
NTPEP Committee Work Plan for Geosynthetic Reinforcement for Walls and Fills

NTPEP Designation: REGEO-19-01



**National Transportation Product Evaluation Program
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INTRODUCTION

The National Transportation Product Evaluation Program (NTPEP) was established to minimize the amount of duplicative testing of transportation materials performed by AASHTO member states by providing a process where manufacturer/suppliers submit their products to NTPEP for laboratory and/or field testing. The results of the testing are then shared with member departments for their use in product quality verification.

This practice provides NTPEP member departments information about the geosynthetic reinforcement testing and facility audit program. In keeping with the NTPEP philosophy of purely testing materials and auditing facilities for compliance with the work plan, no conclusions are provided with the test results. The evaluation and acceptance or rejection of the product test and facility audit results are left up to each member department.

1. SCOPE

1.1 This work plan covers the requirements and testing criteria for the National Transportation Product Evaluation Program (NTPEP) evaluation of geosynthetic reinforcement for reinforced soil walls, reinforced slopes, and reinforced fills over soft ground. NTPEP serves the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

1.2 This program provides performance test results as well as index test results. Performance tests require an engineered interpretation of the results, whereas index test results may be used directly by member states to assess compliance with product acceptance requirements for a specific geosynthetic application and may also be a property that is certifiable by a manufacturer. These index test results may be used to indicate "probable" compliance of a product to a manufacturer's certified MARV values.

1.3 The purpose of AASHTO's NTPEP REGEO work plan for geosynthetic reinforcement is to establish a list of manufacturing plants and private label companies, and their associated geosynthetic reinforcement products that conform to the quality control and product testing requirements of this work plan. Tests for the complete assessment of long-term strength of geosynthetic reinforcement products require considerable time and expense, as well as specialized expertise, to conduct and interpret. State DOT materials laboratories are not generally equipped to conduct all of the tests referenced in the standards, and equipping all, or most, of the labs to do so would not be cost effective. Some of the test procedures are quite specialized and the equipment would not be useable for other products or materials. An essential component of the work plan is to establish the requirements for auditing manufacturers and private labelers in order to confirm repeatability and consistency in the manufacturing and/or quality control processes of companies admitted into the program. Most State DOT's lack the time and resources to conduct such audits and may use the results published by NTPEP as part of their local product evaluation program.

1.4 AASHTO member departments can then use this information in their quality assurance program for geosynthetic reinforcement. This may include utilizing this information to establish a qualified supplier list and/or a qualified products list.

1.5 By participating in this program, the participant agrees to supply geosynthetic reinforcement that follows the minimum quality control provisions of the program. NTPEP validates this agreement through testing the geosynthetic reinforcement product(s) to verify compliance with the applicable standard and auditing the participant's quality system.

1.6 The manufacturer or private label company agrees that NTPEP may use the test results and audit reports along with other relevant information for review and verification of compliance with this NTPEP work plan and the applicable AASHTO specification. If compliance is demonstrated, the NTPEP will list the product(s) and facilities conforming to this work plan in DataMine, NTPEP's online database.

1.7 *This work plan may involve hazardous materials, operations, and equipment. It does not purport to address all safety problems associated with its use. When conducting evaluations for the test methods included in this work plan, please use the required personal protective equipment (PPE). It is the responsibility of the user of this work plan to establish the appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- AASHTO R 69 – Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement
- AASHTO T 96 – Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

2.2 ASTM Standards:

- ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- ASTM D4354 – Standard Practice for Sampling of Geosynthetics for Testing
- ASTM D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
- ASTM D4439 – Standard Terminology for Geosynthetics
- ASTM D4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
- ASTM D4603 – Standard Test Method for Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer
- ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- ASTM D5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- ASTM D5262 – Standard Test Method for Creep Testing of Geosynthetics
- ASTM D5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- ASTM D5818 – Standard Test Method for Installation Damage Testing of Geosynthetics

- ASTM D5885 – Standard Test Method for Oxidative Induction Time of Polyolefins by High- Pressure Differential Scanning Calorimetry
- ASTM D6637/D6637M – Standard Test Method for Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
- ASTM D6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
- ASTM D6992 – Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
- ASTM D7409 – Standard Test Method for Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns

Note 1 – All ASTM test methods referenced herein are copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania, USA 19428-2959. All AASHTO specifications referenced herein are copyrighted by American Association of State Highway and Transportation Officials, 444 North Capitol Street N.W., Suite 249, Washington, D.C. 20001.

2.3 Other Test Standards:

- ISO/DIS 10722-1 – Procedure for simulating damage during installation. Part 1: Installation in granular materials
- ENV ISO 13438:1999 – Geotextiles and Geotextile-Related Products - Screening Test Method for Determining the Resistance to Oxidation
- GRI-GG8 – Determination of the Number Average Molecular Weight of PET Yarns Based on a Relative Viscosity Value

3. TERMINOLOGY

- 3.1 **Annual NTPEP Audit** – Audit of a manufacturer’s plant and associated internal test facilities by a NTPEP auditor and any AASHTO member department co-auditor that wishes to participate.
- 3.2 **Audit Supervisor** – The individual responsible for administering and managing the audit program.
- 3.3 **Deficiency, Major** – A procedure missing from the quality system: nonconformance that results in the probable shipment of nonconforming product.
- 3.4 **Deficiency, Minor** – A quality issue that does not result in the breakdown of the quality system, failure in part of the documented system.
- 3.5 **Geogrid** – Geosynthetic formed by a regular network of integrally connected elements with apertures greater than 1/4 inch to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to function primarily as reinforcement.
- 3.6 **Geostrip** – Polymeric material in the form of a strip (also sometimes called a polymer strap) of width not more than 8 inches, used in contact with soil or other materials in geotechnical and civil engineering applications, or both.
- 3.7 **Geosynthetic Lot** – The amount of geosynthetic produced per product style under the same standard operating conditions during a specific period of time not to exceed 12

consecutive months.

- 3.8 **Geosynthetic Reinforcement** – Geogrids, geostrips, and geotextiles that reinforce soil or aggregate for retaining walls, soil slopes and embankments.
- 3.9 **Geotextile** – Permeable geosynthetic comprised solely of textiles.
- 3.10 **Independent Laboratory Acceptable to NTPEP** – Laboratory that is accredited by the Geosynthetic Accreditation Institute (GAI) to perform specific tests as outlined in the work plan and has on-site qualified technicians and equipment necessary to perform the tests per ASTM and AASHTO standards.
- 3.11 **Initial Audit** – The first NTPEP audit conducted at a manufacturing plant.
- 3.12 **Lot Summary** – A lot specific table showing all sequential sample roll/coil test results and the associated lot statistics for each measured property. Statistics presented include average, standard deviation, minimum and maximum average roll/coil value.
- 3.13 **Manufacturer** – All producing plants and testing laboratories a manufacturer owns and operates.
- 3.14 **MARV** – The minimum average roll value (MARV) for the geosynthetic, defined as the average value minus two (2) standard deviations from documented quality control test results for a defined lot of production sampled in accordance with ASTM D4354, Table 1.
- 3.15 **Maximum Test Value** – The maximum test value for the geosynthetic, defined as the highest average roll/coil value from documented quality control test results for a defined lot of production sampled in accordance with ASTM D4354, Table 1.
- 3.16 **MD** – Machine direction of the geosynthetic.
- 3.17 **Minimum Test Value** – The minimum test value for the geosynthetic, defined as the lowest average roll/coil value from documented quality control test results for a defined lot of production sampled in accordance with ASTM D4354, Table 1.
- 3.18 **NTPEP Auditor** – An individual retained by NTPEP to review submittals, coordinate auditing and testing, and report audit findings and resin and geosynthetic split sample test results.
- 3.19 **NTPEP Geosynthetics Technical Committee Chairman** – The individual responsible for all technical aspects of the work plan and together with the NTPEP manager, resolves any conflicts that may arise.
- 3.20 **NTPEP Manager** – The individual responsible for overseeing that all areas of the program are conducted in accordance with this work plan.
- 3.21 **NTPEP Split Sample** – Specimen selected from the production line or inventory to be tested by both the manufacturer and NTPEP designated independent laboratory.
- 3.22 **Periodic Testing** – Additional testing completed on specimens collected aside from those collected during the annual on-site audit.
- 3.23 **Plant** – An individual geosynthetic manufacturing facility.
- 3.24 **Private Label Products** – Private label products are products currently listed in NTPEP by a

source manufacturer and offered for sale under the private label company's brand.

- 3.25 **Product Category** – A series of private label products distinguished by their manufacturing process and polymer. For this REGEO work plan, product categories include either woven geotextile or punched and drawn, woven/knitted and coated or welded geogrid. See AASHTO M 288 for geosynthetic terminology.
- 3.26 **Product Line** – A series of products manufactured using the same polymer (including stabilizers) in which the polymer for all products in the line comes from the same source and/or is purchased or manufactured by the geosynthetic manufacturer using the same property and material specifications for the base polymer plus additives, the manufacturing process is the same for all products in the line, and the only difference is in the product weight/unit area or number of fibers contained in each reinforcement element. A series of products manufactured at multiple facilities may be considered the same product line if the control of the manufacturing process and materials used for all products can be verified as described in Section 6.2.2.
- 3.27 **Product Style** – The proprietary name/number used as a designation for a specific product.
- 3.28 **Production Line** – A sequential operation established in a manufacturing plant to take raw material and produce a geosynthetic product ready for use. The production line may consist of several steps and equipment components or a singular step and equipment.
- 3.29 **Production Unit** – Regarding a geosynthetic lot, a production unit shall be defined as a product roll/coil.
- 3.30 **Quality Management System (QMS)** – The system by which a manufacturer or private labeler controls and documents the quality of the products it produces or distributes.
- 3.31 **QMS Desk Top Audit** – A complete review of a participant's QMS and the corresponding documentation by NTPEP or its designee.
- 3.32 **Raw Materials** – Materials acquired by a geosynthetic manufacturer for use in a production line to create a finished geosynthetic product, such as raw polymer/resin, strips, straps, fibers (including slit film fibers), yarns and polymeric additives (e.g., antioxidants, carbon black, fillers, other polymers to create polymer blends, dyes, and reworked material). Unfinished or partially finished fabrics, felts, etc., are not considered raw materials.
- 3.33 **Raw Material Lot** – A lot of raw material for a geosynthetic manufacturing facility is a railcar or truckload, hopper truckload, or truckload of boxes, but no larger than the lot of raw material as defined by the raw material supplier.
- 3.34 **Recycled Plastic** – Post consumer (e.g., detergent bottles, etc.) recycled polymer used to produce geosynthetic for non-DOT jobs.
- 3.35 **Reworked (or Regrind) Material** – A plastic from a processor's own production that has been reground, pelletized, or solvated after having been previously processed by molding, extrusion, etc. (ASTM D883).
- 3.36 **Single-Stream Resin** – A single stream resin is a feed of one virgin resin and may include carbon black pellets and reworked material.

- 3.37 **Source Manufacturer** – The manufacturer that functions as the source for a finished product and who is responsible for the quality of the finished product, including the QC testing conducted to assure the quality of the product.
- 3.38 **Surveillance Audit** – An audit conducted by NTPEP at a plant after major deficiencies are noted during a previous on-site audit. If a local DOT performs a plant audit, which is not the annual inspection by NTPEP, and finds major non-compliance issues, then a follow up NTPEP audit will be performed at the manufacturer’s expense. Surveillance audits may not necessarily be announced and will proceed regardless of the availability of key QC staff.
- 3.39 **XD** – Cross-machine direction of the geosynthetic.

4. SIGNIFICANCE AND USE OF THE NTPEP GEOSYNTHETIC REINFORCEMENT PROGRAM

4.1 The NTPEP Geosynthetic Reinforcement Program assesses the conformance of both manufacturing plants and products, and those who provide products manufactured by others (i.e., private label products). The program includes the following:

- 4.1.1 Desk Top Audit of the Participant’s Quality Management System (at least once every three years, if the participant has not been previously audited for the GTX or SSGEO work plans)
- 4.1.2 Initial and Annual On-Site NTPEP Audits
- 4.1.3 Split Sample Testing of Geosynthetic Reinforcement (obtained during auditing of participants)
- 4.1.4 Identification of Geosynthetic Products (marking/tagging and labeling)
- 4.1.5 A NTPEP website with the following information:
 - 4.1.5.1 A listing of geosynthetic products, by manufacturer or private label company and product style, tested and found to conform to the requirements of AASHTO R 69;
 - 4.1.5.2 A listing of participating manufacturing plants and private label companies with a QMS found to conform to this work plan; and
 - 4.1.5.3 A document library containing this work plan and a secure online database, i.e., DataMine, where AASHTO member departments can view participants’ QMS documents and test results. DataMine can be accessed through the AASHTO/NTPEP web site link at <http://data.ntpep.org/>.

5. APPLICATION FOR PROGRAM INCLUSION

5.1 Participants in the NTPEP Audit Program for geosynthetic reinforcement (defined as geosynthetic manufacturers and private label companies) must apply through the NTPEP DataMine website during each submittal cycle. Every year, the submittal cycle opens September 17th and ends November 30th. (Note: The submittal cycle is set up this way so that the audit tour can be prepared for the year, beginning in January) Every 3rd year, participants must submit a completed pre-audit application so that a desktop review can be performed by NTPEP for each participating facility. The desktop review must be completed before the on-site audit can be scheduled.

5.2 Any manufacturer of geosynthetic products or private label company that sells geosynthetic reinforcement manufactured by others under their own brand may participate in the program. For information regarding costs, and their associated due dates, please refer to the terms and conditions located under DataMine's Legal Information section.

5.3 For companies that distribute geosynthetic products under a private label and that wish to have those products included in the NTPEP program, the manufacturers that produce those products must participate in and conform to this NTPEP work plan and maintain a current listing for the product.

5.4 A two-step process will be used. The first step is a complete product qualification evaluation conducted using a product line basis, performed at a relatively low frequency (i.e., every 9 years), that could be used by member departments for the purpose of product acceptance. The second step is a more limited evaluation conducted at 3-year intervals between the 9-year product qualification testing cycles for quality verification purposes.

5.5 If a product manufacturer desires to submit additional products not included with the most recent NTPEP product qualification testing submission for a given product line, such products may rely upon the previous (but most recent) qualification testing for the product line, allowing a limited quality verification testing program to be used to evaluate the new products, if the following are true:

5.6.1 It has been less than 4 years since the last product qualification testing was conducted for the product line.

5.6.2 It can be demonstrated that the new products are part of the existing product line in accordance with the product line definition provided in this work plan and AASHTO R 69.

5.6.3 The limited quality verification testing program demonstrates that the new products are consistent with the rest of the product line in accordance with the criteria provided in AASHTO R 69.

5.7 When changes are made in a NTPEP listed product tested and reported under the REGEO program, the manufacturer shall notify the NTPEP program manager. Any changes in fundamental manufacturing method, nominal product weight, base polymer(s) architecture, or coatings/stabilizers will be considered a product change, and a reevaluation of the product may be required by NTPEP for continued listing. Changes in the published property MARV's or minimum values for the product (from those that were published at the time of the current NTPEP evaluation) will not be considered as a product change if the change can be shown to be a result of a reduction in manufacturing variability as documented by routine lot summary calculations.

5.8 The participation process is summarized as follows:

5.8.1 The participant must make a formal request through the NTPEP website to participate in the program. The request must list the participant's facilities and products to be evaluated and describe the participant's QMS.

5.8.2 Once the QMS is found to conform, the participant facility or facilities, including all associated internal testing facilities, the participant desires to qualify will be audited. This shall constitute the initial audit. Geosynthetic samples will be taken for testing in accordance with the appropriate AASHTO or ASTM specification and this NTPEP work plan. For the initial audit, the required minimum number of products tested will depend on the current status of the product testing cycle for the participant. However, the participant may request up to 100% of their products be tested as part of the initial audit.

5.8.3 An on-site audit will be scheduled approximately 4 weeks in advance. The plant will receive an announcement letter from AASHTO.

5.8.4 The testing program focuses on the product line as described in AASHTO R 69 and herein. Therefore, the testing program, both for product qualification (once every 9 years) and quality verification (at 3-year intervals between the 9-year full product line testing cycles), must be adequate to determine the long-term strength of the reinforcement for each product in the product line, taking advantage of the similarity in the characteristics in the products within the product line to interpolate to intermediate weight or strength products within the line. An adequate number of products within a single product line will be tested to fully characterize the product line, per AASHTO R 69. The number of products within the product line that need to be tested to accomplish this may vary depending on the size of the product line, the number of manufacturer operating or subcontracted production facilities, the range in properties encompassed by the product line, and possibly other issues specific to the product line under consideration.

5.8.5 For private label products, since the products that are private labeled must be from a source manufacturer who has been audited by NTPEP and found compliant, only a limited check testing program on representative products within the product category will be conducted. The private label report will be updated and posted when the source manufacturer completes qualification or verification testing and has a new report posted.

5.8.6 Audit reports are released to the NTPEP website and can be viewed by all AASHTO member departments and the personnel from the participant company at which the audit was conducted. A copy of the draft summary is also provided to the plant personnel at the completion of the on-site audit.

5.8.7 Each participating company is listed on the NTPEP website, showing if they are compliant with the program.

Note 2 – If major deficiencies are noted during an on-site audit, a surveillance audit will be required to be completed. Surveillance audits may not necessarily be announced and will proceed regardless of the availability of key QC staff.

6. ANNUAL MANUFACTURING PLANT AUDITS

6.1 Once initial plant QMS and product conformance is established as described in Section 5 above, annual NTPEP auditing and testing will be required for a manufacturer's plant to remain on the NTPEP list of compliant plants. The annual audits will be announced to the manufacturer in advance to make sure the manufacturer's key quality and manufacturing personnel are available during the audit. Audits will not occur on weekends or national holidays.

6.2 Annual plant audits will include the following:

6.2.1 **Documentation Review** – The auditor(s) will check the availability of the most current AASHTO and ASTM standards, review training and competency records, and evaluate the most current quality manual documentation and equipment records to verify implementation of the plant's QMS.

6.2.2 **Production Line Inspection** – During production line inspection, the auditor(s) will walk through the manufacturing process as necessary to complete the full audit, but in a manner that protects the manufacturer's intellectual property, to observe the conditions of the lines and to investigate the control of the product line manufacturing process based on conformance and compliance with process control plans and quality standards to determine whether or not the

grouping of products into a product line meets AASHTO R 69 requirements. The control of the manufacturing process and materials used for all products in the product line will be verified by the auditor. This will include verification that the same base polymer(s) and/or yarn are used in all products included in the product line, verification of polymer control, verification of quality standards, and verification of manufacturing process control. To determine the acceptability of treating a series of products from the same manufacturer as a product line, the requirements in AASHTO R 69 shall be met. If the audit verifies that the properties of the polymer used in the manufacture of the geosynthetic reinforcement are consistent regardless of the polymer source used, the requirement to reevaluate/retest the product or product line due to a polymer source change may be waived at the discretion of NTPEP.

6.2.3 Sampling and Testing – Audits will include the sampling of geosynthetic reinforcement from current production or inventory. The products sampled for independent testing will be those that are newly submitted to the program and/or those re-submitted on the 9-year product qualification evaluation cycle or at the intermediate 3-year cycle product line quality assurance evaluation. If no product submittals have been received for the year of the audit, a single product will be sampled for verification of index properties as detailed in Section 8.2.5.4, Table 1. Samples will be submitted to the NTPEP designated independent laboratory for evaluation. Additional samples will be taken from the same rolls/coils and tested by the manufacturer. During sampling, the auditor(s) will verify that marking/tagging and labeling are compliant with the requirements and take representative pictures of the marking/tags and labels. If a sample is taken from production instead of inventory and then later the manufacturer informs NTPEP that the roll/coil the sample was taken from does not meet the QMS requirements, resampling may be necessary. Any resampling will be at the discretion of NTPEP and the associated costs will be borne by the manufacturer.

6.2.3.1 Sampling will be conducted on a product line basis. Therefore, sampling will focus on the primary and secondary products that will be used to characterize the product line as identified by the auditor and will be conducted on a 9-year product qualification evaluation cycle. The remaining products in the product line will only have a limited sampling during this 9-year cycle.

6.2.3.2 A small sample or a photograph of all products to be included in the product line will be visually assessed to determine the degree of visual consistency between all products in the product line.

6.2.3.3 Once an initial assessment of the product line has been made, performance and additional index property sampling and testing for installation damage, creep, and durability will be conducted as specified in AASHTO R 69 for the products identified as a product line. Product specific test results for installation damage, creep, and durability as described in AASHTO R 69 will be obtained for a product selected and designated as the primary product plus a minimum of two other products in the product line to verify consistency of the other products in the line with the “primary” product and the ability to interpolate installation damage, creep and durability behavior to estimate strength reduction factors for the entire product line. Note that for durability a reduction factor is not provided, instead, the applicability of the default values included in AASHTO R 69 is evaluated. More products in the proposed product line may need to be tested depending on the size of the product line and the ability, once test data is obtained, to extend the test results from the representative products to the remaining products in the product line.

6.2.3.4 For the products not tested as primary or secondary products for product line characterization, a limited testing program to verify consistency of the product line shall be conducted as specified in AASHTO R 69. If all products submitted to be included in the product line are not available for sampling during the manufacturing plant visit by the NTPEP auditor/sampler, the following options to address the products not available for

sampling may be considered by NTPEP:

- Obtain whatever information is available for each product in the line that is not available for sampling, including information regarding traceability, manufacturing QC processes and target product geometries. Issue the report for the products that were available for sampling and testing, and report which products in the line that were not available for sampling. Attempt to sample the remaining products in the line not sampled in subsequent plant visits by an NTPEP sampler. Subsequent plant visits for the additional sampling will be conducted, on average, no more than once per year, and NTPEP will make arrangements with the manufacturer to identify the best time to obtain samples of the remaining products.
- The manufacturer may choose to withdraw one or more of the products not available for sampling from the product line rather than attempting future sampling visits.

Note 3 – Products not available for sampling that are lighter/weaker than the lightest/weakest product in the line sampled will not be included in the product line.

6.2.4 Inventory Inspection and Traceability – The auditor(s) will inspect the condition of the geosynthetic reinforcement in the plant’s inventory storage facility. Additionally, the auditor(s) will select various product styles of geosynthetic reinforcement and verify that roll/coil test results, raw material lot test results/certifications, and a lot summary associated with each lot representing the product style selected are available for the samples of geosynthetics selected.

6.2.5 Quality Control Testing Evaluation – Each geosynthetic manufacturer will be asked to demonstrate the quality control tests they perform on a regular basis. While performing each test, the most current AASHTO or ASTM test methods shall be referenced as needed. The equipment used for each test will be examined and applicable records will be reviewed.

6.2.6 The NTPEP Audit Team – The NTPEP audit team consists of the NTPEP auditor (AASHTO employee or designated subcontracted auditor) and an AASHTO member department co-auditor(s) from any state that wishes to participate. The auditor will produce a single audit report, which will include findings from both the auditor and AASHTO member department co-auditor(s), if present.

6.2.7 Inspection Visits and Testing – AASHTO member departments using the NTPEP listing have the right to conduct inspection visits and audit any manufacturer’s plant and associated laboratory included in the program to determine compliance with the program requirements. These visits may not necessarily be specifically scheduled. Unscheduled inspection visits will be announced to the manufacturing plant by pre-announcing a window of a minimum two weeks of time for the audit to take place. They may also randomly select samples of product in production for confirmation testing.

Note 4 – Inspection visits may result in the need for an additional NTPEP surveillance audit.

6.3 Proprietary Information – The manufacturer may reserve the right to require NTPEP audit team and/or AASHTO members to sign confidentiality agreements prior to visiting plants or facilities to protect information the manufacturer considers to be proprietary. The confidentiality agreement shall not restrict the ability of NTPEP to distribute information in the final audit report necessary to understand the audit findings to the NTPEP membership. Information not necessary to understand the audit findings shall not be reported or distributed. NTPEP members shall not distribute such information to anyone outside of their organizations.

6.4 For manufacturers that have multiple plants, an audit will need to be conducted at each plant with regard to the geosynthetic products produced in each of the respective plants submitted for NTPEP evaluation. For materials defined as raw materials, the producer of the raw materials does not need to be audited; however, traceability and quality control/quality assurance procedures and documentation used/obtained by the geosynthetic manufacturer will be evaluated as part of the geosynthetic manufacturer audit.

7. ANNUAL PRIVATE LABEL COMPANY AUDITS

7.1 An annual audit is required of companies that private label products produced by others. The focus of the audit is to establish traceability of the private label products to an audited geosynthetic manufacturing plant that is in compliance with this work plan. The private label company audit will include documentation review as applicable to records traceability and retention, and QC/QA procedures used by the private label company and all its participating warehouse/distribution facilities to assure the quality of the products they purchase, private label and sell, inventory/warehouse inspection to evaluate the condition of the private labeled rolls/coils and product marking/tagging, and sampling and testing of randomly selected rolls/coils of product. The annual audits will be announced to the company in advance to make sure the company's key quality personnel are available during the audit. Audits will not occur on weekends or national holidays.

7.2 AASHTO member departments using the NTPEP listing have the right to conduct inspection visits and audit any private label company included in the program to determine compliance with the program requirements. These visits may not necessarily be specifically scheduled. Unscheduled inspection visits will be announced to the private label company by pre-announcing a window of a minimum two weeks of time for the audit to take place. They may also randomly select samples of product for confirmation testing.

8. QUALITY MANAGEMENT SYSTEM (QMS) REQUIREMENTS FOR MANUFACTURERS

8.1 NTPEP audits will be based on a manufacturer following a quality control program at the plant that provides the following information: assurance that the geosynthetic products produced meet the requirements of AASHTO R 69 and that these products conform to this NTPEP work plan. The manufacturer will implement a documented QMS. Each manufacturer shall include elements that it considers necessary to assure that products meet R 69 requirements, but as a minimum, for geosynthetic manufacturers, the QMS shall include or address the following:

- 8.1.1 Organization and Organizational Policies
- 8.1.2 Product Marking, Tagging, and Labeling
- 8.1.3 Manufacturing Process and Documentation Control
- 8.1.4 Quality Control of Raw Materials
- 8.1.5 Quality Control Inspection, Measurement, and Testing for Geosynthetic Reinforcement Products
- 8.1.6 Quality Control Personnel - Training and Competency Evaluation
- 8.1.7 Statistical Analysis of Test Results
- 8.1.8 Resolution of Non-Conforming Product or Test Results

- 8.1.9 Retention of Records and Test Results, and Product Traceability
 - 8.1.10 Quality Control Testing Facilities
 - 8.1.11 Marking, Tagging, Storing, Shipping, and Handling of Finished Geosynthetic Reinforcement Products
 - 8.1.12 Internal Quality Audits of Each Plant Producing Product
 - 8.1.13 Lists of Plants, Quality Control Testing Facilities, and Technicians
- 8.2 The following sections provide more information about each of the 13 elements identified above.

8.2.1 (Detailed information for 8.1.1) Organization and Organizational Policies –

The QMS shall indicate the line of authority from the QC testing technicians to the QC manager, ensure that QC testing technicians have the authority to require corrective action, and ensure that the QC manager is independent of production management and of equal status.

8.2.2 (Detailed information for 8.1.2) Product Marking, Tagging, and

Labeling – Each geosynthetic manufactured for NTPEP program participation shall be clearly labeled as described in Section 8.2.2.3. In addition, physical marking of products is required for geotextiles and geostrips and optional for geogrids as described in Section 8.2.2.1. For geogrids that are not marked, tagging is required at each end of the roll as described in Section 8.2.2.2. Once the unique manufacturer marking or tag has been established, NTPEP notification is required before making any changes to the marking/tagging.

8.2.2.1 Marking shall be printed on the product at a frequency of at least once per 16.4 ft (5 meters). As a minimum, the physical marking shall include the unique NTPEP ID assigned to the manufacturing plant facility. In addition, manufacturers are encouraged to mark products with any or all of the information from the product labeling. The mark will be established and recorded by NTPEP, in collaboration with the manufacturer, during the application process for the initial audit.

8.2.2.2 Tagging shall be securely attached to geogrid products at the beginning and end of each roll. Tags shall be durable, tamper proof, and non-removable (without cutting) and shall be unique for each manufacturer and manufacturing plant facility. As a minimum, the tagging shall include the unique NTPEP ID assigned to the manufacturing plant facility. In addition, manufacturers are encouraged to include any or all of the information from the product labeling on the tagging. The tag will be established and recorded by NTPEP, in collaboration with the manufacturer, during the application process for the initial audit or at a later on-site audit if tagging was not required by this work plan at the time of the initial audit.

8.2.2.3 Labels shall be affixed by the product manufacturer to one end of the outside of the geosynthetic roll/coil outer wrapping and both ends of the inside of the geosynthetic roll core (for products that have a core) where they are easily visible for inspection. For geosynthetic rolls wider than 6.6 ft (2 meters) without a core, labels shall be affixed to both ends of the outer wrapping. Labeling shall be attached in a manner that would make the label difficult to remove or replace. As a minimum, the labeling shall contain the following information about the product and its production: the roll/coil and lot number, the product name (if the manufacturer is supplying the product to a private

label company, the product name is the one that will be used by the private label company), the production date, NTPEP ID number (shall match the marking or tags on the product) and “NTPEP listed”. If the permanent mark or secure tag described above contains all the information required for the labels, only one label on one end of the outside of the geosynthetic roll/coil outer wrapping is required and affixing labels to the geosynthetic roll core may be eliminated.

8.2.3 (Detailed information for 8.1.3) Manufacturing Process and Documentation Control – Each geosynthetic manufacturer shall establish, document, and maintain a QMS available for review by the NTPEP audit team, similar to the QMS documentation required for a certificate of registration from the International Organization for Standardization (ISO) 9001:2015 quality management system. If a manufacturer owns multiple geosynthetic manufacturing plants, each plant shall have its own QMS.

8.2.4 (Detailed information for 8.1.4) Quality Control of Raw Materials – The QMS shall include requirements for evaluating the quality of incoming resins, yarns, and other raw materials. The manufacturer shall do, as a minimum, the following:

- Establish specifications to be used for procuring raw materials used in the manufacture of geosynthetic reinforcement products and confirm that Certificates of Analysis (COA) demonstrate compliance with those specifications.
- COAs are provided with each raw material shipment (if shipment contains more than one lot as defined by the raw materials supplier lot definition, COAs shall be provided for each raw material lot).
- If more than one raw material supplier lot is used in a single lot of geosynthetic product, the geosynthetic manufacturer shall have specified maximum variances of COA properties allowed in a single geosynthetic product lot.
- If geosynthetic manufacturer conducts raw materials QA testing to verify the COA provided by a supplier, those QA test results shall be traceable to the COA’s and raw materials lot numbers.
- Geosynthetic manufacturer maintains records of raw materials such that COAs, showing raw material suppliers’ lot numbers, are traceable to final geosynthetic product on a roll/coil geosynthetic lot specific basis.

8.2.5 (Detailed information for 8.1.5) Quality Control Inspection, Measurement and Testing for Geosynthetic Reinforcement Products

8.2.5.1 The QMS shall describe the geosynthetic manufacturer’s visual inspection and production monitoring procedures. As a minimum the procedure shall require the manufacturer to conduct visual inspections continuously during production of the final product for the following:

- Holes,
- Damage,
- Thin spots,
- Other workmanship items as described herein, and
- Proper product marking/tagging and labeling.

8.2.5.2 The QMS shall also describe production equipment operational indicators to assure consistency in the operation of the production line. Examples include temperature sensors, pressure sensors, and any other indicators that can be used to quickly assess malfunctions. These operational indicators shall alert the production staff of the problem in a timely manner so that production can be immediately stopped to address the issue.

8.2.5.3 The QMS shall define the quality control tests, the method for random sampling, the size of the sample, and the lot size not to exceed 12 consecutive months for production facility quality control sampling and testing. The QMS shall also include an example of a quality control test report form. The QMS shall reference applicable AASHTO and ASTM standards. The QMS shall also describe any company procedures used.

8.2.5.4 The QMS shall require that the manufacturer perform and record the results of QC tests at the frequencies summarized in Table 1.

Table 1: Geosynthetic Reinforcement Manufacturer QC Test Requirements¹

Test Designation	ASTM Standard	Notes	Reported Value	Units	Test Frequency
Wide-Width Tensile Strength and Elongation	D4595 (geotextiles) or D6637/D6637M Method B (geogrids)	Geotextile and Geogrid products only, MD for Uniaxial Geogrid ² products and MD and XD for Biaxial Geogrid ² and Geotextile products	MARV	MD lbs/ft/% XD lbs/ft/%	ASTM D4354 <i>Table 1</i>
Ultimate Tensile Strength and Elongation	D6637/D6637M Method B ³	Geostrip products only, Strip Width measured and reported, Ultimate Tensile Strength calculated on a maximum load basis	MARV	MD lbs/%	ASTM D4354 <i>Table 1</i>
Single Rib Tensile Strength	D6637/D6637M Method A	Geogrid products only, Single Rib Tensile Strength used for Index/Quality Control Testing Only	MARV	MD lbs XD lbs	ASTM D4354 <i>Table 1</i>
Permittivity	D4491	Geotextile products only	Minimum test value	sec ⁻¹	ASTM D4354 <i>Table 1</i>
Apparent Opening Size (AOS)	D4751	Geotextile products only	Maximum test value	mm	ASTM D4354 <i>Table 1</i>
UV Resistance	D4355 (500 hr exposure)	All Geosynthetic products, At least one of lightest weight product within the product line tested	Typical Value ⁴	MD % retained XD % retained	Annually

¹Note that a 1-hour conditioning time is considered sufficient prior to testing of polyolefins and polyesters.

²See AASHTO M 288 for uniaxial and biaxial geogrid terminology.

³ASTM D6637/D6637M for Geostrip products tests a single reinforcing element so there is no normalization to strength per unit width required. For sampling specimens according 8.3.3 of ASTM D6637/D6637M, 5 test specimens shall be selected from one geostrip coil at an interval of one specimen per 5 feet of coil length.

⁴Typical value is the test result of independent testing performed within the previous 12 months.

8.2.5.5 The QMS shall ensure that:

- Each sample selected for quality control inspection and testing is designated with a product ID, sample control number for record keeping and traceability;

- The test report for each sample identifies the product, plant, date, shift of manufacture, and production line, and lot designation for the raw materials; and
- That quality control test reports (not samples) are maintained and available for review for 3 years, and may be in electronic form (i.e., paper copies not required).

8.2.6 (Detailed information for 8.1.6) Quality Control Personnel - Training and Competency Evaluation

8.2.6.1 The QMS shall ensure that:

- The manufacturer's QC manager meets the requirements established by the manufacturer;
- The QC manager qualifies technicians performing QC testing;
- QC personnel are familiar with the tests they perform; and
- QC personnel have sufficient authority to assure that corrective actions are carried out when necessary.

8.2.6.2 The QMS shall describe the manufacturer's QC technician qualification program. As a minimum the program shall include:

- Training in the AASHTO, ASTM, or company test procedures, operation of equipment, the procedures to be used, calculations required, and reporting;
- Demonstration of competency for each required test;
- Demonstration of ability to properly document test results;
- Annual auditing of each technician's ability to satisfactorily perform the required tests; and
- Retraining when a test method is revised.

8.2.6.3 Training and competency reviews shall be documented in such a way that compliance with the requirements for the initial and updated training and the initial and annual competency reviews can be demonstrated for each technician and for each test the technician performs. The documentation shall include the date of the training or competency review and contain the hand written signature or initials of the trainer/reviewer and the technician. This documentation shall be retained, for a minimum period of 5 years, at each facility where quality control testing occurs, and shall be made available to NTPEP for review upon request.

8.2.7 (Detailed information for 8.1.7) Statistical Analysis of Test Results – The QMS shall include a description of the manufacturer's approach using quality control data to monitor production and initiate changes or improvements in production as needed to maintain consistent quality and to establish certifiable property values. The manufacturer shall maintain lot-specific summary tables for each product style (lot summaries). Table 2 is an example of a lot summary table.

Table 2
TEST RESULTS

STYLE: _____ ; LOT #: _____ ; DATES: _____

Date / Time	Roll or Coil No.	Area Wt.	MD Tens	MD Elong.	XD Tens	XD Elong.	Perm	AOS
		g/m ²	N	%	N	%		
			AVERAGE ROLL/COIL VALUES FOR EACH PROPERTY FOR EACH ROLL/COIL TESTED					
	Average							
	_Std. Deviation							
	Minimum							
	Maximum							
	MARV							
	Certifiable Value							

8.2.8 (Detailed information for 8.1.8) Resolution of Non-Conforming Product or Test Results – The QMS shall include a procedure for resolving non-conforming product or test results. The procedure shall specify that:

8.2.8.1 Test reports clearly identify the deficiencies relative to targeted minimum property values;

8.2.8.2 All product produced subsequent to the previous testing be identified and quarantined pending investigation of the failure;

8.2.8.3 Investigations include obtaining and testing check samples, unless the manufacturer decides to only investigate manufacturing contributing factors based on observations and production monitoring records and dispose of the quarantined material without further testing;

8.2.8.4 If the first check sample meets requirements, the manufacturer shall document the reasons for the original failure and may release the quarantined material, with the exception of the roll/coil of material from which the failing sample was obtained, and resume normal production and testing;

8.2.8.5 If the first check sample fails, the manufacturer shall take corrective action to bring the product into conformance, shall note the corrective action on the test report, and shall continue QC testing to verify the deficiency has been corrected;

8.2.8.6 If additional QC testing also fails, the manufacturer shall repeat the process until

the deficiency is corrected;

8.2.8.7 All non-conforming material shall be segregated in the inventory. This segregated inventory shall be handled using one of the following options:

- Re-worked to manufacture new product or
- Scrapped.

8.2.8.8 If no assignable cause is determined for the failing production, then the test values associated with the failing rolls/coils will be maintained in the database or files and kept in the MARV calculation within the lot summary or

8.2.8.9 If an assignable cause is identified for the failing production it shall be documented along with a corrective action, then the failing test values may be removed from the lot summary but must be maintained in the database or files. The failing test values must be replaced by new values reflecting material sampled and tested to validate the corrective action.

8.2.9 **(Detailed information for 8.1.9) Retention of Records and Test Results, and Product Traceability** – The QMS shall describe in detail the process for storing and the location of stored quality control test reports, and how traceability of retained information from raw materials to final products is maintained. The maintained records may be stored in electronic form (i.e., long-term storage of paper copies is not required). The QMS shall ensure that:

8.2.9.1 Test reports are retained for at least 3 years and are available to the NTPEP upon request;

8.2.9.2 Product and product test reports are identified in such a way that the test results for any geosynthetic and raw material used to manufacture the geosynthetic can be located;

8.2.9.3 Documentation that indicates the action taken to resolve raw material or product failures;

8.2.9.4 The manufacturer retains a copy of the NTPEP audit documentation for a facility and actions taken to resolve any noted deficiencies on file at the facility for a period of 5 years;

8.2.9.5 Raw material test reports and the raw material manufacturer's certificate of analysis, and any raw material testing conducted by the geosynthetic manufacturer are traceable to the final product and can be retrieved upon request;

8.2.9.6 The manufacturer maintains a record of QC technician training and competency review documentation;

8.2.9.7 The manufacturer maintains a record of equipment maintenance activities; and

8.2.9.8 The manufacturer maintains a record of all calibration activities, including the person doing the work and the date the calibration activities were performed.

8.2.10 **(Detailed information for 8.1.10) Quality Control Testing Facilities**

Note 5 – QC testing may be performed at a location separate from the

geosynthetic manufacturing facility and/or by independent laboratories. The laboratory shall be subjected to review and evaluation in accordance with this work plan.

8.2.10.1 The QC testing facility shall:

- Maintain current versions of all AASHTO, ASTM, and company test procedures for all tests performed and a current version of the company's QMS documentation;
- Adequately house and allow proper operation of all required testing equipment; and
- Maintain records of all NTPEP reviews and actions taken to resolve any noted deficiencies.

8.2.10.2 The QMS shall describe in detail the requirements for the QC test facility(ies) and include, as a minimum, a description of how the following requirements are met:

- The plant shall cover QC responsibilities at all times, including when the QC manager is away from the plant for any reason.
- The manufacturer's QC manager shall be responsible for QC testing at all facilities and assure that all sampling and testing is done by technicians meeting the requirements of the manufacturer's technician qualification program.
- QC testing equipment shall be calibrated/verified in accordance with the equipment manufacturer's recommendations at least once every 12 months, or in accordance with the established testing standard, by personnel qualified for such work.
- QC testing equipment shall be properly maintained.

8.2.11 **(Detailed information for 8.1.11) Marking, Tagging, Storing, Shipping, and Handling of Finished Geosynthetic Reinforcement Products**

8.2.11.1 The QMS shall:

- Describe the manufacturer's method for permanently marking/tagging the geosynthetic in accordance with the minimum requirements of this Program;
- Detail and explain any coding used to mark/tag the geosynthetic; and
- Describe the procedures used to ensure that product handling, storage, and shipping processes will not adversely affect the material composition, characteristics, or product quality.

8.2.12 **(Detailed information for 8.1.12) Internal Quality Audits of Each Plant Producing Product**

8.2.12.1 The QMS shall include a description of the procedures used to conduct internal audits. The manufacturer, or an independent auditor hired by the manufacturer, shall perform these audits at least annually unless problems in the quality control program or with the quality of the product indicate more frequent audits are necessary. The internal audits shall include the following as a minimum:

- Evaluation of plant inspection,

- Inspection of testing equipment and calibrations,
- Observation of raw material sampling and lot control procedures,
- Observation of final product sampling and testing procedures,
- Review of product certification procedures,
- Review of inspection and testing report documentation, and
- Review of nonconforming product documentation and actions taken.

8.2.12.2 The QMS shall ensure that:

- Audit findings are discussed with plant management and testing technicians and documented in a report;
- Corrective actions are taken as necessary and documented in the report; and
- The most recent report is included in QMS documentation submissions.

8.2.13 **(Detailed information for 8.1.13) Lists of Plants, Quality Control Testing Facilities, and Technicians** – The QMS shall include the address and telephone numbers of all plants and QC testing facilities for which the manufacturer desires NTPEP qualification. The QMS shall also identify the QC contact for each facility with contact information and lines of responsibility.

9. QUALITY MANAGEMENT SYSTEM (QMS) REQUIREMENTS FOR PRIVATE LABEL COMPANIES

9.1 Companies that distribute products manufactured by others under a private label, shall establish a QMS documenting the procedures used to maintain traceability of the products to the source manufacturer, how they maintain quality control of their private label products, requirements for warehousing and storage of the geosynthetic reinforcement products, how they maintain records or quick access to records of the product they purchase and re-sell (including current manufacturer QC data for those products), and that the records retention requirements in this work plan are met. Private label suppliers will be required to participate in and conform to an annual audit of their QMS. Private label products will be subject to sampling/testing at the warehousing location during the annual QMS audit or at DOT customer project sites to verify compliance with these quality requirements. Conformance testing shall be completed in accordance with Section 10.3 of this document.

9.2 The private label company QMS shall include or address the following:

9.2.1 Organization and organizational policies, including locations of all warehousing facilities;

9.2.2 The company's source manufacturer qualification and quality review requirements;

9.2.3 Requirements for visual inspection of each geosynthetic product, verifying the as-manufactured product marking/tagging and labeling, manufacturer supplied certifications, and lot specific source manufacturer QC/QA data;

9.2.4 How the private label company verifies incoming and outgoing shipments of geosynthetic materials at all warehouses/distribution facilities are compliant with the requirements established in the company's quality policies document, including private label product

specifications;

9.2.5 How the company maintains traceability of geosynthetic rolls/coils to specific orders;

9.2.6 Resolution of non-conforming product or test results, including how geosynthetic products that are determined to not meet specification requirements are identified, traced, and quarantined;

9.2.7 How source manufacturer certifications and QC test results are retained or quickly accessed, and private label product traceability to the source manufacturer product data are maintained; and

9.2.8 Marking/tagging, storing, shipping, and handling of finished geosynthetic reinforcement products.

10. PRODUCT CONFORMANCE TESTING (NTPEP SPLIT SAMPLE TESTING)

10.1 The NTPEP Geosynthetic Reinforcement Program requires that geosynthetics be sampled and tested to determine conformance with AASHTO R 69 as the basis for determination of long-term geosynthetic strength.

10.2 Sampling and Testing for Manufacturing Plants

10.2.1 Once initial product evaluation has been established, an AASHTO/DOT auditor will sample geosynthetics during each plant audit as needed. Sampling and testing will be in conformance with Section 6.2.3 of this work plan.

10.2.2 The AASHTO/DOT auditor will randomly select the product roll/coil from which the samples will be taken and oversee the specific product samples taken. Each sample will be split, with the manufacturer retaining one set of samples for in-house testing and the auditor retaining the other set of samples split from the overall sample taken for AASHTO NTPEP testing. If the geosynthetic manufacturer does not have capability to perform a particular test as specified in AASHTO R 69 and this work plan, the split samples may be tested by an independent laboratory that stands in conformance of this work plan. Each set of geotextile or geogrid samples shall consist of a minimum of three laboratory samples measuring 6 feet in length by the width of the roll and shall be obtained from the single roll selected by the auditor. Each set of geostrip samples shall be obtained from of a single coil selected by the auditor. The samples shall not include the outer wrap of the roll/coil. For geotextile or geogrid rolls less than 12 feet wide, the length of the sample shall yield a minimum area of 36 square feet for each sample. The AASHTO/DOT auditor will label all samples to be tested. Two samples are to be sent to the NTPEP designated lab, one for primary testing and one for re-testing, if needed. The third sample is to be retained by the manufacturer for split sample testing.

10.2.3 The AASHTO/DOT auditor shall complete an identification label and attach it to each sample (an example of the label is shown in Figure 1). The completed label shall identify the NTPEP designation number, manufacturer, style, roll/coil number, lot number, the AASHTO/DOT auditor's name, date sampled, and date shipped. Alternatively, this information may be written directly on the geosynthetic sample. The sample shall be clearly marked to indicate the MD along the outer edge of the sample.

AASHTO-NTPEP TEST SAMPLE	
NTPEP DESIGNATION REGEO	
MANUFACTURER _____	
PRODUCT STYLE _____	
ROLL/COIL NO. _____ LOT/BATCH NO. _____	
WHERE SAMPLED _____	
SAMPLED BY _____	
NTPEP REPRESENTATIVE _____	
DATE SAMPLED _____	
DATE SHIPPED _____	

Figure 1. Example geosynthetic product sample identification label.

10.2.4 The sample shall be rolled for shipment to the AASHTO NTPEP designated testing facility. It shall be placed inside, or around, a rigid core during shipment. The package shall be wrapped with a protective cover. If sample rolling is not possible, at the discretion of the manufacturer, the samples may be loosely boxed for shipment to preserve sample integrity.

10.2.5 In addition, an “In-Plant Sampling Report” must be completed by the sampler. One copy of this report must accompany the samples. An example of this report is included in this work plan.

10.2.6 All tests identified in Section 8.2.5 in this work plan shall be conducted. Within 15 days after the sample is taken, the manufacturer shall submit their split sample test results to the NTPEP audit program supervisor. Once the NTPEP laboratory results are available and submitted to the NTPEP audit program supervisor, the NTPEP audit program supervisor will compare the test results and determine if both sets of test results are in compliance with the NTPEP work plan. If any of the test results are not in compliance, the NTPEP audit program supervisor will request from the manufacturer an explanation of any noncompliant test results, including any corrective actions found necessary in the manufacturing process or testing procedures. The NTPEP audit program supervisor will post the comparison of the split sample results and the corrective action taken in the secure area of the NTPEP website, available only to AASHTO member departments and the manufacturer for whom the testing was conducted, and annually evaluate the split sample results and report on testing proficiency.

10.2.7 The test results for a product will be in compliance with this NTPEP work plan if:

10.2.7.1 The test results meet or exceed all the AASHTO R 69 requirements for the product and

10.2.7.2 The test results meet or exceed the manufacturer’s MARV’s, minimums, or maximums for the product established based on the values submitted in the participant’s annual application.

10.3 Sampling and Testing for Products Distributed/Sold under a Private Label

10.3.1 A reduced sampling and testing program will be conducted for NTPEP quality assurance (QA) purposes for companies that market and distribute products manufactured by others to confirm consistency between the product testing conducted by the source manufacturer and NTPEP on the manufacturer’s products as described in the previous section, and the

products distributed and sold under a private label.

10.3.2 “Consistency” is defined as meeting or exceeding the same AASHTO R 69 requirements as the source manufacturer’s audit results demonstrated and that they also meet or exceed the source manufacturer’s MARV, minimum, or maximum for the source product which is based on the source manufacturer’s QC test results conducted in conformance with the source manufacturer audit.

10.3.3 Sampling shall be conducted in a manner that is consistent with the sampling protocol and documentation process as defined in the previous section for testing to evaluate conformance of the manufacturer to this work plan.

10.3.4 Testing conducted on private label products shall include all tests identified in Section 8.2.5.4. Except for UV resistance, testing will be conducted annually on one product from each product category selected at the discretion of the auditor. For UV resistance, testing will be conducted on a 3-year cycle on the lightest weight product from each product category.

11. PRODUCT PERFORMANCE (PRODUCT QUALIFICATION) TESTING

For product qualification, the product performance and evaluation program (note: this is not split sample testing) shall be in compliance with AASHTO R 69. In addition:

11.1 Section 6 of AASHTO R 69 shall be considered fully applicable to the testing identified herein as product qualification testing.

11.2 The lightest or weakest product shall be tested for resistance to installation damage, for UV resistance, and for oven aging (polyolefins only). With regard to installation damage, however, the heavier products must also be tested in addition to the lightest product. Note that for installation damage, the lightest or weakest product may not be the least resistant to installation damage for coated polyester geogrids and geostrips. Hence, every product in the product line is subjected to a limited installation damage testing program in accordance with AASHTO R 69.

11.3 Installation damage testing shall be conducted for a minimum of three soils, one of which shall be classified as a sand in accordance with ASTM D2487 with a d_{50} size within the range of 0.2 to 2 mm, one of which shall be classified as an angular to subangular gravel in accordance with ASTM D2488 with a d_{50} size in the range of 10 mm or more, and with the third soil between these two soils with regard to its gradation.

11.3.1 The installation regimen used for installation damage assessment shall be as follows:

11.3.1.1 Place steel lifting plate

11.3.1.2 Place and compact 8 inches (lift thickness after compaction) of aggregate used for exposure

11.3.1.3 Place geosynthetic sample

11.3.1.4 Place 6 inches (lift thickness after compaction) of the same aggregate with a 15,000 lb (approximate weight) wheeled front end loader and spread aggregate with the wheeled loader tracking on the aggregate over the geosynthetic. Compact aggregate with a single drum 25,000 lbs (approximate weight) vibratory roller using the heavy compaction setting (total equipment weight). For largest d_{50} size, compact gravel with 4 passes of the vibratory

roller. For the two soils with the smaller d_{50} size, compact sandy soil to 95% of AASHTO T 99 or 90% of AASHTO T 180.

- 11.3.2 The installation damage reduction factors obtained will be reported as a function of the d_{50} size of the soil for each geosynthetic product tested.
- 11.3.3 In addition, ISO/DIS 10722-1 (laboratory installation damage resistance test) may be performed for the lightest weight product tested in the product line, as well as heavier products if desired, if this test is used for quality assurance testing for installation damage.
- 11.4 Creep testing to assess RF_{CR} shall be conducted in accordance with AASHTO R 69
- 11.4.1 Single rib geogrid or narrow width geosynthetic reinforcement specimens may be used for this testing if it can be demonstrated that the test results produced using such specimens are consistent with what would be obtained using full wide-width or multi-rib specimens in accordance with AASHTO R 69. To this end, 1,000-hour comparison creep testing of single rib or yarn testing to multi-rib or wide-width specimens on the primary product in the product line used to establish the creep behavior for the product line shall be conducted in accordance with R 69. If the single rib or yarn test results are not consistent with the multi-rib or wide-width test results, then all creep tests must be conducted on multi-rib or wide-width specimens.
- 11.4.2 Creep tests shall be taken to rupture if possible. Load levels shall be selected so that rupture points are as evenly distributed along the log time axis as possible, and rupture times should not be less than 5 hours as specified in AASHTO R 69. Creep rupture data must be adequate for extrapolation to a design life of 75 and 100 years.
- 11.4.3 If the geosynthetic product or product line has been tested previously using a combination of real time and SIM creep testing meeting the requirements of this section, the SIM test results were shown to be consistent with the real time creep test results, and the products have not changed significantly relative to the previously tested products in terms of the polymer characteristics and how the products are processed/manufactured, the rupture envelope for the primary product may be established using only SIM test results without real time creep tests, subject to NTPEP discretion. A minimum of 12 rupture points using SIM shall be obtained in this case and shall be well distributed in time (see part “e” below).
- 11.5 When selected from the optional geosynthetic reinforcement testing program and performed for product performance qualification, in addition to the creep testing conducted to establish the creep rupture envelope, creep strain data shall be obtained for at least one load level low enough to produce a strain level at 1,000 hours of approximately 2% in accordance with AASHTO R 69.
- 11.5.1 A minimum of two specimens per product shall be tested for the 2% strain level.
- 11.5.2 For the low strain creep testing, ASTM D5262 shall be used, unless comparative testing is conducted that demonstrates ASTM D6992 is providing results that are consistent with ASTM D5262 per AASHTO R 69.
- 11.6 Durability testing shall consist of index testing for use with a default durability reduction factor (e.g., molecular weight based on ASTM D4603 and GRI-GG8, carboxyl end group content based on ASTM D7409 for polyesters, and UV resistance based on ASTM D4355 for polyolefins) per AASHTO LRFD Bridge Design Specifications or index testing combined with testing suitable for Arrhenius modeling to a design life of 75 and 100 years, conducted in accordance with AASHTO R 69, investigating appropriate degradation mechanisms (e.g., hydrolysis, oxidation, etc.). An oven aging exposure per ISO 13438:1999 shall be conducted for polyolefin geosynthetics, as a minimum on the lightest weight product in the product

line. Baseline and post-exposure specimens will be tested for tensile properties. The results of this test will be used for subsequent quality assurance testing, and to assure the minimum strength retention criterion is met.

11.7 UV resistance testing in accordance with ASTM D4355 shall also be done on the weakest or lightest weight polyesters products for the purpose of providing guidance on preburial exposure time limits. If UV resistance is found to be less than 50% after 500 hours for uncoated polyester products, a maximum preburial exposure time of 24 hours shall be noted in the report.

11.8 Optional geosynthetic reinforcement tests that may be requested by a manufacturer include pullout and direct shear testing, and testing comparing the NTPEP test results to ISO testing for international use.

11.8.1 Pullout testing to determine coefficient of interaction, C_i : Pullout tests shall be conducted on a product specific basis rather than a product line basis due to the effect product geometry can have on pullout resistance. Pullout tests shall be conducted in accordance with ASTM D6706. Pullout testing shall be conducted on a minimum of three soils, one of which shall be classified as a sandy silt in accordance with ASTM D2487 with a d_{50} size approximately equal to or finer than 0.076 mm, one of which shall be classified as an angular to subangular sandy gravel or gravelly sand in accordance with ASTM D2487 and D2488 with a d_{50} size in the range of 4 to 10 mm, and with the third soil between these two soils with regard to its gradation. The backfill materials selected should be angular to subangular and shall be durable. The coarse sand and gravel portions of the backfill material should have a Los Angeles Abrasion (LA Abrasion) percent loss after 500 revolutions (AASHTO T 96) of no more than 35 percent. As required in the AASHTO LRFD Bridge Design Specifications, pullout test results shall be interpreted to determine F^* and \square using Appendix B of the FHWA Manual "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Vol.'s 1 and 2", FHWA-NHI-10-024 and FHWA-NHI-10-025, respectively (Berg et al. 2009). A minimum of three stress levels shall be tested, to simulated embedment of 5, 10 and 20 feet respectively.

11.8.2 Direct shear testing to determine coefficient of direct sliding, C_{ds} : Direct shear tests shall be conducted on a product specific basis rather than a product line basis due to the effect product geometry can have on the interaction coefficient. Direct shear tests shall be conducted in accordance with ASTM D5321, Procedure B, at the default shearing rate of 0.04 in./minute. Direct shear testing shall be conducted for a minimum of three soils, one of which shall be classified as a sandy silt in accordance with ASTM D2487 with a d_{50} size approximately equal to or finer than 0.076 mm, one of which shall be classified as an angular to subangular sandy gravel or gravelly sand in accordance with ASTM D2487 and D2488 with a d_{50} size in the range of 4 to 10 mm, and with the third soil between these two soils with regard to its gradation. The backfill materials selected should be angular to subangular and shall be durable. The coarse sand and gravel portions of the backfill material should have a Los Angeles Wear (LA Wear) percent loss after 500 revolutions (AASHTO T 96) of no more than 35 percent.

11.8.3 Low Strain Creep Stiffness: Testing shall be performed on the intermediate weight or strength (primary) product in the product line for characterization purposes. The primary product is tested for creep rupture at enough load levels to fully establish the rupture envelope in accordance with AASHTO R 69.

11.8.4 Additional Testing for International Use: The focus of the NTPEP REGEO program is on US testing protocols and engineering practice. However, upon special request by the geosynthetic reinforcement manufacturer, additional testing may be conducted using the same samples collected for the NTPEP testing program as defined in this work plan to meet or to compare to the testing procedures and analysis as specified in ISO/TR 20432 "Guidelines to the Determination of Long-Term Strength of Geosynthetics for Soil Reinforcement". Such additional testing could include, for example:

11.8.1.1 ISO 10319, Geotextiles — Wide-width tensile test

11.8.1.2 ISO/TR 12960, Geotextiles and geotextile-related products — Screening test method for determining the resistance to liquids [acids and alkalis]

11.8.1.3 ISO 13431, Geotextiles and geotextile-related products — Determination of tensile creep and creep rupture behavior

11.8.1.4 EN 12224, Geotextiles and geotextile-related products — Determination of the resistance to weathering

12. PRODUCT PERFORMANCE QUALITY VERIFICATION TESTING

For product performance quality verification, the testing and evaluation program shall be in compliance with AASHTO R 69. In addition:

12.1 For installation damage evaluation, a field exposure trial will be conducted for the most installation damage susceptible product in the series as determined from the product performance (qualification) testing (typically the lightest of weakest product in the series) using the soil with the middle d50 size of the three soils used in the product qualification testing (or use ISO/DIS 10722-1 – if so, must also conduct this test during product qualification testing). Statistical evaluation of this data shall be consistent with AASHTO R 69.

12.2 For creep rupture testing, only one of the products tested as part of the product performance (qualification) testing program, as a minimum, need be tested for quality verification purposes.

12.3 For durability evaluation, conduct 500 hr weatherometer test for polyolefins– must meet AASHTO criteria (e.g., AASHTO LRFD Bridge Design Specifications and AASHTO R 69). For polyesters, conduct ASTM D4603 with GRI-GG8, and ASTM D7409 tests – result must be greater than or equal to AASHTO requirement. UV resistance testing in accordance with ASTM D4355 shall also be done on the weakest or lightest weight of polyesters products for the purpose of providing guidance on preburial exposure time limits. If UV resistance is found to be less than 50% after 500 hours for uncoated polyester products, a maximum preburial exposure time of 24 hours shall be noted in the report.

12.4 For polyolefins, conduct air oven aging in accordance with ISO 13438:1999. Compare the tensile strength retained from these oven aging tests to the tensile strength retained that was observed during product qualification testing. The maximum difference in the strength retained shall be no greater than what is defined as statistically insignificant based on a one-sided student-t distribution at a level of significance of 0.05, per AASHTO R 69.

12.5 When selected from the optional geosynthetic reinforcement testing program and performed for product performance qualification, creep stiffness will be conducted as per article 11.7.3. If the product qualification testing indicates that the creep is log linear at the low strain levels tested, short-term (1,000 second) R+H tests may be used and extrapolated to 1,000 hours in lieu of 1,000-hour creep tests for quality verification purposes. A minimum of two R+H tests shall be conducted for the product selected for quality verification testing. If the product performance (qualification) Testing indicates that the creep is not log linear at the low strain level tested, then a minimum of two full 1,000-hour creep tests must be conducted for the selected product.

13. PRODUCT PERFORMANCE TESTING TO ADD NEW PRODUCTS TO AN EXISTING PRODUCT LINE

To assess whether new products submitted are to be considered part of an existing product line, the testing and evaluation program shall be as follows:

13.1 For installation damage evaluation, a field exposure trial will be conducted for each new product submitted, using the soil with the middle d_{50} size of the three soils used in the product performance (qualification) testing (or use ISO/DIS 10722-1 – if so, must also conduct this test during product qualification testing). If it was determined from the qualification testing for the existing product line to use a single value of RF_{ID} for the entire product line, each of the mean values for the new products shall have a strength retained after damage that is greater than or equal to the value used for the entire product line. If it was determined for the product line from the previous product qualification testing that the value of strength retained after damage is correlated to a characteristic property of the product line, such as product unit weight or product tensile strength, the mean strength retained after damage for the new products shall be compared to the average value obtained from interpolation between the nearest two products in the existing product line to the new products, and the maximum difference between the two means shall be no greater than what is defined as statistically insignificant based on a one-sided student-t distribution at a level of significance of 0.05 per AASHTO 69.

13.2 For creep evaluation for the purpose of determining RF_{CR} , three creep-rupture points shall be obtained for each of the new products being evaluated using SIM (ASTM D6992) or conventional ASTM D5262 tests (for which elevated test temperatures may be employed to accelerate creep) at a load level established at the time of product qualification testing that corresponds to a minimum rupture time of 100,000 hours and one rupture point at a load level that corresponds to a rupture time of 500 hours on the product qualification rupture envelope.

The failure time for each of these four rupture points for each new product shall be equal to or greater than the 95% lower prediction limit of the variable, log time, established by the student's t test of the original product qualification data set per AASHTO R 69.

13.3 For durability evaluation, conduct 500 hr weatherometer test for the weakest or lightest weight of the new products for polyolefins – must meet AASHTO criteria (e.g., AASHTO LRFD Bridge Design Specifications and AASHTO R 69). For polyesters, conduct ASTM D4603 with GRI-GG8, and ASTM D7409 tests – result must be greater than or equal to AASHTO requirement. UV resistance testing in accordance with ASTM D4355 shall also be done on the weakest or lightest weight of polyesters products for the purpose of providing guidance on preburial exposure time limits. If UV resistance is found to be less than 50% after 500 hours for uncoated polyester products, a maximum preburial exposure time of 24 hours shall be noted in the report.

13.4 For polyolefins, conduct air oven aging in accordance with ISO 13438:1999 for the weakest of the new products. Compare the tensile strength retained from these oven aging tests to the tensile strength retained that was observed during product qualification testing. The maximum difference in the strength retained shall be no greater than what is defined as statistically insignificant based on a one-sided student-t distribution at a level of significance of 0.05, per AASHTO R 69.

13.5 When selected from the optional geosynthetic reinforcement testing program and performed for product performance qualification, creep stiffness for the new products shall be evaluated for at least one load level low enough to produce a strain level at 1,000 hours of approximately 2%. If the product qualification testing conducted indicates that the creep is log linear at the low strain levels tested, short-term (1,000 second) R+H tests may be used and extrapolated to 1,000 hours in lieu of 1,000-hour creep tests. A minimum of two R+H tests shall be conducted for each geosynthetic product selected for testing at the load level in which 2% strain at 1,000 hours was achieved in the product qualification testing. If the product qualification testing indicates that the creep is not log linear at the low strain level tested, then a minimum of two full 1,000-hour creep tests must be conducted. The creep stiffness test results for the new products shall meet the statistical criteria per AASHTO R 69.

14. RESOLUTION OF AUDIT OR TESTING FAILURES AND DISPUTES

14.1 When a nonconformance is found during an audit, the burden will be on the participant to identify the cause; develop, implement and document the resolution; and revise the QC plan to assure future conformance. When the participant is found to not conform with one or more aspects of the governing QMS, the following steps shall be taken:

14.1.1 The NTPEP auditor notifies the manufacturer of the issue(s).

14.1.2 The participant furnishes a Corrective Action Report (CAR) to AASHTO within 15 business days of the final NTPEP audit report to the NTPEP auditor. The CAR is to contain: the issue being addressed, the course(s) of action to be taken and a timeline showing when these actions will be taken. There should be sufficient detail to adequately explain the processes to be followed.

14.1.3 If the CAR is not received within 15 business days, NTPEP notifies the participant that their facility is classified as “non-compliant” with AASHTO’s NTPEP audit program. The audit is considered completed and all fees paid will not be refunded.

14.1.4 If the participant still requests to participate in the program, they will need to reapply (See Section 5).

14.2 When the participant has a dispute with NTPEP regarding procedural issues, it shall be handled as follows:

14.2.1 The participant notifies NTPEP in writing of the dispute, providing appropriate documentation for the committee to fully understand the controversy, and requests a resolution.

14.2.2 Copies of the dispute and documentation are forwarded by NTPEP to the technical committee chairman and vice-chairman and to the NTPEP technical committee liaison. The technical committee, less industry representatives, will convene to discuss the dispute and render a decision on the appropriate resolution. Quorum for the purposes of this decision will be either the chairman or vice-chairman, the NTPEP liaison or his/her designee, and one other technical committee member. The chairman or vice-chairman will communicate the resolution to the participant in writing through NTPEP.

14.2.3 The participant may appeal within 30 days of the date of the resolution. If the dispute is not resolved to the participant’s satisfaction, the dispute can be raised to the NTPEP executive committee chairman for resolution by the NTPEP appeals board. The decision by the appeals board is final.

14.3 Inevitably, there are times when the sampled geosynthetic fails to meet specification requirements, or the manufacturer’s MARV, minimum, or maximum for the product established based on the QMS evaluated as part of this audit program, when tested by NTPEP, or when the manufacturer is found, during an audit, to have neglected one or more aspects of the governing QMS during manufacturing. While the manufacturer may request a retest, if enough sample is available, the burden will be on the manufacturer to identify the cause, document the resolution, and revise his QC plan to assure future conformance. All results will be reported. Any retesting or re-auditing will be at the discretion of NTPEP and the associated costs will be borne by the manufacturer.

14.4 Disagreements with NTPEP regarding test results will be handled as follows:

14.4.1 The manufacturer should verify that their manufacturing process is operating correctly,

that test equipment is calibrated, and that test procedures are correct. If these conditions are met, a set of three samples shall be obtained by an AASHTO representative in accordance with Section 10.2, as appropriate, from the same lot as the failing test. The samples shall be taken from one of the originally sampled geosynthetic reinforcement rolls/coils or from another geosynthetic reinforcement roll/coil of the same lot made during the same shift.

14.4.2 The manufacturer will test one of the samples, and if the results meet the AASHTO R 69 requirements and the MARV, minimum, or maximum for the product as determined based on the manufacturer's QC test results, the AASHTO representative will send one sample of the same product to an independent laboratory in conformance of this work plan and a second sample to NTPEP and request that the product be tested. NTPEP will consider the dispute resolved if the manufacturer's test results are in conformance with this work plan and conform with at least one of the other testing facility results (i.e., the manufacturer's test results and either the independent or NTPEP laboratory test results are determined to be in compliance with this work plan as specified in Section 10). If this is not the case, the manufacturer should repeat the process of checking the manufacturing process, the equipment calibration and the test procedures until satisfactory agreement with inter-laboratory testing is accomplished.

14.5 To withdraw from the program, a written request must be received by the NTPEP manager at least five business days before the auditing/sampling is to begin. For information regarding costs, and their associated due dates, please refer to the terms and conditions located under DataMine's Legal Information section.

15. PUBLIC NOTICE

15.1 One of the primary reasons for a quality control program is to instill confidence in the end-user and the general public that the materials being used for infrastructure construction are of sufficient quality and to facilitate use of products that have proven to be of sufficient quality.

15.2 To this end the program will provide for public notice of companies, plants, and products found to conform with the provisions of this work plan via website postings, with official electronic reports issued to AASHTO member departments.

16. MODIFICATION OF QUALIFIED PRODUCTS (RETEST REQUIREMENTS)

16.1 Product design may change over time as manufacturers improve their products and optimize their manufacturing processes. When a design change is made in a NTPEP listed product, the manufacturer shall notify the NTPEP of the change within 30 days and submit samples for re-consideration of conformance with this work plan.

16.2 Any changes in manufacturing method, product weight, polymer components (including coatings and stabilizers), and/or polymer component(s) source, will be considered a product change, and a reevaluation of the product may be required by NTPEP for continued listing. Changes in the published property MARV's or minimum values for the product (from those that were published at the time of the current NTPEP evaluation) will not be considered as a product change if the change can be shown to be a result of a reduction in manufacturing variability as documented by routine lot summary calculations.

17. KEYWORDS

NTPEP; DataMine; reinforcement geosynthetics; geogrids; geostrips; geotextiles