

Grant 24-02

11.18.08

6229

# SUBGRADE RESTORATION PLAN

## CELL 2 LANDFILL PERMIT NO. 24-02

**International Paper Industrial Landfill  
Columbus County  
Riegelwood, NC**



**NOVEMBER 2008**

Prepared by:



URS Corporation – North Carolina  
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24-02 11 18 08 6229



RIEGELWOOD MILL  
865 JOHN L. RIEGEL ROAD  
RIEGELWOOD, NC 28456  
PHONE 910-362-4900

November 13, 2008

Mr. Geoffrey H. Little  
Environmental Engineer – Solid Waste Section  
North Carolina Department of Environment and Natural Resources  
Division of Waste Management  
1646 Mail Service Center  
Raleigh, NC 27699-1646

Subject: Cell 2 Landfill Subgrade Restoration  
International Paper Industrial Landfill  
Columbus County, North Carolina  
Permit No. 24-02

Dear Mr. Little:

During a September 29, 2008 meeting in your office International Paper agreed to provide plans describing subgrade restoration activities we propose for our Cell 2 landfill area. As you are well aware, our proposed Cell 2 landfill area has experienced significant disturbance while LCP-HoltraChem and their contractors have been performing PCB-impacted sediment remediation activities. Further, the protracted remediation activities have long delayed International Papers' intended Cell 2 landfill development activities.

We are hereby confirming our intent to proceed with subgrade restoration work as depicted on the attached engineering plans. These restoration activities will be limited to areas within the Cell 2 lateral landfill expansion approved during 2002. Although the attached plans show the full subgrade development elevations, the subgrade restoration work will be performed subject to the following limitations:

1. only within the originally approved Cell 2 footprint,
2. earthwork will only occur below elevation +30, and
3. the underdrain piping system will be installed to manage surface and groundwater.

Subgrade development requiring the import of borrow soil will be delayed until after a Permit to Construct has been received. International Paper will submit a complete set of drawings, as part of a Construction Permit Application, to the Solid Waste Section in the near future.

Please call me with any questions concerning this submittal.

Yours truly,



Edward J. Kreul  
Manager - Environmental Performance  
International Paper

Enclosures:

**DRAWINGS**

Drawing 1	Subgrade Restoration Plans Title Sheet
Drawing E1	Existing Conditions
Drawing E2	Underdrain Layout and Piping
Drawing E3	Base Grades Grading Plan
Drawing G1	Cross Sections
Drawing G2	Underdrain Details

**APPENDICES**

Appendix A	Construction Specifications
Appendix B	Construction Quality Assurance Manual



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November 13, 2008

Mr. Edward J. Kreul  
Manager Environmental Performance  
International Paper  
865 John L. Riegel Road  
Riegelwood, NC 28456

Subject: **Cell 2 Landfill Subgrade Restoration  
International Paper Industrial Landfill  
Columbus County, North Carolina  
Permit No. 24-02  
URS Project No. 31826244**

Dear Mr. Kreul:

URS Corporation is submitting herein 3 copies of Drawings, Construction Specifications, and a Quality Assurance Manual for the above referenced work as requested following our September 29, 2008 meeting with NCDENR Division of Waste Management (DWM) staff in Raleigh. During that meeting DWM staff verbally agreed with our request to perform subgrade restoration activities, to reshape soil disturbed during excavation work being completed by LCP-HoltraChem within the Cell 2 landfill footprint. We agreed to submit a written notice of intent to proceed with this restoration work along with confirmation International Paper would limit the restoration activities to earthmoving below elevation +30 (no borrow soil import), and installation of the groundwater underdrain piping system.

We stand ready to assist you with implementation of this project and ask that you call us at 919-461-1100 with any questions concerning this submittal.

Sincerely yours,

  
Richard K. Lowe  
Principal Geotechnical Engineer

  
Conan Fitzgerald, P.E.  
Sr. Project Manager



## **Technical Specifications**

### **International Paper Industrial Landfill Cell 2 Subgrade Restoration**

**Riegelwood, North Carolina**

Prepared for:

#### **International Paper**

805 John L. Riegel Road  
Riegelwood, North Carolina

**November 2008**

#### **URS Corporation**

1600 Perimeter Park Drive Suite 400  
Morrisville, NC 27560

**INTERNATIONAL PAPER INDUSTRIAL LANDFILL  
CELL 2 SUBGRADE RESTORATION  
RIEGELWOOD, NORTH CAROLINA**

**TECHNICAL SPECIFICATIONS**

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02270	Erosion and Sedimentation Control
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02640	Valves
02710	Drainage Aggregate
02720	Storm Water Systems
02930	Revegetation

**SECTION 02110**  
**SITE PREPARATION**

Site Preparation: Site Preparation includes clearing, grubbing, and stripping operations which precede the proposed construction.

A. DESCRIPTION

1. General:

- a. The Contractor shall furnish all labor, material, and equipment to complete Site Preparation in accordance with the Contract Drawings and these Specifications.
- b. Principal items of work include:
  - 1. Notifying all authorities owning utility lines running to or on the property. Protect and maintain all utility lines to remain and cap those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.
  - 2. Clearing the site within the clearing limits, including removal of grass, brush, shrubs, trees, loose debris, and other encumbrances except for trees to remain.
  - 3. Boxing and protecting all areas to be preserved.
  - 4. Removing all topsoil from designated areas and stockpiling on site where directed by the Engineer for future use.
  - 5. Disposing from the site all debris resulting from work under this Section.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223

B. MATERIALS Not Used.

C. SUBMITTALS Not Used.

D. CONSTRUCTION

1. Clearing of the Site:

- a. Clearing limits, as shown on the Contract Drawings, shall be established by the Contractor's Surveyor. Once established, the clearing limits shall be inspected and approved by the Engineer prior to clearing the affected areas.
- b. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shown on the Contract Drawings shall be cleared and grubbed.
- c. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, fencing, and other perishable and objectionable material within the clearing limits.

Should it become necessary to remove a tree, bush, brush, or other plants adjacent to the area to be excavated, the Contractor shall do so only after permission has been granted by the Engineer.

- d. Excavation resulting from the removal of trees, roots, and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02223, Embankment, of these Specifications.
- e. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, they are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2. Stripping and Stockpiling Existing Topsoil:

- a. Existing topsoil on the site within areas designated on the Contract Drawings shall be stripped to whatever depth it may occur, and reused to surface outboard slopes.
- b. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling.

- c. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

3. Grubbing:

- a. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks, and other perishable materials to a depth of at least 6 inches below ground surfaces.
- b. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

4. Disposal of Cleared and Grubbed Material:

All trees, stumps, roots, bushes, and refuse shall be disposed of by burning (Only if allowed by the Owner and local zoning) or shall be removed from the site and disposed of by the Contractor. The Contractor shall receive written authorization from the Owner prior to burning. Any material other than plant growth shall not be burned. On-site and off-site disposal areas are subject to approval by the Engineer. Ashes and residue from burning operations shall be removed from the site and disposed of by the Contractor. The Contractor shall also obtain all of the required permits for his burning operations, as applicable.

END OF SECTION

## SECTION 02140

### DEWATERING

Dewatering: Dewatering refers to controlling and disposing of surface and shallow ground water as is necessary for proper excavation, compaction, and other operations requiring dry conditions.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete Dewatering in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223

#### B. MATERIALS Not Used.

#### C. SUBMITTALS

Procedures for Dewatering proposed by the Contractor shall be submitted to the Engineer for review prior to any Dewatering operations.

#### D. CONSTRUCTION

1. The Contractor shall do all Dewatering as required for the completion of the work. All surface or ground water removed by Dewatering operations shall be disposed of in accordance with all applicable regulations.
2. The Dewatering system shall be of sufficient size and capacity as required to control ground water or seepage to permit proper excavation operations, embankment construction and reconstruction, sub grade preparation, and to allow concrete to be placed in a dry condition. The system shall include a sump system or other equipment, appurtenances, and other related earthwork necessary for the required control of surface water. The Contractor shall drawdown ground water

to at least 3 feet below the bottom of excavations at all times in order to maintain a dry and undisturbed condition.

3. The Contractor shall take all the steps that he considers necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment at the site and to assure that the materials used for the Dewatering systems will not erode, deteriorate, or clog to the extent that the Dewatering systems will not perform properly during the period of Dewatering.
4. The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled and its disposal provided for at each berm, structure, etc. when necessary. The entire periphery of the excavation area shall be ditched and diked to prevent surface water from entering the excavation where applicable. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to the Owner. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.
5. The Contractor shall be responsible for and shall repair without cost to the Owner, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by his failure to maintain and operate the Dewatering system proposed and installed by the Contractor.

END OF SECTION

## SECTION 02222

### EXCAVATION

Excavation: Excavation includes excavating, sealing, hauling, scraping, undercutting, removal of accumulated surface water or ground water, stockpiling, and all necessary and incidental items as required for bringing the landfill and related structures to the specified lines and grades.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment required to complete Excavation of the landfill containment area and related structures in accordance with the Contract Drawings and these Specifications, except as noted below:

- a. Clearing and grubbing and removal of topsoil is addressed in Section 02110, Site Preparation, of these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Site Preparation	02110
Dewatering	02140
Embankment	02223
Erosion and Sedimentation Control	02270
Roadway Work	02500
CQA Manual	Attached

##### 3. Quality Assurance:

Quality Assurance during Excavation will be provided by the Owner as described in the accompanying Project CQA Manual.

##### 4. Definitions:

- a. Excavation: shall consist of the removal and satisfactory disposal and/or stockpiling of materials located within the limits of construction including widening cuts and shaping of slopes necessary for the preparation of

roadbeds, landfill slope areas, cutting of any ditches, channels, waterways, entrances, and other work incidental thereto.

- b. Borrow: shall consist of approved material required for the construction of embankments/fills or for other portions of the work.
- c. Unsuitable Material: is any in-place or excavated material which contains undesirable materials, or is in a state which is not appropriate; in the opinion of the CQA Engineer, for the intended use or support of planned structures, embankment, or excavation. This may include but not be limited to organic material, waste/refuse, soft, or wet material not meeting required specifications, etc.
- d. Unsuitable Materials Excavation (Overexcavation): shall consist of the removal and satisfactory disposal of all unsuitable material located within the limits of construction. Where excavation to the finished grade section shown results in a subgrade or slopes of unsuitable material, the Contractor shall overexcavate such material to below the grade shown on the Contract Drawings or as directed by the Engineer and CQA Engineer.

B. MATERIALS

Excavation shall include the removal of all soil, weathered rock, boulders, conduits, pipe, and all other obstacles encountered and shown on the Contract Drawings or specified herein.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Descriptive information on Excavation equipment to be used.

D. CONSTRUCTION

1. The Contractor shall conduct Excavation activities in such a manner that erosion of disturbed areas and off site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.
2. The Contractor shall excavate to the lines and grades shown on the Contract Drawings and stockpile all suitable excavated materials. As the excavation is made, the materials will be examined and identified to the CQA Engineer.

The Contractor will perform all surveys necessary to establish and verify lines and grades for all Excavation, including pipe excavations, soil overexcavation, and anchor trenches.

3. Stockpiling:

The Contractor shall stockpile the materials in appropriate stockpiles as approved by the CQA Engineer. The Contractor shall use equipment and methods as necessary to maintain the moisture content of soils stockpiled (excluding topsoil) at or near their optimum moisture content.

Stockpiles shall be properly sloped and the surfaces sealed by the Contractor at the end of each working day, or during the day in the event of heavy rain, to the satisfaction of the Engineer.

4. The Contractor shall protect all existing facilities and structures including, but not limited to, existing utilities, monitoring wells, signs, grade stakes, etc. during the grading and stockpiling operations.
5. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such sheeting, timbering, pumping, and drainage as may be required.
6. The Contractor shall be responsible for Dewatering as described in Section 02140, Dewatering, of these Specifications, when necessary.
7. Excavation slopes shall be flat enough to avoid sloughs and slides that will cause disturbance of the subgrade or damage of adjacent areas. Slides and overbreaks which occur due to negligence, carelessness, or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as directed by the Engineer at no additional cost to the Owner.
8. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded. All protruding roots and other vegetation shall be removed from slopes.
9. The bottom of all excavations for structures and pipes shall be examined by the CQA Engineer for bearing value and the presence of unsuitable material. If, in the opinion of the CQA Engineer, additional Excavation is required due to the low bearing value of the subgrade material, or if the in-place materials are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted structural fill, or material directed by the CQA Engineer. No payment will be made for subgrade disturbance caused by inadequate Dewatering or improper construction methods.

10. Any areas excavated below design subgrade elevations by the Contractor, unless directed by the CQA Engineer, shall be brought back to design elevations at no cost to the Owner. The Contractor shall place and compact such material in accordance with Section 02223, Embankment, of these Specifications.
11. The Contractor shall dispose of excess or unsuitable excavation materials on-site at location(s) approved by the Owner.
12. The Contractor shall properly level-off bottoms of all excavations. Proof-rolling shall be conducted with appropriate equipment.
13. Upon reaching subgrade elevations shown in excavation areas, the Contractor shall scarify sub grade soils to a minimum depth of 6" and obtain the CQA Engineer's approval of quality. If unsuitable materials are encountered at the subgrade elevation, perform additional excavations as approved by the CQA Engineer to remove unsuitable materials.
14. Overexcavation and Backfill:

Where subgrade materials are determined to be unsuitable, such materials shall be removed by the Contractor to the lengths, widths and depths approved by the CQA Engineer and backfilled with suitable material in accordance with Section 02223, Embankment, of these Specifications unless further excavation or earthwork is required. No additional payment will be made for such excavation and backfill 1 foot or less than the finished subgrade. Unsuitable material excavation greater than 1 foot beneath the finished subgrade shall be made on a unit price basis for excavation and backfill, only as approved by the Engineer and CQA Engineer prior to the work. Unit price for overexcavation and backfill greater than 1 foot in depth shall include disposal of unsuitable materials.
15. All cuts shall be brought to the grade and cross section shown on the Contract Drawings, or established by the Engineer, prior to final inspection.
16. The Contractor shall protect finished lines and grades of completed excavation against excessive erosion, damage from trafficking, or other causes and shall repair any damage at no additional cost to the Owner.
17. Trench Excavation:
  - a. All pipe Excavation and trenching shall be done in strict accordance with these Specifications, all applicable parts of the OSHA Regulations, 29 CFR 1926, Subpart P, International Paper's Excavating and Trenching Procedures, and other applicable regulations. In the event of any conflicts in this information, safe working conditions as established by the appropriate OSHA guidelines shall govern.

- b. The minimum trench widths shall be as indicated on the Contract Drawings. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Contract Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing.
  - c. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.
  - d. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, obstructions, or structures.
  - e. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet.
  - f. Pipe Bedding: All pipe bedding shall be as shown on the Contract Drawings, unless otherwise specified herein.
18. Sheeting and Bracing:
- a. The Contractor shall furnish, place, and maintain such sheeting and bracing which may be required to support sides of Excavation or to protect pipes and structures from possible damage and to provide safe working conditions in accordance with current OSHA requirements. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the sole expense of the Contractor. The Contractor shall be responsible for the adequacy of all sheeting and bracing used and for all damage resulting from sheeting and bracing failure or from placing, maintaining, and removing it.
  - b. The Contractor shall exercise caution in the installation and removal of sheeting to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to sheeting installation or removal.
  - c. All sheeting and bracing shall be removed upon completion of the work.
19. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding

and mulching or other required erosion and sedimentation control operations shall be performed at the Contractor's sole expense.

END OF SECTION

## SECTION 02223

### EMBANKMENT

Embankment: Embankment is the on-site compacted fill that provides the foundation and the berms for the containment area, the subgrade for some access roadways and structures, and backfill around structures and piping.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete Embankment including borrowing, hauling, screening, discing, drying, compaction, control of surface and subsurface water, final grading, sealing, and all necessary and incidental items as detailed or required to complete the Embankment, all in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications

<u>Work</u>	<u>Section</u>
Dewatering	02140
Excavation	02222
Erosion and Sedimentation Control	02270
Roadway Work	02500
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> ).
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTMD 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.

4. Quality Assurance:

Quality Assurance during placement of Embankment will be provided by the Owner as described in the accompanying Project CQA Manual.

5. Definitions:

- a. Embankment: Shall include construction of all site earthwork including roadways, subgrade, perimeter berm embankments, including preparation of the areas upon which materials are to be placed. Embankment may also be referred to as structural and/or controlled fill. All Embankment materials will be Borrow unless otherwise noted on Contract Drawings or specified by the Engineer.
- b. Prepared Subgrade: The ground surface after clearing, grubbing, stripping, excavation, scarification, and/or compaction, and/or proof rolling to the satisfaction of the CQA Engineer.
- c. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters. Well-graded is used to define a material type that, when compacted,

produces a strong and relatively incompressible soil mass free from detrimental voids.

- d. Unclassified Fill: The nature of materials to be used is not identified or described herein but must be approved by the Engineer prior to use.

B. MATERIALS

1. Embankment materials shall consist of clean well-graded natural soil classified as SM, SP, SC, ML, MH, CL-ML, CL or CH (ASTM D 2488) containing no topsoil or other deleterious material. Other material classifications may be approved by the Engineer.
2. Stones or rock fragments shall not exceed one half the maximum lift thickness as compacted in any dimension.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Descriptive information on compaction equipment to be used for construction of Embankment and appurtenant structures.

D. CONSTRUCTION

1. The Contractor shall conduct Embankment activities in such a manner that erosion of disturbed areas and off-site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.
2. All placement and compaction of Embankment shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.
3. Embankment shall be placed and compacted to the lines and grades shown on the Contract Drawings. Placement of Embankment outside the construction limits shall occur only as directed and approved by the Engineer.

The Contractor will perform all surveys necessary to establish and verify lines and grades for all Embankment.

4. The Contractor shall protect all existing facilities including, but not limited to, utilities and monitoring wells.

5. Subgrade Preparation:
  - a. The CQA Engineer shall inspect the exposed subgrade prior to placement of Embankment to assure that all rocks, topsoil, vegetation, roots, debris, or other deleterious materials have been removed.
  - b. Prior to placement of Embankment, the exposed subgrade shall be proofrolled using a static smooth-drum roller, loaded tandem axle dump truck, or other suitable equipment in the presence of the CQA Engineer. Any soft or unsuitable materials revealed before or during the in-place compaction shall be removed as directed by the CQA Engineer and replaced with suitable Embankment.
6. Surfaces on which Embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the Embankment with the existing surface.
7. The Contractor shall be responsible for preparing the materials for the Embankment, including but not limited to, in-place drying or wetting of the soil necessary to achieve the compaction criteria of these Specifications.
8. The Contractor shall be responsible for Dewatering as described in Section 02140, Dewatering, of these Specifications, when necessary.
9. Embankment materials shall be placed in a manner permitting drainage and in continuous, approximately horizontal layers.
10. Compaction Requirements:
  - a. The Contractor shall compact Embankment in accordance with the requirements shown in Table 1 of this section. If Embankment does not meet the specified requirements, the Contractor shall rework the material, as may be necessary and continue compaction to achieve these requirements, or remove and replace the material to achieve the specified requirements, at Contractor's expense.
  - b. Each lift shall be compacted prior to placement of succeeding lifts. In confined areas, mechanical equipment, suitable for small areas and capable of achieving the density requirements, shall be required.
  - c. Lift compaction shall be performed with an appropriately heavy, properly ballasted, penetrating-foot or smooth-drum vibratory compactor depending on soil type. Compaction equipment shall be subject to approval by the CQA Engineer.

11. Embankment that becomes excessively eroded, soft, or otherwise unsuitable shall be removed or repaired by the Contractor as directed by the CQA Engineer, at no cost to the Owner.
12. The exposed surface of Embankment shall be rolled with a smooth-drum roller at the end of each work day to protect from adverse weather conditions.
13. Where Embankment is to be placed and compacted on slopes that are steeper than 3: 1, the subgrade shall be benched to a minimum depth of 6 inches and the Embankment shall be placed in horizontal lifts.
14. Backfilling for Structures and Piping:
  - a. All structures, including manholes and pipes shall be backfilled with Embankment as shown in the Contract Drawings and as described in these Specifications.
  - b. Where sheeting is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when sheeting is removed. If significant volumes of soil cannot be prevented from clinging to the extracted sheets, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below sub grade that sheeting will be driven in similar soil conditions or employ other appropriate means to prevent loss of support.
  - c. When backfilling around structures, do not backfill until concrete has sufficiently cured (as determined by the CQA Engineer) and is properly supported. Place backfill in a manner to avoid displacement or damage of structures.

**TABLE 1: REQUIRED EMBANKMENT PROPERTIES**

ITEM	Required % Standard Proctor (ASTM D698) <sup>2</sup>	Required Moisture Content (ASTM D 3017) <sup>3</sup>	Maximum Lift Thickness (Compacted) (inches)
Embankment	95	± 4% of Optimum Moisture Content	8
Embankment Beneath Structures and Roads <sup>1</sup>	98		8
Backfill Around Structures	95		8
Backfill in Pipe Trenches	95		6
Unclassified Fill	N/A	N/A	N/A

Notes:

1. Embankment beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope. Embankment beneath roads shall be considered to include all embankment placed within 2 vertical feet of the final wearing surface and shall also include shoulders.
2. Determine field density using ASTM D 2922, ASTM D 1556, ASTM D 2167, or ASTM D 2937.
3. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959.

END OF SECTION

## SECTION 02240

### GEOTEXTILES

Geotextiles: For the proposed construction, a Type GT -S (Separator/Filter) Geotextile is specified. The Type GT -S Geotextile will be placed in the leachate collection system, as a component of the Geonet Composite, between soil subgrade and aggregate in access roads, and in some erosion control and drainage applications.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Geotextiles including all necessary and incidental items as detailed or required for the Contractor to complete the installation in accordance with the Contract Drawings and these Specifications, except as noted below:

- a. Geotextiles used as a Silt Fence is covered under Section 02270, Erosion and Sedimentation Control, of these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Erosion and Sedimentation Control	02270
Roadway Work	02500
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO) are hereby made a part of these specifications.

ASTM D 3786	Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
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ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
AASHTO M 288	Standard Specification for Geotextiles.

4. Quality Assurance:

Quality Assurance during installation of Geotextiles will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

Labels on each roll of Geotextile shall identify the length, width, lot and roll numbers, and name of Manufacturer.

2. The Type GT -S Geotextile shall be a woven, nonwoven spunbonded, or nonwoven needlepunched synthetic fabric consisting of polyester or polypropylene manufactured in a manner approved by the Engineer. Note that Type GT-S

Geotextile used as a component of the Geonet Composite shall be a nonwoven fabric.

3. All Geotextiles shall conform to the properties listed in Table 1 of this section.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit one copy of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each type of Geotextile attesting that the Geotextiles meet the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample (4" x 6") of each Geotextile to be used. The samples shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
3. Quality Control Certificates: For Geotextiles delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of each type of Geotextile supplied. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.
4. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All Geotextiles shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Failing CQA Material Control Tests:

Geotextiles that are rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of Geotextiles supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Installation of Geotextiles:
  - a. The surface receiving the Geotextiles shall be prepared to a relatively smooth condition, free of obstructions, excessive depressions, debris, and very soft or loose pockets of soil. This surface shall be approved by the CQA Engineer prior to Geotextile placement.
  - b. Geotextiles shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, Geotextiles shall be rejected by the CQA Engineer if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.
  - c. The Geotextiles shall be placed smooth and free of excessive wrinkles.
  - d. On slopes, Geotextiles shall be anchored at the top and unrolled down the slope. In the presence of wind, all Geotextiles shall be weighted with sandbags or other material as approved by the CQA Engineer. Geotextiles uplifted by wind may be reused upon approval by the CQA Engineer.
4. Seams:
  - a. All Geotextile seams shall be sewn. On slopes greater than 10 percent, all seams shall be oriented parallel to (in the direction of) the slope unless otherwise approved by the Engineer.
  - b. Seams to be sewn shall be sewn using a Type 401 stitch. One or two rows of stitching may be used. Each row of stitching shall consist of 4 to 7 stitches per inch. The minimum distance from the geotextile edge to the stitch line nearest to that edge (seam allowance) shall be 1.5 inches if a Type SSa (prayer or flat) seam is used. The minimum seam allowance for all other seam types shall be 1.0 inches. All seams must be approved by the CQA Engineer.
  - c. Alternately, the Contractor may overlap or heat bond adjacent panels with methods approved by the Engineer.
5. Repair Procedures:
  - a. Any Geotextile that is torn or punctured shall be repaired or replaced, as directed by the CQA Engineer, by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of Geotextile placed over the failed areas and shall overlap the existing Geotextile a minimum of 6 inches from any point of the rupture. Patches shall be spot sewn so as not to shift during cover placement.

- b. Slopes Less Than or Equal to 10 Percent: Damaged areas of a size exceeding 10 percent of the roll width shall be removed and replaced across the entire roll width with new material. Damaged areas of a size less than 10 percent of the roll width may be patched.
- c. Slopes Greater Than 10 Percent: Geotextile panels which require repair shall be removed and replaced with new material. Replacement material shall be sewn as previously described in this specification.

6. Cover Placement:

Placement of cover over Geotextiles shall be performed in a manner as to ensure that the Geotextiles are not damaged. Cover material shall be placed such that excess tensile stress is not mobilized in the Geotextile.

**TABLE 1: REQUIRED GEOTEXTILE PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE <sup>1</sup>
			TYPE GT-S
Geotextile Construction (NW = Nonwoven) (W = Woven)	-----	-----	NW <sup>2</sup> or W <sup>3</sup> NW (See Note 5)
Mass per Unit Area (Unit Weight)	ASTM D 5261	oz/yd <sup>2</sup>	N/A 6 (See Note 5)
Ultraviolet Resistance (500 hrs)	ASTM D 4355	%	70
Strength Class <sup>4</sup>	AASHTO M 288	Class	2
Grab Tensile Strength	ASTM D 4632	lbs	160 (NW) 250 (W)
Grab Tensile Elongation	ASTM D 4632	%	≥ 50 (NW) < 50 (W)
Puncture Resistance	ASTM D 4833	lbs	55 (NW) 90 (W)
Trapezoidal Tear Strength	ASTMD4533	lbs	55 (NW) 90 (W)
Burst Strength	ASTM D 3786	psi	200 (NW) 400 (W)
Apparent Opening Size (AOS)	ASTMD 4751	U.S. Sieve	70+
Permittivity	ASTMD 4491	sec <sup>-1</sup>	1.0

Notes:

1. Minimum Average Roll Value (MARV).
2. Nonwoven geotextiles that have been heat calendared are not acceptable, unless approved by the Engineer in advance.
3. Woven geotextiles formed exclusively with slit film fibers are not acceptable.
4. AASHTO M 288 criteria includes the above listed requirements for: Grab Tensile Strength, Grab Tensile Elongation, Puncture Resistance, Trapezoidal Tear Strength, and Burst Strength.
5. Required for Geonet Composite.

**TABLE 2: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>MINIMUM TEST FREQUENCY</b>
Mass per Unit Area (Unit Weight)	ASTM D 5261	200,000 ft <sup>2</sup>
Ultraviolet Resistance (500 hrs)	ASTM D 4355	Periodic
Grab Tensile Strength	ASTMD4632	200,000 ft <sup>2</sup>
Grab Tensile Elongation	ASTMD 4632	200,000 ft <sup>2</sup>
Burst Strength (Diaphragm Methods)	ASTMD 3786	200,000 ft <sup>2</sup>
Apparent Opening Size (AOS)	ASTMD 4751	Periodic
Permittivity	ASTMD 4491	Periodic
Puncture Resistance	ASTM D 4833	200,000 ft <sup>2</sup>
Trapezoidal Tear Strength	ASTM D 4533	200,000 ft <sup>2</sup>

END OF SECTION

## SECTION 02270

### EROSION AND SEDIMENTATION CONTROL

Erosion and Sedimentation Control: Erosion and Sedimentation Control is a system of construction practices and engineered structures which act to minimize surface water induced erosion of disturbed areas and resulting sedimentation off-site.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of and maintain Erosion and Sedimentation Control facilities and other construction in accordance with the Contract Drawings and these Specifications.

All Erosion and Sedimentation Control work shall be in accordance with the latest edition of the North Carolina Erosion and Sediment Control Planning and Design Manual.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
Rip Rap	02271
Rolled Erosion Control Products	02275
Storm Water Systems	02720
Revegetation	02930

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 3786	Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

B. MATERIALS

1. Permanent Ditches, Swales, and Drainage Channels:

Permanent ditches, swales, and drainage channels shall be constructed as shown on the Contract Drawings.

2. Silt Fence:

Silt fences shall be constructed as shown on the Contract Drawings and as needed, based on the Contractor's discretion and Engineer's approval. The silt fence is a permeable barrier erected within and downgradient of small disturbed areas to capture sediment from sheet flow. It is made of filter fabric buried at the bottom, stretched, and supported by posts and wire mesh backing. Silt fence shall conform to the following properties:

- a. Posts: Posts shall be 3 feet long "U" or "T"-type steel or wood posts.
- b. Filter Fabric: Filter fabric shall be a woven geotextile made specifically for sediment control. Filter fabric shall conform to the properties listed in Table 1 of this section.

3. Geotextiles:

Geotextiles shall conform to the requirements of Section 02240, Geotextiles, of these Specifications.

4. Filter Berms:

Filter berms shall be constructed as shown on the Contract Drawings.

5. Rip Rap:

Rip Rap shall conform to the requirements of Section 02271, Rip Rap, of these Specifications.

6. Rolled Erosion Control Products (RECPs):

Rolled Erosion Control Products (RECPs) shall conform to the requirements of Section 02275, Rolled Erosion Control Products, of these Specifications.

7. Other Work:

In addition to the erosion control measures shown on the Contract Drawings, the Contractor shall provide adequate means to prevent any sediment from entering any storm drains, drop inlets, ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of off-site areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed. All paved areas shall be scraped and swept as necessary to prevent the accumulation of dirt and debris. Work associated with this provision shall be considered incidental to the project and no separate payment will be made.

8. Temporary and Permanent Ground Cover:

The Contractor shall provide temporary or permanent ground cover adequate to restrain erosion on erodible slopes or other areas within 15 working days or 30 calendar days (whichever is shorter) following completion of any phase of grading.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all Erosion and Sedimentation Control materials manufactured for the project have been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Establishment of Erosion Control Devices:

- a. All erosion control structures will be constructed according to the Contract Drawings and these Specifications.
- b. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion control devices may need to be adjusted on several occasions to reflect the current phase of construction.
- c. Erosion control devices shall be established prior to the work in a given area. Where such practice is not feasible, the erosion control device(s) shall be established immediately following completion of the clearing operation.
- d. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation.
- e. The location and extent of erosion control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from construction areas. All deviations from the control provisions shown on the Contract Drawings shall have the prior approval of the Engineer.

2. Maintenance of Erosion Control Devices:

- a. The Contractor shall furnish the labor, material, and equipment required for maintenance of all erosion control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device.
- b. All erosion control devices shall be inspected immediately after each significant rainfall event, and appropriate maintenance conducted.
- c. Maintenance shall include, but not be limited to:
  - (1) The removal and satisfactory disposal of trapped sediments from basins or silt barriers;

- (2) Replacement of filter fabrics used for silt fences upon loss of specified efficiency; and
    - (3) Replacement of any other components which are damaged or cannot serve the intended use.
  - d. Sediments removed from erosion control devices shall be disposed of in locations that will not result in off-site sedimentation as approved by the Engineer.
  - e. All erosion control structures shall be maintained to the satisfaction of the Engineer until the site has been stabilized.
3. Finish Grading:
- All disturbed areas shall be uniformly graded to the lines, grades, and elevations shown on the Contract Drawings. Finished surfaces shall be reasonably smooth, compacted, and free from irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from either blade or scraper operations. Areas shall be finished to a smoothness suitable for application of topsoil.
4. Seeding:
- Seeding shall conform to the requirements of Section 02930, Revegetation, of these Specifications.
5. Cleanup:
- a. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.
  - b. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

**TABLE 1: REQUIRED SILT FENCE FILTER FABRIC PROPERTIES**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>VALUE<sup>1</sup></b>
Grab Tensile Strength <sup>2</sup>	ASTM D 4632	lbs	100 x 100
Grab Elongation	ASTM D 4632	%	15 (Max.)
Trapezoidal Tear Strength <sup>2</sup>	ASTM D 4533	lbs	50 x 50
Burst Strength	ASTMD 3786	psi	265
Puncture Resistance	ASTM D 4833	lbs	55
Ultraviolet Resistance (500 hrs)	ASTM D 4355	%	80
Apparent Opening Size (AOS)	ASTMD 4751	U. S. Sieve	20 (Max.)/40 (Min.)
Permittivity	ASTMD 4491	sec <sup>-1</sup>	0.20

Notes:

1. Minimum Average Roll Value (MARV).
2. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

## SECTION 02271

### RIP RAP

Rip Rap: This section includes all rip rap aprons and channel protection.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Rip Rap for protection of against erosion as indicated, including all necessary and incidental items, in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
Erosion and Sedimentation Control	02270
Storm Water System	02720

##### 3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) is hereby made a part of these Specifications.

NCDOT                      Road and Bridge Specifications.

#### B. MATERIALS

1. Rip Rap: Rip Rap shall be of the size indicated on the Contract Drawings and shall conform to NCDOT Section 1042, Stone for Rip Rap.

2. Geotextiles: Geotextiles shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.

#### C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results prior to installation, that all Rip Rap has been produced in accordance with these Specifications.
2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Surface Preparation:
  - a. Trim and dress all areas to conform to the Contract Drawings as indicated with tolerance of 2 inches from theoretical slope lines and grades.
  - b. Bring areas that are below allowable minimum tolerance limit to grade by filling with compacted Embankment material similar to adjacent material.
  - c. Geotextiles shall be placed as shown on the Contract Drawings and in accordance with Section 02240, Geotextiles, of these Specifications.
  - d. Do not place any stone material on the prepared surface prior to inspection and approval to proceed from the Engineer.

2. Placing Rip Rap:

Rip Rap shall be placed in accordance with NCDOT Section 1042, Rip Rap.

END OF SECTION

## SECTION 02275

### ROLLED EROSION CONTROL PRODUCTS

Rolled Erosion Control Products: Rolled Erosion Control Products (RECPs) include erosion control blankets (ECB), and turf reinforcement matting (TRM) placed in channels and on slopes.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of all RECPs in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Erosion and Sedimentation Control	02270
Revegetation	02930

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 1777	Standard Test Method for Thickness of Textile Materials.
ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
ASTM D 5035	Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

Labels on each RECP shall identify the length, width, product name, and name of Manufacturer.

2. Erosion Control Blanket (ECB) (Double Net):

ECB (double net) shall consist of a machine-produced mat of curled wood excelsior. At least 80 percent of the individual excelsior fibers shall be 6 inches or more in length. The excelsior fibers shall be evenly distributed over the entire blanket. The top and bottom sides of the blanket shall be covered with a photodegradable extruded plastic or woven biodegradable mesh. The mesh shall be attached to the curled wood excelsior with degradable thread. ECB (double net) shall also conform to the properties listed in Table 1 of this section. ECB (double net) shall be CURLEX II, as manufactured by American Excelsior Company, or approved equal.

3. Turf Reinforcement Matting (TRM):

TRM shall consist of a machine-produced mat of mechanically or melt-bonded polymer nettings, monofilaments, or fibers entangled to form a strong, dimensionally stable, three dimensional permanent vegetation reinforcement structure. The mat shall be crush-resistant, pliable, water-permeable, and highly resistant to chemical and environmental degradation. TRM shall also conform to the properties listed in Table 1 of this section. TRM shall be LANDLOK TRM 435, as manufactured by Synthetic Industries, or approved equal.

4. Anchors: Anchors for RECPs shall consist of machine made staples of No. 8 gage new steel wire formed into a "U" shape. The size when formed shall be not less than 8 inches in length with a throat of not less than 1 inch in width. Longer anchors may be required for loose soils. Other anchors, such as metal pins or plastic pegs, may also be used if approved in advance by the Engineer.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit one copy of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each RECP attesting that each RECP meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of each RECP to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
3. Furnish copies of delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All RECPs shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.
2. Installation - General:
  - a. Placing of RECPs shall be done immediately following seeding. Seeding shall be performed in accordance with Section 02930, Revegetation, of these Specifications.
  - b. RECPs shall be placed to the lines and grades shown on the Contract Drawings. The earth surface shall be smooth and free from stones, clods, or debris which will prevent the contact of the RECP with the soil. Care shall be taken to preserve the required line, grade, and cross section of the area.
  - c. RECPs shall be unrolled in the direction of the flow of water and shall be applied without stretching so that it will lie smoothly but loosely on the soil surface.
  - d. At the time of installation, RECPs shall be rejected, if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.
  - e. The Engineer may require adjustments in the installation requirements to fit individual conditions.

3. Installation - Channels:

RECPs installed in channels shall be unrolled parallel to the direction of water flow. The first roll shall be centered longitudinally in the channel and anchored with staples. Subsequent rolls shall be installed outward to the edges of the channel and be lapped to allow installation of a common row of anchors. RECP ends shall be overlapped with the upstream ends on top ("shingled"). Refer to the Contract Drawings for installation details.

4. Installation - Slopes:

RECPs installed on slopes shall be oriented in vertical strips and anchored. Subsequent rolls shall be installed outward to the edge(s) of the original roll and be lapped to allow installation of a common row of anchors. RECP ends shall be shingled. Refer to the Contract Drawings for installation details.

5. Maintenance:

Maintenance of RECPs shall be in accordance with Section 02270, Erosion and Sedimentation Control, of these Specifications.

**TABLE 1: REQUIRED ROLLED EROSION CONTROL PRODUCT PROPERTIES**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>VALUE<sup>1</sup></b>
<b>Erosion Control Blanket (ECB) (Double Net)</b>			
Mass per Unit Area (Unit Weight)	ASTM D 5261	lbs/yd <sup>2</sup>	0.975 ± 10%
Aperture Size - Mesh	Measured	inches	1.0 x 1.0 (max.)
Maximum Permissible Shear Stress (Un-Vegetated)	-----	lb/ft <sup>2</sup>	1.65
<b>Turf Reinforcement Matting (TRM)</b>			
Mass per Unit Area (Unit Weight)	ASTM D 5261	oz/yd <sup>2</sup>	8
Thickness	ASTM D 1777	inches	0.35
Tensile Strength <sup>2</sup>	ASTM D 5035	lbs/ft	145 x 110
Tensile Elongation	ASTM D 5035	%	50 (max.)
Porosity	Calculated	%	90
Resiliency	ASTM D 1777	%	80
UV Stability	ASTM D 4355	%	80
Maximum Permissible Velocity (Long-Term Vegetated)	-----	ft/sec	8
Maximum Permissible Shear Stress (Long-Term Vegetated)	-----	lb/ft <sup>2</sup>	3

Notes:

1. Minimum Average Roll Value (MARV).
2. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

## SECTION 02500

### ROADWAY WORK

Roadway Work: Roadway Work refers to the construction of gravel road surfaces.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment required to complete construction of all Roadway Work including gravel roads in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223
Geotextiles	02240

##### 3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) is hereby made a part of these Specifications:

NCDOT          Road and Bridge Specifications

#### B. MATERIALS

##### 1. Geotextiles:

Geotextiles shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.

##### 2. Aggregate Base Course (ABC):

All work, including materials, associated with ABC shall be in accordance with NCDOT Section 1005, General Requirements for Aggregate.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all materials for Roadway Work have been produced in accordance with these Specifications.
2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. General:

All Roadway Work including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses, and types as shown on the Contract Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt or gravel, depending upon the material encountered, unless otherwise indicated.

2. Earthwork:

The earthwork for all Roadway Work shall be completed in accordance with Section 02222, Excavation, and Section 02223, Embankment, of these Specifications and as shown on the Contract Drawings.

3. Geotextiles:

Geotextiles shall be placed as shown on the Contract Drawings and in accordance with Section 02240, Geotextiles, of these Specifications. If overlapped seams are used, overlaps shall be a minimum of 12 inches.

4. Aggregate Base Course:

ABC shall be constructed in accordance with NCDOT Section 1005, General Requirements for Aggregate, except that mixing, moisture addition, and compaction testing may be omitted.

END OF SECTION

## SECTION 02602

### SUBMERSIBLE PUMPS

Submersible pumps: Submersible pumps are used for removal and conveyance and control of groundwater from the underdrain manhole.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation, start-up services specified and also including placement of the equipment into satisfactory and acceptable operation. The submersible pumps shall also be in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Precast Concrete Structures	02608
HDPE Pipe	02614

##### 3. Quality Assurance:

Quality Assurance during placement of submersible pumps will be provided by the Owner as described in the accompanying Project CQA Manual.

#### B. MATERIALS

##### 1. General:

- a. Pump shall be constructed of stainless steel wetted parts including casing, stator housing, impellers, seal and bearing housings, fasteners, seal springs, and discharge fittings. O'Rings shall be Viton material. Upper mechanical seal to be carbon/ceramic. Lower seal to be silicon carbide/silicon carbide.
- b. Impeller shall be multivane, semi-open and capable of passing 1/4" solids, sand.
- c. Pump shall provide a flow of 60 gpm at a discharge pressure of 50 feet of head.
- d. Pumps shall be free standing with built in strainer.

2. Motor:

- a. The motor shall be 2.0 hp and suitable for operation on three phase 480 volt power.
- b. Motor shall have a fixed stator operating on a permanently lubricated anti-friction bearings with dual mechanical seals. Seals shall operate in an oil bath and motor shall be air filled type. Motor to have built in thermal protection.
- c. Power cable shall be heavy duty submersible type, jacketed, continuous length, and sized per U.S. NEC standards. The cable shall be equal to the depth of the manhole plus 20' minimum.

3. Carrier:

- a. A stainless steel lifting cable shall be provided with each pump. Cable shall be ¼" stainless steel, 7 x 19 strand construction, rated a minimum breaking strength of 6,400 pounds and shall be equipped with necessary clips with a removable link connector at the pump and a snap hook at the upper end with a properly sized eye bolt to serve as and anchor for the snap hook. Cable length shall be 40 feet and shall be adjusted to the required well depth to minimize slack and facilitate lifting.

4. Controls:

- a. Panel shall be rated NEMA 4X stainless steel. Panel shall be capable of operating 2x pumps with 2 hp motor using 3 phase, 460 volt service.
- b. The controller shall be an Intrinsically Safe Duplexer (ISD) built for intrinsically safe pump control operation. The controller's intrinsically safe float switch inputs shall be designed to allow safe handling of float switches by lift station personnel. The ISD Controller is to be labeled UL913, as an Intrinsically Safe device.
- c. The controller is to be designed to simplify control panel construction by incorporating four intrinsically safe relays, an alternator, a lag pump delay timer, two HOA switches, a push-to-test switch, and a lead/lag/auto select switch into the unit.
- d. The ISD controller must have the following features:
  - (1) Level indicators
  - (2) HOA switches
  - (3) Power-on indicator

- (4) Push-to-test switch
  - (5) Lead/lag/auto switch
  - (6) Output indicators
  - (7) High-level alarm indicator
  - (8) Float out-of-sequence indicator
  - (9) Internal alternator
  - (10) Lag pump time delay.
- e. The Push-to-Test push-button (which internally closes the Off and the Lead float inputs), allows the operator to test the automatic pump call function of the unit, as well as the related pump control circuitry.
  - f. The Float Switch out-of-sequence logic float switches not opening or closing as they should. This logic also compensates for float switch failure conditions, and allows for continued pump operation. The float out-of-sequence indicator is to be turned off by either a return to normal float sequencing, or by resetting the control power.
  - g. The controller must provide a delay for the lead pump immediately following a power interruption.
  - h. The panel shall be equipped with a properly sized main breaker, motor protector switch/motor starter with 120V coil, main TVSS surge suppressor.
  - i. A terminal shall be provided for use with float switches.

5. Instrumentation:

- a. Four wet well floats with a NO wired switch shall be provided.
- b. Floats shall be self weighted type and provided with 35 feet of cable.
- c. Floats shall be polypropylene casing with PVC type STO cable with hermetically sealed switch.

C. SUBMITTALS

- 1. Operations and Maintenance Manuals shall be provided and shall be provided and shall include troubleshooting guide, system controls operator instructions, pump assembly and service guide, pump operating characteristics, electrical as-built

schematic, bill of materials of electrical control panel, warranty statement, contact statement, and additional information as necessary for normal operation and maintenance of the system.

2. Submittal shall include pump performance data, assembly drawings, electrical schematics, key components cut sheets, fittings installation details, warranty statement, and list any revisions or exceptions to all specifications.
3. Manufacturer's installation and start-up instructions.

#### D. CONSTRUCTION

##### 1. Installation:

- a. Pumps shall be properly installed by the contractor based upon the contract documents and manufacturers instructions.
- b. Control panels shall be installed to meet local codes and all electrical routing between the control panel and equipment shall allow for recovery and installation necessary for service and prevent moisture or fumes from entering control panel.
- c. Flow meter sensor fitting shall be installed per manufacturers instructions and shall ensure that the sensor tee fitting remains full at all time for proper recording of flow totals.
- d. All piping, pipe supports, required pipe fittings, check valves, and isolation valves shall be supplied and installed by the contractor.
- e. All wires and terminals shall be labeled on each end. Wires shall be color coded where applicable to connecting components.

##### 2. Start-up:

- a. After installation the manufacturer shall provide system start-up services including the following services:
  - (1) Inspect installation and adjust or set all necessary adjustments for proper service.
  - (2) Test and record pump control operating characteristics including flow rates, amperage, and level readings and cycles at start and completion of testing.
  - (3) Confirm that the installation is correct and advise contractor of any revisions necessary for proper maintenance or operation.

- (4) A final start-up report shall be furnished which shall include the as-built.

END OF SECTION

## SECTION 02608

### PRECAST CONCRETE STRUCTURES

Precast Concrete Structures: Precast Concrete Structures are used in the underdrain management system.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Precast Concrete Structures in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223
Submersible Pumps	02602
HDPE Pipe	02614
Valves	02640
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
ASTM C 443	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
ASTM C 478	Standard Specification for Precast Reinforced Concrete Manhole Sections.
ASTM C 497	Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
ASTM C 789	Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.

ASTM C 850                      Standard Specification for Precast Reinforced Concrete Box Sections for Culvers, Storm Drains, and Sewers with Less Than 2 feet of Cover Subjected to Highway Loadings.

ASTM C 990                      Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

4.     Quality Assurance:

Quality Assurance during placement of Precast Concrete Structures will be provided by the Owner as described in the accompanying Project CQA Manual.

B.     MATERIALS

1.     Precast Concrete Manholes: All precast concrete manholes shall be constructed from non-shrink, 4,000 psi compressive strength concrete in conformance with ASTM C 478 and as detailed on the Contract Drawings.
2.     Precast Concrete Boxes: All precast concrete boxes shall be constructed from non-shrink, 4,000 psi compressive strength concrete in conformance with ASTM C 789 or ASTM C 850, as applicable, and as detailed on the Contract Drawings.
3.     Joints: All joints shall be sealed with preformed plastic gaskets in conformance with ASTM C 990 or rubber gaskets in conformance with ASTM C 443.
4.     Steps: All steps shall be constructed of 0.5 inch reinforcing rod completely encased in corrosion-resistant rubber or plastic. The upper surfaces of each step shall have a traction tread of self cleaning rubber cleats and guide lugs on both sides to prevent slippage.
5.     Frames and Covers: Frames and covers, where shown on the Contract Drawings, shall consist of 1/4" Aluminum frames and covers (Bilco, or equal) equipped with handles and shall be of the opening size as indicated on the Contract Drawings. Markings on the covers shall indicate the intended use of the structure and shall be acceptable to the Owner.
6.     Markings: All Precast Concrete Structures shall include markings clearly identifying the date of manufacture, the name of the manufacturer, and any other pertinent information.

7. Epoxy Coating: Where indicated on the Contract Drawings, an epoxy coating shall be applied. Epoxy coating shall be by Sherwin-Williams, or approved equal. Follow the Manufacturer's recommendations in applying the epoxy coating.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. The Contractor shall submit shop drawings for Precast Concrete Structures for approval at least 4 weeks prior to construction. Shop drawings shall show complete design, installation, and construction information in such detail as to enable the Engineer to determine the adequacy of the proposed units for the intended purpose. Details of steel reinforcement size and placement shall be included. The shop drawings shall include a schedule which will list the size and type of precast structure at each location where the precast structures are to be used.
2. Submit a certification and summary of all required test results, prior to installation, that all Precast Concrete Structures have been produced in accordance with these Specifications.

D. CONSTRUCTION

1. The Precast Concrete Structures shall be installed at the locations and to the elevations indicated on the Contract Drawings. The Contractor shall give the CQA Engineer sufficient notice so he may observe the field location and installation activities.
2. The Precast Concrete Structures will be bedded and backfilled as indicated on the Contract Drawings.
3. Precast Concrete Structures which are damaged or become damaged will be rejected or shall be repaired in a manner approved by the Engineer at the Contractor's sole expense.

END OF SECTION

## SECTION 02614

### HIGH DENSITY POLYETHYLENE (HDPE) PIPE

High Density Polyethylene (HDPE) Pipe: HDPE Pipe is used in the collection and transmission of groundwater and leachate from the landfill.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of HDPE Pipe in accordance with the Contract Drawings and these Specifications. The Contractor shall also clean and test pipelines where required.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223
Protective Cover	02256
Precast Concrete Structures	02608
Drainage Aggregate	02710
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
ASTM D 3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
ASTM D 3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
ASTM F 412	Standard Terminology Relating to Plastic Piping Systems.
ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ASTM F 1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
ASTM F 1473	Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.
ASTM F 2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.

4. Quality Control:

The Contractor will perform pressure testing of HDPE Pipe as described in this section.

5. Quality Assurance:

Quality Assurance during placement of HDPE Pipe will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. All HDPE Pipe shall be manufactured from new materials meeting the physical requirements shown in Table 1 of this section.
2. All HDPE Pipe shall have smooth interior walls and the SDR and diameter of the pipe shall be as shown on the Contract Drawings.
3. All HDPE Pipe having an outside diameter 3.5 inches and larger shall meet the requirements of ASTM F 714. All HDPE Pipe having an outside diameter less than 3.5 inches shall meet the requirements of ASTM D 3035.
4. Visible defects, such as cracks, creases, crazing, non-uniformly pigmented areas, or undispersed raw materials shall not be acceptable and will result in rejection of the pipe by the CQA Engineer.
5. Pipe Perforations: The perforations of the perforated HDPE Pipe shall be as shown on the Contract Drawings.
6. All HDPE Pipe fittings shall be in accordance with ASTM D 3261 and shall be manufactured by the Manufacturer of the HDPE Pipe supplied for the project and shall be pressure rated to match the system piping. The fittings shall be manufactured from the same materials as the pipe itself. The butt fusion outlets of fittings shall be machined to the same SDR as the system piping to which they are to be fused.
7. Materials used as anchorage for pipe cleanouts shall be provided and installed under this section. Concrete shall be in accordance with Section 03310, Concrete Work, of these Specifications.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, confirming all HDPE Pipe manufactured for the project has been produced in accordance with these Specifications.
2. Submit a copy of the HDPE Pipe Manufacturer's recommendations for shipping, handling, and storage of pipe.
3. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

4. Survey Results:

After placement of HDPE Pipe, survey results shall be submitted for review prior to acceptance.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All HDPE Pipe shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. HDPE Pipe Installation:

- a. The Contractor shall install HDPE Pipe to the lines and grades shown on the Contract Drawings. Line and grade of piping shall be maintained with laser or approved equivalent. The Contractor shall give the CQA Engineer sufficient notice so that he may observe field location and installation activities.
- b. Excavation for underdrain and leachate discharge lines shall be backfilled as directed by the Engineer as shown on the Contract Drawings. Sand backfill or approved soil backfill compacted to at least 95 percent of the Standard Proctor dry density (ASTM D 698) shall be used.

Sharp stones or other potentially damaging material shall be removed from the base of the trench prior to placement of the piping. A leveling course, as required, shall consist of sand or other approved material.

c. Pipe Connections: Joining of HDPE Pipe shall be as follows:

- (1) General pipe sections shall be butt-fusion welded according to the Manufacturer's recommendations and shall be performed by a Manufacturer's authorized, trained fusion technician.
- (2) Pipe ends to be butt-fusion welded shall be clean and dry at the time of welding. No welding shall occur during precipitation or excessive moisture.
- (3) The Contractor shall grind burrs or other potentially damaging areas in the welds prior to placement of the pipe.
- (4) Specified bolted pipe connections shall be made as specified on the Contract Drawings using stainless steel hardware and neoprene gaskets.

- (5) Polyethylene stub ends and flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene.
- (6) Properly executed electrofusion fittings may be used.
- d. Perforated HDPE Pipe shall be placed during construction as shown on the Contract Drawings.

3. Cleaning:

All HDPE Pipe shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

4. Pressure Testing:

- a. Only sections of solid piping where factory or field joints have been performed require pressure testing except as noted below.
  - (1) Any section of pipe showing visual signs of damage or that is of questionable quality may be required to be pressure tested as directed by the CQA Engineer.
  - (2) Cleanout risers within the containment areas do not require pressure testing.
- b. All underdrain and leachate discharge piping shall be pressure tested by the Contractor prior to approval by the CQA Engineer.
- c. Pressure testing shall be conducted by the Contractor in a manner approved by the Engineer. Such testing shall be observed by the CQA Engineer.
- d. The underdrain and leachate discharge lines shall be tested as follows:
  - (1) All gravity piping shall be tested using low-pressure air in accordance with ASTM F 1417.
  - (2) All force main piping shall be tested using hydrostatic pressure in accordance with ASTM F 2164.

The pressures used in testing must not exceed the working pressure of the lowest rated component in the system (i.e. valves, meters, flanges, unions,

etc.). The Manufacturer's recommendation for pressure testing may also be acceptable as an alternative if approved in advance by the Engineer.

Pressure testing of short sections of underdrain discharge line or leachate discharge line to be placed in confined or inaccessible areas may be pressure tested by the Contractor prior to installation when approved by the Engineer. Temporary fittings, etc. required to plug section ends shall be provided by the Contractor at no expense to the Owner.

Any underdrain and/or leachate discharge line that does not meet the pressure test criteria shall be repaired and retested at the Contractor's expense. No underdrain and/or leachate discharge line shall be approved until successful pressure testing is completed.

5. Surveying:

All HDPE Pipe shall be surveyed on 100 foot centers and at bends to ensure the proper location and grade of the piping.

This work shall be performed at the Contractor's cost by a surveyor registered in the State of North Carolina.

**TABLE 1: REQUIRED HDPE PIPE PROPERTIES**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>VALUE<sup>1</sup></b>
Material Designation	ASTM D 412	-----	PE 3408
Cell Classification	ASTM D 3350	-----	345464 C
Density	ASTM D 1505	g/cm <sup>3</sup>	0.955
Melt Flow Index	ASTM D 1238	g/10 min	0.1
Flexural Modulus	ASTM D 790	psi	130,000
Tensile Strength ( <i>j4</i> Yield)	ASTMD 638	psi	3,200
SCG (PENT)	ASTMF 1473	hrs.	> 100
Hydrostatic Design Basis at 73 <sup>0</sup> F	ASTM D 2837	psi	1,600
UV Stabilizer	ASTM D 1603	% Carbon Black	2 - 3%

Notes:

1. Nominal Values.

END OF SECTION

## SECTION 02640

### VALVES

Valves: Gate, swing check, plug, and air release valves are to be installed in the leachate management system of the landfill.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of all valves including all fittings, appurtenances, and transition pieces required for a complete and operable installation in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Precast Concrete Structures	02608
HDPE Pipe	02614
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American National Standard Institute (ANSI) is hereby made a part of these specifications.

ANSI B 16.1                      Pipe Flanges and Flanged Fittings.

##### 4. Quality Assurance:

Quality Assurance during installation of Valves will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. Valve Materials and Construction:

- a. All valves shall be constructed of new, first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated.
- b. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.
- c. Valves shall have flanged ends for exposed service and mechanical joint, or butt fused (for Polyethylene valves) ends for buried service, unless otherwise shown on the Contract Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping.

2. Ball Valves:

Ball valves shall be constructed of Polyethylene body material compatible with the pipe materials to permit butt fusion or electrofusion welding, and polypropylene ball and stem adapter, or similar materials. Flowserve Nordstrom valves compatible with adjacent pipe are recommended for gravity sewer system applications, or approved alternate materials.

3. Gate Valves:

Gate valves shall be rated to 150 psi at 70°F. Body shall be PVC. The valve shaft shall be cast iron or stainless steel and be of blow out proof design. Seals shall be Teflon. Gate valves shall have flanged (ANSI) ends. Gate valves shall be as manufactured by ITT Engineered Valves, or equal.

4. Swing Check Valves:

Swing Check Valves shall be constructed of solid cast iron or stainless steel with Teflon seats and seals. Valves intended for chemical service shall be constructed of materials suitable for the intended service. Valves shall have an external lever and weight. Check valves shall have flanged (ANSI) ends. Valves shall be capable of top entry to facilitate cleaning and repair without removal from the line. Valves shall incorporate a single disc design. Check valves shall be as manufactured by Crane, ITT, M&H, or equal.

5. Plug Valves:

Plug valves shall be of the non-lubricated, tapered type. Valve body shall be semisteel

with flanged end connection drilled to ANSI 125 lb. Standard Valves shall be furnished with a drip-tight shutoff plug mounted in stainless steel or Teflon over phenolic bearings, and shall have a resilient facing bonded to the sealing surface. Plug valves shall be as manufactured by Crane, ITT, M&H, or equal.

5. Air Release Valves:

Air release valves (leachate pump station) shall operate by sealing a BUNA-N rubber outlet seat with a peripheral float as the liquid enters the valve chamber to raise the float. The valve shall satisfactorily withstand hydrostatic pressures of 300 psi. The valve shall be constructed of cast iron body and top flange with stainless steel or bronze and brass trim. The peripheral guided float shall be stainless steel. Air release valves shall be as manufactured by Crispin, or equal.

Air release valves (leachate forcemain) are to be supplied by the Owner and installed by the Contractor.

6. Valve Operators:

The valve operator shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valve will be subjected. All gearing shall be totally enclosed, sealed, and permanently lubricated. Extended operators shall be constructed of 3 16 stainless steel.

7. Valve Boxes:

Valve boxes shall be constructed of reinforced concrete or cast iron, have cast iron lids, and shall generally be as shown on the Contract Drawings. Valve boxes shall be of the appropriate size depending on the particular valve installed. Valve boxes shall be approved by the Engineer prior to installation. Precast concrete valve boxes shall be in accordance with Section 02608, Precast Concrete Structures, of these Specifications.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all valves manufactured for the project have been produced in accordance with these Specifications.
2. Submit Shop Drawings for all valves and accessories prior to installation. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics, and complete descriptive information to demonstrate full compliance with the Contract Documents.
3. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

4. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories. The Manufacturer( s) shall delete all information which does not apply to the equipment being furnished.

D. CONSTRUCTION

1. Before installation, all valves shall be lubricated, manually opened and closed to check their operation, and the interior of the valves shall be thoroughly cleaned.
2. Install all valves where shown on the Contract Drawings in accordance with the Manufacturer's instructions.
3. Install all valves so that operating handwheels or wrenches may be conveniently turned but without interfering with access, and as approved by the Engineer.
4. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes. Concrete valve footings shall be provided for each unsupported valve where recommended by the Manufacturer or as directed by the Engineer.
5. Valve boxes shall be set plumb, and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

END OF SECTION

## SECTION 02710

### DRAINAGE AGGREGATE

Drainage Aggregate: Drainage Aggregate includes aggregate which is placed around underdrain and leachate collection pipes (gravel columns) and in the sumps for the purpose of groundwater and leachate collection and removal.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete the installation of Drainage Aggregate in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
HDPE Pipe	02614
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the North Carolina Department of Transportation (NCDOT) are hereby made a part of these specifications.

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates.
VDOT	Road and Bridge Specifications.

4. Quality Assurance:

Quality Assurance during placement of Drainage Aggregate will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. No. 78 Stone:

- a. A granular material (NCDOT No.78 or alternate gradation if approved by the Engineer) from a non-carbonate source ( $\leq 15\%$  carbonate content by ASTM D 3042) shall be used as a filter media over No. 57 stone as shown on the Contract Drawings and shall be approved by the CQA Engineer at least four weeks prior to construction.
- b. The collection media shall consist of sub-angular or smoother particles and shall be sound, durable, and free from seams, cracks, or other structural defects. The material shall be free of shale, clay, friable materials, and debris.
- c. The collection media shall meet the following gradation criteria and have a coefficient of permeability of  $1 \times 10^{-1}$  cm/sec. (ASTM D 2434) or greater.

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 Inch	100
1/2 Inch	98 – 100
3/8 Inch	75 - 100
No. 4	20 - 45
No. 8	0 - 15
No. 200	$\leq 0.6$

The Engineer may approve an alternate gradation if the material meets permeability criteria.

2. No. 57 Stone:

- a. Coarse aggregate (NCDOT No. 57 or alternate gradation if approved by the Engineer) from a non-carbonate source ( $\leq 15\%$  carbonate content by ASTM D 3042) shall be placed around the collection pipes and within the sumps and as the gravel roadways as where shown on the Contract Drawings and shall be approved by the CQA Engineer at least four weeks prior to construction.

- b. Coarse aggregate shall consist of rounded or sub-angular or smoother particles and shall be sound, durable, and free from seams, cracks, or other structural defects. The material shall be free of shale, clay, friable materials, and debris. Coarse aggregate consisting of long, thin, angular particles may be rejected in the sole discretion of the Engineer.
- c. Coarse aggregate shall meet the following gradation criteria.

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 Inch	100
1 Inch	95 - 100
1/2 Inch	25 - 60
No.4	0 - 10
No.8	0 - 5
No. 200	≤ 0.6

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

- 1. Before approval is given to proceed, the Contractor shall submit descriptive information on equipment to be used for placement of the Drainage Aggregate.
- 2. The Contractor shall submit at least two bulk samples each of the underdrain and leachate collection media and coarse aggregate from each material source for approval at least four weeks prior to beginning construction of the underdrain collection system. Along with the bulk samples, the Contractor shall also submit a certification from each material source that the materials proposed meet the specified gradation requirements.

D. CONSTRUCTION

- 1. Failing CQA Material Control Tests:

Drainage Aggregate that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of Drainage Aggregate supplied as replacement for rejected material shall be performed by the CQA Engineer at the Contractor's cost.

2. The Drainage Aggregate is placed directly over geosynthetics and piping; thus, extreme caution shall be exercised by the Contractor to prevent damage to these materials.

Test areas to evaluate potential damage due to equipment operations may be required by the Engineer to assess equipment to be used by the Contractor at the Contractor's sole expense. Test area parameters shall be determined by the Engineer and Contractor in advance of construction of the leachate collection system.

3. Placement of Drainage Aggregate within the containment area shall be conducted only when the CQA Engineer is informed by the Contractor of intent to perform such work.
4. The Contractor shall exercise care in maintaining a true line and grade for all piping during placement and spreading of Drainage Aggregate.
5. Drainage Aggregate shall be placed over geosynthetics only after areas have been released by the Geosynthetics Installer and the CQA Engineer. Drainage Aggregate shall be placed as specified below:
  - a. Drainage Aggregate shall be placed and spread with low ground pressure equipment (6 psi ground pressure or less) as approved by the CQA Engineer to reduce potential damage to the underlying geosynthetics. The surface of geosynthetics shall be off-limits to construction traffic.
  - b. Low ground pressure equipment used to spread Drainage Aggregate shall operate on at least 1 foot of material overlying geosynthetics and/or piping. Sharp turning of tracked equipment on the Drainage Aggregate will not be permitted.
  - c. On side slopes, place Drainage Aggregate from the bottom up unless otherwise approved by the Engineer. No material shall be dumped down a slope.
  - d. Drainage Aggregate shall not be placed over standing water or ice.
  - e. Drainage Aggregate shall not be compacted within the limits of the containment area.
  - f. Drainage Aggregate shall be placed to the lines and grades as shown on the Contract Drawings. Drainage Aggregate placed beyond these limits shall be removed at the Contractor's sole expense if required by the Engineer.

6. The Drainage Aggregate shall be spread in a manner that minimizes development of wrinkles in the underlying geosynthetics. Any portion of the underlying geosynthetics that develops excessive wrinkles or crimp shall be repaired by the Geosynthetics Installer at no expense to the Owner.
  - a. Drainage Aggregate shall be placed before noon or at other times when the ambient air temperature is not more than 75°F to minimize wrinkling of underlying geosynthetics unless otherwise approved by the Engineer.
  - b. If during spreading, excessive wrinkles develop, the Contractor shall adjust placement and spreading methods, or cease until the underlying geosynthetics cool and wrinkles decrease in size.
  - c. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and spreading methods or underlying geosynthetics that become crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.
7. Stockpiling of Drainage Aggregate within the limits of the containment area shall be subject to advance approval by the Engineer. Any hauling equipment (dump trucks, etc.) operating within the containment area shall have a minimum of 3 feet of separation between the vehicle wheels and the Geomembrane.

The Contractor shall minimize equipment operations directly over coarse aggregate.

8. The CQA Engineer may require removal of Drainage Aggregate and/or other underlying layers at the Contractor's sole expense to allow examination of the underlying geosynthetics and/or piping. Any damage to the underlying layers or excessive wrinkling or crimping during placement of Drainage Aggregate shall be repaired in accordance with the applicable section of these Specifications at the Contractor's sole expense.

END OF SECTION

## SECTION 02720

### STORM WATER SYSTEMS

Storm Water Systems: Storm Water Systems shall include all piping, pipe fittings, flared end sections, and other appurtenances designated to convey stormwater.

#### A. DESCRIPTION

##### 1. General:

The contractor shall furnish all labor, material, and equipment to complete installation of Storm Water Systems in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223
Erosion and Sedimentation Control	02270
Rip Rap	02271

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO), and the North Carolina Department of Transportation (NCDOT) are hereby made a part of these specifications.

ASTM C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
ASTM C 150	Standard Specification for Portland Cement.
ASTMD 1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.

ASTMD 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
AASHTO M 36	Specification for Corrugated Steel Pipe.
AASHTO M 252	Specification for Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter.
AASHTO M 294	Specification for Corrugated Polyethylene Pipe, 12 to 36 Inch Diameter.
NCDOT	Road and Bridge Specifications.

B. MATERIALS

1. Corrugated Metal Pipe (CMP):

- a. Corrugated metal pipe and fittings shall be of the sizes shown or specified and shall conform to every aspect of AASHTO M 36.
- b. Corrugated metal pipe shall be fabricated from galvanized steel sheets. Corrugation profile shall be 2% inch crest to crest and  $\frac{1}{2}$  inch crest to valley, and sheet thickness shall be 16 gage/.064 inch minimum.
- c. Pipe sections shall be helically corrugated with each pipe end rerolled to obtain no less than two (2) annular corrugations.
- d. Coupling Bands: CMP shall be firmly joined by coupling bands in accordance with the manufacturer's recommendations. These bands shall be not more than two nominal sheet thicknesses lighter than the thickness of the pipe to be connected and in no case lighter than 0.052 inches.
- e. All CMP utilized for permanent installation shall have gasketed joints.
- f. Asphaltic or bituminous coatings shall be applied in conformance with the manufacturer's requirements, as applicable.

2. Corrugated Polyethylene (CPE) Pipe:

CPE pipe and fittings shall be of the sizes and type shown on the Contract Drawings and shall conform to every aspect of AASHTO M 252 (3 to 10 inch diameters) or AASHTO M 294 (12 to 36 inch diameters). All Type S CPE pipe shall have watertight joints.

4. Flared End Sections:

Flared end sections shall be reinforced and shall be fabricated from the same materials meeting the same requirements as the pipe to which they are connected. All reinforced concrete and corrugated metal flared end sections shall meet the requirements of the NCDOT. Corrugated polyethylene flared end sections shall be as recommended by the pipe manufacturer.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all Storm Water Systems have been produced in accordance with these Specifications.
2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. All piping shall be installed by skilled workmen and in accordance with the best standards for piping installation. Proper tools and appliances for the safe and convenient handling and installation of the pipe and fittings shall be used.
2. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be defective. If any defective piece should be discovered after having been installed, it shall be removed and replaced at the Contractor's expense.
3. Excavation and backfilling of pipe trenches shall be as described in Section 02222, Excavation and Section 02223, Embankment, respectively, of these Specifications.
4. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. No materials shall be dropped or dumped into the trench.

5. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fittings, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.
6. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade.
7. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense.
8. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

END OF SECTION

## SECTION 02930

### REVEGETATION

Revegetation: Revegetation includes permanent Revegetation of all site areas disturbed by the Contractor whether inside the Contract Limits or not.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete Revegetation in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Embankment	02223
Erosion and Sedimentation Control	02270
Rolled Erosion Control Products	02275

##### 3. Warranty:

The Contractor shall be responsible for the satisfactory establishment and growth of a permanent stand of vegetation for a period of one year following the final seeding as judged by the Engineer. During this period, the Contractor shall be responsible for the maintenance items described in Section D.4 of this Specification.

#### B. MATERIALS

1. Limestone: Unless otherwise defined by specific soil tests, supply agricultural grade ground limestone conforming to the current "Rules, Regulations, and Standards of the Fertilizer Board of Control."
2. Fertilizer: Unless otherwise defined by specific soil tests, supply commercial fertilizer of 10-20-10 analysis, meeting applicable requirements of State and Federal law. Do not use cyanamic compounds of hydrated lime. Deliver fertilizer in original containers labeled with content analysis.

3. Grass Seed: Supply fresh, clean, new-crop seed as specified in Table 1 of this section. Do not use seed which is wet, moldy, or otherwise damaged. Deliver seed in standard sealed containers labeled with producer's name and seed analysis, and in accord with US Department of Agriculture Rules and Regulations under Federal Seed Act.
4. Mulch: Supply clean, seed-free, threshed straw of oats, wheat, barley, rye, beans, or other locally available mulch material.
  - a. Do not use mulch containing a quantity of matured, noxious weed seeds or other species that will be detrimental to seeding, or provide a menace to surrounding land.
  - b. Do not use mulch material which is fresh or excessively brittle, or which is decomposed and will smother or retard growth of grass.
5. Binder: Supply emulsified asphalt or synthetic binder.
6. Water: Supply potable, free of substances harmful to growth.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Results of soil tests performed and proposed modifications, if any, to the specified requirements.
2. Certificates for each grass seed mixture, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed. Certify that each container of seed delivered is fully labeled in accordance with Federal Seed Act and equals or exceeds specification requirements.
3. Copies of invoices for fertilizer, showing grade furnished and total quantity applied.

D. CONSTRUCTION

1. The Contractor shall establish a smooth, healthy, uniform, close stand of grass from the specified seed. Prior to Revegetation, the Contractor shall adequately test the soils to be revegetated to ensure the adequacy of the specified requirements. Any modifications to these requirements deemed necessary after the review of soil test results, shall be at the Contractor's sole expense. The Engineer will perform the observations to determine when successful Revegetation is achieved.

2. Soil Preparation:

- a. Limit preparation to areas which will be planted soon after preparation.
- b. Loosen surface to minimum depth of four (4) inches.
- c. Remove stones, sticks, roots, rubbish and other extraneous matter over three (3) inches in any dimension.
- d. Spread lime uniformly over designated areas at the rate specified in Table 1 of this section.
- e. After application of lime, prior to applying fertilizer, loosen areas to be seeded with double disc or other suitable device if soil has become hard or compacted. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
- f. Distribute fertilizer uniformly over areas to be seeded at the rate specified in Table 1 of this section.
  - (1) Use suitable distributor.
  - (2) Incorporate fertilizer into soil to depth of a least two (2) inches.
  - (3) Remove stones or other substances which will interfere with turf development or subsequent mowing.
- g. Grade seeded areas to smooth, even surface with loose, uniformly fine texture.
  - (1) Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
  - (2) Fine grade just prior to planting.

3. Seeding:

- a. Use approved mechanical power driven drills or seeders, mechanical hand seeders, or other approved equipment.
- b. Distribute seed evenly over entire area at the rate specified in Table 1 of this section.

- c. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds, excessive moisture, or other factors.
- d. Resume work only when favorable condition develops, or as directed by the Engineer.
- e. Lightly rake seed into soil followed by light rolling or cultipacking.
- f. Immediately protect seeded areas against erosion by mulching or placing Rolled Erosion Control Products in accordance with Section 02275 of these Specifications, where applicable.
  - (1) Spread mulch in a continuous blanket at the rate specified in Table 1 of this section.
  - (2) Immediately following spreading mulch, secure with evenly distributed binder at the rate specified in Table 1 of this section.

4. Maintenance:

The Contractor shall be responsible for maintaining all seeded areas through the end of his warranty period. The Contractor shall provide, at his expense, protection of all seeded areas against damage at all times until acceptance of the work. Maintenance shall include, but not be limited to, the following items:

- a. Regrade and revegetate all eroded areas until adequately stabilized by grass.
- b. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.
- c. Replant bare areas using same materials specified.

**TABLE 1: SEEDING SCHEDULE**

<b>MATERIAL</b>	<b>SEED TYPE</b>	<b>MINIMUM SEED PURITY (%)</b>	<b>APPLICATION RATE<sup>1</sup></b>
Lime	-----	-----	4,000 lbs/acre
Fertilizer	-----	-----	1,000 lbs/acre
Seed	Kentucky 31 Tall Fescue	97	100 lbs/acre
	Red Top	94	2 lbs/acre
	Common Bermudagrass <sup>2</sup>	97	15 lbs/acre
	Sericea Lespedeza <sup>2</sup>	98	20 lbs/acre
	Seasonal Nurse Crop <sup>3</sup>	97	20 lbs/acre
Mulch	-----	-----	1,500 lbs/acre
Binder	-----	-----	150 gallons/acre

Notes:

1. Application rates and/or chemical analysis shall be confirmed or established by a soil test.
2. From May through October, use hulled seed.
3. Use seasonal nurse crop in accordance with seeding dates as stated below:

February 1 - April 30  
 May 1 - August 31  
 September 1 - November 15  
 November 16 - January 31

END OF SECTION

# **Construction Quality Assurance Manual**

**International Paper Industrial Landfill  
Cell 2  
Riegelwood, North Carolina**

Prepared for:

**International Paper**

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**November 2008**

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INTERNATIONAL PAPER INDUSTRIAL LANDFILL  
 CELL 2  
 RIEGELWOOD, NORTH CAROLINA  
 CONSTRUCTION QUALITY ASSURANCE MANUAL

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## **SECTION 1.0 GENERAL**

### **1.1 INTRODUCTION**

This Construction Quality Assurance (CQA) Manual has been prepared to provide the Owner, (Design) Engineer, and CQA Engineer the means to govern the construction quality and to satisfy landfill certification requirements under current solid waste management regulations.

More specifically, this CQA Manual addresses the soils and geosynthetics components of the liner system and the leachate collection & recovery (LCR) system. The liner system, as referenced herein, consists of a soil subgrade and a HDPE geomembrane liner. The LCR system consists of a layer of geonet drainage media with collection piping/stone.

The CQA Manual is divided into the following sections:

- Section 1.0 General
- Section 2.0 CQA Documentation
- Section 3.0 Earthwork CQA
- Section 4.0 Geomembrane CQA
- Section 5.0 Leachate Collection & Recovery System CQA
- Section 6.0 Geonet Drainage Media CQA
- Section 7.0 Geotextile CQA
- Section 8.0 Geosynthetic Clay Liner CQA

### **1.2 DEFINITIONS RELATING TO CONSTRUCTION QUALITY**

#### **1.2.1 Construction Quality Assurance (CQA)**

In the context of this Manual, Construction Quality Assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the liner and LCR systems installation with the project drawings and the project specifications. CQA is provided by the CQA Engineer as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

#### **1.2.2 Construction Quality Control (CQC)**

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, and/or the Contractor to ensure that the materials and the workmanship meet the requirements of the project drawings and the project specifications. The manufacturer's specifications and quality control (QC) requirements are included in this CQA Manual by reference only. A complete updated version of each geosynthetic component manufacturer's QC Plan shall be incorporated as part of the Contractor's CQC Plan.

### **1.2.3 CQA Certification Document**

At the completion of construction, a certification document will be prepared by the CQA Engineer and submitted to State Solid Waste Regulators. The certification report will include all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the Geosynthetic Installers, and all CQA testing performed by the CQA Engineer.

### **1.2.4 Discrepancies Between Documents**

The Contractor is instructed to bring discrepancies to the attention of the CQA Engineer who shall then notify the Engineer for resolution. The Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents (this may also require the approval of State Solid Waste Regulators). Unless otherwise determined by the Engineer, the more stringent requirement shall be the controlling resolution.

## **1.3 PARTIES TO CONSTRUCTION QUALITY ASSURANCE**

### **1.3.1 Description of the Parties**

The parties to Construction Quality Assurance and Quality Control include the Owner, Engineer, Contractor, Geosynthetics Manufacturer, Geosynthetics Installer, CQA Engineer, Geosynthetics CQA Laboratory, and Soils CQA Laboratory.

#### **1.3.1.1 Owner**

The Owner is International Paper, who owns and/or is responsible for the facility.

#### **1.3.1.2 Engineer**

The Engineer is responsible for the engineering design, drawings, and project specifications for the liner and LCR systems. The Engineer is an official representative of the Owner. The Engineer serves as communications coordinator for the project, initiating the meetings outlined in Section 1.7. The Engineer shall also be responsible for proper resolution of all quality issues that arise during construction. The Engineer is URS Corporation.

#### **1.3.1.3 Contractor**

The Contractor is responsible for the construction of the subgrade, earthwork, and for placement of the liner and LCR systems. The Contractor is responsible for the overall CQC on the project and coordination of submittals to the CQA Engineer. Additional responsibilities of the Contractor are defined by the project specifications.

#### 1.3.1.4 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is (are) responsible for the production of the geosynthetic components used in landfill construction. The Manufacturer(s) is (are) responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

#### 1.3.1.5 Geosynthetics Installer

The Geosynthetics Installer(s) is (are) routinely a subcontractor of the Contractor and is (are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations. The Installer may also be responsible for transportation of these materials to the site, and for the preparation and completion of anchor trenches.

#### 1.3.1.6 CQA Engineer

The CQA Engineer is a representative of the Owner, is independent from the Contractor, and is responsible for observing, testing, and documenting activities related to the CQA of the earthworks at the site, and the installation of the soil and geosynthetic components of the liner and LCR systems. The CQA Engineer may make field observations and review submittals for the Engineer and is responsible for notifying the Owner and Engineer of all quality issues that arise during construction. The CQA Engineer is also responsible for issuing a facility certification report, sealed by a Professional Engineer registered in The State of North Carolina.

#### 1.3.1.7 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner and LCR systems. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The services of the Geosynthetics CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

#### 1.3.1.8 Soils CQA Laboratory

The Soils CQA Laboratory is a party, independent from the Owner, which is responsible for conducting geotechnical tests on conformance samples of soils and aggregates used in structural fills and the liner and LCR systems. The services of the Soils CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

### **1.3.2 Qualifications of the Parties**

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQA of all materials for the liner and LCR systems. Where applicable, these qualifications must be submitted by the Contractor to the Owner and Engineer for review and approval.

#### **1.3.2.1 Contractor**

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Manual.

#### **1.3.2.2 Geosynthetics Manufacturers**

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications.

#### **1.3.2.3 Geosynthetic Installer(s)**

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner and LCR systems. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Engineer. The Geomembrane Installer must be approved by the Geomembrane Manufacturer.

#### **1.3.2.4 CQA Engineer**

The CQA Engineer will act as the Owner's Quality Assurance Representative. The CQA Engineer will perform CQA testing to satisfy the requirements of this CQA Manual and will prepare the CQA certification document. The CQA Engineer will have experience in the CQA aspects of the construction and testing of landfill liner and LCR systems, and be familiar with ASTM and other related industry standards. The activities of the CQA Engineer will be performed under the supervision of a Registered Professional Engineer.

#### **1.3.2.5 Geosynthetics CQA Laboratory**

The Geosynthetics CQA Laboratory will have experience in testing geosynthetics and be familiar with ASTM, GRI, and other applicable test standards. The Geosynthetics CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

#### 1.3.2.6 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in testing structural fills, soil liners, and aggregates, and be familiar with ASTM and other applicable test standards. The Soils CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

### **1.4 SCOPE OF CONSTRUCTION QUALITY ASSURANCE MANUAL**

The scope of this CQA Manual includes the CQA of the soils and geosynthetic components of the liner and LCR systems for the subject facility. The CQA for the selection, evaluation, and placement of the soils is included in the scope.

### **1.5 UNITS**

In this CQA Manual, all properties and dimensions are expressed in U.S. units.

### **1.6 REFERENCES**

The CQA Manual includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM) and/or the Geosynthetic Research Institute (GRI). Appendix A contains a list of these procedures.

### **1.7 CQA MEETINGS**

To facilitate the specified degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

#### **1.7.1 Geosynthetics CQA Meeting**

A CQA Meeting will be held at the site prior to placement of the geosynthetics. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and the Geosynthetic Installation Superintendent(s).

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties.

### **1.7.2 CQA Progress Meetings**

Progress meetings will be held between the Engineer, the CQA Engineer, the Contractor, the Geosynthetic Installation Superintendent(s), and representatives from any other involved parties at the frequency dictated in the project specifications. These meetings will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Engineer will log any problems, decisions, or questions arising at this meeting in his daily report. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties. These meetings will be documented by the Engineer and minutes will be transmitted to affected parties.

### **1.7.3 Problem or Work Deficiency Meetings**

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and representatives from any other involved parties. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Engineer and minutes will be transmitted to affected parties.

## **1.8 CONTROL VERSUS RECORD TESTING**

### **1.8.1 Control Testing**

In the context of this CQA Manual, Control Tests are those tests performed on a material prior to its actual use in construction to demonstrate that it can meet the requirements of the project plans and specifications. Control Test data may be used by the Engineer as the basis for approving alternative material sources.

### **1.8.2 Record Testing**

Record Tests are those tests performed during the actual placement of a material to demonstrate that its in-place properties meet or exceed the requirements of the project drawings and specifications.

## **SECTION 2.0 CQA DOCUMENTATION**

### **2.1 DOCUMENTATION**

An effective CQA plan depends largely on recognition of construction activities that should be monitored and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Engineer will document that quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner and Engineer with his daily and weekly progress reports including signed descriptive remarks, data sheets, and logs to verify that required CQA activities have been carried out. These reports shall also identify potential quality assurance problems. The CQA Engineer will also maintain at the job site a complete file of project drawings, reports, project specifications, a CQA Manual, checklists, test procedures, daily logs, and other pertinent documents.

### **2.2 DAILY CQA REPORT**

The CQA Engineer's reporting procedures will include preparation of a daily report which, at a minimum, will include the following information, where applicable:

- a unique identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a reduced-scale Site Plan showing all proposed work areas and test locations;
- descriptions and locations of ongoing construction;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- off-site materials received, including quality verification documentation;

- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality;
- summaries of pertinent discussions with the Contractor and/or Geosynthetic Installers; and
- the CQA Engineer's signature.

The daily report must be completed at the end of each CQA Engineer's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the Owner and Engineer.

### **2.3 CQA PROGRESS REPORTS**

The CQA Engineer will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. At a minimum, this report will include the following information, where applicable:

- a unique identifying sheet number for cross-referencing and document control;
- the date, project name, location, and other information;
- a summary of work activities during the progress reporting period;
- a summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;
- summary of all test results, failures and retests, and
- signature of the CQA Engineer.

The CQA Engineer's progress reports must summarize the major events that occurred during that week. Critical problems that occur shall be communicated verbally to the Engineer immediately as well as being included in the weekly reports. The CQA Engineer's weekly report must be submitted to the Owner and Engineer no later than the Monday following the week reported.

### **2.4 CQA PHOTOGRAPHIC REPORTING**

Photographs shall be taken by the CQA Engineer at regular intervals during the construction process and in all areas deemed critical by the CQA Engineer.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. These records will be presented to the Engineer upon completion of the project.

In lieu of photographic documentation, videotaping may be used to record work progress,

problems, and mitigation activities. The Engineer may require that a portion of the documentation be recorded by photographic means in conjunction with videotaping.

## **2.5 DEFICIENCIES**

The Owner and Engineer will be made aware of any significant recurring nonconformance with the project specifications. The Engineer will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

## **2.6 DESIGN AND/OR PROJECT TECHNICAL SPECIFICATION CHANGES**

Design and/or project specification changes may be required during construction. In such cases, the CQA Engineer will notify the Engineer. The Engineer will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Engineer, and will take the form of an addendum to the project specifications. All design changes shall include a detail (if necessary) and state which detail it replaces in the plans.

## **2.7 FINAL CQA REPORT**

At the completion of each major construction activity at the landfill unit, the CQA Engineer will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, etc. The CQA Engineer will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Engineer will also provide summaries of all the data listed above with the report. The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the Record Drawings will be done by the Contractor's Construction Surveyor. These documents will be certified by the Contractor and delivered to the CQA Engineer and included as part of the final CQA (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency to expedite completion and review.

At a minimum, the items shown in Table 2.1 shall be included in the Final CQA Report.

## 2.8 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, will be stored by the CQA Engineer in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner.

**TABLE 2.1: FINAL CQA REPORT GENERAL OUTLINE**

1.0	Introduction
2.0	Project Description
3.0	CQA Program
	3.1 Scope of Services
	3.2 Personnel
4.0	Earthwork CQA
5.0	Geomembrane CQA
6.0	Leachate Collection & Recovery (LCR) System CQA
7.0	Geonet Composite CQA
8.0	Geotextile CQA
9.0	Geosynthetic Clay Liner CQA
10.0	Summary and Conclusions
11.0	Project Certification

### Appendices

Appendix A	Specification Clarifications/Modifications
Appendix B	Photographic Documentation
Appendix C	CQA Reporting
	C1 CQA Reports
	C2 CQA Meeting Minutes
Appendix D	Earthwork CQA Data
	D1 CQA Test Results
Appendix E	Geomembrane CQA Data
	E1 Manufacturer's Product Data Submittals and Quality Control Certificates
	E2 Subgrade Acceptance Certificates
	E3 Trial Seam Logs
	E4 CQA Test Results
Appendix F	Leachate Collection & Recovery (LCR) System CQA Data
	F1 Manufacturer's Product Data Submittals and Quality Control Certificates
	F2 CQA Test Results
Appendix G	Geonet Composite CQA Data
	G1 Manufacturer's Product Data Submittals and Quality Control Certificates
	G2 CQA Test Results

**TABLE 2.1 (CONTINUED):**

Appendix H	Geotextile CQA Data
	H1 Manufacturer's Product Data Submittals and Quality Control Certificates
	H2 CQA Test Results
Appendix I	Geosynthetic Clay Liner
	I1 Manufacturer's Product Data Submittals and Quality Control Certificates
	I2 CQA Test Results
Appendix J	Record Drawings

## **SECTION 3.0 EARTHWORK CQA**

### **3.1 INTRODUCTION**

This section of the CQA Manual addresses earthwork (excavation and embankment) and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, field control and record tests, and resolution of problems.

### **3.2 EMBANKMENT MATERIAL APPROVAL**

All material to be used as compacted embankment shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

#### **3.2.1 Control Tests**

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries shall be made in the daily log.

During stockpiling operations, control tests, as shown on Table 3.1, will be performed by the CQA Engineer prior to placement of any compacted embankment.

### **3.3 SUBGRADE APPROVAL**

The CQA Engineer shall verify that the compacted embankment subgrade is constructed in accordance with the project specifications.

### **3.4 EARTHWORK CONSTRUCTION**

#### **3.4.1 Construction Monitoring**

- A. Earthwork shall be performed as described in the project specifications.
- B. Only soil previously approved by the CQA Engineer (see Section 3.2) shall be used in construction of the compacted embankment. Unsuitable material will be removed prior to acceptance by the CQA Engineer.
- C. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying,

scarification, etc.) shall be completed before the CQA Engineer will allow placement of subsequent lifts.

- D. The CQA Engineer shall monitor protection of the earthwork during and after construction.

### **3.4.2 Control Tests**

The control tests, as shown on Table 3.1, will be performed by the CQA Engineer prior to placement of compacted embankment.

### **3.4.3 Record Tests**

The record tests, as shown on Table 3.2, will be performed by the CQA Engineer during placement of compacted embankment.

#### **3.4.3.1 Record Test Failure**

Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

### **3.4.4 Judgmental Testing**

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

## **3.5 DEFICIENCIES**

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 3.1: CQA TESTING PROGRAM FOR EMBANKMENT  
MATERIAL APPROVAL**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Visual Classification	ASTM D 2488	Each Soil
Moisture-Density Relationship	ASTMD 698	5,000 CY per Each Soil

**TABLE 3.2: CQA TESTING PROGRAM FOR COMPACTED EMBANKMENT**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
<b>CONTROL TESTS: (See Table 3.1)</b>		
<b>RECORD TESTS:</b>		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 2922 <sup>1</sup>	20,000 ft <sup>2</sup> per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)
Moisture Content	ASTM D 3017 <sup>2</sup>	20,000 ft <sup>2</sup> per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.
2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.

## **SECTION 4.0 GEOMEMBRANE CQA**

### **4.1 INTRODUCTION**

This section of the CQA Manual addresses the geomembrane components of the liner and final cover systems and outlines the CQA program to be implemented with regard to manufacturer and installer approval, material approval, subgrade approval, field and laboratory control and record tests, repairs, and resolution of problems.

### **4.2 GEOMEMBRANE MANUFACTURER AND INSTALLER APPROVAL**

The Contractor shall submit the qualifications of the Geomembrane Manufacturer and the Geomembrane Installer, as described in the specifications, to the CQA Engineer for approval.

### **4.3 GEOMEMBRANE MATERIAL APPROVAL**

#### **4.3.1 Geomembrane Product Data**

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### **4.3.2 Shipment And Storage**

During shipment and storage, all geomembrane will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### **4.3.3 Quality Control Certificates**

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls or sheets related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### **4.3.4 Material Control Tests**

Samples for material control tests, as shown on Table 4.1, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geomembrane. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll or sheet width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All control test results must be available at the site prior to the deployment of all geomembrane. The CQA Engineer will examine all results from laboratory conformance testing.

#### 4.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geomembrane Installer will replace the roll or sheet of geomembrane that is in nonconformance with the project specifications with a roll or sheet that meets project specifications.
- B. The Geomembrane Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll or sheet will be tested until a passing roll or sheet is found. This additional conformance testing will be at the expense of the Geomembrane Installer. If either of the two closest rolls or sheets fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

## 4.4 GEOMEMBRANE INSTALLATION

### 4.4.1 Handling

The Geosynthetic Installer will handle all geomembrane in such a manner as required by the project specifications.

### 4.4.2 Earthwork

#### 4.4.2.1 Surface Preparation

The Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given to the CQA Engineer prior to commencement of geomembrane installation in the area under consideration. The CQA Engineer will give a copy of this certificate to the Engineer.

To ensure a timely covering of the underlying surface, the Engineer may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Engineer and CQA Engineer any change in the supporting soil condition that may require repair work. If the CQA Engineer concurs with the Geomembrane Installer, then the Engineer will ensure that the supporting soil is repaired.

#### 4.4.2.2 Anchorage System

The CQA Engineer will verify that anchor trenches have been constructed and backfilled according to project specifications and design drawings.

### 4.4.3 Geomembrane Placement

#### 4.4.3.1 Field Panel Identification

The CQA Engineer will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Engineer at the Geosynthetics CQA Meeting (see Section 1.7.2).

The Geomembrane Installer will establish a table or chart showing correspondence between roll or sheet numbers and field panel identification codes. This documentation shall be submitted to the CQA Engineer weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

#### 4.4.3.2 Field Panel Placement

4.4.3.2.1 Location: The CQA Engineer will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved or modified in Section 4.4.3.1.

4.4.3.2.2 Installation Schedule: The CQA Engineer will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Engineer on the acceptability of that change.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

4.4.3.2.3 Placement of Geomembrane: The CQA Engineer will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Engineer will verify that the supporting soil has not been damaged by weather conditions.

4.4.3.2.4 Damage: The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage. The CQA Engineer will advise the Engineer which panels, or portion of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Engineer. Repairs will be made according to procedures described in this section.

As a minimum, the CQA Engineer will document that:

- the panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc. are either marked by the Geomembrane Installer for repair or the panel is rejected.

#### **4.4.4 Field Seaming**

##### 4.4.4.1 Seam Layout

The Geomembrane Installer will provide the CQA Engineer with a seam layout drawing, i.e., a drawing of the area to be lined showing all expected seams. The CQA Engineer and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of practice and this CQA Manual. In addition, no panels not specifically shown on the seam layout drawing may be used without the Engineer's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Geosynthetics CQA Meeting (see Section 1.7.2). An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Engineer.

##### 4.4.4.2 Requirements of Personnel

The Geomembrane Installer will provide the CQA Engineer with a list of proposed seaming personnel and their experience records. This document will be reviewed by

the CQA Engineer for compliance with project specifications.

#### 4.4.4.3 Seaming Equipment and Products

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the Engineer and CQA Engineer for their approval. Only seaming apparatus which have been specifically approved by make and model will be used. The CQA Engineer will submit all documentation to the Engineer for his concurrence.

#### 4.4.5 Field Seam Control Tests

##### 4.4.5.1 Trial Seams

- A. Prior to production seaming, after four (4) hours of continuous seaming, and/or when significant changes in geomembrane or ambient temperature occurs, the Geomembrane Installer shall make trial seams to verify that seaming conditions and procedures are adequate. Trial seams shall be performed by each operator of extrusion welders and by the primary operator of each wedge welder using seaming equipment to be used in production seaming.
- B. Trial seams shall be performed for each welder to be used and by each operator of extrusion welders, and by the primary operator of each fusion welder. A passing trial seam shall be made prior to the beginning of each seaming period. Typically, this is at the start of the day and after lunch break.
- C. Fusion welded trial seams shall be approximately 72" x 12" with the seam centered lengthwise. For extrusion welding, the trial seams shall be approximately 36" x 12" with the seam centered lengthwise. A minimum of four coupons will be tested in peel and shear (two each) (ASTM D 6392) by the Geomembrane Installer using a field tensiometer. All coupons shall meet the minimum seam strength requirements as shown in the project specifications.
- D. Each trial seam shall be assigned a number and the test results recorded in the appropriate log by the Geomembrane Installer. The CQA Engineer shall observe all trial seam welding and field testing, and shall compile all trial seam data.

#### 4.4.6 Field Seam Record Tests

##### 4.4.6.1 Nondestructive Seam Continuity Testing

The Geomembrane Installer shall test and document all seam welds continuously over their full length using one of the following nondestructive seam tests. This testing shall be performed simultaneously with geomembrane seaming as the work progresses and not at the completion of all field seaming.

- A. Vacuum Testing shall conform to ASTM D 5641 requirements.
- B. Air Pressure Testing (for double seam with an enclosed space) shall conform to ASTM D 5820 requirements and the requirements listed in Table 4.2.

The CQA Engineer shall observe the nondestructive testing on a full time basis to ensure conformance with this CQA Manual and the project specifications.

#### 4.4.6.2 Field Destructive Seam Testing

- A. The Geomembrane Installer will obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 500 linear feet of weld. The sample shall be cut into two equal-length pieces, one to be given to the Geomembrane Installer for field destructive seam testing and one given to the CQA Engineer as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.
- B. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392) by the Geomembrane Installer using a field tensiometer. Four of five coupons shall meet the minimum seam strength requirements as shown in the project specifications.
- C. The CQA Engineer or the Owner may require additional random samples to be taken for testing in areas which visually appear defective, where conditions differ from trial seam conditions, or areas that appear to differ from the project requirements.
- D. All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in this manual.

#### 4.4.6.3 Geosynthetics CQA Laboratory Destructive Testing

- A. The Geomembrane Installer will obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per day to confirm field destructive seam tests. The sample shall be cut into two equal-length pieces, both to be given to the CQA Engineer for laboratory destructive seam testing and as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.
- B. Laboratory destructive test samples will be packaged and shipped to the

Geosynthetics CQA Laboratory by the CQA Engineer in a manner that will not damage the test sample.

- C. A minimum of five coupons each will be tested in peel and two coupons in shear (ASTM D 6392) by the Geosynthetics CQA Laboratory. Four of five coupons shall meet the minimum seam strength requirements as shown in the project specifications.
- D. All geomembrane destructive test samples that fail to meet project specifications shall be saved and sent to the CQA Engineer for observation.
- E. The CQA Engineer will review laboratory test results as soon as they become available.

#### 4.4.6.4 Field Seam Record Test Failure

For noncomplying tests, the CQA Engineer will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;
- confirm and record the location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;
- provide a walk-through inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Manual and project specifications; and
- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

#### 4.4.6.5 Defining Extent of Field Seam Record Test Failure

All defective seam test failures must be bounded by acceptable destructive tests. The CQA Engineer will document repair actions taken in conjunction with all seam test failures.

### 4.4.7 Repairs & Verification

#### 4.4.7.1 Repair Procedures

- A. All repair procedures shall be in accordance with the project specifications. The CQA Engineer will observe all repair procedures.
- B. All surfaces shall be clean and dry at the time of the repair.

- C. After an extrusion weld is made, no more than 1/4 inch of abrasion shall be visible beyond the weld.

#### 4.4.7.2 Repair Verification

- A. Each repair shall be numbered and logged by the Geomembrane Installer.
- B. Each repair shall be non-destructively tested by the Geomembrane Installer using the methods described above. Repairs which pass non-destructive testing shall be taken as an indication of an adequate repair.
- C. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the CQA Engineer. A failed test indicates that the repair shall be redone and retested until passing test results are achieved.

## 4.5 LINER SYSTEM ACCEPTANCE

The Geomembrane Installer and the Geosynthetic Manufacturers will retain all ownership and responsibility for the geosynthetics in the landfill unit until acceptance by the Owner.

The geomembrane component of the liner system will be accepted by the Owner when:

- the installation is finished;
- verification of the adequacy of all seams and repairs, including associated testing, is complete;
- CQA Engineer provides the Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Geomembrane Installer.
- CQA Engineer furnishes the Engineer with a certification, submitted by the Geomembrane Installer that the geomembrane was installed in accordance with the Geomembrane Manufacturer's recommendations as well as the project drawings and project specifications;
- all documentation of the installation is completed including the CQA Engineer's final report; and
- certification by the CQA Engineer, including Record Drawing(s), sealed by a Professional Engineer registered in the state in which the project is located, has been received by the Engineer.

The CQA Engineer will certify that the installation has proceeded in accordance with this CQA

Manual and the project specifications for the project except as noted to the Engineer.

#### **4.6 MATERIALS IN CONTACT WITH GEOMEMBRANES**

The quality assurance procedures indicated in this subsection are only intended to assure that the installation of these materials does not damage the geomembrane. All reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

##### **4.6.1 Soils**

Prior to placement, the CQA Engineer will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Engineer a written surface acceptance certificate in accordance with Section 4.4.2. All soil materials shall be placed and compacted in accordance with project specifications.

##### **4.6.2 Sumps and Appurtenances**

The CQA Engineer will verify that:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the project specifications;
- extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas; and
- the geomembrane or appurtenances have not been visibly damaged while making connections to appurtenances.

#### **4.7 DEFICIENCIES**

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 4.1: CQA TESTING PROGRAM FOR GEOMEMBRANE MATERIAL APPROVAL**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>TEST FREQUENCY</b>
Thickness	ASTM D 5199/D 5994	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Density	ASTM D 1505/D 792	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Carbon Black Content	ASTM D 1603	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Carbon Black Dispersion	ASTM D 5596	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Tensile Properties:	ASTM D 638 (Type IV)	
Tensile Strength at Yield		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Tensile Strength at Break		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Elongation at Yield		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Elongation at Break		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Tear Resistance	ASTM D 1004	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>

Notes:

1. Whichever provides the larger number of tests.

**TABLE 4.2      AIR PRESSURE TEST REQUIREMENTS**

<b>MATERIAL</b>	<b>MIN. PRESSURE (PSI)</b>	<b>MAX. PRESSURE DROP (PSI) AFTER 5 MINUTES</b>
60 Mil HDPE	25	3

## **SECTION 5.0 LEACHATE COLLECTION & RECOVERY (LCR) SYSTEM CQA**

### **5.1 INTRODUCTION**

This section of the CQA Manual addresses the leachate collection and discharge piping, sumps, manholes, valves, drainage aggregate, and the protective cover layer of the LCR system. By reference to Sections 6.0 and 7.0 of this CQA Manual, this section also addresses the geonet drainage media and geotextiles that are included in the LCR system. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

### **5.2 LCR MATERIAL APPROVAL**

The CQA Engineer shall verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

#### **5.2.1 High Density Polyethylene (HDPE) Pipe**

- A. Receipt of Contractor's submittals on HDPE pipe.
- B. Review of submittals for HDPE pipe for conformity to the project specifications.
- C. Conduit lines external to the collection system are to be pressure tested as required by the project specifications and demonstrated to be leak-free.

#### **5.2.2 Sumps/Manholes**

- A. Receipt of Contractor's submittals on sumps/manholes.
- B. Review of submittals for sumps/manholes for conformity to the project specifications.

#### **5.2.3 Valves**

- A. Receipt of Contractor's submittals on valves.
- B. Review of submittals for valves for conformity to the project specifications.

#### **5.2.4 Drainage Aggregate**

- A. Receipt of Contractor's submittals on drainage aggregate.
- B. Review of submittals for drainage aggregate for conformity to the project specifications.

- C. Verify that drainage aggregate in stockpiles or at borrow sources conforms to the project specifications.
- D. Conduct material control tests in accordance with Table 5.1.

#### **5.2.5 Geonet Composite**

The CQA program for geonet composite is presented in Section 6.0 of this CQA Manual.

#### **5.2.6 Geotextiles** (Verify for each type of Geotextile)

The CQA program for geotextiles is presented in Section 7.0 of this CQA Manual.

#### **5.2.7 Protective Cover**

- A. Review the proposed source of protective cover for conformance with the project specifications.
- B. Conduct material control tests in accordance with Table 5.1.

### **5.3 LCR SYSTEM INSTALLATION**

The CQA Engineer will allow installation of the collection layer of the LCR system to proceed only after he has provided certification of the installed HDPE geomembrane.

The CQA Engineer will monitor and document the construction of all LCR components for compliance with the project specifications. Monitoring the construction work for the components of the LCR system includes the following:

- monitoring the minimum vertical buffer maintained between field equipment and the geomembrane;
- monitoring that the placement of the LCR components does not fold or damage the geomembrane or other underlying layers.

### **5.4 DEFICIENCIES**

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 5.1: CQA TESTING PROGRAM FOR LEACHATE COLLECTION SYSTEM**

<b>COMPONENT</b>	<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>MINIMUM TEST FREQUENCY</b>
<b>CONTROL TESTS:</b>			
<b>Drainage Aggregate (Each Type):</b>	Gradation	ASTM C 136	5,000 CY
	Carbonate Content	ASTM D 3042	1 per source
	Permeability (No. 8 Stone Only)	ASTM D 2434	10,000 CY
<b>Protective Cover:</b>	Visual Classification	ASTM D 2488	Each Load

## **SECTION 6.0 DRAINAGE GEOCOMPOSITE CQA**

### **6.1 INTRODUCTION**

This section of the CQA Manual addresses drainage geocomposite (DGC) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

### **6.2 DGC MATERIAL APPROVAL**

#### **6.2.1 DGC Product Data**

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### **6.2.2 Shipment And Storage**

During shipment and storage, all DGC will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### **6.2.3 Quality Control Certificates**

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### **6.2.4 DGC Material Control Tests**

Samples for material control tests, as shown on Table 6.1, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the DGC. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all DGC. The CQA

Engineer will examine all results from laboratory testing.

#### 6.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geosynthetic Installer will replace the roll of DGC that is in nonconformance with the project specifications with a roll that meets project specifications.
- B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

### 6.3 DGC INSTALLATION

#### 6.3.1 Handling And Placement

The Geosynthetic Installer will handle and place all DGC in such a manner as required by the project specifications.

#### 6.3.2 Stacking And Joining

When several layers of DGC are stacked, care should be taken to ensure that stacked DGC are placed in the same direction. Stacked DGC will never be laid in perpendicular directions to the underlying DGC (unless otherwise specified by the Engineer). The CQA Engineer will observe the stacking of DGC.

Adjacent rolls of DGC will be joined according to construction drawings and project specifications.

#### 6.3.3 Repairs

Any holes or tears in the DGC will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

### 6.3.4 Placement Of Overlying Materials

All soil materials located on top of DGC shall be placed in accordance with the project specifications.

### 6.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 6.1: CQA TESTING PROGRAM FOR DGC MATERIAL APPROVAL**

PROPERTY	TEST METHOD	TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Thickness (geonet only)	ASTMD 5199	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Density (geonet only)	ASTM D 1505	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Ply Adhesion	ASTM D 413/ GRI GC7	100,000 ft: <sup>2</sup> or 1 per Lot <sup>1</sup>
Transmissivity	ASTMD 4716 <sup>2</sup>	1 per Resin Lot

Notes:

1. Whichever provides the larger number of tests.
2. Conduct tests for transmissivity in accordance with the conditions given in the project specifications.

## **SECTION 7.0 GEOTEXTILE CQA**

### **7.1 INTRODUCTION**

This section of the CQA Manual addresses geotextiles and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

### **7.2 GEOTEXTILE MATERIAL APPROVAL**

#### **7.2.1 Geotextile Product Data**

For each type of geotextile to be used, the CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### **7.2.2 Shipment And Storage**

During shipment and storage, all geotextiles will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### **7.2.3 Quality Control Certificates**

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### **7.2.4 Geotextile Material Control Tests**

Samples for material control tests, as shown on Table 7.1, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geotextiles. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all geotextiles. The

CQA Engineer will examine all results from laboratory testing.

#### 7.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geosynthetic Installer will replace the roll of geotextile that is in nonconformance with the project specifications with a roll that meets project specifications.
- B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

### 7.3 **GEOTEXTILE INSTALLATION**

#### 7.3.1 **Handling And Placement**

The Geosynthetic Installer will handle and place all geotextiles in such a manner as required by the project specifications.

#### 7.3.2 **Seams And Overlaps**

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

#### 7.3.3 **Repairs**

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

#### 7.3.4 **Placement Of Overlying Materials**

All soil materials located on top of a geotextile shall be placed in accordance with the project specifications.

## 7.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 7.1: CQA TESTING PROGRAM FOR GEOTEXTILE  
MATERIAL APPROVAL**

PROPERTY	TEST METHOD	TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Grab Tensile Strength	ASTM D 4632	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Puncture Resistance	ASTM D 4833	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Trapezoidal Tear Strength	ASTM D 4533	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>

Notes:

1. Whichever provides the larger number of tests.
2. CQA testing is not required for geotextiles placed outside of the containment area.

## **SECTION 8.0 GEOSYNTHETIC CLAY LINER (GCL) CQA**

### **8.1 INTRODUCTION**

This section of the CQA Manual addresses geosynthetic clay liner (GCL) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

### **8.2 GCL MANUFACTURER AND INSTALLATION APPROVAL**

The Contractor shall submit the qualifications of the GCL Manufacturer and the GCL Installer, as described in the specifications, to the CQA Engineer for approval.

### **8.3 GCL MATERIAL APPROVAL**

#### **8.3.1 GCL Product Data**

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### **8.3.2 Shipment And Storage**

During shipment and storage, all GCL will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### **8.3.3 Quality Control Certificates**

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### **8.3.4 GCL Material Control Tests**

Samples for material control tests, as shown on Table 8.1, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the GCL. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all GCL. The CQA Engineer will examine all results from laboratory testing.

#### 8.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geosynthetic Installer will replace the roll of GCL that is in nonconformance with the project specifications with a roll that meets project specifications.
- B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

## 8.4 GCL INSTALLATION

### 8.4.1 Handling And Placement

The Geosynthetic Installer will handle and place all GCL in such a manner as required by the project specifications.

### 8.4.2 Seams and Overlaps

All GCL will be seamed or overlapped in accordance with project specifications. The CQA Engineer will observe any repair.

### 8.4.3 Repairs

Any holes or tears in the GCL will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

### 8.4.4 Placement Of Overlying Materials

All geosynthetic liner system components located on top of GCL shall be placed in accordance with the project specifications.

## 8.5 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 8.1: CQA TESTING PROGRAM FOR GDM MATERIAL APPROVAL**

PROPERTY	TEST METHOD	TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Hydraulic Conductivity	ASTM D 5084/D 5887	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Bentonite Content	ASTM D 5993 (@ 0% moisture)	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Peel Strength	ASTM D 6496	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>

Notes:

1. Whichever provides the larger number of tests.

## Appendix A

### Reference List of Test Methods

**INTERNATIONAL PAPER INDUSTRIAL LANDFILL  
RIEGELWOOD, NORTH CAROLINA**

**CQA MANUAL  
APPENDIX A: REFERENCE LIST OF TEST METHODS**

**American Society American Society of Testing and Materials (ASTM):**

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTMD 413	Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
ASTM D 422	Standard Test Method for Particle Size Analysis of Soils.
ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> ).
ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTMD 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTMD 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).

ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates.
ASTMD 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTMD 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTMD 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTMD 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

ASTM D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
ASTMD 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

Geosynthetic Research Institute (GRI):

GRI GC7	Determination of Adhesion and Bond Strength of Geocomposites.
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