

Thank you for purchasing our PYRAMAT<sup>®</sup> High Performance Turf Reinforcement Mat (HPTRM) or Turf Reinforcement Mat (TRM) by Propex Operating Company, LLC (Propex). This document provides installation and maintenance guidelines for PYRAMAT used as channel armoring to increase channel resiliency towards forces created by high velocities and shear stresses. PYRAMAT provides permanent erosion protection on the side slopes and/ or bed of a channel.

Temporary securing pins (pins) are used during installation to hold PYRAMAT in place. Pins also promote vegetation establishment keeping PYRAMAT in intimate contact with the soil.

PYRAMAT is an Engineered Earth Armoring Solution <sup>™</sup> with a unique design for each specific project. While Propex has made every effort to ensure general validity, this information should not be used for a specific application without independent professional examination and verification of its suitability, applicability, and accuracy. The documentation provided herein is for general information only, and is intended to present installation guidance only. Project specific contract documents take precedence when pin placements are different than what is represented in this document. Depending upon the critical nature of the structure to be armored, work restrictions may be in place such as limiting installation based on growing seasons, weather patterns, etc. Work should be performed under the provisions set forth for the specific project. Propex Engineering Services is available for support during installation to consult for solving constructability issues encountered in specific applications. Please feel free to call our technical support hotline at (800) 621-1273.

## **BEFORE INSTALLATION BEGINS**

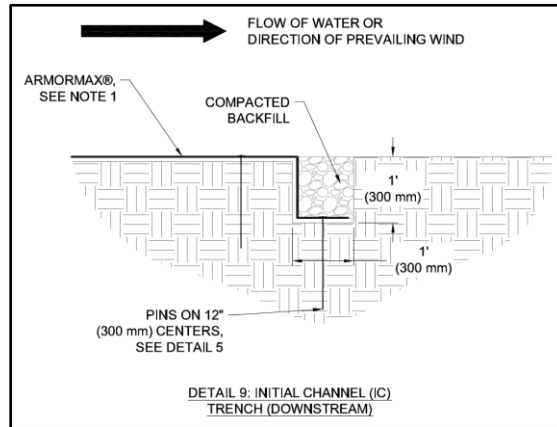
- *Coordinate with a Propex Representative:* A pre-construction meeting with the construction team and a representative from Propex is recommended prior to installation. This meeting should be scheduled by the contractor with at least a two week notice prior to construction.
- *Gather the Tools Needed:* Tools that you will need to install PYRAMAT include a pair of industrial shears to cut PYRAMAT, tape measure, and mallet or hammer.
- *Determine Vegetation Establishment Strategy:* The method of vegetation establishment should be determined prior to the start of installation. Different vegetation establishment methods require different orders of installation. Refer to *VEGETATION ESTABLISHMENT* for further guidance.

## **INSTALLATION OF PYRAMAT FOR CHANNELS**

### **SITE PREPARATION**

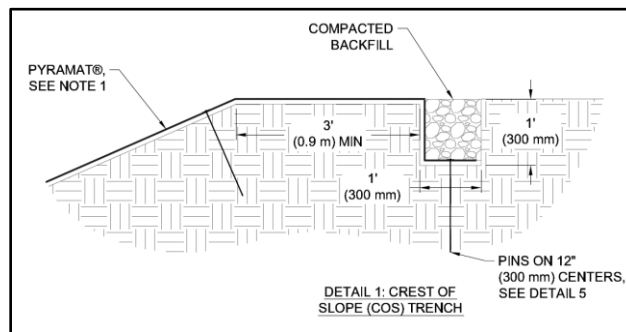
It is recommended during all stages of site preparation that disturbed soils remain unprotected for not more than a single day. Depending on project size this may require progressive site preparation during installation.

1. Grade and compact the area in the channel where PYRAMAT will be installed. The channel surface should be uniform and smooth, having all rocks, clods, vegetation or other objects removed so that during *PYRAMAT LAYDOWN*, PYRAMAT comes in direct, intimate contact with the channel surface.
2. Prepare the area to be armored with PYRAMAT by loosening the topsoil to promote better vegetation establishment. This may be accomplished with a rotary tiller on slopes 3:1 or flatter. For slopes greater than 3:1, prepare topsoil in a safe manner.
3. Excavate an Initial Channel (IC) trench a minimum of 12 in x 12 in (300 mm x 300 mm) across the channel at the downstream end of the project (Figure 1). Deeper IC trench and/or hard armoring may be required for channels that have the potential for scour.



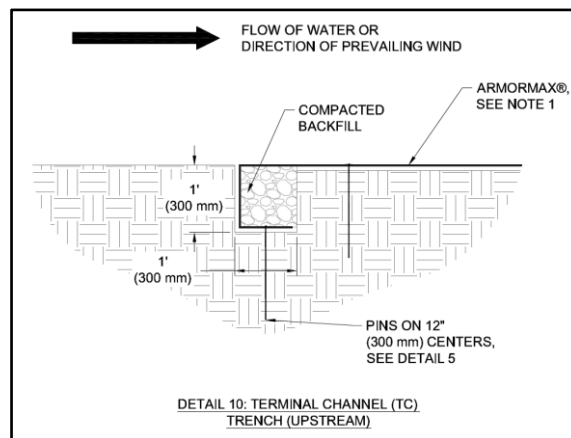
**Figure 1: Initial Channel (IC) Trench**

4. Excavate a Crest of Slope (COS) trench a minimum of 12 in x 12 in (300 mm x 300 mm) along both sides of the installation. Each COS trench must be a minimum of 3 ft (900mm) over the crest of the bank, preferably on a relatively flat surface (Figure 2).



**Figure 2: Crest of Slope (COS) Trench**

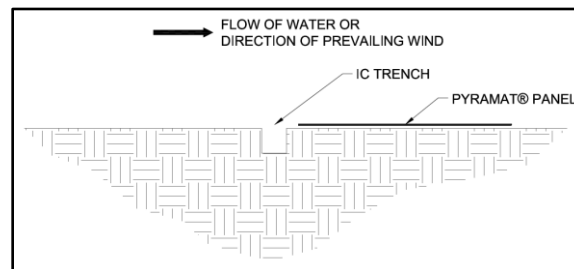
5. Excavate a Terminal Channel (TC) trench a minimum of 12 in x 12 in (300 mm x 300 mm) across the channel at the upstream end of the project (Figure 3). Deeper TC trench and/or hard armoring may be required for channels that have the potential for scour.
6. If seeding, refer to *VEGETATION ESTABLISHMENT* for additional considerations during site preparation.



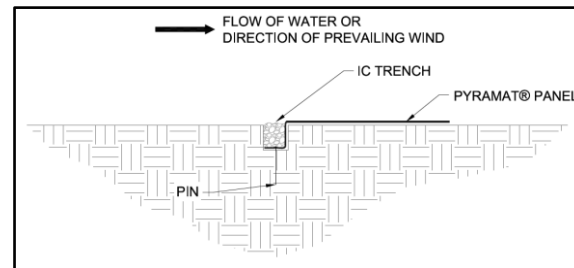
**Figure 3: Terminal Channel (TC) Trench**

## PYRAMAT LAYDOWN

- Starting with the downstream end of the site select one of the COS trenches to begin the *PYRAMAT LAYDOWN* process. To ensure proper anchoring of the overlapped areas the proceeding roll width must be laid out before the current roll width can be anchored with exception to the final roll width at the TC trench. For straight sections of a channel, PYRAMAT panel lengths should be long enough to construct both COS trenches while also covering the surface of the channel being armored. (Figure 16) Panel edges should rest perpendicular to the channel center line. For best results, panels of PYRAMAT should be continuous and free from seams or roll end overlaps that are parallel to the centerline of the channel. Panel edge overlapping should follow a pattern of placing each proceeding panel's edge ovetop the previous panel edge, shingling the panels in the direction of the water flow.
- Lay the PYRAMAT panel on the downstream side of the IC trench (Figure 4). Place the panel edge in the IC trench, ensuring full coverage along the bottom of the entire IC trench with the PYRAMAT (Figure 5).

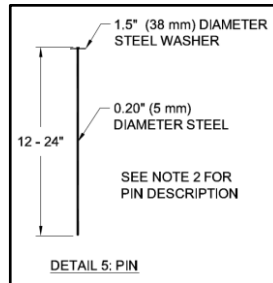


**Figure 4: Initial Channel (IC) Trench Alignment**



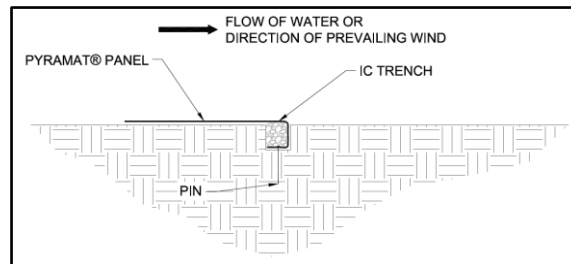
**Figure 5: Initial Channel (IC) Trench Placement**

- Secure PYRAMAT with pins in the IC trench (Figure 5). Pins should be made of steel with a 0.20 in (5 mm) minimum diameter, having a 1.5 in (38mm) diameter washer at the head, and a length between 12 and 24 in (300-600 mm) with sufficient ground penetration to resist pullout (Figure 6). Longer pins may be required for looser soils. Heavier metal stakes may be required in rocky soils. Suggested placement of pins for the IC trench is along the bottom of the trench with pins on 12 in (300 mm).



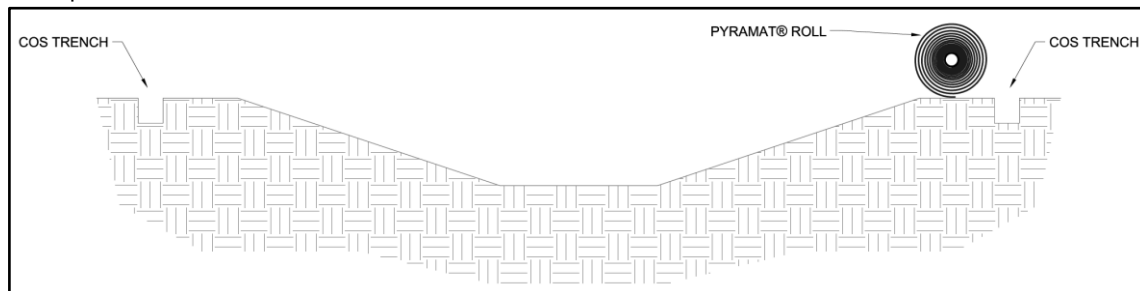
**Figure 6: Securing Pin**

4. Backfill and compact the IC trench (Figure 5).
5. Fold the PYRAMAT panel over the top of the compacted IC trench (Figure 7) and place each panel end into the respective COS trenches.

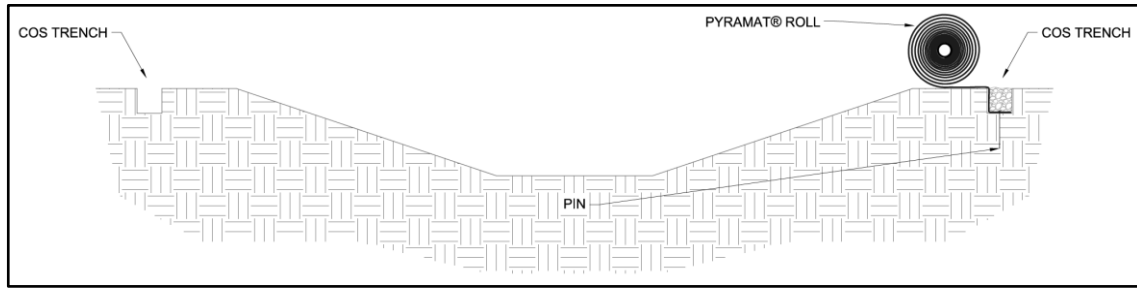


**Figure 7: Initial Channel (IC) Trench Complete**

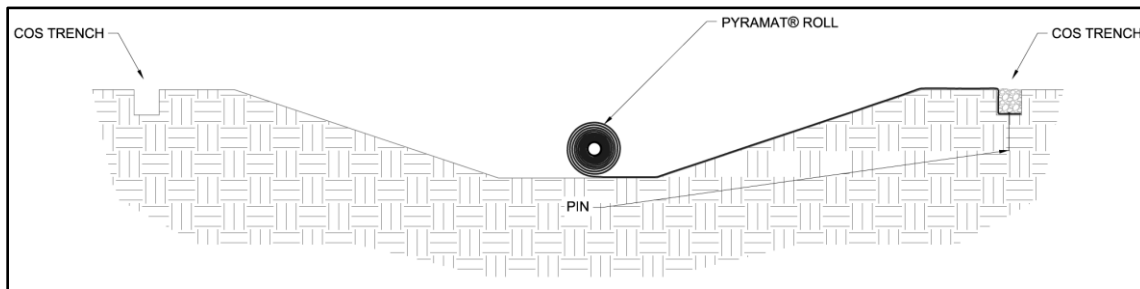
6. Place the next PYRAMAT panel by laying the PYRAMAT roll so that the roll end points towards the COS trench (Figure 8), with a 3 inch (75 mm) overlap created at adjacent panel edge locations. Ensure that adjacent panel edges maintain a minimum 3 inch (75 mm) overlap during *PYRAMAT LAYDOWN* (Figure 12).
7. Secure PYRAMAT with pins in the COS trench (Figure 9). Suggested placement of pins for the COS trench is along the bottom of the trench on 12 in (300 mm) centers. Pins should also be installed on panel edge overlaps in the COS trench.



**Figure 8: Top of Bank (COS) Trench Alignment**



**Figure 9: Top of Bank (COS) Trench Placement**



**Figure 10: Perpendicular Placement of PYRAMAT across Channel**

8. Backfill and compact the COS trench in the location of the first PYRAMAT panel only (Figure 9).
9. Unroll the PYRAMAT roll on the channel surface in the area to be armored. (Figure 10) Ensure that PYRAMAT has intimate contact with the ground and all irregular surfaces beneath PYRAMAT are removed.
10. Secure PYRAMAT panels in place using pins across the channel surface according to the project's engineered design. Pin placement should reflect a checkerboard pattern across the channel surface for best results (Figure 11 and Figure 12).
  - Roll edges shall be overlapped a minimum of 3 in (75 mm) with pins placed on 12 in (300 mm) centers (Figure 12).
  - Roll ends shall be overlapped a minimum of 6 in (150 mm) with upstream panel on top. Secure roll end overlaps with two rows of pins staggered 6 in (150 mm) apart on 12 in (300 mm) (Figure 13)
  - For channel bank heights or channel bottom widths greater than 45 ft (13.7 m), install simulated check slots. This method includes placing two rows of pins 12 in (300 mm) apart on 12 in (300 mm) centers at 45 ft (13.7 m) maximum intervals or across the midpoint of the slope for slope lengths less than 60 ft (18.2 m) (Figure 14).
  - At the break in slope interface towards the channel bed, it is suggested that Pins be installed on 12 in (300 mm) centers (Figure 15).

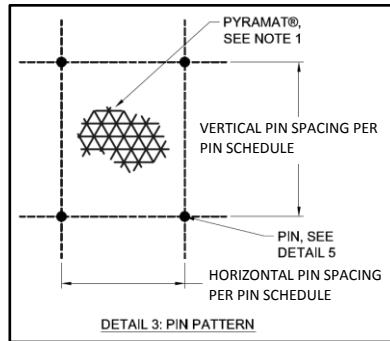


Figure 11: Example Pin Pattern

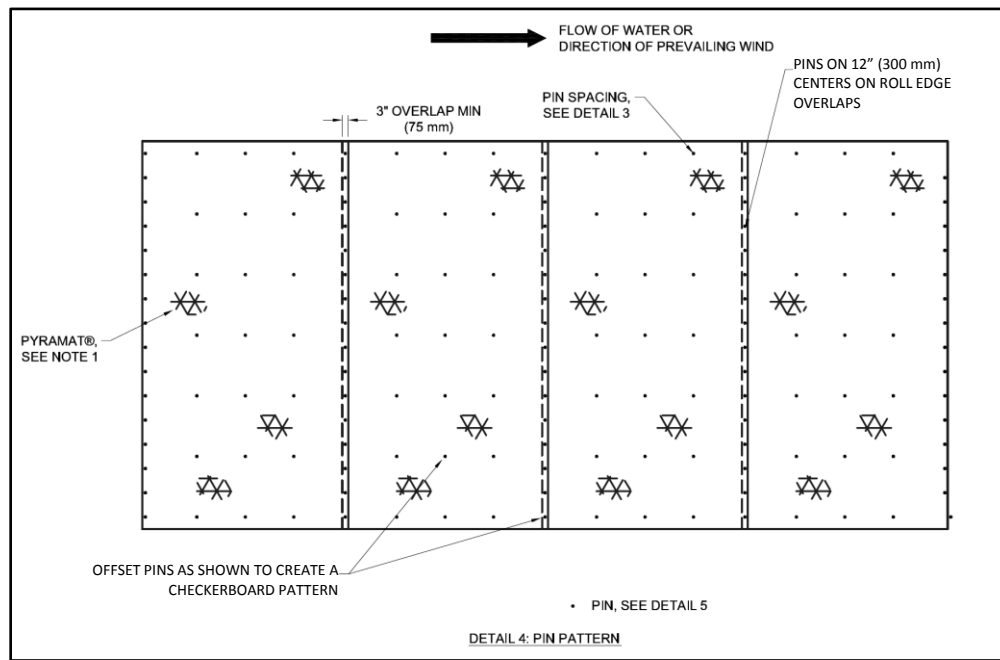


Figure 12: Example Edge Overlap Pattern

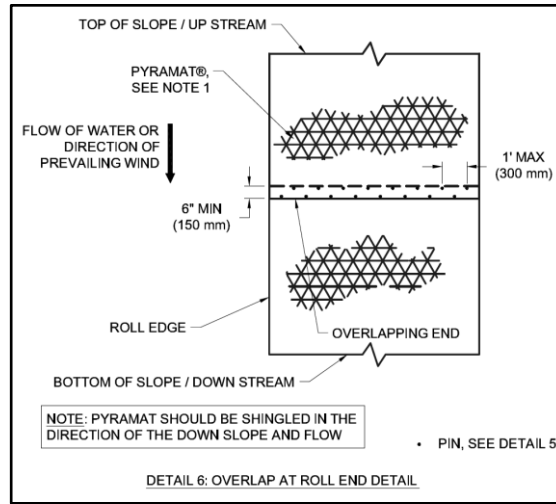


Figure 13: Roll End Overlap

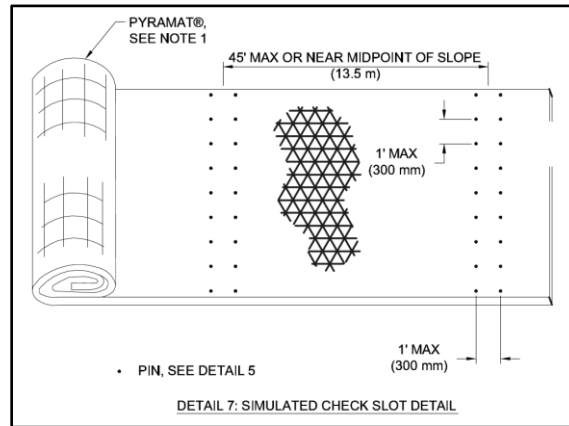


Figure 14: Simulated Check Slot

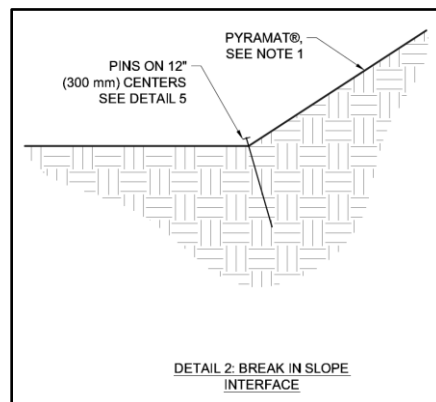
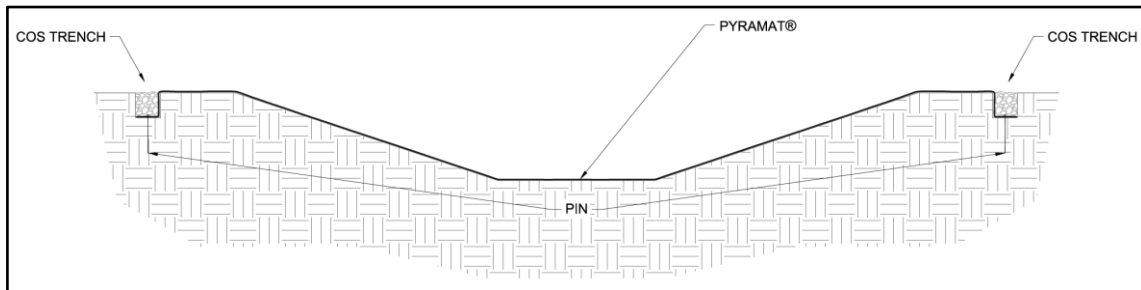


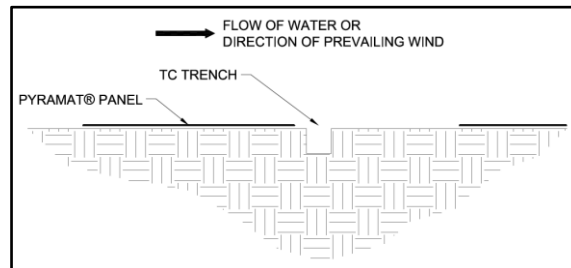
Figure 15: Break in Slope Interface

11. Secure PYRAMAT with pins in the opposite COS trench. Suggested placement of pins for the opposite COS trench is along the bottom of the trench on 12 in (300 mm) centers (Figure 16).
12. Backfill and compact the opposite COS trench in the location of the first PYRAMAT panel only (Figure 16).

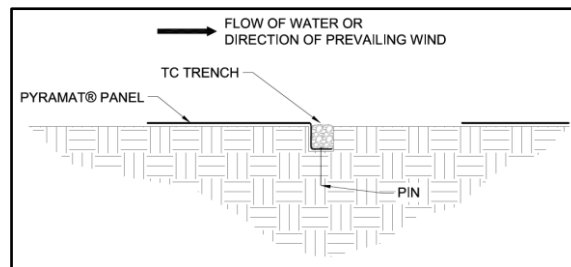


**Figure 16: Top of Bank (COS) Trenches Complete**

13. Continue to work down the length of the channel by repeating steps 6 through 9 overlapping each adjacent PYRAMAT panel by 3 inches (75 mm) (Figure 12). The last PYRAMAT panel should terminate on the Terminal Channel (TC) trench with pins on 12 in (300 mm) centers
14. Lay the last PYRAMAT panel on the upstream side of the TC trench (Figure 17). Place the panel edge in the TC trench, ensuring full coverage along the bottom of the entire TC trench with the PYRAMAT (Figure 18).
15. Secure PYRAMAT with pins in the TC trench. Suggested placement of pins for the TC trench is along the bottom of the trench with pins on 12 in (300 mm) centers (Figure 18).



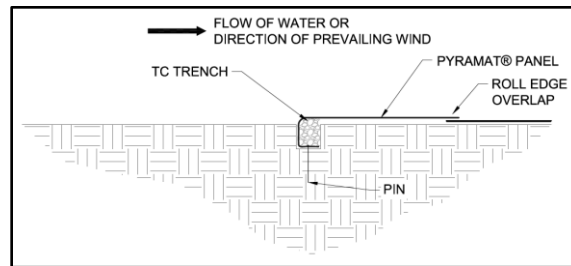
**Figure 17: Terminal Channel (TC) Trench Alignment**



**Figure 18: Terminal Channel (TC) Trench Placement**

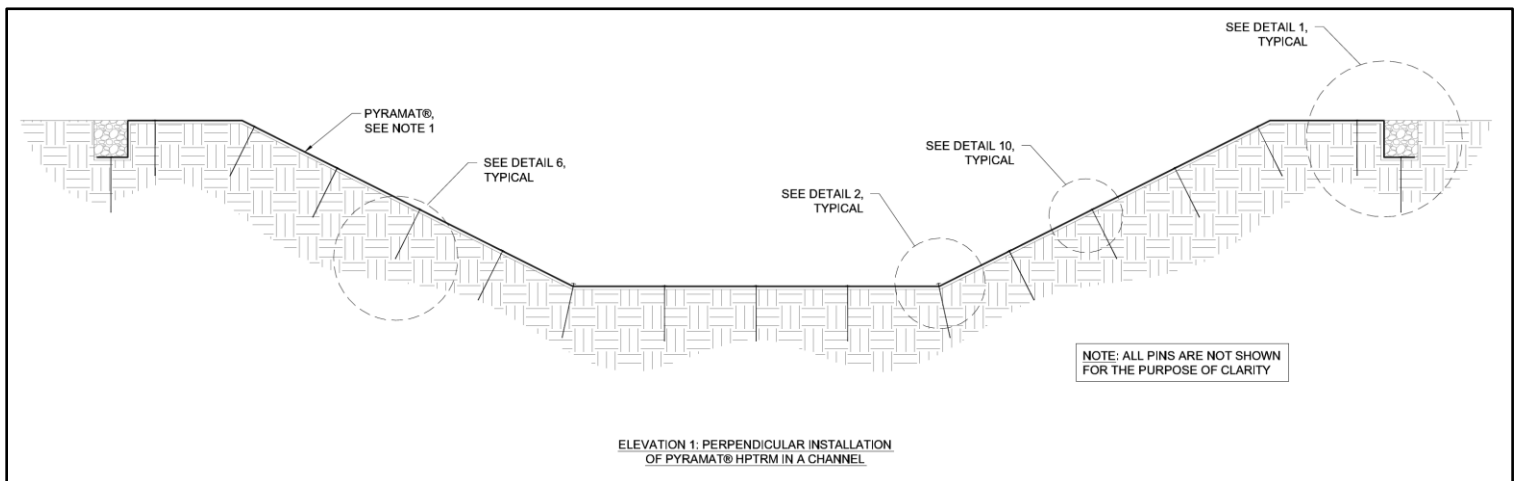
16. Backfill and compact the TC trench (Figure 18).
17. Fold the PYRAMAT panel over the top of the compacted TC trench (Figure 19) ensuring a minimum 3 inch (75 mm) overlap and place each panel end into the respective COS trenches.





**Figure 19: Terminal Channel (TC) Trench Complete**

18. At a minimum, PYRAMAT panels should be pinned entirely across the channel surface, pins should be installed in the trenches, and the trenches should be backfilled and compacted at the end of each day to minimize rework in the case of a major rain event. Specific project conditions may warrant further evaluation of installation order for ease. An example elevation view (Figure 20) of a channel armored with PYRAMAT can be seen below for overall reference. Consult Propex Engineering Services at 800.621.1273 with any questions that you may have.



**Figure 20: Completed Channel Elevation View**

## VEGETATION ESTABLISHMENT

Vegetation can be established with PYRAMAT by broadcast seeding, hydraulic seed application (hydroseeding), or sodding. Seed application rate, seed type, sod type, and irrigation rate should be selected based on local or site specific knowledge and time of year. For best results, consider having a site specific soil test performed to help determine what soil amendments, such as lime and fertilizer, need to be incorporated into the soil to promote healthy vegetation.

### WITH SEED

1. Determine the seed location. Seed can be placed entirely on top of soil filled PYRAMAT, or alternatively 50% below PYRAMAT prior to pinning and anchoring, with the remainder placed on top of soil filled PYRAMAT. If a rain event occurs prior to vegetation establishment, having 50% of the seed below PYRAMAT ensures that some seed remains in place. Seed placed entirely on top of soil filled PYRAMAT will allow for faster vegetation establishment.

2. If seeding below PYRAMAT, ensure 50% of the seed is placed prior to the installation of PYRAMAT.
3. Once PYRAMAT is in place, distribute soil on top by filling the pyramid like projections of PYRAMAT. The proper amount can be visually measured by making the top ridges of the pyramid projections barely visible, or is approximately 1 inch thick when measured. Soil filling can be accomplished manually or by using a small piece of equipment. Do not place excessive soil above PYRAMAT. See *PROJECT SPECIFIC CONSIDERATIONS* for guidance on driving equipment across PYRAMAT.
4. After seed has been placed, for added protection, install a Landlok® Erosion Control Blanket (ECB) above the soil-filled PYRAMAT.
5. Irrigate as necessary to establish and maintain vegetation until 75% of vegetation has established and has reached a height of 2 inches. Frequent, light irrigation will need to be applied to seeded areas if natural rain events have not occurred within two weeks of seeding. When watering seeded areas, use a fine spray to prevent erosion of seeds or soil. Do not over irrigate. Proper irrigation guidance is provided under the Maintenance portion of this document.

### **WITH SOD**

1. Sod will be always placed on top of PYRAMAT.
2. Sod staples should be used to secure the sod against PYRAMAT. During the placement of the sod, ensure that PYRAMAT is 100% covered by tightly adjoining rolls or squares of sod along edges. Any voids in between sod pieces should be filled with clean loose soil.
3. Irrigate as necessary. Proper irrigation guidance is provided under the Maintenance portion of this document.
4. Monitor to identify areas where browned/dead sod emerges. These areas may need to be addressed to ensure proper sod establishment.

### **PROJECT SPECIFIC CONSIDERATIONS**

1. For applications that require special transitions (i.e. connections to riprap, concrete, T-walls, etc.), refer to the project specific drawings or consult with Propex Engineering Services at (800) 621-1273.
2. A deeper trench and/or hard armoring may be required when channels have severe scour potential at IC and TC trenches.
3. For installing PYRAMAT panels around curved sections of a channel, trim panels at an angle so that no more than two layers of PYRAMAT overlap at any point in time. Additional pins may be needed to secure panel edges towards the break in slope interface depending upon the radius of the curved channel. Install pins as necessary to securely fasten PYRAMAT to the ground.
4. Allowable Vehicle Traffic:
  - A. If using equipment on PYRAMAT, it should be of the rubber-tired type and should avoid sharp turns. Tracked equipment is not permitted to drive over the PYRAMAT without vegetation at any time.
  - B. Avoid any traffic over PYRAMAT if loose or wet soil conditions exist.
5. Disturbed areas should be reseeded. If ruts or depressions develop for any reason, rework soil until smooth and reseed or sod such areas.

## SHORT-TERM AND LONG-TERM MAINTENANCE

The purpose of this section is to provide some general guidelines for performing short-term and long-term maintenance of PYRAMAT with respect to maintaining vegetation reinforced with PYRAMAT, and patching of PYRAMAT (in the event it needs to be removed or replaced). These procedures are to be considered minimum guidelines for proper maintenance, and further maintenance techniques may be appropriate considering local practices and procedures.

### PYRAMAT PROTECTED CHANNEL

For PYRAMAT to be most effective, it is important to ensure that it is properly maintained both during construction and after construction. Identifying trouble areas is easy with PYRAMAT, and it can make identifying potential threats much simpler and manageable. Look for areas with sparse, dying, or no vegetation as these are obvious signs that PYRAMAT is losing intimate contact with the channel surface. If loss of ground surface occurs, PYRAMAT will need to be removed and reinstalled as described in *PATCHING AND REPAIRS* Section after the eroded area is backfilled with compacted soil that is similar to material of the slope. After PYRAMAT is reinstalled, re-establish vegetation on the newly installed PYRAMAT and disturbed areas. Monitor the sites to determine if frequent watering may be required to establish vegetation.

To minimize exposure to unwanted maintenance and repair, PYRAMAT armored channels should be free of unauthorized vehicular traffic. Routine maintenance and slope inspections should be performed with rubber tired vehicles. Tracked equipment such as skid steers, excavators, or dozers should only be allowed to traffic over PYRAMAT in times of emergency after vegetation establishment is complete. Failure to control unauthorized traffic can result in PYRAMAT being damaged resulting in erosion below PYRAMAT during storm events. In addition, routine mowing maintenance should be used to keep the protected area free of unwanted brush, saplings, and trees. Selective herbicides that target only the unwanted plants can be used as long as the vegetation established with PYRAMAT is not impaired. Failure to control the sapling and tree growth can result in the trees being uprooted during a flood.

### MAINTAINING VEGETATION

Good vegetative cover will ensure maximum performance of PYRAMAT. Vegetative cover care starts before a project is complete and is ongoing until all PYRAMAT is installed. Vegetative cover should be given every opportunity to grow and establish well. This will require that a contractor periodically fertilize, water, and mow the grasses as needed until a project is complete in the short-term, with the owner of the channel fulfilling the maintenance of the channel in a similar fashion for the long-term. For the entire lifecycle of PYRAMAT, every effort must be made to prevent unauthorized encroachments, grazing, vehicle traffic, the misuse of chemicals, or burning during inappropriate seasons.

1. After the installation of vegetation is complete, immediately water and soak the entire area using a fine spray to prevent erosion and loss of seeds. A suggested amount of water is identified below. Prior to installation if using sod, the sod pads in storage should be kept moist at all times and not stored for more than 24 hours from site arrival to installation. Warmer weather will necessitate more frequent applications than listed below.
  - A. For each reach/segment of installed vegetation, watering shall be conducted immediately after each installation or the day's work.
  - B. First 30 days, completed segments shall be watered daily with a minimum of 0.75 and a maximum of 1.0 inches per square foot per day (20,364 gallons minimum, 27,152 gallons maximum per acre per day).
  - C. Second 30 days, the watering may be reduced to 0.50 inches per square foot per day (13,576 gallons maximum per acre per day) or as required based upon the condition of the sod.

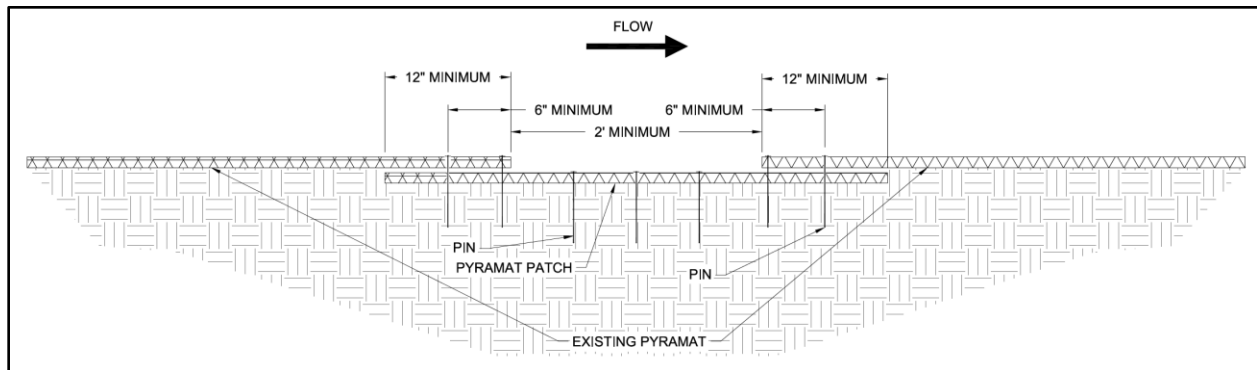
- D. Avoid excessive application of water, so that surface runoff does not occur. Runoff should be prohibited. However, additional watering may be required for repaired or damaged areas.
2. Initial fertilizing should be applied 14 days after vegetation is placed, using 25-lbs per acre ammonium nitrate or ammonium sulfate. Post-fertilization should be conducted 30 to 45 days after installation, using an application rate of 25-lbs per acre (ammonium nitrate or ammonium sulfate). Application example: in order to apply ammonium nitrate or ammonium sulfate at a rate of 25-lbs per acre, 75 lbs of 33-0-0 is required.
3. Implement best practices for mowing over PYRAMAT. While PYRAMAT is designed to withstand non-hydraulic stresses such as mowing, there are procedures to minimize exposure to unwanted damage.
  - A. Immediately after installation, signage and post shall be installed stating that "Vehicles and Pedestrians are Prohibited from Access" on the slopes and the newly installed vegetation. Signage shall be posted every 1,500 lineal feet.
  - B. Vegetated areas should be mowed to a height no less than 6 inches and no greater than 12 inches from natural ground after a period of 60 days of growth. The excessive grass clippings created from mowing shall be evenly spread on the slope section outside of the armored area. Periodic and final grass mowing should be performed until final inspection and acceptance of slope work. Monitor the vegetated areas throughout winter months and generate reports as needed, noting any issues that should be addressed. Minimum mowing heights will depend on the vegetation density and should be as follows:
    - i. 6" with 0 – 30% vegetation establishment
    - ii. 4" with 30 – 70% vegetation establishment
    - iii. 3" with 70 – 100% vegetation establishment
  - C. To prevent damage to the newly established vegetation, the mowing tractor should be fitted with 3-rib agriculture tires. Note that tractors with 8-foot flail mowers provide best results. Tractors with 15-foot brush hogs should avoid sharp turns up the slope to prevent damage to vegetation.
  - D. Mowing should not take place for a minimum of 48 hours after a rainfall event of 2 inches or more to minimize the potential for rutting and/or damage to the slope surface. Maintenance mowing of the slope should be done on a consistent basis to prevent vegetation growing to more than 3 feet in height. This will minimize thatch thickness and potential damage to PYRAMAT. If turn-around pads are present, operate mowing equipment utilizing the turn-around pads to the fullest extent. The mowing blade height over PYRAMAT should be a minimum of 8 inches. However, should vegetation grow to more than 3 feet in height, the mowing blade height for the condition should be a minimum of 12 inches.
4. Some special circumstances may exist. When mowing the crown of a slope with a crown or crest equal to or exceeding 20%, it should be mowed with an articulating arm mower to minimize the potential for the mower blades to catch PYRAMAT at the channel surface. The articulating arm mower should be level on the surface with the articulating arm extending over the crown. **Pay close attention to areas where the slope changes.** The mower blades should be set at a minimum height of 8 inches. If the PYRAMAT is damaged by the mowing blades at any time, mowing should stop immediately and further direction should be obtained to continue activity. Repair the damaged area as described in the *PATCHING AND REPAIRS* section below.
5. PYRAMAT protected channels are not as susceptible to animal burrowing due to the tenacity of the PYRAMAT; however, inspections to detect the presence of burrowing animal activity are generally most effective immediately after the slope has been mowed. Animal burrows that are identified should be thoroughly

excavated and inspected, backfilled with compacted soil that is similar to material of the slope, and vegetation re-established. This will avoid the possibility of water piping through unfilled portions of the burrows. Should PYRAMAT be damaged, it is to be repaired as described *PATCHING AND REPAIRS* section below.

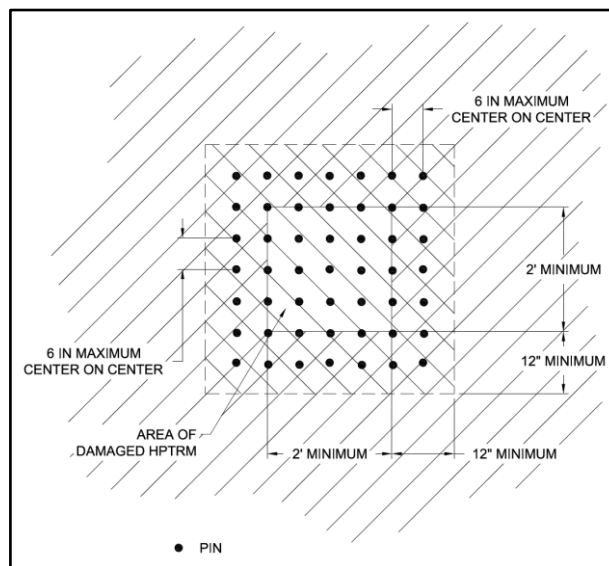
## **PATCHING AND REPAIRS**

PYRAMAT may require localized repair at times. For emergency repairs, an adequate supply of PYRAMAT should be maintained in inventory with the necessary tools to install. This will allow for a timely, initial repair of the system.

1. In order to identify areas in need of repair, the site should be patrolled immediately after mowing and after rain events of 2 inches or more. When patrolling look for areas of sparse vegetation, exposed edges of PYRAMAT, and areas where direct contact between PYRAMAT and the channel surface is compromised. PYRAMAT should be rated as *Acceptable*, *Minimally Acceptable*, or *Unacceptable* during inspection.
  - A. *Acceptable (A)* - The rated area is in satisfactory, acceptable condition, and will function as designed and intended during the rain event. PYRAMAT has no exposed edges, is installed tightly by maintaining direct contact to the channel surface with no rilling beneath, and has over 90% vegetation cover. There is no noticeable damage present.
  - B. *Minimally Acceptable (M)* - The rated area has a minor deficiency that needs to be corrected. The minor deficiency will not seriously impair the functioning of the area during the next rain event; however, the overall reliability of the project will be lowered because of the minor deficiency. PYRAMAT has 75% vegetation cover with un-vegetated patches as large as one square yard. Edges of PYRAMAT are exposed with noticeable damage. Minimal erosion has occurred underneath PYRAMAT.
  - C. *Unacceptable (U)* - The rated area is unsatisfactory. The deficiency is so serious that the area will not adequately function in the next rain event. PYRAMAT has been physically torn, ripped, or lifted from the channel surface. Less than 75% vegetation cover is present with un-vegetated patches being greater than 1 square yard, and there is evidence that erosion is occurring beneath PYRAMAT.
2. Repair any raised or exposed edges of PYRAMAT by driving existing and additional pins along the edges as necessary to securely fasten to the ground. Inspect areas where the vegetation is not growing on top of PYRAMAT. Many times this is an indicator that PYRAMAT has lost contact with the ground beneath. Check for voids beneath PYRAMAT and fill any holes, gullies, etc. with compacted fill material if possible. Replace PYRAMAT as described below.
3. To repair PYRAMAT, cut out and remove damaged areas in a square configuration a minimum size of 2 ft by 2 ft. Remove all vegetation and debris atop of PYRAMAT. Loosen the top 1 to 2 in of soil in the patch area then seed. The subgrade of area to be patched shall be prepared to be smooth and uniform and transition smoothly into the in-situ area. Cut a square PYRAMAT patch a minimum of 12 in greater than the damaged area for all four sides of the patch. Overlap the patch area in all directions a minimum of 12 in. The patch overlaps shall be tucked under the existing damaged PYRAMAT material (Figure 21 and Figure 22).



**Figure 21: PYRAMAT Patch Cross Section**



**Figure 22: PYRAMAT Patch Plan View**

4. Install pins on 6 in (150 mm) (max) centers. For larger areas of damage, anchors should be installed to match existing anchor pattern. Once PYRAMAT is in place, vegetate per project specifications.

## SUMMARY

Maintenance should consist of watering and weeding, repair of all erosion, and any re-seeding as necessary to establish a uniform stand of vegetation during construction and beyond. A minimum of 70% of the armored area should be covered with no bare or dead spots greater than 10 ft<sup>2</sup> (1 m<sup>2</sup>). Establishing vegetation should not be mowed prior to 70% vegetative density and a minimum grass growth of 4 in (100 mm). Throughout the duration of the project, the contractor should be responsible for mowing to facilitate growth and should not let the vegetation in the armored areas exceed 18 in (450 mm). In addition, the Contractor should water all grassed areas as often as necessary to establish satisfactory growth and to maintain its growth throughout the duration of the project. After the project is complete, it is the responsibility of the Owner to maintain and upkeep all PYRAMAT installed areas for long term performance and best results as described herein for superior channel armoring.