APPENDIX 'E'

HIGH STRENGTH WOVEN GEOSYNTHETIC

GEOSYNTHETICS USED IN SUBGRADE STABILIZATION

Prepared by:

TenCate Geosynthetics Americas
365 South Holland Drive
Pendergrass, GA 30567
Tel. (706) 693-2226
Fax (706) 693-2044
www.tencate.com

July, 2013

General

This document is prepared to help ensure the geosynthetic soil reinforcement, once installed, will perform its intended design functions. To do so, the geosynthetic must be identified, handled, stored and installed in such a way that its physical property values are not affected and the design conditions are ultimately met as intended. This document does not account for every possible construction scenario. However, this document contains information consistent with generally accepted practices of identifying, handling, storing and installing geosynthetic materials for most roadway applications. If you have questions regarding a specific project or encounter conditions other than those described herein, call 888-795-0808. Failure to follow these guidelines may result in the unnecessary failure of the geosynthetic in a properly designed application.

Material Identification, Storage and Handling

The geosynthetic shall be rolled on cores having strength sufficient to avoid collapse or other damage from normal use. Each roll shall be wrapped with a plastic covering to protect the geosynthetic from damage during shipping and handling. Each roll shall be identified with a durable gummed label or the equivalent, clearly legible on the outside of the roll wrapping. The label shall indicate the manufacturer's name, the style number and the roll number.

Upon delivery, check the TenCate Mirafi® geosynthetic roll labels to verify the correct product has been received. Immediately inspect the geosynthetic to ensure it is free of any flaws or damage that might have occurred during shipping or handling.

While unloading or transferring the geosynthetic from one location to another, prevent damage to the wrapping, core, label or the geosynthetic itself. If the geosynthetic is to be stored for an extended period of time, the geosynthetic shall be located and placed in a manner that ensures the integrity of the wrapping, core and label as well as the physical properties of the geosynthetic. This can be accomplished by elevating the geosynthetic off the ground on dunnage and ensuring that it is adequately covered and protected from ultraviolet radiation, chemicals that are strong acids or strong bases, fire or flames including welding sparks, temperatures in excess of 140° F (60° C), and human or animal destruction.

Geosynthetic Placement and Overlap

Image 1 – Subgrade Preparation

Clear, grub and excavate (as required) to the plan subgrade or undercut elevation, stripping topsoil, deleterious debris and unsuitable material from the site. Cut stumps and other projecting vegetation as close and even to the ground surface as practical. Specialized equipment with low ground pressure, as directed by the Engineer, may be required for very soft soils (CBR ≤ 1.5%) to minimize subgrade disturbance. In addition, it may also be beneficial to leave root mats in place in such instances. The surface of the subgrade should be relatively smooth and level (Image 1), and depressions or humps greater than 6 inches (15 cm) should be graded out (i.e., back bladed/back dragged).

The geosynthetic reinforcement shall be placed directly on the prepared subgrade (Image 2). It should be rolled out flat and tight with no folds or wrinkles. Unroll the geosynthetic in the direction of travel so that the machine direction (i.e., long axis) of the roll is parallel with channelized traffic patterns. Adjacent rolls should be overlapped along their sides and ends as a function of subgrade strength as follows:

CBR ≥ 3%	12” to 18” (30-45 cm) overlap
1% ≤ CBR < 3%	24” to 36” (60-90 cm) overlap
0.5% ≤ CBR < 1%	36” (90 cm+) or Sewn*
CBR < 0.5%	Sewn*

* Please contact your local TenCate Geosynthetics representative for recommended sewing practices.

Image 2 – Geosynthetic Deployment

If the need for 40" inches (1M) of overlap is reached, it is strongly suggested that the overlap is sewn or otherwise adhered to limit the potential formation of a slip plane between the overlapped panels. *Note: very heavy loading and very soft subgrades will also warrant sewn seams instead of overlapping panels*. Prior to fill placement, the geosynthetic can be held in place using U-shaped sod staples or simply by strategically placing shovelfuls of the fill to weigh down the geosynthetic. Overlap ("shingle") the geosynthetics in the direction fill will be spread to avoid peeling-back of the geosynthetic at overlaps by the advancing fill, just as shingles on a roof are installed to prevent water flowing beneath the adjacent row of shingles below.

Cut and overlap the geosynthetic to accommodate curves. Cutting may be done with sharp shears, razor knives or handheld power (i.e., "cutoff") saws. Cut the geosynthetic to conform to immovable protrusions, such as manhole covers and vertical utilities.

Fill Placement

Aggregate fill, as specified, should be placed directly over the geosynthetic in 8 - 12 (20-30 cm) inch loose lifts. Typically, if the design section thickness is ≤ 16 inches (40 cm), the entire section should be placed and compacted in one single lift to minimize further degradation of the subgrade.

Image 3 – End dumping aggregate

On relatively competent subgrades (CBR ≥ 4%), standard, highway-legal, rubber-tired vehicles (end dumps and belly dumps) may be driven over the exposed geosynthetic at slow speeds (less than 5 mph [8 km/hr]), and in straight paths. These vehicles can dump aggregate fill as they advance, provided this construction traffic will not cause significant rutting upon bare subgrade. Sudden braking, sudden starting and sharp turning should be avoided. Tracked construction equipment must not be operated directly upon the exposed geosynthetic. A minimum aggregate fill thickness of 6 inches (15 cm) is required prior to operation of tracked equipment on the geosynthetic. In addition, turning of tracked equipment should be kept to a minimum to prevent tracks from displacing the fill and damaging the geosynthetic.

Image 4 – Spreading aggregate over geosynthetic

Over softer subgrades (CBR < 4%), aggregate fill should be end-dumped from the edge of the previously placed material (Image 3), spreading from the middle outward (Image 4).

Compaction

Standard compaction methods may be used unless the soils are very soft (CBR ≤ 1.5%). In such cases, static compaction with a light smooth drum roller is considered prudent (Image 5).

Once a stable working platform has been achieved, compact aggregate fill to project specifications, after it has been graded smooth and before it is subjected to accumulated traffic.

Image 5 – Smooth Drum Roller

Aggregate Fill Considerations

Preferred (not required) fill gradation for roadway applications is well-graded crushed aggregate fill with a maximum particle size of 1½ inches (40 mm) and less than 10% fines (passing #200 sieve). For unpaved applications, most clean granular fills, including sands are acceptable.

Installation and Repairs for Utility Cuts or Damaged Areas

Repairs to roadway reinforcement geosynthetics can be made in the field by placing a repair panel or patch over the damaged area. The repair panel should extend a minimum of 3 ft (0.9 m) beyond the edges of the damaged geosynthetics as shown in Image 6. Pullout and/or direct sliding calculations should be performed by the project engineer to verify the minimum required overlap length to meet a specific project's requirements.

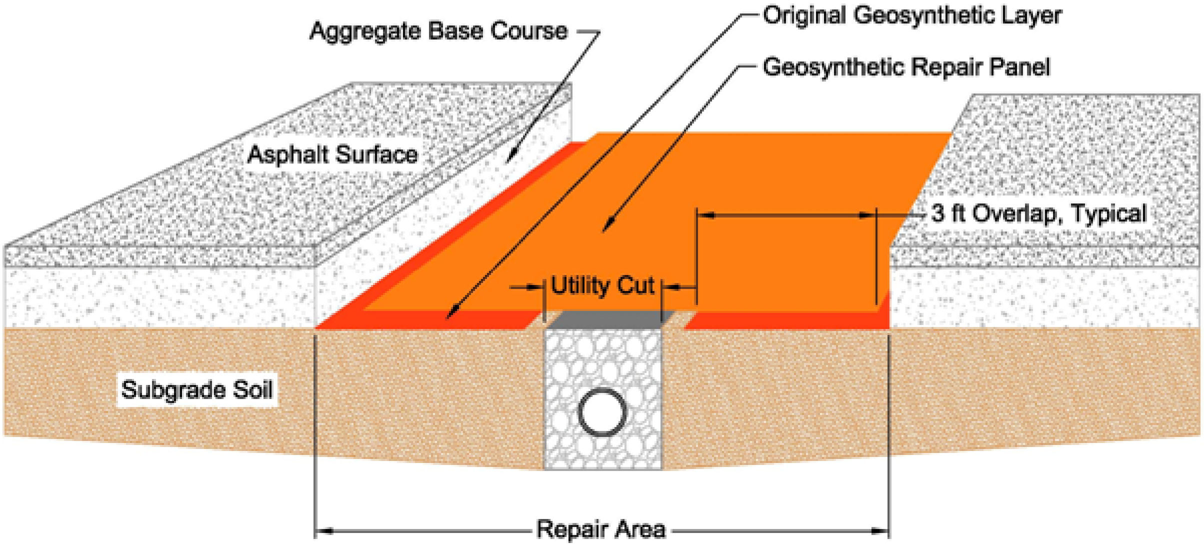

Image 6 – Typical Utility Cut Geosynthetic Repair Detail (NTS)

When placing roadway reinforcement geosynthetics in trenches or against excavations that terminate at existing curb and gutter, the geosynthetic can be wrapped up the sides of the excavation as shown in Image 7. Doing so provides extra embedment for the geosynthetic to resist pullout and sliding forces by sandwiching the material between the vertical faces of the existing materials and the newly compacted fill.

Image 7–Extending the Geosynthetic Reinforcement up a Vertical Face

TENCATE
Mirafi®

TENCATE GEOSYNTHETICS
Americas

Mirafi® RS380*i*

CONFINEMENT FILTRATION REINFORCEMENT SEPARATION

Mirafi® RS380*i* is a specially designed geosynthetic that integrates the key performance characteristics to maximize performance. Extensive performance testing has been performed per AASHTO and FHWA guidelines to validate performance for both paved and unpaved roads. The patented weave pattern and unique Orange identifier yarn make the Mirafi® RS380*i* a unique performance geotextile.

Roadway Design and Performance Properties	Guidance Document / Test Method	Unit	Design / Calibration Value	
Base Course M_R Improvement Factor[1]	AASHTO R50-09	---	1.3	
Traffic Benefit Ratio: TBR[2,3,4]	AASHTO R50-09	---	3.9 / 5.2 / 21.75	
Cyclic Tensile Modulus @ 2% Permanent Strain: J_{cyclic}[3] (MARV)	ASTM D7556	lb/ft (kN/m)	MD	CD
			54,406 (794)	72,907 (1064)
Interaction Coefficient: C_i[5]	ASTM D6706	---	0.89	
Pore Pressure Dissipation Ratio[2]	Measured	---	1.6	
Average Dynamic Filtration Pore Size	ASTM D6767	microns	O_{95} - 392 O_{85} - 328 O_{60} - 245 O_{50} - 195	
Tensile Strength @ 2% Strain (MARV)	ASTM D4595	lb/ft (kN/m)	MD	CD
			600 (8.8)	1,020 (14.9)
Tensile Strength @ 5% Strain (MARV)	ASTM D4595	lb/ft (kN/m)	1,800 (26.3)	2,256 (32.9)

Index Properties	Test Method	Unit	Roll Value
Apparent Opening Size, AOS (Maximum Roll Value)	ASTM D4751	U.S Sieve (mm)	40 (0.425)
Hydraulic Flow Rate (MARV)	ASTM D4491	gal/min/ft^2 (l/min/m^2)	75 (3,056)
Permittivity (MARV)	ASTM D4491	sec^{-1}	0.9
UV Resistance (at 500 hours exposure)	ASTM D4355	% strength retained	90

Notes:

[1] Value Determined from Results of Independent Testing Performed at Kansas State University in accordance with NCHRP Report 512 "Accelerated Pavement Testing: Data Guidelines" and AASHTO R50-09 Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures." Multiplier for Unbound Granular Material; for SG M_R between 4.5 and 6.9 ksi (30.9 and 47.4 MPa).

[2] Value Determined from Results of Independent Testing Performed at GeoTesting Express (GeoComp) "A Laboratory Evaluation of the Performance of TenCate Mirafi® Geosynthetics in Roadway Stabilization Applications – Georgia Silt Subgrade," September 1, 2011. 9-kip {40 kN} Wheel Load, SG CBR = 1%, 12-inch (300-mm) Crushed Aggregate BC (CBR > 25%), 3-inch (75-mm) Rut Depth.

[3] Value Determined from Results of Independent Testing Performed at LTRC "Performance of Reinforced–Stabilized Unpaved Test Sections Built Over Native Soft Soil Under Full-Scale Moving Wheel Loads," TRR Volume 2511, 2015. Measured at 0.34-inch (8.64 mm) Rut Depth; Peak Pore Pressure 6-inches (150 mm) Below Geosynthetic.

[4] Value Determined from Results of Independent Testing Performed at GeoTesting Express (GeoComp) "A Laboratory Evaluation of the Performance of TenCate Mirafi® Geosynthetics in Roadway Stabilization Applications – Montana Clay Subgrade," September 1, 2011. 9-kip (40 kN) Wheel Load, SG CBR = 1.8%, 8-inch (200-mm) Rounded Aggregate BC (CBR > 25%), 3-inch (75-mm) Rut Depth.

[5] Interaction Coefficient value is for sand (SP) or gravel (GW) based on testing conducted by SGI Testing Services.

~~[6] Typical Value Determined from Specimen Results of Independent Testing Performed at TRI Environmental, Various Dates.~~

U.S. Patent 8,333,220 and 8,598,054

TenCate, Mirafi, and the color ORANGE used in connection with geosynthetic or geotextile products are registered and/or unregistered trademarks of Nicolon Corporation.

Disclaimer: TenCate assumes no liability for the accuracy or completeness of this information or for the ultimate use by the purchaser. TenCate disclaims any and all express, implied, or statutory standards, warranties or guarantees, including without limitation any implied warranty as to merchantability or fitness for a particular purpose or arising from a course of dealing or usage of trade as to any equipment, materials, or information furnished herewith. This document should not be construed as engineering advice.

FGS000726
ETQR15

QUALITY ASSURANCE GAI-LAP ACCREDITED LABORATORY
GAI-LAP-25-97