind the wrap-face will need to be widened by using supplemental geosynthetic layers sandwiched in-between the upper fabric of a given lift and the lower fabric layer of the subsequent lift. Apply a thin layer of soil at fabric interfaces to eliminate complete fabric-to-fabric contact.
- L. Where each wrap-face lift ends at the lateral project limits, the wall face should be curved slightly into the slope and buried, leaving no HPTRM loose ends exposed at the ground surface. Overall wall layout and foundation steps are specified in the Construction Plans, but foundation grade elevations may need to be modified to match actual field conditions during construction. Damage to the Engineered Wrap-Face Vegetated Solution resulting from Contractor vehicles, equipment, or operations shall be repaired.

3.18 PROTECTION

- A. Keep construction traffic away from the limits of the VFREW.
 - 1. Do not operate equipment directly on top of the VFREW system.
 - 2. Install and maintain temporary erosion control devices per the contract documents and manufacture recommendations.
 - 3. Manage stockpiled material and staging sites to prevent damage to in situ soils intended to remain in place.

3.20 METHOD OF MEASUREMENT

Measurement is based on the number of square feet of Vegetative Faced Reinforced Earth Walls installed as shown on the plans.

3.21 BASIS OF PAYMENT

Payment will be made at the unit bid price per square footage of Vegetative Faced Reinforced Earth Walls extents. Included with this item is supply, deliver, storage, preparation, installation, and all labor, materials, and equipment necessary to install all Vegetative Faced Reinforced Earth Walls system and all its components as indicated on the plans and as recommended by the manufacturer and specified by the Engineer.