Attachment VII
Technical Specifications

Solid Waste Permit #498
Bristol Integrated Solid Waste Management Facility
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SCS ENGINEERS

02218208.17 | **February 17, 2023**
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SPECIFICATIONS

SECTION 01 45 00

CONSTRUCTION QUALITY CONTROL

1.0 GENERAL

1.1 SECTION INCLUDES

- Quality Control Requirements
- Tolerances.
- References.
- Labeling.
- Testing and inspection services.
- Examination.
- Preparation.

1.2 QUALITY CONTROL REQUIREMENTS

1.2.1 Construction Quality Control

The CONTRACTOR is responsible for construction quality control (CQC) and shall establish and maintain an effective quality control system in compliance with the Contract Documents. The construction quality control system shall consist of plans, procedures, tests and observation, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction and manufacturing operations, both on-site and off-site, and shall be keyed to the proposed construction sequence.

Contractor will be required to provide, coordinate and oversee the following activities on the Project in accordance with the Specifications and CQA Manual:

1.2.1.1 Materials Testing

Laboratory and field soil and geosynthetics testing in accordance with the project specifications.

1.2.1.2 Operational Testing

Laboratory and field soil and geosynthetics testing to guide construction operations.

1.2.1.3 Surveying

Field stake-out surveying and surveying to facilitate construction operations.

1.2.2 Construction Quality Assurance

The Owner is responsible for and will provide Construction Quality Assurance (CQA), which will provide independent monitoring and verification of compliance with all construction and CQC requirements.

Minimum testing requirements are included in applicable Specification sections. Owner will provide the following testing on the Project:

1.2.2.1 Materials Testing

Laboratory and field soil and geosynthetics testing as outlined in the project specifications.

All tests which fail to comply with the minimum requirements shall be retested at Contractor's expense using Owner's contracted representatives. Owner reserves the right to direct additional testing and sampling.

1.2.2.2 Surveying

Provision of construction quality assurance surveying.

1.2.2.3 Drawings

Record drawings.

Results of all analyses shall be submitted to Engineer as soon as they are available. Should any analyses show that the product or material tested does not comply with the Specification, Contractor shall remove, repair, or replace the product or material at no expense to Owner. Contractor may, at his option and expense, perform additional testing to substantiate the claim the product or material complies with the specification requirements.

1.3 MEASUREMENT AND PAYMENT

Separate payment will not be made for providing and maintaining an effective Construction Quality Control program, CONTRACTOR Quality Control (CQC) Plan and associated testing provisions during the progression of the work will not be paid for separately and shall be included within the applicable work item on the bid form.

1.4 QUALITY CONTROL AND CONTROL OF INSTALLATION

1.4.1

Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

1.4.2

Comply with manufacturers' instructions, including each step in sequence.

1.4.3

When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

1.4.4

Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

1.4.5

Perform Work by persons qualified to produce required and specified quality.

1.4.6

Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

1.4.7

Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.5 TOLERANCES

1.5.1

Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

1.5.2

Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

1.5.3

Adjust products to appropriate dimensions; position before securing products in place.

1.6 REFERENCES

1.6.1

For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

1.6.2

Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

1.6.3

Obtain copies of standards where required by product specification sections.

1.6.4

When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.6.5

Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.7 TESTING AND INSPECTION SERVICES

1.7.1

The Contractor may employ a third party firm to support construction quality control on the project.

1.7.2

Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing. Refer to Section 01 45 29 for laboratory requirements.

1.7.3

The independent firm will perform tests, inspections, and other services specified in individual specification sections and as required by Engineer.

1.7.4

Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Engineer.

1.7.5

Reports will be submitted by independent firm to Engineer and Contractor, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

1.7.6

Contractor shall cooperate with independent firm; furnish samples of materials, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1.7.6.1

Notify Engineer and independent firm 48 hours prior to expected time for operations requiring services.

1.7.6.2

Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

2.0 PRODUCTS

2.1 CONSTRUCTION QUALITY CONTROL PLAN

2.1.1 Content of the CQC Plan

The CQC plan shall include, as a minimum, the following to cover all construction and manufacturing operations, both on site and off site, including work by subcontractors, fabricators, suppliers and purchasing agents:

2.1.1.1 Organizational Chart

A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the Site Superintendent or someone higher in the CONTRACTOR's organization. Site Superintendent in this context shall mean the individual with responsibility for the overall management of the project including quality and production.

2.1.1.2 Resumes

A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the Site Superintendent or someone higher in the CONTRACTOR's organization. Site Superintendent in this context shall mean the individual with responsibility for the overall management of the project including quality and production.

2.1.1.3 Letter of Authorization

A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality

control representatives outlining duties, authorities and responsibilities. Copies of these letters and documents will also be furnished to the Owner.

2.1.1.4 Testing

Control, verification and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, and person responsible for each test.

2.1.1.5 Inspection

Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

2.1.1.6 Deficiencies

Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

2.1.1.7 Daily Report and Monthly Report

Reporting procedures, including proposed reporting formats.

2.1.1.8 A list of the definable features of work.

A definable feature of work is a task which is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the Pre-Construction Conference and subsequent progress meetings.

2.1.1.9 Samples

Samples of all daily report and inspection forms.

2.1.1.10 Laboratories

The name and address of all quality control laboratories.

2.1.2 Acceptance of Plan

Acceptance of the CONTRACTOR's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Owner reserves the right to require the CONTRACTOR to make changes in his CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

2.1.3 Notification of Changes

After acceptance of the CQC plan, the CONTRACTOR shall notify the ENGINEER in writing a minimum of seven (7) calendar days prior to any proposed change. Proposed changes are subject to acceptance by the ENGINEER and OWNER.

3.0 EXECUTION

3.1 CONSTRUCTION QUALITY CONTROL ORGANIZATION

3.1.1 CQC System Manager

The CONTRACTOR shall identify an individual within his organization at the site of the work who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the CONTRACTOR. This CQC System Manager shall be on the site at all times during construction and will be employed by the CONTRACTOR, except as noted in the following. An alternate for the CQC System Manager will be identified by the CQC System Manager in the plan to serve in the event of the system manager's absence. Periods of absence may not exceed 2 weeks at any one time, and not more than 15 workdays during a calendar year. The requirements for the alternate will be the same as for the designated CQC system manager.

3.1.2 CQC Organizational Staffing

The CONTRACTOR shall provide a CQC staff which shall be at the site of work at all times during progress of the work, with authority to take any action necessary to ensure compliance with the contract.

3.1.3 CQC Staff

Following are the minimum requirements for the CQC staff. These minimum requirements will not necessarily assure an adequate staff to meet the CQC requirements at all times during construction. The actual strength of the CQC staff may vary during any specific work period to cover the needs of the work period. When necessary for a proper CQC staffing on-site, the CONTRACTOR will add additional staff at no cost to the OWNER. This listing of minimum staff in no way relieves the CONTRACTOR of meeting the basic requirements of quality construction in accordance with contract requirements. All CQC staff members shall be subject to acceptance by the OWNER.

3.1.3.1 CQC System Manager:

The CQC System Manager shall demonstrate that they have a minimum of 2 years landfill construction experience on construction similar to this contract. The CQC System Manager shall be assigned as system manager but may also have duties as project superintendent in addition to quality control.

3.1.3.2 Supplemental Personnel

A staff shall be maintained under the direction of the CQC system manager to perform all QC activities. The staff must be of sufficient size to ensure adequate QC coverage of all work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties,

but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities. The QC plan will clearly state the duties and responsibilities of each staff member.

3.1.4 Organizational Changes

The CONTRACTOR shall obtain OWNER acceptance before replacing any member of the CQC staff. Requests shall include the names, qualifications, duties, and responsibilities of each proposed replacement.

3.2 EXAMINATION

3.2.1 Existing Conditions

Verify existing site conditions are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

3.2.2 Specific Conditions

Examine and verify specific conditions described in individual specification sections.

3.3 CONTROL

3.3.1 Construction Quality Control

Construction Quality Control is the means by which the CONTRACTOR ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The controls shall be adequate to cover all construction operations, including both on-site and offsite fabrication, and will be keyed to the proposed construction sequence. The controls shall be conducted by the CQC System Manager for all definable features of work, as follows:

3.3.1.1

A review of each paragraph of applicable specifications.

3.3.1.2

A review of the contract plans.

3.3.1.3

A check to assure that all materials and/or equipment to be used have been tested, submitted, and approved.

3.3.1.4

A check to assure that provisions have been made to provide required control inspection and testing.

3.3.1.5

Examination of the work area to assure that all required preliminary work has been completed and in compliance with the contract.

3.3.1.6

A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawing or submitted data, and are properly stored.

3.3.1.7

A review of the appropriate activity hazard analysis to assure safety requirements are met.

3.3.1.8

Discussion of procedures for constructing the work including repetitive deficiencies. Document construction tolerances and workmanship standards for the work.

3.3.1.9

A check to ensure that the portion of the plan for the work to be performed has been accepted by the ENGINEER.

3.3.1.10

A check of preliminary work to ensure that it is in compliance with contract requirements. Review minutes of the preparatory meeting.

3.3.1.11

Verification of full contract compliance. Verify required control inspection and testing.

3.3.1.12

Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with sample panels if appropriate.

3.3.1.13

Resolve all differences between parties.

3.3.1.14

Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

3.3.1.15

The ENGINEER shall be notified at least 24 hours in advance of beginning any actions. A meeting shall be conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the above actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The CONTRACTOR shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.3.2 Follow-up

Daily checks shall be performed to assure continuing compliance with contract requirements, including control testing, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The CONTRACTOR shall not build upon or conceal non-conforming work.

3.3.3 Additional Requirements

Additional control may be required on the same definable features of work if the quality of ongoing work is unacceptable as determined by the ENGINEER; or if there are changes in the CQC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.4 TESTS

3.4.1 Testing Procedure

The CONTRACTOR shall perform tests specified or required to verify that control measures are adequate to provide a product which conforms to contract requirements. Testing includes operation and/or acceptance tests when specified. The CONTRACTOR shall procure the services of an approved testing laboratory or establish an approved testing laboratory at the project site. Testing laboratories are subject to approval by the ENGINEER as specified in Section 01 45 29, Quality Control Testing Laboratories. A list of CQC tests to be performed shall be by the furnished by the CONTRACTOR as a part of the CQC plan. The list shall give the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required. The CONTRACTOR shall perform the following activities and record and provide the following data:

3.4.1.1

Verify that testing procedures comply with contract requirements.

3.4.1.2

Verify that facilities and testing equipment are available and comply with testing standards.

3.4.1.3

Check test instrument calibration data against certified standards.

3.4.1.4

Verify that recording forms and the test identification control number system, including all of the test documentation requirements, have been prepared

3.4.1.5

Results of all tests performed, both passing and failing tests, will be recorded on the Quality Control report for the date performed. Tests shall be clearly labeled as passing or failing. Invitation for Bids/Project Manual paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. An information copy of tests performed by an off-site or commercial test facility will be provided directly to the ENGINEER. Failure to submit timely test reports, as stated, may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.4.2 Testing Laboratories

3.4.2.1 Capability Check

The ENGINEER reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques.

3.4.2.2 On-Site Laboratory and Equipment

The OWNER reserves the right to utilize the CONTRACTOR∋S quality control testing laboratory and equipment to check the CONTRACTOR'S testing procedures, techniques, and test results at no additional cost to the OWNER.

3.5 COMPLETION INSPECTION

At the completion of all work or any increment thereof established by a completion time stated in the Contract or stated elsewhere in the Project Manual, the CQC system manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved plans and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC system manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the ENGINEER. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

END OF SECTION 01 45 00

SECTION 01 45 29

QUALITY CONTROL TESTING LABORATORIES

1.0 GENERAL

1.1 DESCRIPTION

This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained by the General Contractor.

1.2 REFERENCE SPECIFICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- ASTM D 3740 Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- ASTM E 329 Standard Practice for Use in Evaluation of Testing and Inspection Agencies as Used in Construction

1.3 REQUIREMENTS

1.3.1 Accreditation Requirements:

Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing associated with the project.

1.3.2 Inspection and Testing:

Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by Engineer. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of Engineer to such failure.

1.3.3 Written Reports

Testing laboratory shall submit test reports to Resident Engineer, Contractor, unless other arrangements are agreed to in writing by the Resident Engineer. Submit reports of tests that fail to meet construction contract requirements.

1.3.4 Verbal Reports

Give verbal notification to Resident Engineer immediately of any irregularity.

1.4 APPROVAL OF LABORATORY

The CONTRACTOR shall submit the Qualifications of his proposed Quality Control Testing Laboratory(s) to the ENGINEER for approval within 14 days after receipt of notice to proceed and prior to initiating work or subcontractor agreements.

1.5 TESTING EQUIPMENT CALIBRATION

1.5.1 Calibration

Calibrated at maximum 12 month intervals or interval specified by applicable ASTM requirement whichever is more frequent. Calibration shall utilize devices of accuracy traceable to either National Institute of Standards and Technology (formerly the National Bureau of Standards) or accepted values of natural physical constants.

1.5.2 Certification

Submit copy of certificate of calibration for all test equipment utilized, made by accredited calibration agency to the ENGINEER for approval.

1.6 SUBMITTALS

1.6.1 Certificate of Compliance of Laboratory Qualifications

CONTRACTOR shall submit the name and address of organization, laboratory qualifications, certificates of calibration for all test equipment, and blank test forms for the following:

- Independent Geosynthetics QC Laboratory
- Independent Soils QC Laboratory
- Manufacturing Quality Control Laboratory

1.7 TEST REPORTS

Promptly submit reports of inspections and tests to ENGINEER within 48 hours of test, including:

- Date issued.
- Project title and number.
- Testing laboratory name and address.
- Name and signature of inspector.

- Date of inspection or sampling.
- Record of temperature and weather.
- Date of test.
- Identification of product and specification section.
- Location in project.
- Type of inspection or test.
- Results of tests and observations regarding compliance with Contract Documents.

2.0 PRODUCTS

Not used.

3.0 EXECUTION

3.1 EARTHWORK

3.1.1 General:

The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified herein, within the agreed to time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:

3.1.1.1

Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the Engineer regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to Engineer extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.

3.1.1.2

Provide part time observation of fill placement and compaction and field density testing to verify that earthwork compaction obtained is in accordance with contract documents.

3.1.1.3

Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.

END OF SECTION 01 45 29

SECTION 02 21 00

SURVEYING

1.0 GENERAL

1.1 SUMMARY

Section includes requirements for surveying, field engineering, and record documents.

1.2 CONTRACTOR'S SURVEYOR

CONTRACTOR is required to utilize a positioning system and/or an independent surveyor licensed in Virginia to provide field engineering and surveying services as required for layout and construction of the project as indicated on the Drawings and specified herein. The CONTRACTOR's surveyor shall:

- Locate existing features,
- Generate cut sheets,
- Provide construction stake out.

The Owner's surveyor will perform the following:

- Create final Record Drawings,
- Create the Geomembrane Record Drawing,
- Provide survey base maps for record Drawings,
- Provide survey controls, and verify the work as the Owner deems necessary.

1.3 DEFINITIONS

1.3.1 Existing Features

Existing Features include but are not limited to the following:

EXAMPLE LIST ONLY:

- Access Roads
- Buried piping
- Grass lined, rip rap lined, and gabion lined channels
- Groundwater Monitoring wells, Gas Monitoring Probes, and LFG collection wells
- Leachate Systems
- Manholes
- Stormwater Systems (Drop inlets, slope drains, Culverts, ditches, etc.)
- Stormwater Basins

1.3.2 Independent Surveyor:

Employed by an organization which is independent from the CONTRACTOR.

1.4 SUBMITTALS

Within 14 days before commencing work, submit the following items to the ENGINEER for review:

1.4.1 Qualifications of Surveyor

Submit surveyor's name, Virginia license number, and qualifications.

1.4.2 Project Record Documents

Upon Substantial Completion of the Work, notify ENGINEER for development of record documents. Final payment will not be made until satisfactory record documents are recorded by ENGINEER.

1.5 MONTHLY INSPECTIONS

To verify the CONTRACTOR's monthly progress payment requests, the following items shall be made available for monthly inspection by the ENGINEER:

1. Record Documents, including updated construction schedule
2. CONTRACTOR SURVEYOR'S Measurements, Notes, and Cut Sheets

1.6 SITE CONDITIONS

1.6.1 Existing Grades

The Contract Drawings depict approximate current surface elevations. Filling activities, maintenance activities, regrading, and routine settlement may have occurred since the original survey.

1.6.2 Existing Features

CONTRACTOR is required to field verify the location of existing features. The OWNER'S record drawings are available to the CONTRACTOR. The existence and location of features are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and existing features. The OWNER and the ENGINEER take no responsibility for the accuracy of these record drawings implied or otherwise.

1.6.3 Field Verification

Prior to construction, verify the location of existing features at points of connection or tie-in to the Work.

1.6.4 Field Conditions and Measurements

The CONTRACTOR shall base all measurements, both horizontal and vertical, from established benchmarks. The CONTRACTOR shall be responsible for field verification of all dimensions and conditions at the job site.

1.6.5 Discrepancies

Should the CONTRACTOR discover any discrepancy between actual conditions and those indicated which prevent following good practice or the intent of the Drawings and Specifications, he shall notify the ENGINEER in writing and request clarification and instructions on how to proceed. The CONTRACTOR shall not proceed with his work until he has received the same from the ENGINEER.

1.6.6 No Additional Payment

No claims shall be made for extra payment or extensions of Contract completion time if the CONTRACTOR fails to notify the ENGINEER of any discrepancy before proceeding with the aspect of the Work.

2.0 PRODUCTS

Not Used

3.0 EXECUTION

3.1 FIELD SURVEY WORK

3.1.1 Control Points

The OWNER will identify existing project control points at the site for the CONTRACTOR. The OWNER will, at the CONTRACTOR'S cost and as soon as possible, replace lost or destroyed project control points to the same accuracy of the existing project control points. Base replacements on the original survey control points. Relate all work to the facility elevation datum and coordinate system. The CONTRACTOR is responsible for all construction layout and staking.

3.1.2 Benchmarks

Establish and maintain a minimum of two permanent benchmarks on the site, referenced to data established by survey control points. Record benchmark locations, with horizontal and vertical data, on Project Record Documents. Do not change or relocate benchmarks or control points without prior written approval by the OWNER. Promptly report lost or destroyed reference points or requirements to relocate reference points because of necessary changes in grades or locations.

3.1.3 Site Improvements

Work from lines and levels established by benchmarks and markers to set lines and levels as needed to properly locate each element of the Project. Locate and lay out site improvements, including stakes for slopes, grading, fill and topsoil placement, utility slopes and invert elevations by

instrumentation and similar appropriate means. Calculate and measure required dimensions within indicated or recognized tolerances. Do not scale Drawings to determine dimensions.

3.1.4 Relocation of Existing Utilities

Furnish information necessary to adjust, move or relocate existing features, structures, utility poles, lines, services or other appurtenances located in, or affected by construction. Coordinate with local authorities having jurisdiction.

3.1.5 Surveyor's Log

Keep neat legible notes of all measurements and calculations made by him while surveying and laying out the work. Maintain a surveyor's log of control and other survey work. Make this log available for reference.

3.2 TOLERANCES

Elevations and 2 foot contour lines shown on the drawings are approximate. However, minimum and maximum slope requirements shown on the drawings and specified herein must be observed at all times. Slopes shall be constructed as indicated.

3.2.1 Liner

3.2.1.1 Earthwork

Earthwork shall be graded to ±0.2 feet of required grade provided required minimum slopes are maintained and minimum thicknesses for components of the liner or cover system are obtained.

3.2.1.2 Piping

Piping shall be graded to ±0.1 feet provided required slopes are maintained.

3.3 RECORD DOCUMENTS

3.3.1 General

Do not use existing record documents for construction purposes. Protect new record documentation from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the ENGINEER's reference during normal working hours. Store record documents and samples in CONTRACTOR'S field office apart from documents used for construction. Provide files, racks, and secure storage for record documents and samples. Backup electronic documents at least once per week.

3.3.2 Recording

1. Label and file record documents and samples in accordance with Specification Section number listings in Table of Contents of this Invitation for Bids/Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.

2. Preparation of project record documents shall be by personnel skilled as a draftsman competent to prepare the required drawings.
3. Record and update daily record information from field notes, on set of blue line prints, and copy of Invitation for Bids/Project Manual.
4. Record information concurrently (daily) with construction progress. Do not conceal work until required information is recorded.
5. Record deviations from required lines and levels, and advise the ENGINEER when deviations that exceed indicated or recognized tolerances are detected. On Project Record Drawings, record deviations that are accepted and not corrected.

3.3.3 Record Drawings

Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

Mark record sets with red erasable pencil. Mark new information that is important to the OWNER, but was not shown on Contract Drawings or Shop Drawings. Note related Change Order numbers where applicable. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set. Legibly mark each item to record actual construction, including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
2. Measured locations of liner systems, internal utilities, and appurtenances concealed in construction, referenced to visible and accessible features of construction.
3. Field changes (dimensions and detail)
4. Changes by Modifications made by the ENGINEER or OWNER.
5. Details not on original Contract Drawings.
6. References to related Shop Drawings and Modifications.
7. Depths of various elements of the Work in relation to datum.

3.3.4 Record Specifications

Maintain one complete copy of the Project Manual, including addenda and one copy of other written construction documents such as Change Orders and Field Order issued in printed form during construction. Mark these documents to show substantial variations in actual work performed in comparison with the text of the Specifications, Change Order, and Field Order. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related record drawing information and product data. Legibly mark up each Section to record:

1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
2. Changes made by Change Order or Field Order.
3. Other matters not originally specified.

3.3.5 Geomembrane Record Drawing

The OWNER's surveyor or ENGINEER shall prepare a geomembrane record drawing. The contractor will coordinate installation of the geomembrane to allow owner's surveyor to record the layout. The CONTRACTOR will not place additional layers until the survey is complete. This drawing shall be signed and sealed by the surveyor. The minimum scale is 1" = 50', and the maximum sheet size is 24" X 36". The following information is mandatory:

1. 2' contours
2. Approximate Location and size of all panels installed and seam welds
3. Label all panel and roll numbers
4. Label destructive sample numbers and geomembrane repair numbers
5. Label and locate the location of each repair, cap strip, liner penetration, pipe boot, and destructive sample.
6. Horizontal and vertical coordinates of the anchor trench
7. Slopes and breaks in grade

3.3.6 Record Product Data

Maintain one copy of each approved Product Data submittal. Mark these documents to show significant variations in actual work performed in comparison with information submitted. Include variations in products delivered to the site, and from the manufacturer's installation instructions and recommendations. Give particular attention to concealed products and portions of the work which cannot be otherwise be readily discerned later by direct observation. Note related Change Orders and mark-up of record drawings and Specifications.

Upon completion of mark-up, submit complete set of record Product Data to the ENGINEER for the OWNER'S records.

3.3.7 Record Sample Submitted

Immediately prior to the date or dates of Substantial Completion, the CONTRACTOR will meet at the site with the ENGINEER and the COUNTY'S personnel to determine which of the submitted samples that have been maintained during progress of the work are to be transmitted to the OWNER for record purposes. Comply with delivery to the OWNER'S sample storage area.

3.3.8 Miscellaneous Record Submittals

Refer to other Specification Sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the work. Immediately prior to the date or dates of substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the ENGINEER for the OWNER'S records. Miscellaneous record submittals include but are not limited to:

- Field test records
- Inspection certificates
- Manufacturer's certificates
- Manufacturer's Warrantees

3.3.9 Inspection

Verify locations of survey control points and existing features prior to starting work. Promptly notify ENGINEER of any discrepancies.

3.3.10 Survey for Measurement and Payment

Measurement for payment calculations shall be performed by the OWNER'S surveyor. Drawings and calculations shall be checked and sealed by the SURVEYOR. In the event of a dispute, Contractor must provide documentation from a Surveyor Licensed in the Commonwealth of Virginia. An Independent Surveyor may be called to verify grades and or volumes in the event of any disagreements.

END OF SECTION 02 21 00

SECTION 31 00 00

EARTHWORK

1.0 GENERAL

1.1 DESCRIPTION

1.1.1

The work in this section includes all labor, materials, equipment, construction quality control (CQC) testing, and incidentals required to perform earthwork for the final cover system installation as shown on the Plans and as specified herein and in General Conditions.

1.1.1.1

Earthwork includes, but is not limited to excavation, filling, backfilling and compacting earthen materials to achieve base grades and final grades for the final cover system installation. This includes backfilling of trenches and anchor trenches; sheeting and shoring; subbase test pad construction; dewatering; general backfilling and compacting, constructing diversion berms, and grading around structures; segregating, stockpiling, screening, and other material processing of excavated materials for on-site use; disposing of earth materials, as required to complete construction and associated features shown on the Plans.

1.1.2

The cost of all excavation shall be incorporated into the base bid. No distinction will be made insofar as payment between soil, rock and waste materials if encountered.

1.1.3

CONTRACTOR is responsible for all construction layout and staking.

1.1.4 Related Work Specified Elsewhere

- Section 31 10 00 Clearing and Grubbing
- Section 31 05 16 Aggregates
- Section 31 05 19.16 LLDPE Geomembrane
- Section 31 23 33 Trenching, Backfilling and Compacting

1.2 DEFINITIONS

1.2.1 Excavation

Excavation means the removal of soil, waste, rock, debris and other materials to the proposed grading limits indicated on the PLANS.

1.2.2 Unauthorized Excavation

Unauthorized excavations shall be backfilled and compacted as specified for authorized excavations at no additional cost to the OWNER.

1.2.3 Additional Excavation

When excavation has reached required subgrade elevations, notify the ENGINEER, who will make an inspection of conditions. If the ENGINEER determines that bearing materials at required subgrade elevations are unsatisfactory, continue excavation until satisfactory bearing materials are encountered. Replace excavated material with suitable fill material as directed by the ENGINEER.

1.2.4 Maximum Dry Density

Maximum dry weight in pounds per cubic foot (pcf) of a specific soil material as determined by ASTM D698.

1.2.5 Optimum Moisture Content

The moisture content at which the maximum dry density of a soil material is determined by ASTM D698.

1.2.6 General Fill Material

Fill material is material used for trench backfill, structural fill and backfill and embankment. The availability of onsite soils for use as fill material may be limited.

1.2.7 Filled Areas

Filled areas are areas which have received trench backfill, structural fill or embankment materials, placed and compacted as specified herein.

1.2.8 Borrow Fill

Borrow fill and borrow trench backfill are suitable materials meeting requirements specified herein.

1.2.9 Reference Standards

- ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort

- ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
- ASTM D2434 Standard Test Method for Permeability of Granular Soils (Constant Head)
- ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D4373 Standard Test Method for Calcium Carbonate Content of Soils
- ASTM D5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

1.3 SUBMITTALS

1.3.1

Refer to SECTION 01 33 00 – SUBMITTAL PROCEDURES for submittal requirements.

1.3.2

Sheeting, shoring and bracing shall be designed and signed by a registered professional ENGINEER and submitted for approval.

1.3.3 Federal

OSHA excavation safety standards 29 CFR, s.1926-650, Subpart P.

1.3.4 State and Local

State and County construction safety regulations.

1.3.5 Utility

Contact “Miss Utility” prior to any excavation.

1.4 PROJECT CONDITIONS

1.4.1 Site Information

The CONTRACTOR shall be responsible for having determined to his satisfaction, prior to the submission of his bid, the confirmation of the ground, the characteristics and quality of the

substrata, the types and quantities of materials to be encountered, the nature of the groundwater conditions, the prosecution of the work, the general and local conditions and all other matters which can in any way affect the work under this Contract.

Additional test borings and other exploratory operations may be performed by CONTRACTOR, at the CONTRACTOR'S option; however, the OWNER will not pay for such additional exploration.

1.4.2 Existing Structures

Shown on the Plans are certain surface and underground structures adjacent and/or within the work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the CONTRACTOR. The CONTRACTOR shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from injury by the CONTRACTOR. If they are broken or injured, they shall be restored immediately by the CONTRACTOR at his expense.

1.4.3 Protection of Persons and Property

1.4.3.1

Barricade open excavations or trenches occurring as part of this work and post warning signs or lights, as appropriate.

1.4.3.2

CONTRACTOR shall plan and conduct operations to prevent damage or disturbance to existing structures and utilities, buried utilities, existing monitoring wells, roads, signs, trees and bench marks.

1.4.3.3

Protect existing slopes, embankments, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

1.4.3.4

Failure of ENGINEER to order the use of bracing or sheeting or shoring shall not in any way or to any extent relieve the CONTRACTOR of any responsibility concerning the condition of excavations or of his obligations under this Contract.

1.4.3.5

Work is restricted to the area provided for CONTRACTOR'S use.

1.4.3.6

Side slopes shall be maintained in stable condition under all normal anticipated weather conditions for the period that the excavation will be open. The CONTRACTOR shall regrade side slopes to be a more stable configuration if so directed by ENGINEER.

1.4.4 Dust Control

The CONTRACTOR shall conduct operations and maintain the area of his activities, including sweeping and sprinkling of roadways, so as to minimize the creation and dispersion of dust to the satisfaction of the OWNER.

1.4.5 Traffic

Traffic inside and outside the site is anticipated. The CONTRACTOR shall coordinate with the OWNER regarding traffic control during construction. CONTRACTOR shall primarily utilize the access road on the eastern perimeter of the landfill.

1.5 QUALITY CONTROL

1.5.1 Regulations

All materials and labor furnished under this section shall comply with OSHA, ASTM, ANSI and other applicable Federal, State and County codes and regulations including revisions to the date of the Contract. Comply with the pertinent sections of the following standards:

Virginia Erosion and Sediment Control Handbook (VESCH), latest edition

Virginia Department of Transportation (VDOT) Road & Bridge Specifications, latest edition

1.5.2 Specifications

Provide Construction Quality Control (CQC) in accordance with Section 01 45 00 - CONSTRUCTION QUALITY CONTROL.

1.5.3 Workers

Use adequate number of skilled workers who are thoroughly trained and experienced in the specified requirements and the methods needed for proper performance of the work in this Section.

2.0 PRODUCTS

2.1 MATERIALS

2.1.1 General Fill Material

2.1.1.1 Availability On-Site

It is intended that on site soils can be used as fill material. General Fill is available on-site from borrow areas depicted on the plans, leachate pipe trenches, other related excavations, or may be excavated from surrounding areas approved by the ENGINEER.

2.1.1.2 Quality

General Fill shall be inorganic soil, that is not excessively wet or saturated, free of stone, rock or gravel larger than three (3) inches in any dimension, and free of debris, waste, frozen materials, vegetation, organic materials, roots, and other deleterious matter. The CONTRACTOR must provide preconstruction testing as required by the Specifications to demonstrate suitability. The suitable excavated soil materials shall be capable of maintaining its stability on all slopes. Excess or unsuitable material shall be removed and disposed as directed by the ENGINEER to the designated areas on-site stockpiles.

2.1.1.3 Off-site General Fill

If off-site soils are to be used, the CONTRACTOR shall identify the source a minimum of 3 weeks in advance of intent to import. The Owner's Quality Assurance personnel shall be given access to the site to obtain necessary samples for testing and proofing of the soil material. Off-site imported soil must have a minimum of 50% material finer than a No. 200 sieve, a minimum liquid limit of 30 and a maximum plasticity index of 20.

2.1.1.4 Use of General Fill

General Fill shall be used for backfilling and filling as shown on the PLANS, and for areas as otherwise directed by the ENGINEER.

2.1.2 Controlled Subgrade Material

Controlled subgrade material is the upper 12 inches of material prior to placement of the geomembrane within the final cover area. Controlled subgrade shall be inorganic soil free of roots, limbs, stone, rock or gravel larger than three (3) inches in any dimension trash, excessive organics, and deleterious material. The soil shall have a classification of SC, ML, CL, MH, or CH as defined in the Unified Soil Classification System (ASTM D 2487), or otherwise approved by the ENGINEER.

2.1.3 Bedding Layer

The top 6 " of intermediate/daily cover will function as a bedding layer and is to be smooth and free of sticks, rocks larger than 1 inch, or other irregularities which could puncture the synthetic cap. Not more than 1 percent by weight of particles larger than 3/8-inch in diameter shall be allowed within the bedding layer. The surface of the bedding layer will contain no particles larger than 3/8 inches, and the surface will be free of sharp or angular stone that may puncture the geomembrane. Mechanical screening, raking or other methods to remove oversize particles shall be provided by CONTRACTOR as necessary. Hand grooming of the surface may be required.

2.1.3.1 Stability

The satisfactory excavated soil materials shall be capable of maintaining its stability on all slopes. Excess or unsatisfactory material shall be removed and disposed as directed by the ENGINEER to the designated areas on-site designated by the OWNER.

2.1.3.2 Protection of Subgrade

Subbase (bedding layer) material shall be protected from excessive heat and desiccation cracking, freezing, or softening by precipitation, after placement and compaction. If disturbed, the subbase shall be recompacted or reworked to meet specifications.

2.1.4 Aggregates, Including, Aggregate Surrounding Perforated Horizontal Collection Pipe

Refer to SECTION 31 05 16 - AGGREGATES.

2.1.5 Trench Backfill

2.1.5.1 Open Areas

Fill material for trenches in open areas shall have a maximum density not less than 100 pounds per cubic foot as determined by ASTM D698. The top 12 inches of backfill material shall contain no rocks larger than one inch in the greatest dimension. Material from two feet above pipes to 12 inches below surface shall contain no more than 25 percent rocks, none being larger than four inches in the greatest dimension. Liquid limit shall not exceed 40 and plasticity index shall not exceed 25.

2.1.5.2 Embankments

Fill material for structural fill and embankments higher than four feet shall have a maximum density not less than 100 pounds per cubic foot as determined by ASTM D698, and shall contain no more than 25 percent rocks, none being larger than four inches in the greatest dimension. Liquid limit shall not exceed 25 and plasticity shall not exceed 6.

2.1.6 Bedding for Pipe and Pipe Structures

Soil backfill material shall be clean structural fill free of stones larger than 2 inches, construction debris, refuse, muck, soft clay, loam, sponge material, vegetation/organic matter, or angular rock. Suitable excavation material may be used for backfilling around installed pipe, subject to approval by ENGINEER.

2.1.7 Sheeting and Shoring

Sheeting, shoring and bracing materials shall be timber or steel, designed to retain the earth around structures to prevent cave-in and settlements, and to fulfill all safety requirements.

2.1.7.1 Timber

Timber shall be structural grade with minimum working stress of 1100 psi.

2.1.7.2 Steel

Steelsheet piling shall conform to requirements of ASTM A328, continuous interlocking type.

2.1.8 Other Materials

All other materials, not specifically described, but required for proper completion of the work shall be selected by the CONTRACTOR and approved by the ENGINEER.

3.0 EXECUTION

3.1 PREPARATION

3.1.1 Dewatering

3.1.1.1

The CONTRACTOR shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations, and shall keep such excavations dry so as to obtain a satisfactory foundation condition until the fill, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels.

3.1.1.2

Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottom, and soil changes detrimental to stability of subgrades and foundations. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structure as a result of inadequate dewatering or other construction methods shall be removed and replaced by crushed stone as required by the ENGINEER at the CONTRACTOR's expense. The bottom of excavations shall be rendered firm and without standing water before placing structures or pipes. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

3.1.1.3

Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.1.1.4 Disposal of Water Removed by Dewatering System

Dispose of water in such a manner as to cause no inconvenience to the OWNER, the ENGINEER, or others involved in work about the site. Trench excavations shall not be used as temporary drainage ditches.

3.1.1.5 Construction Quality Assurance (By Others)

3.1.1.5.1

The CONTRACTOR shall coordinate his work with the OWNER's CQA Representative to allow testing and monitoring of all work components to proceed.

3.1.1.5.2

There shall be no additional compensations to the CONTRACTOR for any construction delays caused by the CONTRACTOR's failure to plan, coordinate, and schedule work to include all CQA activities.

3.1.1.6 Construction Quality Control

CONTRACTOR shall provide pre-construction material verification and Construction Quality Control testing of earth materials as indicated in Table 31 00 00 and Section 01 45 00 - CONSTRUCTION QUALITY CONTROL. General fill, backfill, controlled subgrade soil, and erosion control soil are subject to the relevant tests in Table 31 00 00 - 1. The erosion control soil will not be compacted.

Table 31 00 00 - 1 Soils and Aggregates Test Frequency

Test	ASTM Designation or Other Test Method	CQC Frequency	CQA Frequency
Compacted Density	D6938, D1556, or D2937	1 per 90 ft x 90 ft grid per lift	1 per acre per lift
Compacted Moisture Content	D6938 or D2216	1 per 90 ft x 90 ft grid per lift	1 per acre per lift
Compacted Density - Trench Backfill	D6938, D1556, or D2937	1 per 100 linear ft per lift	1 per 1000 linear ft per lift
Compacted Moisture Content - Trench Backfill	D6938 or D2216	1 per 100 linear ft per lift	1 per 1000 linear lift
Classification and Atterberg Limits	D2487 and D4318, respectively	1 per 10,000 cy	1 per project
Road Aggregates	D6938 or D2937	1 per 100 linear feet of road, a minimum of 1 test per lift of select fill	1 per 1000 linear feet of road, a minimum of 1 test per lift of select fill
Backfill Placement	Observation, Field Measurement	Continuous observation	Survey Verification
Bedding Layer and Erosion Control/Vegetative Soil Thickness	Observation, Field Measurement	Continuous observation	Survey Verification (100 ft x 100 ft grid)
Grain Size Analysis (Borrow Source or in-place material for subgrade)	D6913 and D1140	1 per 10,000 cy	1 per project
Natural Moisture Content (Borrow Source or in-place material for subgrade)	D2216	1 per 10,000 cy	1 per project
Classification (Borrow Source or in-place material for subgrade)	D2487	1 per 10,000 cy	1 per project

Atterberg Limits (Borrow Source or in-place material for subgrade)	D4318	1 per 10,000 cy	1 per project
Moisture-Density Relationship (Borrow Source or in-place material for subgrade)	D698	1 per 10,000 cy and changes in material	1 per project
Shear Strength (Borrow Source or in-place material for subgrade)	D2850 or D1557	1 per 10,000 cy	1 per project
Hydraulic Conductivity (Borrow Source for layers with permeability requirement)	D5084	1 per source and change in material	1 per project

Notes:

- Every fifth sample tested with ASTM D6938 shall be verified by ASTM D1556, Sand Cone or ASTM D2937, Drive Cylinder unless Engineer specifies otherwise.
- Every fifth sample tested with ASTM D6938 shall be verified with ASTM D2216, Laboratory Determination of Water Content of Soil, Rock, and Soil-Aggregate Mixtures unless Engineer specifies otherwise.
- Test locations shall be identified by the Contractor by horizontal and vertical control and presented on drawing or sketch indicating dimensions.
- If a test fails to meet the required compaction level or moisture content, then the area represented by that test shall be reworked and retested at the Contractor's expense Corrective measures shall be documented in the Quality Control and Quality Assurance reports.
- The Contractor shall plug test locations with a 50% cap soil, 50% bentonite mixture compacted in 2" lifts to control leakage unless otherwise noted in the technical specifications.

3.2 GENERAL

3.2.1

The CONTRACTOR shall perform excavations described in whatever substance encountered to dimensions and elevations shown on the Contract Drawings. Excavation shall be unclassified. The CONTRACTOR shall be responsible for verifying the grades and dimensions as shown.

3.2.2

Existing utilities, structures, and fencing shall be protected during the construction period, and if damaged or removed by the CONTRACTOR in his operations, shall be repaired or replaced by the CONTRACTOR at no additional cost to the Owner.

3.2.3

The Owner shall retain a Quality Assurance Officer to monitor Earthwork included in this section. The QAO shall be present on site during subgrade approval and fill and backfill operations.

3.3 EXCAVATION

3.3.1 General

3.3.1.1

Excavation equipment operators and other concerned parties shall be familiar with subsurface obstructions as shown on the PLANS.

3.3.1.2

Excavation work shall be performed in a safe and proper manner with appropriate precautions being taken against hazards and in accordance with the Health and Safety Plan. Excavations shall provide adequate working space and clearances for the work to be performed therein. If walls of the excavation cannot be kept stable, the excavation shall be properly shored and braced.

3.3.1.3

Excavation shall be unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered. Well/boring/test pit logs performed on-site are available for information only to the CONTRACTOR.

3.3.1.4

If subgrade "pumping" is encountered during excavation, perform the following:

3.3.1.4.1

Excavate and remove the underlying unsuitable material for a minimum depth of 12 inches.

3.3.1.4.2

Proof-roll and compact by appropriate heavy equipment for at least 6 passes and approve by the ENGINEER.

3.3.1.4.3

Backfill with General Fill or Subbase material as directed by the ENGINEER and compact to a stable condition approved by the ENGINEER.

3.3.1.5

Excavation shall conform to the limits indicated on the PLANS and as specified herein. This work shall include shaping, sloping, grading and other work necessary in bringing the site to the required grade, alignment, and cross-section.

3.3.1.6

Unsatisfactory materials shall be removed to the required depth and replaced to the satisfaction of the ENGINEER with General Fill or Subbase material. Unsatisfactory materials shall be removed and disposed of in the designated areas on-site as directed by the ENGINEER.

3.3.1.7 Stockpiling of Excavated Materials

Satisfactory excavated materials shall be stockpiled in such a manner as to prevent nuisance conditions, including but not limited to endangering work areas or obstructing drive ways and natural water courses. Valve pit covers, valve boxes, or other utility controls shall be left unobstructed and accessible at all times. The CONTRACTOR shall limit operations to the project areas shown on the drawings unless otherwise approved by the ENGINEER. Surface drainage shall not be hindered.

3.4 TRENCH EXCAVATION FOR AIR, LANDFILL GAS AND FORCEMAIN PIPES, AND LIQUIDS MANAGEMENT STRUCTURES

3.4.1

Trench width shall be minimized to greatest extent practical but shall conform to the following:

- Sufficient to provide room for installing, jointing, and inspecting piping, but in no case wider at top of pipe than pipe barrel outside diameter plus 18 inches unless otherwise depicted on the plans or approved by the ENGINEER.
- Trench enlargements at pipe joints.
- Sufficient for sheeting, bracing, sloping, and dewatering.
- Sufficient to allow thorough compacting of backfill adjacent to bottom half of pipe.

3.4.2

Excavate trenches to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil.

3.4.2.1

For pipes less than 6 inches in nominal size, do not excavate beyond indicated depths. Excavate bottom cut to accurate elevations and support pipe on undisturbed soil.

3.4.2.2

For pipes 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe. At each pipe joint, dig bell holes to relieve pipe bell of loads and ensure continuous bearing of pipe barrel on bearing surface.

3.4.3

No more than 200 feet of trench within landfill area may be opened in advance of pipe laying operations at one time unless approved by the ENGINEER.

3.4.4

All trenches shall be constructed in a uniform grade, and free of standing water. The CONTRACTOR shall be responsible for maintaining these conditions. Subgrade soils that become soft, loose, or unsatisfactory as a result of inadequate dewatering and cannot be stabilized or recompacted shall be removed and replaced by VDOT Size No. 3 stone or approved equal at the CONTRACTOR'S expense.

3.4.5

Excavation for appurtenances shall maintain a minimum clearance of 12 inches between their outer surfaces and the face of the excavation, or sheeting, if used.

3.4.6

Document the location, elevation, size, material type and function of all new subsurface installations, and utilities encountered during the course of construction and include this information as part of the Record Plans prior to the ENGINEER'S approval of payment for that work.

3.5 STABILITY OF EXCAVATIONS

3.5.1 General

Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

3.5.2 Side Slopes

Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

3.5.3 Shoring and Bracing

Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations during period excavations will be open. Extend shoring and bracing as excavation progresses.

3.6 STORAGE OF EXCAVATED AND BORROW MATERIALS

Stockpile excavated and borrow materials acceptable for backfill, General Fill, and Subbase, where directed by the ENGINEER. Place, grade, and shape stockpiles for proper drainage.

Comply with all erosion and sediment control requirements by state and local authorities.

3.7 SUBGRADE APPROVAL

Prior to installation, subgrades to receive structures or fill shall be evaluated prior to fill placement by the QAO. Such evaluation may include the observation of subgrade performance during proof-rolling with a loaded tandem dump truck provided by the CONTRACTOR. At least three passes are to be made with a fully loaded tandem dump truck. Areas that are deemed unsuitable (rutting, pumping, etc.) for fill placement by the QAO shall be clearly identified in both horizontal and vertical extent with recommendations for improvements and submitted to the ENGINEER for further action.

3.8 BACKFILL AND FILL

3.8.1 General

Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.

3.8.1.1 General Site Grading

Use General Fill or Subbase where indicated on the PLANS.

3.8.1.2 Aggregates

Use VDOT designated aggregates and other fill materials as indicated on the PLANS.

3.8.1.2.1

Do not backfill trenches until tests and inspections have been made. Use care in backfilling to avoid damage or displacement of pipe systems. Work which is covered or concealed without the knowledge and consent of the ENGINEER shall be uncovered or exposed for inspection at no cost to the OWNER. Partial backfill may be made to restrain the pipe during pressure testing if pressure test is required. No more than 50 feet of trench with pipe in place shall be partially backfilled at any time.

3.8.2 Timing of Backfill

Backfill excavations as promptly as work permits.

3.8.3 Depth And Mixing Of Fill Layers

Fill and backfill soil shall be placed in layers that when compacted shall not exceed six (6) inches. Each layer shall be spread evenly and shall be thoroughly bladed and mixed during the spreading to obtain uniformity of material in each layer.

3.9 PLACEMENT AND COMPACTION

3.9.1 General

3.9.1.1 Ground Surface Preparation

Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or scarify surfaces so that fill materials will bond with existing surfaces. Subgrade shall be approved by the QAO prior to material placement.

3.9.1.2 Bedding Layer

Material placed, or in-situ, as the 6" bedding layer shall be compacted to a minimum of 90% of the maximum dry density, as determined by ASTM D698 (Standard Proctor). The surface shall be rolled smooth and be free of rocks or stones in excess of 3/8 inch prior to placement of the overlying liner.

The thickness of the final cover bedding layer will be a minimum of 6 inches, confirmed by QA survey points on a 100-foot by 100-foot grid over the cap surface area, before and after the installation of the bedding layer. Alternatively, the CONTRACTOR may elect to verify the bedding layer thickness by excavating test pits on a 100-foot by 100-foot grid over the cap surface area. The test pits will be excavated by the CONTRACTOR, and the QAO will observe and measure the test pit depths. The CONTRACTOR will backfill test pits with bentonite clay.

The liner installer shall provide written acceptance of the subgrade before installing liner.

3.9.1.3 Synthetic Liner/Cap Protection

Surfaces to be lined/capped shall be smooth and free of all rocks, stones, sticks, roots, sharp objects or debris of any kind which could damage the synthetic liner/cap. The upper six inches of the prepared area shall contain no particles larger than 1 inches in diameter. If needed, the upper layer of foundation soil shall be screened to eliminate particles larger than 1 inches. If necessary, the surface shall be groomed by hand to bring the surface up to the desired smoothness. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in the grade. Mo standing water or excessive moisture shall be allowed. Final compaction of the synthetic liner bedding layer shall be with smooth steel wheel roller. The liner/cap installation CONTRACTOR shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

3.9.1.4 Moisture Content

Fill and backfill soil shall be compacted at a moisture content within a range of ±3% of the optimum moisture content, unless otherwise approved by the QAO. As required, fill and backfill soil shall be dried by aerating with a scarifier, disc harrow, blade, or other equipment or by such other means as may be necessary. As required, fill and backfill soil shall be wetted by the use of water trucks or

sprinklers. Dried or wetted fill or backfill soil shall be thoroughly mixed to provide a material of uniform moisture content. Do not place backfill or fill material on surfaces that are submerged soft, muddy, frozen, or unstable.

Where subgrade or fill material must be moisture conditioned before compaction:

- Uniformly apply water to surface of subgrade or fill material. Apply water as necessary to prevent free water from appearing on surface during or subsequent to compaction operations. The CONTRACTOR shall process soil materials so that moisture is uniformly mixed into soils.
- Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density and moisture range. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced uniformly to a satisfactory value.

3.9.1.5 Nonconforming Material

Re-compact areas or lifts if soil density and moisture tests indicate inadequate compaction and/or moisture. No additional compensation shall be given to the CONTRACTOR due to re-working of failed areas. The extent of area for repair shall be determined by the ENGINEER.

3.9.1.6 Filling Adjacent to Structures

Place backfill and fill materials evenly adjacent to structures or piping to required elevations. Prevent wedging action of backfill against structures or displacement of piping by carrying material uniformly around structure or piping to approximately same elevation in each lift.

3.9.1.7 Subbase Lift Bonding

Provide good bond between Subbase Liner lifts by using a sheepsfoot roller, or discing the surface before placing the next loose lift. Unless otherwise approved by the ENGINEER, do not smooth roll the Subbase surface until the final lift has been placed and compacted.

3.9.1.8 Landfill Gas Pipe Aggregates

Aggregates surrounding perforated landfill gas collection pipe shall not be compacted, but shall be placed to achieve lines and grades as shown on the Plans.

3.9.1.9 Rainfall

The surface of a compacted lift may be smooth rolled at the end of the day to increase runoff in the event of rainfall. Surfaces smooth rolled shall be scarified with equipment prior to placement of the subsequent soil lifts.

3.10 COMPACTION OF FILL

Compact fill materials and aggregates not less than the following percentages of maximum dry density in accordance with ASTM D 698 or to a maximum obtainable density as follows:

3.10.1 Compaction

Compaction of each layer, unless otherwise specified, as shown on the Contract Drawings and determined in the field shall be continuous over its entire area and the compaction equipment shall make sufficient trips to verify that the required density has been obtained. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted in six (6) inch maximum compacted thickness lifts. The minimum dry density of the soil shall be at least ninety percent (90) of the maximum dry density as determined by ASTM D698 (standard Proctor), unless otherwise shown on the Contract Drawings.

3.10.2 Compaction Equipment

Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Prior to placing the fill, at the preconstruction meeting or a minimum of 7 days prior to usage, the CONTRACTOR shall submit to the ENGINEER, for approval, a list of compaction equipment to be used. The ENGINEER shall have 7 days to approve or disapprove the list. The list shall include the type of equipment, manufacturer and size.

3.10.3 Equipment Certification

If, in the opinion of the ENGINEER, the compaction equipment is not acceptable, the CONTRACTOR may demonstrate the suitability of such equipment in a test area within the prepared fill site.

3.10.4 Fill Faces

Fill faces shall be compacted. Compacting operations shall be continued until the slope faces are stable but not too dense for planting and there is no appreciable amount of loose soil on the surface. Compaction efforts should be limited to “walking-in” slopes with a tracked dozer. Compacting of the slopes may be done progressively as the fill is brought to its total height or compacting of the slopes may be done after the fill is brought to its total height.

3.10.4.1 Erosion

CONTRACTOR shall maintain and prevent erosion of Fill at all times during construction. Repair of damages to the Subbase due to inadequate maintenance, and erosion shall be at the CONTRACTOR's own expense.

3.11 QUALITY CONTROL

CONTRACTOR to provide testing in accordance with Table 31 00 00-1 Testing Frequency Summary – Earth Material Construction Quality Control Testing.

3.12 GRADING

Uniformly grade all areas disturbed by the project, at trench locations, excavated and fill areas and adjacent transition areas so that finished surfaces are at the proposed grade or are approximately at preexisting grades, adjusted as required to provide positive drainage.

Fill and excavation areas shall be kept free of standing water with positive drainage maintained. Sloping of the fill surface and drainage ditches shall be provided to carry off water as it collects. Pumping shall be required to remove water from areas that cannot drain naturally.

3.13 SEASONAL LIMITS

No fill material shall be placed, spread or rolled while the ground is frozen or thawing, or during unfavorable weather conditions. When the work is interrupted by inclement weather, fill operations shall not be resumed until the moisture content and density of the previously placed fill are as specified. Fill surfaces exposed to inclement weather or standing water shall be scarified to a depth of 6 inches, compacted and tested prior to placing addition fill lifts.

3.14 INTEGRITY OF THE WORK

It shall be the CONTRACTOR's responsibility to maintain the integrity of the work. Work that is damaged by weather or construction activities shall be restored and retested at the CONTRACTOR's expense.

3.14.1 Protection of Graded Areas

Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

3.14.2 Repair

Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

3.14.3 Reconditioning Compacted Areas

Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density and moisture range prior to further construction.

3.14.4 Settling

Where settling is measurable or observable at excavated areas during project, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 FINISHING WORK

3.15.1 Subbase

After the Subbase has been installed, the CONTRACTOR shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

3.15.2 Drainage Structures

All drainage structures shall be constructed and maintained as necessary along the completed section.

3.15.3 Elevations

Unless otherwise specified by the ENGINEER, the elevation of all constructed grades shall be within 0.2 feet of those shown on the PLANS. The thicknesses of all Final Cover System components such as Erosion Control and Vegetative Layers are minimum values.

3.15.4 Finish Grading

After berms, ditches, swales, shoulders, and embankments are completed, the disturbed areas shall be finish graded. Any lumber, undesirable materials, and rocks larger than the 3 inches in size shall be removed from the surface immediately and the surface shall be prepared for final landscaping.

3.16 DISPOSAL OF EXCESS AND WASTE MATERIALS

The Bristol ISWMF does not have an active landfill waste placement operations ("working face") area and is in the process of installing various remedial measures prior to closure. During this interim period, waste that is excavated during construction activities can be relocated and covered within the landfill. Waste relocation within the SWP #498 landfill will be required to establish the newly proposed intermediate/daily soil cover grade.

During the regrading of the intermediate/daily soil cover, the CONTRACTOR shall be responsible for stripping off the existing intermediate/daily soil cover, moving waste as needed to approach design grade, and replacing and restoring the Intermediate Soil Cover layer. CONTRACTOR shall minimize the open area of disturbed waste at any given time.

The CONTRACTOR shall place waste materials encountered during trenching activities in neat piles adjacent to the work area. Prior to the end of the working day, the CONTRACTOR shall haul the excavated waste materials to a designated area for waste relocation at the site, as directed by the OWNER. The CONTRACTOR shall be responsible for stripping off the existing Intermediate Soil Cover material, unloading and spreading the excavated waste, "tracking it in" with suitable equipment, and replacing and restoring the Intermediate/daily Soil Cover layer.

OWNER shall not require the CONTRACTOR to pay tipping fee for disposal of excavated waste materials encountered during work activities. If odors or emissions from the excavated waste become a nuisance as determined by the OWNER, CONTRACTOR shall increase the frequency of excavated waste removal as directed by the ENGINEER.

END OF SECTION 31 00 00

SECTION 31 05 13

EROSION CONTROL AND VEGETATIVE SUPPORT LAYERS

1.0 GENERAL

1.1 REQUIREMENTS INCLUDED

Provide personnel, equipment, and materials to excavate, haul, and place the erosion control layer above the synthetic cap and the vegetative support layer above the erosion control layer to promote vegetative growth.

1.2 RELATED REQUIREMENTS

Construction Quality Assurance Manual

- Section 31 00 00 Earthwork

2.0 PRODUCTS

2.1 EROSION CONTROL/PROTECTIVE COVER LAYER

The erosion control/protective cover layer (soil cushion) shall be soil free of debris, roots and other organic matter, frozen material, sharp objects or other harmful matter that may damage the synthetic cap. This soil shall have no particle size greater than 2 inches. The soil used in the erosion control/protective cover layer shall be a fine-grained soil, based on the Unified Soil Classification System, capable of supporting vegetative growth.

Soil for the erosion control/protective cover layer shall come from either an on-site borrow area provided by the Owner or an off-site borrow area provided by the Contractor.

Laboratory tests will be required in accordance with the Construction Quality Assurance Plan.

2.2 VEGETATIVE SUPPORT LAYER

The vegetative support layer shall be topsoil or amended soil capable of promoting and sustaining vegetative growth. The soil may be either off-site topsoil, on site topsoil, and/or soil mixed with suitable organic amendment. Wastewater treatment plant sludge is not a suitable amendment. The soil or soil mixture shall be free of debris, large roots, stumps, or frozen material. The soil shall have a pH between 6 and 7.5 (prior to liming or fertilization), contain at least 1.5 percent organic matter (by weight), and have a maximum particle size of 1 inch. Soluble salts shall be < 500 ppm.

2.3 SUITABLE ORGANIC AMENDMENT (IF NEEDED)

Soil shall be amended with compost as needed to provide the minimum organic matter. The following chart shall be used to increase organic content.

OM % (dry wt) Existing	Cubic Yards per Acre Compost
0.0	100
0.5	75
1.0	50

2.3.1 Compost Material

Compost shall be premium compost, McGill SoilBuilder, by McGill Environmental Systems, Waverly, Virginia or approved equivalent.

Compost shall be mature, stable, weed free, and produced by aerobic decomposition of organic matter. Compost shall contain no unprocessed chunks of wood or bark, visible refuse or other physical contaminants, substances toxic to plans, or over 5% sand, silt, clay or rock material by dry weight.

Compost shall be tested and certified in accordance with the United States Composting Council's Seal of Testing Approval program.

Parameter	Range	Testing Method
pH	5.0-8.5	TMECC 4.11A
Soluble Salt Concentration	< 10dS/m	TMECC 4.10-A
Moisture	30-60% wet weight basis	SMEWW 2540B
Organic Matter	30-65% dry weight basis	TMECC 5.07-A
Particle Size	98% pass through ¾" screen or smaller	TMECC 2.02-B
Stability (Carbon Dioxide evolution rate)	>80% relative to positive control	TMECC 5.08-B
Parameter	Range	Testing Method
Maturity (Seed emergence and seedling vigor)	>80% relative to positive control	TMECC 5.05-A

Parameter	Range	Testing Method
Physical contaminants (man made inerts)	<1% dry weight basis	TMECC 3.08-A
Chemical contaminants	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels:	
Arsenic	< 41ppm	TMECC 4.06-AS
Cadmium	< 39 ppm	TMECC 4.06-CD
Copper	< 1,500 ppm	TMECC 4.05-CU
Lead	< 300 ppm	TMECC 4.06-PB
Mercury	< 17 ppm	TMECC 4.06-HG
Molybdenum	< 75 ppm	TMECC 4.05-MO
Nickel	< 420 ppm	TMECC 4.06-NI
Selenium	< 100 ppm	TMECC 4.06-SE
Zinc	< 2,800 ppm	TMECC 4.06-ZN
Biological contaminants (pathogens)	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels:	
Fecal coliform	< 1,000 MPN per gram, dry weight basis	TMECC 7.01
Salmonella	< 3 MPN per 4 grams, dry weight basis	TMECC 7.02

3.0 EXECUTION

3.1 PLACEMENT AND COMPACTION

The erosion control/protective cover layer shall be a uniformly spread lift of soil. Compaction shall be limited to tracking equipment. Surface roughen the final layer. The material shall be placed and spread in such that equipment will not operate directly on the synthetic cap. The material layer shall be installed in one lift without compaction so that the placement of the material shall not damage the synthetic cap.

The vegetative support layer shall be a uniformly spread lift. Compaction shall be limited to tracking equipment. Surface roughen the top.

Spreading of the material shall be accomplished using wide track equipment such as a Caterpillar D5 or D3, Low Ground Pressure bulldozer or equivalent.

Pumping and rutting of the material will not be permitted. Where required, haul roads shall be constructed on the cap of sufficient depths for the operation of pans or other earth moving equipment without rutting or pumping.

When placing the soil on slopes, placement shall begin at the bottom of the slope and worked up. Under no circumstances shall the material be pushed down the slopes.

3.2 THICKNESS VERIFICATION

The thickness of the final cover erosion control and vegetative cover layers as shown on the Drawings are minimum requirements. The thicknesses will be confirmed by QA survey points on a 100-foot by 100-foot grid over the cap surface area, before and after the installation of the soil layers. Alternatively, the CONTRACTOR may elect to verify the erosion control and vegetative cover thickness by excavating test pits on a 100-foot by 100-foot grid over the cap surface area. The test pits will be excavated by the CONTRACTOR, and the QAO will observe and measure the test pit depths. The CONTRACTOR will backfill test pits with soil that meets the specifications for the erosion control and vegetative cover layers.

END OF SECTION 31 05 13

SECTION 31 05 16

AGGREGATES

1.0 GENERAL

1.1 SUMMARY

The requirements for riprap, pipe bedding aggregates, road base course, leachate collection layer, construction entrance, and other miscellaneous as shown in the PLANS, and are specified herein and General Conditions.

Related Work Specified Elsewhere:

- Section 01 45 00 Construction Quality Control
- Section 31 00 00 Earthwork
- Section 31 05 19.13 Geotextile Fabrics
- Section 31 05 19.16 LLDPE Geomembrane Liner

1.2 REFERENCE SPECIFICATIONS

The publications listed below form a part of this specification to the extent referenced in the text. The publications are referenced to in the text by basic designation only.

1.2.1 State Of Virginia

- Virginia Department of Transportation (VDOT) Road and Bridge Specifications (VDOTRBS), April 2020
- Virginia Erosion and Sediment Control Handbook (VESCH), latest edition

1.2.2 American Society for Testing and Materials (ASTM) Standard Test Methods/Practice

- ASTM C 88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C 131 Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM D 75 Sampling Aggregates
- ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

- ASTM D 698 Laboratory Compaction Characteristics Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
- ASTM D 1556 Density and Unit Weight of Soil in Place by the Sand Cone Method
- ASTM D 2487 Classification of Soils for Engineering Purposes
- ASTM D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
- ASTM D 4373 Calcium Carbonate Content of Soils
- ASTM D5856 Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-Wall, Compaction-Mold Permeameter
- ASTM E 11 Wire Cloth Sieves for Testing Purposes
- ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

1.3 SUBMITTALS

1.3.1 Prequalification

Submit the material source, descriptions, and material specifications certified by the supplier to the ENGINEER for approval.

1.3.2 Approval of Material Sources

The sources of the material to be used for producing aggregates shall be selected not less than thirty (30) days prior to the time the material will be required in the work. Any changes in the source of materials shall be reported to the ENGINEER immediately. The new source shall be approved by the ENGINEER. Allow a minimum of 10 days for review and approval. The CONTRACTOR shall be fully responsible for any delays in construction due to changes in material sources.

1.3.3 Certificate of Compliance

The CONTRACTOR shall submit to the ENGINEER for approval at least 15 days before procurement Certificate of Compliance from the manufacturer that the supplied materials meet the specifications herein.

2.0 PRODUCTS

2.1 GENERAL

2.1.1 Quality

Aggregates shall consist of clean, sound, durable particles of crushed stone, or gravel, and screenings. Slag shall not be used.

2.1.1.1

CONTRACTOR shall obtain materials that meet the specifications and can be used to meet the grade and smoothness requirements specified herein, after all compaction and proof rolling operations have been completed.

2.1.1.2

Aggregates shall be free of silt and clay (as defined by ASTM D 2487), vegetable matter, and other objectionable materials or coatings.

2.1.1.3

Drainage Layer and Type 1 aggregate surrounding perforated landfill gas collection pipe shall contain less than 15% by weight of calcium carbonate as measured by ASTM D4373.

2.1.2 Fine Aggregate

Fine aggregate refers to the portion passing the No. 4 sieve. Fine aggregate may contain angular particles produced by crushing stone, or gravel that meets the requirements for wear and soundness specified by VDOTRBS Section 202. Material designations for the various fine aggregates used on the project shall be as specified on the PLANS.

2.1.3 Coarse Aggregate

2.1.3.1

Coarse aggregate refers to the portion retained on the No. 4 sieve, and shall be angular or rounded particles of uniform density. Coarse aggregate may contain angular particles produced by crushing stone, or gravel that meets the requirements for wear and soundness specified by the VDOTRBS Section 203.

2.1.3.2

The coarse aggregate shall have a loss of density not greater than 10 percent of the weighted average at five cycles when tested for soundness. The coarse aggregate shall have a percentage of wear not exceeding 40 percent after 500 revolutions as determined by the requirements of VDOTRBS Section 203.

2.1.3.3

Material designations for the various coarse aggregates used for the project shall be as specified on the PLANS.

2.1.3.4

The percentage of flat and/or elongated particles shall not exceed 20 in the fraction retained on the 1/2 inch sieve and in the fraction passing the 1/2 inch sieve. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width

greater than 3. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein.

2.2 MATERIALS

2.2.1 VDOT Aggregates

All specified aggregates shall be in accordance with VDOTRBS Section 206.

2.2.2 Horizontal Collector and Vertical Caisson Aggregate

2.2.2.1

Material shall be composed of sub-rounded to rounded particles, or such that it will not damage or puncture any underlying geotextile and/or HDPE geomembrane layers.

2.2.2.2

Shall be non-calcareous, with a maximum carbonate content of 15% by weight as measured by ASTM Method D4373

2.2.2.3

Shall consist of VDOT Size Number 3 coarse aggregate, or equivalent AASHTO-designated material with the following gradation:

Sieve/Particle Size (inches)	Percentage Finer by Weight
2-1/2	100%
2	90-100
1-1/2	35-70
1	0-15
1/2	0-5

2.2.3 RIPRAP

Riprap shall be supplied and installed in accordance with VDOTRBS Section 204 and the VESCH. Riprap shall be sized as indicated on the PLANS. Geotextile filter fabric shall be in accordance with 31 05 19.13.

3.0 EXECUTION

3.1 EQUIPMENT

3.1.1 Weather Limitation

Aggregates shall be placed in accordance with VDOTRBS Section 309. Areas of completed work that are damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

3.2 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in a manner and at locations approved by the ENGINEER. Aggregates shall be stockpiled on the cleared and leveled areas designated by the OWNER so as to prevent segregation. Materials obtained from different sources shall be stockpiled separately. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.2.1 STOCKPILE CLEANUP

Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

3.3 PREPARATION OF UNDERLYING COURSE

Prior to placing aggregate, the underlying course shall be cleaned of all foreign substances. At the time of construction of the course, the underlying course shall contain no frozen material. The underlying course shall conform to Section 31 00 00 - EARTHWORK.

3.4 GRADE CONTROL

During construction, the lines and grades shall be maintained by the CONTRACTOR.

3.5 PLACING

3.5.1 Roadway

Roadway crushed stone base material shall be placed in accordance with VDOT RBS Section 308 subbase course.

3.5.2 Coarse Aggregate

Coarse aggregate bedding and backfill material shall be placed in accordance with VDOT RBS Section 303 earthwork.

3.5.3 Horizontal Collector Aggregate

Horizontal Collector Aggregate shall not be compacted. Placement to the lines and grades shown on the Plans shall be performed in a manner that will prevent damage to any underlying geotextile and LLDPE geomembrane layers, and meet equipment ground pressure/minimum thickness criteria in Section 31 05 19.16- LLDPE GEOMEMBRANE LINER.

3.6 RIPRAP INSTALLATION

Place filter fabric over areas to receive riprap and anchor the fabric. Fill void spaces between large stones with stone of suitable size to leave the surface evenly conforming to the required contour. Place riprap with a minimum average thickness of 18 inches or as indicated on the Contract Drawings. Grout riprap in place as indicated in the Contract Drawings.

3.7 QUALITY CONTROL

Refer to Section 31 00 00 - EARTHWORK for quality control testing requirements for Drainage Layer and Type 1 aggregates.

END OF SECTION 31 05 16

SECTION 31 05 19.13

GEOTEXTILE FABRICS

1.0 GENERAL

1.1 SUMMARY

1.1.1 Scope

This section covers the material, installation, and testing of the nonwoven geotextile for the liner system, cover system, road underlayment, and/or riprap bedding underlayment for a municipal solid waste landfill. The nonwoven geotextile fabric shall be furnished by the CONTRACTOR unless otherwise specified. The nonwoven geotextile shall be installed as shown on the plans. The nonwoven geotextile shall be prepared and installed per these specifications, referenced specifications and as detailed on drawings. CONTRACTOR shall provide all labor, materials, equipment, and services necessary for the placement of the nonwoven geotextile.

1.2 RELATED SECTIONS

1.2.1 Intent

The provisions and intent of the AGREEMENT, including the General Condition, Supplemental Conditions and other requirements of the Contract Documents apply to the WORK as specified in this section. WORK related to this section is described throughout the Specifications.

1.3 REFERENCES

The current specifications of American Society for Testing and Materials (ASTM) shall apply as noted for testing and acceptance of materials and construction. Current and applicable ASTM methods were determined by the Geosynthetic Research Institute.

1.3.1 Related Requirements

Comply with applicable codes and regulations as required by regulatory agencies having jurisdiction over this work. Comply with the pertinent sections of the following standards:

American Society for Testing and Materials (ASTM)

American Association of State Highway and Transportation Officials (AASHTO)

Geosynthetic Research Institute (GRI) Test Methods and Standards

1.4 VIRGINIA DEPARTMENT OF TRANSPORTATION (VDOT) STANDARD SPECIFICATIONS, LATEST EDITION SUBMITTALS

1.4.1 Shop Drawings

CONTRACTOR shall submit Shop Drawings and product data for components for approval within 30 calendar days of Notice to Proceed. A change in the manufacturer shall require resubmittal.

1.4.2 Nonwoven Geotextile

Shop Drawings shall include:

1.4.2.1 Seaming or Tying Procedures

Complete description of field seaming or tying procedures

1.4.2.2 Penetration

Manufacturer shall provide Shop Drawings detailing the manner and materials to be used for all nonwoven geotextiles penetrations. This shall include, however is not limited to pipes, manholes and the like.

1.4.2.3 Work Plan

Work Plan for nonwoven geotextile installation, including man power and equipment requirements.

1.4.2.4 Field Testing

Detailed description of field testing methods to be performed, if required.

1.4.3 Affidavit or Compliance

Provide six (6) hard copies or one (1) electronic copy of an affidavit, certifying that all nonwoven geotextile material furnished for this Project (reference Project title) comply with all requirements specified in the Contract Documents. NO nonwoven geotextile material shall be shipped until the affidavits are submitted to CQA Consultant and ENGINEER.

1.4.4 Test Reports

Provide six (6) hard copies or one (1) electronic copy of Factory Quality Control Testing.

1.5 QUALITY ASSURANCE

1.5.1 Single Source

All nonwoven geotextile material provided by the contractor shall be obtained from a single material supplier and all nonwoven geotextile sheets shall be manufactured by a single manufacturer unless approved by the ENGINEER.

1.5.2 Manufacturer's Qualification and Experience

Manufacturer shall be a specialist in the manufacture of nonwoven geotextile material and shall have at least 3 years' experience in the manufacture of nonwoven geotextile material. Manufacturer shall have manufactured and have installed, successfully, at least 5 million square feet nonwoven geotextile material during the last 3 years.

1.5.3 Installer's Qualification and Experience

Installer shall be a specialist in the installation of nonwoven geotextile material and shall have at least 3 years' experience in the installation of nonwoven geotextile material. Installer shall have installed at least 5 million square feet of nonwoven geotextile material during the last 3 years. Installer shall submit a list of similar projects (preferably in Virginia). At a minimum the list shall include installation type, completion date, contact person name, address and telephone number. Installer shall provide continuous on-site supervision; a complete resume of the on-site supervisor shall be included as part of the Bid package. CONTRACTOR shall adhere to the experience levels outlined above when installing the nonwoven geotextile material.

1.5.4 Installer's Filed Services and Reports

Retain services of a nonwoven geotextile material installer's factory trained representative with demonstrated ability and experience in field seaming or tying, testing and all other pertinent aspects of the installation to perform the services listed below:

1.5.4.1 Inspection/Supervision

Inspect the nonwoven geotextile material and supervise any corrective work required. Prepare an inspection report to be submitted to CQA Consultant and ENGINEER weekly.

1.5.4.2 Handling

Supervise the unloading, handling, and storage of all nonwoven geotextile material.

1.5.4.3 Placement

Supervise the handling, unrolling, and placement of all nonwoven geotextile material.

1.5.4.4 Seaming/Tying

Perform all seaming or tying of all nonwoven geotextile material.

1.5.4.5 Repairs

Perform all repairs to damaged nonwoven geotextile material.

1.5.4.6 Granular Drainage Material

Coordinate work with the CONTRACTOR during the placement of the granular drainage material over the nonwoven geotextile material.

1.5.4.7 Project Report

Prepare a written report at the completion of the Project which includes the following:

1.5.4.7.1

Complete identification of nonwoven geotextile material, including but not limited to, material type, physical properties and other pertinent data.

1.5.4.7.2

Complete description of field seaming/tying system used including material, method, seam overlap width and seaming/tying material.

1.5.4.7.3

"As-built" Drawings showing actual layout of nonwoven geotextile sheets, pipe penetration details and anchor trench/material run-out details.

1.5.4.7.4

An affidavit of compliance from the nonwoven geotextile material installer containing the following wording:

"I (name and title), as the duly authorized representative of (Company Name), hereby certify that the installation of the nonwoven geotextile material has been completed in accordance with the terms and conditions of the Contract Documents.

By:_____

(signature)

Witness:_____

(signature)

Date:_____

1.5.5 Quality Control during Manufacture

CONTRACTOR shall provide a Quality Control Manual.

1.5.6 Manufacturer's Certifications

CONTRACTOR shall provide ENGINEER and CQA Consultant with certified copies of test results.

1.5.7 Independent Testing

OWNER and/or ENGINEER may employ and pay for an independent Testing Laboratory to perform additional testing of the nonwoven geotextile material. CONTRACTOR, shall, at no additional cost,

provide samples to ENGINEER and/or Independent Testing Laboratory for the quality of the material provided.

1.5.8 Acknowledgement

CONTRACTOR shall be solely responsible to the OWNER for the quality of the material provided. Should any of the tests performed on the material yield unsatisfactory results, CONTRACTOR will be responsible for replacing the material with satisfactory material without delaying the total Project time and without any cost to OWNER.

1.6 DELIVERY, STROAGE, AND HANDLING

1.6.1 General

Manufacturer and CONTRACTOR shall follow the guidelines stated in ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

1.6.2 Labeling

Each roll of nonwoven geotextile material delivered to the site shall be labeled by the manufacturer identifying the manufacturer's name, product identification, lot number, roll number, and roll dimensions.

1.6.3 Protection

Filter fabric and/or geonet/filter fabric composite shall be protected from ultraviolet light exposure, precipitation, or other damage from the natural elements, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Nonwoven geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

1.6.4 Delivery Inspection

CONTRACTOR shall provide all labor and equipment required to assist OWNER and ENGINEER in inspection of materials upon deliver to the site.

2.0 PRODUCTS

2.1 NONWOVEN GEOTEXTILES

2.1.1 Manufacturer

Geotextile used for filtration shall be manufactured by SKAPS Industries, Inc. or approved equal. Manufacturer shall submit a certificate to the ENGINEER stating the name of the manufacturer, the chemical composition of the filaments or yarns, and other pertinent information so as to fully describe the geotextiles. At a minimum the other pertinent data shall include Grab Strength, Elongation, Puncture Strength, and Apparent Opening Size. The manufacturer shall include in the certificate a guarantee stating that the geotextile that is furnished meets the requirements of GRI Test Methods GT 12a and GT 13.

2.1.2 Performance

All geotextile shall be a continuous filament needle punched or needle punched with staple fabric, or nonwoven fabric composed of synthetic filaments which are formed into a stable network such that the filaments retain their relative position. They shall be inert to biological degradation and naturally encountered chemicals, alkalis and acids. Geotextiles shall conform to the following minimum average roll values (MARV):

Table 1. Geotextile for Liner Cushion

16 oz/yd² Nonwoven Geotextile					
Test Method	Fabric Property	Geotextile Values[1]	Unit	MQC Testing Frequency	Conformance Testing Frequency
ASTM D4533	Trapezoidal Tear Strength	145	lbs	200,000 ft²	-
ASTM D4632	Grab Tensile Strength	370	lbs	200,000 ft²	200,000 ft²
ASTM D3786	Burst Strength	500	Psi	200,000 ft²	
ASTM D4632	Grab Tensile Elongation	50	%	200,000 ft²	-
ASTM D5261	Mass per unit area	16	oz/yd²	200,000 ft²	200,000 ft²
ASTM D6241	Puncture Strength	900	lbs	200,000 ft²	200,000 ft²
ASTM D7238	UV resistance[2]	70	%	200,000 ft²	-
ASTM D4751	AOS (MaxARV)	#100	Sieve #	200,000 ft²	-
ASTM D4491	Permittivity	0.2	sec^{-1}	200,000 ft²	-

1 All values are MARV except UV resistance (minimum value) and AOS (MaxARV).
2 Evaluation to be on 2.0 inch strip tensile specimens per ASTM D 5035 after 500 lt. hrs. exposure.

Table 2. Geotextile for Road Underlayment

8 oz/yd² Nonwoven Geotextile					
Test Method	Fabric Property	Geotextile Values[3]	Unit	MQC Testing Frequency	Conformance Testing Frequency
ASTM D4533	Trapezoidal Tear Strength	56	lbs	200,000 ft²	-
ASTM D4632	Grab Tensile Strength	158	lbs	200,000 ft²	200,000 ft²
ASTM D4632	Grab Tensile Elongation	50	%	200,000 ft²	-
ASTM D5261	Mass per unit area	8	oz/yd²	200,000 ft²	200,000 ft²
ASTM D6241	Puncture Strength	320	lbs	200,000 ft²	200,000 ft²
ASTM D7238	UV resistance[4]	70	%	200,000 ft²	-
ASTM D4751	AOS (MaxARV)	#70	Sieve #	200,000 ft²	-
ASTM D4491	Permittivity	0.02	sec^{-1}	200,000 ft²	-

3 All values are MARV except UV resistance (minimum value) and AOS (MaxARV).
4 Evaluation to be on 2.0 inch strip tensile specimens per ASTM D 5035 after 500 lt. hrs. exposure.

Table 3. Geotextile for Riprap Bedding Underlayment

8 oz/yd² Nonwoven Geotextile					
Test Method	Fabric Property	Geotextile Values[5]	Unit	MQC Testing Frequency	Conformance Testing Frequency
ASTM D4533	Trapezoidal Tear Strength	56	lbs	200,000 ft²	-
ASTM D4632	Grab Tensile Strength	158	lbs	200,000 ft²	200,000 ft²
ASTM D4632	Grab Tensile Elongation	50	%	200,000 ft²	-
ASTM D5261	Mass per unit area	8	oz/yd²	200,000 ft²	200,000 ft²
ASTM D6241	Puncture Strength	320	lbs	200,000 ft²	200,000 ft²
ASTM D7238	UV resistance[6]	70	%	200,000 ft²	-
ASTM D4751	AOS (MaxARV)	#50	Sieve#	200,000 ft²	-
ASTM D4491	Permittivity	0.02	sec^{-1}	200,000 ft²	-

2.1.3 Manufacturing Quality Control

The geotextile shall be subjected to MQC testing for the characteristics listed in the corresponding properties table. The MQC tests shall be performed according to the test methods and frequencies listed in the table. Test results shall be compared to the values and qualifiers listed in the table for purposes of evaluating acceptable products.

2.1.4 CONFORMANCE TESTING

The separation geotextiles shall be subjected to conformance testing for the characteristics listed in the corresponding table; the conformance tests shall be performed according to the test methods and frequencies listed. The test results shall be compared to the values and qualifiers listed in the table for purposes of evaluating acceptable products.

5 All values are MARV except UV resistance (minimum value) and AOS (MaxARV).
6 Evaluation to be on 2.0 inch strip tensile specimens per ASTM D 5035 after 500 lt. hrs. exposure.

2.1.5 Packaging

The geotextile shall be uniformly rolled onto a core, and shall be wrapped in plastic to protect the material from moisture and damage during shipment. Protective wrapping shall be left on the geotextile until installation. Rolls shall be externally tagged for easy field identification. External tagging shall include the following:

- Name of Manufacturer
- Product Type
- Product Grade
- Lot Number
- Physical Dimensions (length, width & weight)

The geotextile shall not be exposed to precipitation prior to being installed. The geotextile shall not be exposed to sunlight for more than 15 days unless otherwise specified and guaranteed in writing by the geotextile manufacturer.

3.0 EXECUTION

3.1 PREPARATION FOR NONWOVEN GEOTEXTILE

3.1.1 Installation over LLDPE Geomembrane Liner

Prepare the geomembrane liner surface to receive the nonwoven geotextile material in accordance with manufacturer's recommendations.

3.1.2 Inspection

The geomembrane liner surface shall be inspected and approved by the ENGINEER and CQA Consultant and nonwoven geotextile installer prior to placement of the nonwoven geotextile material.

3.1.3 Anchor Trench

The anchor trench shall be excavated to the line, grade, and width shown on the Drawings, prior to nonwoven geotextile material placement. Installer, ENGINEER and CQA Consultant shall verify that the anchor trench has been constructed according to the contract plans.

3.1.4 Desiccation

If the anchor trench is located in a clay susceptible to desiccation, no more than the amount of trench required for the nonwoven geotextile to be anchored in 1 day shall be excavated to minimize desiccation of the anchor trench soils.

3.1.5 Corners

Slightly rounded corners shall be provided in the trench where the nonwoven geotextile adjoins the trench so as to avoid sharp bends in the nonwoven geotextile.

3.1.6 Backfilling of Anchor Trench

The anchor trench shall be backfilled and compacted by CONTRACTOR, as approved by CQA consultant. Backfill material shall consist of select foundation soil material. Trench backfill material shall be placed in 8 inch thick loose lifts and compacted by a method and equipment type approved by CQA Consultant. Material shall be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698.

3.1.7 Protection

Care shall be taken when placing granular drainage material over the nonwoven geotextile to prevent any damage to the nonwoven geotextile material. At no time shall construction equipment come into direct contact with the nonwoven geotextile material. If damage occurs, it shall be repaired prior to the completion of placing the granular drainage material.

3.2 NONWOVEN GEOTEXTILE PLACEMENT

3.2.1 Installation-General

CONTRACTOR shall meet all manufacturer's Specifications and comply with the following unless approved in writing by CQA Consultant, ENGINEER, and manufacturer.

3.2.1.1 Placement

Geotextile shall be placed smoothly and in direct contact with the underlying medium. Excessive wrinkles shall not be acceptable. Care should be taken when placing geotextile on textured liner. Excessive shifting of the material when trying to place on textured liner could result in rejection of the material. Tears shall not be acceptable even when patched. Equipment shall never be run directly on the geotextile.

3.2.1.2 Ballasting

All nonwoven geotextile shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until removed and replaced with cover material or adjoining nonwoven geotextile.

3.2.1.3 Compliance

All nonwoven geotextile shall be installed to meet all manufacturer's specifications and as indicated in the specifications an as shown on the Drawings.

3.2.1.4 Projections/Debris

Prior to placing the nonwoven geotextile, care shall be taken not to entrap stone, excessive dust, or moisture that could damage the nonwoven geotextile , generate clogging, or hamper subsequent seaming or tying of the nonwoven geotextile.

3.2.1.5 Damage

CONTRACTOR shall take any necessary precautions to prevent damage to the underlying geomembrane liner during placement of the nonwoven geotextile.

3.2.1.6 Contamination

During placement of nonwoven geotextile, care shall be taken not to entrap stone, excessive dust, or moisture that could damage the nonwoven geotextile, generate clogging, or hamper subsequent seaming or tying of the nonwoven geotextile.

3.2.1.7 Protection

Nonwoven geotextile shall not be exposed to precipitation prior to being installed, and shall not be exposed to direct sunlight for more than 15 days.

3.2.2 Seaming/Tying

Perform seaming/tying operations as follows:

3.2.2.1 Slopes Greater than 10:1

On slopes steeper than ten (10) horizontal: one (1) vertical, all nonwoven geotextile material shall be seamed or tied. Seaming shall be by sewing, fusion, ties or other approved means. All seams shall be continuously seamed using the double stitch prayer or flat seam (SSa-2), spot seaming is not allowed. If ties are to be used, prior approval of the tie material and placement pattern must be obtained during the submittal review process prior to installation of the nonwoven geotextile. Nonwoven geotextile shall be overlapped 6 inches prior to seaming. Cross seams at an angle of 45° or greater from horizontal shall be allowed on slopes steeper than ten (10) horizontal: one (1) vertical. The number of cross seams shall be kept to a minimum and shall be staggered or separated by a minimum of ten (10) feet between adjoining panels. No horizontal seams shall be allowed on slopes steeper than ten (10) Horizontal: one (1) vertical. On slopes 4H:1V (i.e. 20%) or greater, seams shall be continuously sewn.

3.2.2.2 Slopes Less than 10:1

On slopes less than ten (10) horizontal: one (1) vertical, nonwoven geotextile shall be either seamed/tied as indicated above, or overlapped 12 inches. Spot seaming/tying may be considered as a measure against wind uplift. Overlaps shall be oriented in the direction of protective soil placement.

3.2.2.3 Thread

Any sewing shall be done using polymeric thread with chemicals properties equal to or exceeding those of the nonwoven geotextile.

3.2.3 Protection from Damage

Geotextiles should be secured from the wind until final cover is placed. Geotextiles shall be covered within two weeks of installation. The CONTRACTOR is responsible for damage that occurs to the geotextile during installation and will replace the damaged geotextile at no additional cost. The CONTRACTOR shall replace geotextile that is left exposed for more than two weeks.

3.2.4 Geotextile Repair

CONTRACTOR shall repair any damage, as follows:

3.2.4.1 Holes/Tears

Any holes or tears in the fabric shall be repaired as follows:

a. On slopes: A fabric patch shall be sewn into place using a double sewn lock stitch (1/4 in. to 3/4 in. apart and no closer than 1 inch from any edge) with a minimum of 24 inches of overlap in all directions. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.

b. Non-slopes: A fabric patch shall be spot-seamed in place with a minimum of 24 inches of overlap in all directions.

3.2.4.2 Penetrations

Care shall be taken to remove any soil, granular material, or material which may have penetrated through the torn nonwoven geotextile.

3.2.4.3 Daily Placement

The amount of nonwoven geotextile unrolled and laid daily shall be limited to the amount of nonwoven geotextile that can be properly seamed during a 1 day operation. Tack or spot seaming does not constitute a completed seam.

3.3 INSPECTION

3.3.1 Initial Inspection

The nonwoven geotextile material shall be placed after the receiving surface has been property prepared and inspected and approved by the CQA Consultant. No nonwoven geotextile material shall be placed in the absence of the CQA Consultant.

3.3.2 Inspection

Any nonwoven geotextile material placed without CQA Consultant inspection and approval prior to the installation shall be removed in a manner to avoid damage or disturbance to the existing approved work, and nonwoven geotextile material shall be replaced as specified herein, at no additional cost to OWNER.

If an acceptable nonwoven geotextile layer is not obtained because of improper control of placement or seaming/tying procedures, or because of inadequate or improperly functioning equipment, CONTRACTOR shall perform whatever work is required to provide an acceptable nonwoven geotextile layer at no additional cost to O'WNER. This WORK shall include complete removal of unacceptable material area and replacement until an acceptable nonwoven geotextile layer is provided.

END OF SECTION 31 05 19.13

SECTION 31 05 19.16

LLDPE GEOMEMBRANE LINER

1.0 GENERAL

1.1 SCOPE

The work covered in this Section includes the manufacturing, fabrication, testing, supply and installation of Linear Low-Density Polyethylene (LLDPE) geomembrane infiltration layer for the final cover system. The CONTRACTOR shall furnish all labor, materials, transportation, handling, storage, supervision, tools, equipment and other incidentals necessary to install, test, and quality control the geomembrane as required by the Contract Documents.

1.1.1

These specifications describe Linear Low-Density Polyethylene (LLDPE) geomembranes. The supply and installation of these materials shall be in strict accordance with this specification, and be subject to the terms and conditions of the Contract.

1.1.2

The final cover system geomembrane within the disposal area shall be LLDPE with a nominal thickness of 40 mils. Material shall be textured on both sides.

1.2 DEFINITIONS

1.2.1 Owner

The Owner or his designated representative.

1.2.2 Engineer

The Engineer who is acting as the Design Engineer and Owner's designated representative.

1.2.3 QAO

The Quality Assurance Officer who is the on-site project representative.

1.2.4 QAE

The Quality Assurance Engineer, who is in direct supervision of the QAO.

1.3 QUALITY ASSURANCE AND CONTROL DURING INSTALLATION

The ENGINEER or OWNER third party Construction Quality Assurance (CQA) Consultant will observe geomembrane installation and construction and certify that construction is in accordance with Contract Documents. All tests and test frequencies specified in this section are Construction Quality Control (CQC) tests, and these tests are the responsibility of the CONTRACTOR or his representative unless otherwise noted.

1.4 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARD TEST METHODS/PRACTICE:

- ASTM D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
- ASTM D 1004 Initial Tear Resistance of Plastic Film and Sheeting
- ASTM D 1204 Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
- ASTM D 1238 Flow Rates of Thermoplastics by Extrusion Plastometer
- ASTM D 1248 Polyethylene Plastics Molding and Extrusion Materials
- ASTM D 1505 Density of Plastics by the Density-Gradient Technique
- ASTM D 1603 Carbon Black in Olefin Plastics
- ASTM D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
- ASTM D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- ASTM D 4833 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- ASTM D 5199 Measuring Nominal Thickness of Geotextiles and Geomembranes
- ASTM D 5321 Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- ASTM D 5323 Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes
- ASTM D 5596 Standard Test Method For Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- ASTM D 5617 Test Method for Multi-Axial Tension Test for Geosynthetics
- ASTM D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
- ASTM D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry

- ASTM D 6392 Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- ASTM D 6693 Test Method for Determining Tensile Properties of Non-reinforced Polyethylene and Non-reinforced Flexible Polypropylene Geomembranes
- ASTM D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Device
- ASTM D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes
- ASTM D 8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry

GEOSYNTHETICS RESEARCH INSTITUTE (GRI) STANDARD PRACTICE FOR:

- GRI GM-6 Pressurized Air Channel Test for Dual Seamed Geomembranes
- GRI GM-17 Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GRI GM-19a Specification for Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers

1.5 SUBMITTALS

The CONTRACTOR or Geosynthetic INSTALLER shall submit the following information to the ENGINEER for approval at least 30 days (unless otherwise specified) prior to procurement of the geomembrane:

1.5.1 Proof of Manufacturer's Qualifications:

- The Manufacturer must have at least two (2) years documented experience in the manufacture of the geomembrane and/or documented experience totaling 10,000,000 ft^2 of the manufactured geomembrane for at least ten (10) completed facilities.
- Manufacturer's Brochure: Submit complete manufacturer's specifications, descriptive drawings, and literature for the geomembrane, including the product identification and supplier of the polymer resin and recommended method for handling and storage of all materials prior to installation. Include information on plant size, equipment, personnel, number of shifts per day and capacity per shift.
- Manufacturer Quality Control (MQC) Program: Submit a complete description of the geomembrane manufacturer's formal quality control programs for manufacturing, fabricating, testing, quality control, defects repair, handling, and shipping. The description shall include, but not be limited to, polymer resin supplier(s) and product identification, acceptance testing, production sampling and testing, installation testing, documentation of changes, alterations, repairs, retests, and acceptance.

- Prior to Purchasing material the following conformance testing is required: Submit independent quality control laboratory test results demonstrating compliance with material properties listed herein, including *Table 31 05 19.16 – 3* Resin Properties (Without Carbon Black) and *Table 31 05 19.16 - 3*. The independent laboratory tests are to be performed once by an approved laboratory independent of the manufacturer. In addition, the manufacturer must provide a certificate of compliance which states that the material to be installed will use the same resin type and formulation as that for which test results are submitted.

1.5.1.1 Manufacturer Quality Control Certificates:

The Geosynthetic Installer shall submit test reports to the ENGINEER prior to geomembrane shipment. The tests and frequencies are specified in Part 2 - "Manufacturer Quality Control Tests" and material properties.

The following information must be submitted for approval prior to shipping the material:

Resin:

- Batch number, lot number, or identification number and production date(s).
- A certification by a qualified individual employed by the manufacturer that the quality of the resin used to manufacture the geomembrane rolls assigned to this project meets specified properties measured using test methods indicated in the specifications, or equivalent;
- Copy of quality control certificates issued by the Resin Supplier.
- Certified statement that no reclaimed polymer was added to the resin during the manufacture of the actual geomembrane to be used in this project.

Geomembrane:

- Roll numbers, production dates, and identification;
- A certification by a qualified individual employed by the manufacturer that the geomembrane roll assigned to this project meets specified properties measured using test methods indicated in the specifications, or equivalent;
- A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.

Factory Visit:

At the request of the OWNER or the ENGINEER, submit contact names, telephone numbers, addresses, and production schedule information for purposes of scheduling an OWNER or ENGINEER'S plant visit during production.

1.5.2 Proof of Geosynthetic INSTALLER'S Qualifications:

- List at least ten (10) completed facilities totaling a minimum 10,000,000 ft^2, for which the Geosynthetic Installer has manufactured the proposed geomembrane, including thickness, amount, date(s) and intended usage. (See Part 2).

- Show a minimum of two years continuous experience and list completed facilities for which the Geosynthetic Installer has installed geomembrane, totaling a minimum of 10,000,000 ft^2.

- The name or names of the field superintendents who will be proposed for the project and a list of completed facilities for which the field superintendent has installed the selected geomembrane totaling a minimum of 10,000,000 ft^2.

- The name or names of the Master Seamer(s) who will be proposed for the project and a list of completed facilities for which the Master Seamer(s) has installed the selected geomembrane totaling a minimum of 2,000,000 ft^2.

- Construction Quality Control Program: Submit a complete description of the Geosynthetic Installer's formal quality control programs for handling, installing, testing, quality control, and defect repair. The description shall include, but not be limited to installation testing, documentation of changes, alterations, repairs, retests, and acceptance. The document shall include a complete description of seaming by extrusion welding and hot wedge welding.

- Panel Layout Drawing: As a minimum, PLANS shall include an approximate panel deployment sequence, panel orientation, type of weld to be used for each seam, incorporate restrictions on panel and seam orientation, methods of deployment, and details of each step in the construction of any penetrations. The panel layout drawing shall be drawn to scale, and shall indicate areas where horizontal seams will be utilized.

- Proposed schedule of installation showing the critical path of installation.

- Licensed Installer: The Geosynthetic Installer shall be approved and/or licensed by the geomembrane manufacturer.

- Warranty: Submit an advance (sample) copy of the warranty.

1.5.3 Instructions and Drawings Required After Contract Award

1.5.3.1 Storage, Handling, Installation, and Seaming

The Contractor shall furnish complete written instructions to the Engineer for the storage, handling, installation, and seaming of the membrane in compliance with this specification and the condition of his warranty.

1.5.3.2 Repairs

The material supplier shall furnish complete written instructions for the repair of geomembrane material to the Engineer no less than 30 days prior to installation.

1.5.3.3 Layouts

The Contractor shall furnish panel layouts and seam details as required for the membrane installation. The goal of the plan will be to minimize the required number of seams. Care should be taken to reduce areas of stress concentration. Horizontal seams are not allowed unless the slope length exceeds roll lengths. In that event, the horizontal seam will be installed on a 45 degree diagonal across the slope. Details of placement around penetrations, if any, such as pipes shall be provided. The above details must be approved by the Engineer prior to liner installation. Material left outside shall not be exposed to sunlight for more than 30 days.

1.5.4 Shop Drawing Submittals

1.5.4.1 Samples and Specifications

In order to qualify as an approved lining material, the Contractor shall submit material samples and minimum specifications to the Engineer. The specification sheet shall give full details of minimum physical properties and test methods used, site seaming methods, and a certificate confirming compliance of the material with the minimum specifications. A list of similar projects completed in which the manufactured material has been successfully used shall be submitted.

1.5.4.2 Certification

The Contractor shall submit a certification from the manufacturer of the sheeting, stating that the sheeting meets physical property requirements for the intended application, and that the membrane meets the physical requirements of the Geosynthetic Research Institute for the manufacture and installation of LLDPE membrane.

1.5.4.3 Certification Delivery

Upon delivery of the rolls of geomembrane, provide a copy of the certification from the manufacturer certifying the batch delivered to the site meets the minimum specifications and was QC inspected. The certificate shall be signed by a person with authority to bind the manufacturer.

1.5.4.4 Test Results

The Contractor shall submit results of confirmation testing showing that the material lot of the resin used in the membrane supplied meets the material requirements for the resin. A description of the quality control steps used during manufacture shall also be provided.

1.5.5 During Construction Conformance Test Results:

Submit conformance test results to the ENGINEER for approval within 3 days of completed testings. See Part 1.5.C. for conformance testing requirements and frequency.

1.5.6 List of Personnel:

The CONTRACTOR or Geosynthetic Installer shall submit a list of proposed seaming personnel and their experience records. All personnel shall be approved by the ENGINEER before they perform seaming operations.

1.5.7 Submittals Required for Project Closeout

Record Drawings:

Submit geomembrane record drawings to the ENGINEER.

Geomembrane Warranty

Submit geomembrane warranty to the ENGINEER.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Handling

The Geosynthetic Installer's personnel shall handle the material with care, shall use adequate equipment and shall take all precautions necessary to prevent damaging the geomembrane.

1.6.2 Inspection upon Delivery

Upon delivery at the site, the Geosynthetic Installer, in the presence of a CQA Representative, conduct a visual inspection of rolls or factory panels for defects and for damage. This inspection shall be conducted without unrolling rolls or unfolding factory panels unless, in the Geosynthetic Installer's or CQA Representative's opinion, defects or damages are found or suspected.

Defects or flaws in the materials shall be brought to the attention of the CQA Representative. Rolls, factory panels, or portions thereof, which have unacceptable flaws shall be recorded by the CQA Representatives and Geosynthetic Installer, rejected and shall be removed from the site.

Rejected materials shall be replaced by the CONTRACTOR at no additional cost to the OWNER. No time extension will be allowed in the case of rejected materials.

1.6.3 During Construction Conformance Testing

At the direction of the CQA Representative, the Geosynthetic INSTALLER shall take samples from the delivered lot or factory seams retained (delivered along with the lot) and sent to the CQA Geosynthetic Laboratory for conformance testing. The cost for laboratory conformance testing shall be paid by the OWNER. The conformance tests and minimum frequency outlined in *Table 31 05 19.16 - 1* are required prior to installation.

Table 31 05 19.16 - 1 Conformance Testing Requirements

Properties	Test Method	Test Value	Testing Frequency (minimum)
Thickness (min. ave.) – mils • lowest individual for 8 out of 10 values - % • lowest individual for any of the 10 values - %	D 5994	nom -5% (38) -10% (36) -15% (34)	per roll
Tensile Properties • break strength – lb/in. • break elongation - %	D 6693 Type IV	60 300	45,000 ft^2

Properties	Test Method	Test Value	Testing Frequency (minimum)
Puncture Resistance (min. ave.) - lb	D 4833	50	45,000 ft^2
Tear Resistance (min. ave.) - lb	D 1004	22	45,000 ft^2
Carbon Black Content (range)	D 4218[1]	2.0% - 3.0%	45,000 ft^2
Carbon Black Dispersion	D 5596	[2]	45,000 ft^2

All conformance test results shall be reviewed and approved by the ENGINEER prior to any placement. If a conformance test result fails the specifications, at least two additional conformance tests shall be performed on samples taken immediately from adjacent numbered rolls. If both additional conformance test results pass the specifications, the entire lot or 45,000 square feet shall be accepted except that roll from which the failed sample is taken. If any of the conformance test results fails for the two (minimum) additional samples, the entire lot or 45,000 square feet shall be rejected by the ENGINEER.

1.6.4 Storage

The Geosynthetic Installer shall be responsible for ensuring that the stored materials are protected from rain, snow, ice, dirt, ultra violet light, shock, theft, vandalism, passage of vehicles, and other sources of damage. The CONTRACTOR is responsible for clearing, grubbing, and grading necessary to prepare the storage area. Provide for surface water control, access and storage area surfacing, and lighting necessary for adequate unloading of highway transport vehicles and access by construction equipment.

1.7 Warranty

Provide a twenty (20) year material warranty and workmanship defects for a period of one (1) year following the date of final completion of the work under this contract. The warranty required herein shall be provided in addition to any warranty required by the General Conditions.

2.0 PRODUCTS

2.1 MANUFACTURING PLANT VISIT

The Manufacturer shall allow the ENGINEER, CQA Representative, OWNER, or designated alternates to visit the manufacturing plant for a project specific visit. The ENGINEER, OWNER or designated alternate shall be allowed to review the manufacturing process, quality control, laboratory facilities and testing procedures as necessary to verify that:

- Properties guaranteed by the Manufacturer meet all specifications;
- Measurements of properties by the Manufacturer are properly documented and test methods used are acceptable;

[1] Other methods such as D 1603 (tube furnace) or microwave methods are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
[2] Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

- Rolls of geomembrane are free of holes, blisters, or any sign of contamination by foreign matter;
- Packaging and transportation procedures do not damage the geomembrane;
- Roll packages are labeled to indicate the name of the manufacturer, the type of geomembrane, the roll thickness and the roll number; and
- That extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

2.2 GEOMEMBRANES

2.2.1 Single Source

All geomembrane sheets and extrudate material for the construction of the project shall be obtained from a single material supplier and manufacturer. It must be certified and warranted that the sheets, extrudate, and pipe boots are compatible with one another. The Geosynthetic Installer shall provide manufacturer's warranties for the sheets, extrudate material, and pipe boots.

2.3 MATERIAL PROPERTIES

2.3.1 Geomembrane

The membrane shall be comprised of LLDPE material manufactured of new, first quality products designed and manufactured as a component of a hydraulic barrier in landfills or similar structures. The membrane shall have a minimum thickness required by the plans. The raw polymer shall meet or surpass the minimum standards as set forth in the Geosynthetic Research Institute's (GRI) Test Method GM17 "Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes" and GRI Test Method GM19 "Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes".

The membrane shall meet or exceed the requirements of Table 31 05 19.16 - 2. Geomembrane shall meet or exceed the requirements of *Table 31 05 19.16 - 3*. Equivalent test methods are subject to the approval of the ENGINEER.

Table 31 05 19.16 - 2 Resin Properties (without Carbon Black)

Properties	Test Method	Test Value
Minimum Polymer Composition (% polyethylene)	Thermal Gravimetric Analysis (TGA)	95
Geomembrane sheet density (g/cc)	D 1505 / D 792 Method B	≥0.93
Maximum Polymer Melt Index (g/10 min)	D 1238 Condition E	<1.0

2.3.2 Extrudate

Extrudate shall be the same resin as the geomembrane. The manufacturer shall provide documentation and shall certify that the extrudate meets this requirement.

2.3.3 Material Composition

The geomembrane shall consist of new, first-quality products designed and manufactured specifically for the purpose of this project, as satisfactorily demonstrated by prior use. The geomembrane shall be unmodified containing no plasticizer, fillers, chemical additives, reclaimed polymers, or extenders. Approximately 2 percent carbon black shall be added to the resin for ultraviolet resistance. The only other allowable compound elements shall be anti-oxidants and heat stabilizers, of which up to 1.5 percent total, as required for manufacturing, may be added.

2.3.4 Defects

The membrane material shall be so produced as to be free of holes, blisters, undispersed raw materials, or sign of contamination by foreign matter. Defects discovered in the field shall be repaired by cutting out the defect and welding a new piece of membrane material in its place. The weld shall be placed in accordance with the requirements for field welded seams. Seams for repairs shall be tested in accordance with the required field seam test procedures.

2.3.5 Labels

Labels on each roll shall identify the thickness, length, width, and manufacturer's mark number. The roll shall also indicate the date, lot, and batch number of the roll, the square feet in the roll, and the total roll weight as measured after manufacture. Should the total weight not meet the minimum weight based upon the minimum material density of 0.93 g/cc, the material thickness, and square footage provided, then the delivered material will be rejected for use.

2.3.6 Transportation, Handling, and Storage

Transportation, handling, and storage of the membrane shall be in accordance with written instructions from the manufacturer. These instructions shall be supplied prior to delivery of the material. In general, equipment used shall be adequate to handle the rolls of membrane without risk of damage to the material. Extreme care will be taken whenever handling the material. The rolls of membrane shall be stored on a surface free of sticks, rocks, roots, or other matter that may damage the material. Upon delivery, QC and QA personnel shall inspect each roll of material for damage. This inspection shall be recorded and included in the QA/QC reports.

2.3.7 Seams

There shall be no factory seams. Seams shall be welded in the field by factory trained technicians using a non-destructive hot-wedge fusion or extrusion process. Edges of rolled material shall be trimmed at the factory to remove non-conforming material. The first three feet of material on selected rolls shall be used for confirmation testing of the characteristics of the membrane material. Sampling and testing shall be performed by the QAO. Additional tests shall be conducted for each 5,000 square yards of material placed.

2.4 MANUFACTURER QUALITY CONTROL TESTS

2.4.1 Test Reports

Submit all test reports to the ENGINEER for review and approval.

2.4.2 Manufacturer Quality Control (MQC) Tests:

2.4.2.1 Resin

Resin shall be tested at a frequency of one test per resin batch. One batch is defined as one rail car load of resin. As a minimum perform tests for Density and Melt Index. Compliance with the Polymer Composition test requirement shall be established with a manufacturer's certificate of compliance. The finished rolls shall be identified by a roll number corresponding to the resin batch used.

2.4.2.2 Geomembrane

Geomembrane shall be tested for properties required by *Table 31 05 19.16 - 3*. The minimum test frequencies in *Table 31 05 19.16 - 3* shall be observed.

Table 31 05 19.16 - 3 Manufacturer Quality Control Testing Requirements

Properties	Test Method	Test Value	Testing Frequency (minimum)
Thickness (min. ave.) – 40 mils • lowest individual for 8 out of 10 values - % • lowest individual for any of the 10 values - %	D 5994	nom -5% (38) -10% (36) -15% (34)	per roll
Asperity Height (min. ave.) – mils	D 7466	16	Every 2nd roll[3]
Formulated Density (max.) – g/cc	D 1505 / D 792	0.939	50,000 ft^2
Tensile Properties[4] • break strength – lb/in. • break elongation[5] - %	D 6693 Type IV	 60 300	50,000 ft^2
Puncture Resistance (min. ave.) - lb	D 4833	50	50,000 ft^2
Tear Resistance (min. ave.) - lb	D 1004	22	50,000 ft^2
Carbon Black Content, %	D 4218[6]	2.0 - 3.0	50,000 ft^2
Carbon Black Dispersion	D 5596	[7]	50,000 ft^2
Oxidative Induction Time[8] (OIT) (min. ave.) Standard OIT – min. - or – High Pressure OIT – min.	 D 8117 D 5885	 100 400	100,000 ft^2
Oven Aging at 85°C[9] Standard OIT (min. ave.) - % retained after 90 days - or –	D 5721 D 8117	35	per formulation

[3] Alternate the measurement side for double sided textured sheet.
[4] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
[5] Break elongation is calculated using a gage length of 2.0 in. at 2.0 in. /min.
[6] Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
[7] Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3
[8] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
[9] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	60	
UV Resistance[10] High Pressure OIT (min. ave.) - % retained after 1600 hrs[11]	D 7238 D5885	 35	per formulation

3.0 INSTALLATION

3.1 GENERAL REQUIREMENTS

3.1.1 Superintendent

Installation shall be performed under the direction of a qualified field superintendent who shall remain on site and be in charge throughout the entire geomembrane installation (including subbase acceptance, geomembrane layout, panel placement, seaming, testing and repairs) and all other activities performed by the Geosynthetic Installer. The Geosynthetic INSTALLER'S field superintendent shall have previously installed or supervised the installation of a minimum of 10,000,000 ft^2 of the selected geomembrane.

3.1.2 Seaming Personnel

All personnel performing seaming operations shall be qualified by experience and by successfully passing trial seam tests and shall be approved by the CQA Representative prior to installing the geomembrane.

3.1.3 Master Seamer

Actual seaming shall be performed under the direction of a "Master Seamer" who may be the same person as the field superintendent, and who has seamed a minimum of 2,000,000 ft^2 of the selected geomembrane using the type of seaming apparatus as that proposed for use for this project. The Master Seamer must be on site whenever installation and/or seaming is being performed.

3.1.4 Wind

The CONTRACTOR shall provide sufficient ballast and temporary anchorage to protect the material from wind damage or displacement. The CONTRACTOR is responsible for protecting the material from damage due to weather at all times.

3.2 INSTALLATION EQUIPMENT

3.2.1 Seaming Methods

Approved processes for field seaming are extrusion welding and fusion (wedge) welding. Solvent or adhesive welding is prohibited unless approved by the ENGINEER. Proposed alternate processes shall be documented and submitted to the ENGINEER for approval PRIOR to installation. Only apparatus which have been specifically approved by make and model shall be used.

[10] The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C
[11] UV resistance is based on percent retained value regardless of the original HP-OIT value.

3.2.2 Welding Equipment

The Geosynthetic Installer shall provide welding equipment with gauges showing temperatures at the nozzle or barrel (extrusion welder) and at the wedge (fusion welder). The fusion-welding apparatus must be automated self-propelled devices, and shall be equipped with gauges giving the important temperatures and pressures. Equipment shall be maintained in good condition and in adequate number to avoid delaying work in the event of equipment failure or malfunction, and shall be supplied by a power source capable of providing constant voltage under a combined line load. At least one spare operable seaming apparatus of each type used shall be maintained on-site. Equipment used for seaming shall be handled so as to avoid damaging the geomembrane. The welding apparatus shall be able to produce a "double hot wedge" with void for non-destructive testing.

3.2.3 Field Tensiometer

The Geosynthetic Installer shall provide a field tensiometer for on-site peel and shear testing of geomembrane seams. The tensiometer shall be calibrated prior to arrival at the site, capable of performing testing according to ASTM D 6392, and be accompanied by evidence of current valid calibration. The tensiometer shall be motor driven and have jaws capable of traveling at a maximum measured rate of 2 inches per minute. The tensiometer shall be equipped with a gauge that measures the force exerted between the jaws in pounds and have a digital readout.

3.2.4 Punch Press

The Geosynthetic Installer shall provide a punch press for the on site preparation of specimens for testing. The press shall be capable of cutting specimens in accordance with ASTM D 6392.

3.3 PREPARATION

3.3.1 Surface Preparation

Prior to geomembrane panel deployment, the Geosynthetic Installer shall inspect the surface upon which the geomembrane will be placed. The surface shall be smooth, free of rocks, soil particles greater than 3/8-inch, protrusions, sharp objects, and deleterious material that could puncture or abrade the geomembrane. Edges of excavations and grade breaks shall be rounded to preclude sharp corners. As necessary, the surface shall be groomed by hand to bring the surface up to the desired smoothness. The surface should provide a firm, unyielding foundation to provide continuous contact between the surface and the membrane with no sudden, sharp or abrupt changes or break in grade. No standing water or excessive moisture shall be allowed.

3.3.2 Certification of Subgrade Acceptance

The CONTRACTOR shall be responsible for preparing the subgrade soil according to the Contract Documents and geomembrane manufacturer's recommendations. Prior to geomembrane installation the Geosynthetic Installer shall certify in writing that the surface upon which the geomembrane will be installed is acceptable. The Certificate of Acceptance shall be given by the Geosynthetic Installer to the CQA Representative prior to commencement of geomembrane installation in the area under consideration (an example certificate is provided in this section). Commencement of geomembrane installation by the Geosynthetic Installer shall mean acceptance and approval was accomplished.

After the subgrade soil has been accepted by the Geosynthetic Installer, it shall be the Geosynthetic Installer's responsibility to indicate to the CONTRACTOR changes in the subgrade soil condition that require repair work. The CONTRACTOR shall ensure that the subgrade soil is repaired.

3.3.3 Contractor Approval

The installation of the membrane shall be done with labor and equipment provided by the installer of the membrane material. The installer shall provide the proper extrusion or hot-wedge fusion welding equipment for the installation. Only installation methods approved by the manufacturer and the QAO shall be used.

3.3.4 Damaged Subgrade

Prior to geomembrane panel deployment, the CONTRACTOR shall repair damage to the subgrade which has occurred due to his or the Geosynthetic Installer's activities.

3.3.5 Anchor trench

Geomembrane anchor trenches shall be constructed to the lines and grades shown on the PLANS. The geomembrane in the anchor trench shall be constructed as shown on the PLANS, and backfilled as indicated with care not to damage the geomembrane. When the anchor trench will be excavated in soil susceptible to desiccation, no more than the amount of trench required for geomembrane to be anchored in one day shall be excavated. The anchor trench shall be maintained clean and dry prior to backfilling.

3.4 PANEL DEPLOYMENT

3.4.1 Identification

Each field panel shall be given a unique "identification code" (numbers or letters and numbers) consistent with the layout plan.

3.4.2 Installation Sequence

The Geosynthetic Installer shall be responsible for the final installation sequence of geomembrane panels. Geomembrane panels shall not be deployed unless they can be seamed within 8 hours of deployment or earlier.

3.4.3 Orientation

Panels shall be oriented perpendicular to the line of the slope crest. Seams parallel to or less than a 45 degree angle from any crest or toe of slope are defined as horizontal seams. Horizontal seams are prohibited on slopes greater than 10:1 (H:V) and shall be at least 5 feet from the crest or toe of slopes greater than 10:1.

3.4.4 Wrinkles

Geomembrane panels shall be unrolled using methods that will minimize wrinkles and will not damage, stretch, or crimp the geomembrane and shall protect the underlying subsurface from damage. All wrinkles higher than they are wide (across their base) shall be removed by repair methods. The CONTRACTOR and/or Geosynthetic Installer shall also remedy wrinkles which develop during subsequent placement of overlying layers.

3.4.5 Bridging

Material shall be installed to allow for temperature related shrinkage and to avoid bridging of the geomembrane.

3.4.6 Seam Layout

Panels shall be placed such that the seam layout conforms as closely as practicable to the approved panel layout drawing. No panels may be seamed in the field without the CQA Representative's approval. In addition, panels not specifically shown on the seam layout drawing may not be used without the CQA Representative's prior approval. Seams shall be identified using the identification codes shown on the panel and seam layout drawing.

3.5 FIELD SEAMS

3.5.1 Seam Strength

All field seams shall meet or exceed the requirements of *Table 31 05 19.16 - 4* for Geomembrane Seam Properties.

Table 31 05 19.16 - 4 LLDPE Geomembrane Seam Properties

Properties	Test Value[12]
Hot Wedge Seams[13]	
• shear strength, lb/in.	60
• shear elongation at break[14], %	50
• peel strength, lb/in.	50
• peel separation, %	25
Extrusion Fillet Seams	
• shear strength, lb/in.	60
• shear elongation at break[15],%	50
• peel strength, lb/in.	44
• peel separation, %	25

3.5.2 Installation Rate

Contractor shall install membrane at a rate that does not exceed his capacity for patching and testing all field welds each day. Patches and repairs shall be completed and tested (including visual, air pressure and vacuum) each day on the geomembrane material installed. Destructive test samples shall be obtained daily on the LLDPE material installed.

[12] Test Values are provided for 40mil LLDPE geomembrane. For all other material thicknesses refer to GRI-GM19a.
[13] Also for hot air and ultrasonic seaming methods.
[14] Elongation measurements should be omitted for field testing
[15] Elongation measurements should be omitted for field testing

3.5.3 Overlapping

Panels of geomembrane must have a finished overlap of a minimum of three (3) inches for extrusion welding and four (4) inches for fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.

Field seams shall have a minimum width of one (1) inch.

The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

3.5.4 Weather Conditions for Seaming

Unless authorized in writing by the ENGINEER or CQA Representative, no seaming shall be attempted at ambient temperatures below 32°F (0°C) or above 95°F (35°C). If seaming is authorized at temperatures below 32°F (0°C), pre-heating devices shall be placed on all welding machines. Trial seams shall be prepared and tested every two to three hours. Additionally, if the air temperature drops more than 10°F from the time the trial seam(s) were produced, additional trial seams shall be performed as required by the QA Representative.

3.5.4.1 Cold Weather Seaming

Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming may be carried out if the geomembrane is preheated by either the sun or a hot air device, and if there is not excessive cooling resulting from the wind.

3.5.4.2 Warm Weather Seaming

Above an ambient temperature of 50°F (10°C), no preheating is required.

3.5.4.3 Inclement Weather Seaming

In all cases, the geomembrane shall be dry and protected from wind damage. Seaming shall not proceed during precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, in an area of saturated soil, in the presence of wind speeds exceeding 20 mph (32 km/hr), or in an area of free water.

3.5.5 General Seaming Procedures

Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths." Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches (150 mm) beyond the cut in all directions.

As deemed necessary by the Geosynthetic Installer, CONTRACTOR, or CQA Representative, a movable protective layer shall be used below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets. Upon completion of welding, the movable protective layer shall be removed entirely.

For seams which are to be extrusion welded, and as necessary for fusion welds, the seam overlap shall be grinded in accordance with the Manufacturer's instructions, within one hour of the seaming operation and in a way that does not damage the geomembrane. The grind shall not extend more than 0.25 inches past the weld and shall not be excessively deep. The composition of the extrudate used shall be identical to the membrane material.

Welding speed and pressure, preheating temperature, nozzle (die) temperature, ambient air and sheet temperatures, and extrudate bead thickness shall not deviate from the Manufacturer's recommendations or welding criteria established during start-up operations unless approved by the ENGINEER and approved and certified in writing by the Fabricator that such deviation will not result in any short or long term damage to the geomembrane.

The edge of cross seams shall be grinded to a smooth incline (top and bottom) prior to welding.

For extrudate seams, the extrusion welding device shall be purged prior to beginning a seam and until all heat-degraded extrudate has been removed from the barrel.

In locations where a firm substrate does not exist, a flat board, or a similar hard surface shall be provided directly under the seam overlap to achieve proper support.

Seaming shall extend to the outside edge of panels to be placed in anchor trenches.

3.6 PROTECTION

3.6.1 Protection of the Geomembrane

- Providing a smooth insulating plate or fabric beneath hot welding apparatus before and after usage.
- Providing additional protection over the geomembrane in heavily trafficked areas.
- Protecting the geomembrane from ultraviolet exposure. The geomembrane shall not be left exposed (uncovered) to the elements for any period longer than 30 days unless otherwise approved by the ENGINEER.
- Positioning overlaps of panels to facilitate drainage prior to seaming.
- Preventing damage to the geomembrane by scraping, scarring, scuffing, scratching, gouging, handling, trafficking, excessive heat, vibration, leakage of hydrocarbons or any other means.
- Assuring that the prepared surface underlying the geomembrane has not deteriorated or changed significantly since acceptance, and is still acceptable at the time of geomembrane placement.
- Assuring that the surfaces underlying the geomembrane are clean and free of debris.
- Preventing personnel working on the geomembrane from smoking, wearing damaging shoes, or engaging in other activities which could damage the geomembrane.

- Using methods to unroll the panels that do not cause scratches or crimps in the geomembrane and do not damage the underlying surfaces.

- Using methods to place the panels that minimize wrinkles (especially differential wrinkles between adjacent panels). Temperature changes should be considered in scheduling of panel deployment and seaming to minimize shrinkage and expansion problems.

- Adequately anchoring the geomembranes before and after deployment to prevent wind damage.

- Minimizing direct contact with geomembrane; (i.e., protecting the geomembrane with geotextiles, extra geomembrane, or other suitable materials) in areas where excessive traffic may be expected.

- Preventing all wheeled and tracked equipment from driving directly on the geomembrane. See Section 3.11 "PLACEMENT OF GEOCOMPOSITE DRAINAGE NET AND VEGETATIVE SUPPORT LAYER MATERIALS" for required minimum protective cover to allow use of equipment.

- Not allowing the geomembrane surface to be used as a work area for preparing patches, storing tools and supplies, etc.

- Ensuring that sharp objects are not left on the surface of the geomembrane.

3.7 FIELD QUALITY CONTROL TRIAL SEAMS

Trial seams shall be performed in the presence of the CQA Representative. Trial seams shall be made on scrap pieces of geomembrane under the same conditions that production seaming will be performed to verify that seaming conditions are satisfactory. Trial seams shall be made, at a minimum, at the beginning, middle, and end of each work day, and at least once every four hours or as directed by the CQA Representative for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. (Note extra requirements for seaming in cold weather)

The trial seam sample shall be at least three (3) feet long by one (1) foot wide (after seaming) with the seam centered lengthwise. The sample shall be marked with date, ambient temperature, and welding machine number. Four adjoining specimens, each one (1) inch (25 mm) wide, shall be cut from the trial seam sample by the Geosynthetic Installer at locations selected randomly by the CQA Representative. Two of the specimens shall be tested in peel and two tested in shear; none should fail in the seam. If a specimen fails in the seam, the entire trial seam procedure shall be repeated. If an additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two (2) consecutive successful full trial seams are achieved.

3.8 FIELD NONDESTRUCTIVE SEAM TESTING

To check for seam continuity, the Geosynthetic Installer shall nondestructively test 100 percent of field seams over their entire length using a vacuum test unit, air pressure test, or other approved method. Air pressure testing is only applicable to those processes which produce a double seam with an enclosed space, and shall follow GRI GM6, Pressurized Air Channel Test for Dual Seamed Geomembranes. Tests must include visual inspection of seams. A detailed test protocol must be submitted for approval a minimum of 30 days prior to installation of the liner.

Continuity testing shall be performed as the seaming work progresses, not at the completion of all field seaming.

3.8.1 Vacuum Testing Equipment

Test equipment, including but not limited to the following shall be furnished by the Geosynthetic Installer:

- The vacuum box (1 to 3 feet long by 1 foot wide) shall have a transparent viewing window on top and a soft, closed cell neoprene gasket attached to the bottom. The housing shall be rigid and equipped with a bleed valve and vacuum gauge. A separate vacuum source shall be connected to the vacuum box. The equipment shall be capable of inducing and holding a vacuum of 5 psig (10 in of Hg vacuum). The viewing window shall be replaced if it becomes excessively scratched.
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections; mounted on a cushion to protect the geomembrane.
- A rubber pressure/vacuum hose with fittings and connections.
- A bucket and wide paint brush.
- A soapy solution.

3.8.2 Vacuum Test Procedure

- Energize the vacuum pump and adjust the tank vacuum to approximately 5 psig (10 in. of Hg vacuum) (35 kPa absolute).
- Apply soapy solution to wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m by 1.2 m).
- Place the box over the wetted area.
- Close the bleed valve and open the vacuum valve.
- Ensure that a leak tight seal is created by the gasket.
- For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
- If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process.
- All areas where soap bubbles appear indicate leaks or poor seam continuity and shall be marked, repaired and retested.

3.8.3 Air Pressure Test Equipment (GRI GM-6)

- An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.
- A rubber hose with fittings and connections.
- A sharp hollow needle, or other approved pressure feed device.

3.8.4 Air Pressure Test Procedure

- Seal both ends of the seam to be tested (to a maximum length of 500 feet unless other approved by the ENGINEER).
- Insert needle or other approved pressure feed device into the channel created by the dual track fusion weld.
- Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, and sustain pressure for a minimum of 5 minutes.
- If pressure drop exceeds 2 psi (15 kPa), or does not stabilize, locate the faulty area, repair and retest.
- Remove needle or other approved pressure feed device and seal ends and needle puncture with extrudate.

3.9 FIELD DESTRUCTIVE SEAM TESTING

3.9.1 Test Location

To establish that there is adequate seam strength, destructive seam tests shall be performed at selected locations. Test locations shall be determined after seaming, at the CQA Representative's discretion, and may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of inadequate welding. The Geosynthetic Installer shall not be informed in advance of the locations where the seam samples will be taken.

3.9.2 Test Frequency

As a minimum, one test location shall be selected per 500 feet of seam length produced by each welding machine. (This minimum frequency is to be determined as an average taken throughout the entire facility.) Seam strength testing shall be performed as the seaming work progresses, not at the completion of the seaming.

3.9.3 Test Procedure

A three foot minimum sample is taken by the Geosynthetic Installer from the seam and cut into three individual one foot samples. Individual samples go to the Installer CQC Organization, the CQA Representative and the OWNER. The Installer CQC Organization and CQA Representative each cut their respective samples into 5 shear and 5 peel (alternating adjacent) test specimens and conduct the tests in accordance with ASTM D 4437. The remaining sample is archived by the OWNER. The OWNER will be responsible for storing the archive samples.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with specified repair procedures. The continuity of the new seams in the repaired area shall be tested and repaired if necessary.

3.9.4 Geosynthetic Laboratory Testing

If destructive seam testing is to be performed off-site, packaging and shipping of destructive test samples shall be conducted in a manner which will not damage the test sample. The CQA Representative shall verify that packaging and shipping conditions are acceptable. This procedure shall be fully outlined prior to construction.

Testing shall include "Shear Testing" and "Peel Testing" (ASTM Designation D 6392). The minimum acceptable values to be obtained in these tests are those indicated in *Table 31 05 19.16 - 4*. At least 5 specimens shall be tested for each test method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). At least 4 of the 5 specimens tested shall meet or exceed the requirements indicated in *Table 31 05 19.16 - 4*. The failed specimen must not be so significantly different in failure load (>80% of average failure load of the other four specimens) so as to be "suspect" of other problems.

The Geosynthetic Installer's laboratory test results shall be presented in writing to the CQA Representative, ENGINEER and the OWNER as required by ASTM D 6392.

3.9.5 Procedures for Destructive Test Failures

All failed seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet (50 m) of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing.

The CONTRACTOR is responsible for providing quality seams. For all QA retests due to destructive failures exceeding 10% of all tests, the CONTRACTOR shall be charged to QA time and lab costs.

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the CQA Representative, the Geosynthetic Installer, the CONTRACTORS independent CQC laboratory, or by field tensiometer. The Geosynthetic Installer has two options:

- The Geosynthetic Installer can reconstruct the seam between any two passing test locations;

- The Geosynthetic Installer can trace the welding path to an intermediate location (at 3 m (10 feet) minimum from the point of the failed test in each direction) and take a single specimen for an additional field test at each location. If these additional specimens pass the test, then full samples are taken. If these samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated, in that direction, to establish the zone in which the seam should be reconstructed.

3.10 DEFECTS AND REPAIRS

3.10.1 Identification

The entire geomembrane, including seams, shall be visually examined by the CQA Representative for identification of visual defects, holes, blisters, undispersed raw materials and signs of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the Geosynthetic Installer if dust, mud or other matter inhibits examination. All areas having defects and/or requiring repairs shall be repaired at no additional cost to the OWNER.

Work shall not proceed with any materials which will cover locations which have been repaired until the CQA Representative has re-examined the repaired area and applicable laboratory test results with passing values are available. Panels or portions or panels which, in the opinion of the CQA Representative, are damaged beyond repair shall be removed from the site and replaced.

3.10.2 Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the QA Representative, Geosynthetic Installer, and ENGINEER. The procedures available include:

3.10.2.1 Patching

Patching will be used to repair large holes, tears, areas of undispersed raw materials, and contamination by foreign matter.

3.10.2.2 Grinding and Rewelding

Grinding and rewilding will be used to repair small defective sections of extruded seams less than one foot in length.

3.10.2.3 Spot Welding

Spot Welding will be used to repair small tears, pinholes, or other minor, localized flaws.

3.10.2.4 Capping

Capping will be used to repair large lengths of failed seams; (maximum allowable cap width is three feet).

3.10.2.5 Removal

Removing a bad seam and replacing with a strip of new material welded into place -- used with large lengths of fusion seams.

3.10.2.6 Other methods

Other methods approved by the ENGINEER.

3.10.2.7 Repair Provisions

In addition, the following provisions shall be satisfied:

Surfaces of the geomembrane which are to be repaired by extrusion welding shall be abraded no more than one hour prior to the repair.

- All surfaces must be clean and dry at the time of the repair.
- All seaming equipment used in repairing procedures must be approved.
- The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the CQA Representative.
- Patches or caps shall extend at least six (6) inches (150 mm) beyond the edge of the defect, and all corners of the patches shall be rounded with a radius of at least three (3) inches (75 mm).
- The geomembrane below large caps should be appropriately cut or removed to avoid water or gas collection between the two sheets.

3.10.3 Labeling

Repaired field defects, patches, reworked seams, repaired fishmouths and other non-standard field seams shall have the following information marked on the liner with a marker suitable for the purpose:

- Initials of Welder
- Date of Weld
- Initials of QC Technician
- Date of QC Test
- Indication of Pass/Fail

3.10.4 Verification of Repairs

Each repair shall be nondestructively tested. Repairs which pass the non-destructive test shall be taken as an indication of an adequate repair. At the discretion of the QA Representative, large repairs may require destructive test sampling. In the case of failed tests, the repair shall be redone and retested until a passing test result is obtained. The CQA Representative shall observe all non-destructive testing of repairs and shall record the identification of each repair, date, technician, and test outcome. The liner may not be covered until defects, patches, etc. have been properly tested, logged, and marked.

3.10.5 Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA Representative shall indicate which wrinkles shall be cut and reseamed by the Geosynthetic Installer. The seam thus produced shall be tested like any other seam. Wrinkle size shall be evaluated during the time of day and under conditions similar to those expected when overlying protective cover/drainage layer material is to be placed. All wrinkles higher than they are wide (across their base) shall be removed by repair methods.

3.10.6 Bridging

The geomembrane shall be continuously supported on the accepted subgrade. Bridging (unsupported geomembrane) is not permissible. Geosynthetic Installer shall take necessary steps to prevent bridging and repair or replace any geomembrane so affected.

3.11 PLACEMENT OF GEOCOMPOSITE DRAINAGE NET AND VEGETATIVE COVER LAYER MATERIALS

3.11.1 Weather Conditions

Placement of the geocomposite drainage net and overlying vegetative cover layer soils on the geomembrane shall not proceed at an ambient temperature below 40°F (5°C) nor above 95°F (35°C) unless otherwise approved by the CQA Representative.

3.11.2 Material Exposure

The geomembrane shall not be left exposed (uncovered) to the elements including UV light, for any period more than thirty (30) days.

3.11.3 Soils

All soils installed in direct contact with the geomembrane shall have a maximum particle size of 3/8 inches.

3.11.4 Equipment

All protective cover/drainage layer materials placed over geomembrane (and other geosynthetics) shall be installed without damaging the geosynthetics. Equipment used for placing soil shall not be driven directly on the geomembrane. A minimum thickness of one (1) foot of soil is required between a light dozer (such as a low ground pressure Caterpillar D-3 or lighter) and the geomembrane. Placement of material overlying the geosynthetics shall be in conformance with the guidelines for equipment ground pressure in

Table 31 05 19.16 - 5 Soil Thickness for Equipment Operating over Geomembrane

Equipment Ground Pressure (psi)	Minimum Soil Thickness (inches)
<4	12
4-6	15
6-8	18
8-11	24

3.11.5 Heavily Trafficked Areas

In heavily trafficked areas such as access ramps, soil cover thickness shall be at least three (3) feet.

3.12 DOCUMENTATION OF CONSTRUCTION

3.12.1 Report

- Upon project completion, the CQA Representative shall prepare a Construction Certification/Documentation Report. This report will document that the work was accomplished according to the Construction Contract Documents, and summarize quality control and quality assurance tests and inspection. If appropriate, supplementary information such as modifications approved by the ENGINEER shall be included to justify deviations from the original contract documents. Justification for all such deviations must be fully documented in the Report. At a minimum, the report shall contain the following information:

- Identification of parties and their roles and responsibilities with signatures of key personnel and an officer of their employer's company.

- Scope of work.

- Summary of the project construction activities.

- Construction Quality Assurance methodology.

- Test and inspection results.

  – Results of prequalification testing (including extrudate);

  – The results of all non-destructive seam tests.

  – Subgrade acceptance forms.

- Construction Quality Assurance certification statement, sealed and signed by a licensed professional ENGINEER.

- Geomembrane record drawings.

- Panel and seam layout record drawing.

- Sample location drawing.

- Sample tags with duplicates.

- Inventory of amount of material used versus amount delivered to the site.

- CQA and CQC records regarding panel deployment, seaming, and repairs.

  – The Geosynthetic Installer shall provide necessary signatures, test results, record drawings, and inspection results as described by aforementioned Part 3.12

- The results of the test and monitoring reports shall be turned over to the ENGINEER for review on a daily basis. Reports shall be complete within 24 hours of the installation of

the panel, seam, repair, etc. Test results and corrections shall be completed prior to placement of cover material.

3.13 LANDFILL GAS CONTROL DURING INSTALLATION

The CONTRACTOR shall be responsible for temporary control and extraction of landfill gas during installation of the geomembrane to avoid formation of "bubbles" underneath the geomembrane.

3.14 SANDBAGS

Liner shall be adequately weighted down with sand bags to limit wind uplift. Unless otherwise noted, sandbags shall remain the property of the Owner upon completion.

3.15 PAYMENT

Payment by the Owner for installation of the membrane shall not be made until testing is completed and the test results reviewed and approved.

3.16 CERTIFICATE

CERTIFICATE OF ACCEPTANCE OF SOIL SUBGRADE BY GEOSYNTHETIC INSTALLER	
INSTRUCTIONS: This part of the certificate should be completed by the CONTRACTOR.	
Contractor	Project
Name:	Location:
Address:	Project:
Location of Soil Subgrade Surface to be Utilized (Include Sketch, if Needed):	
Contractor Authorized Representative:	
Name:	
Title:	
Signature/Date:	
INSTRUCTIONS: This part of the certificate should be completed by the Geomembrane Geosynthetic Installer.	
I the undersigned, duly authorized representative of:	
	(Geomembrane Installation Company)
Do hereby accept the soil subgrade (soil supporting the geomembrane) and shall be responsible for its integrity and suitability, in accordance with the specifications from this date to completion of the installation.	
Geosynthetic Installer Authorized Representative:	
Name:	
Title:	
Signature/Date:	

END OF SECTION 31 05 19.16

SECTION 31 05 19.26

DRAINAGE GEOCOMPOSITE

1.0 GENERAL

1.1 SUMMARY

The work covered in this Section includes the manufacture, fabrication, testing, supply and installation of the drainage geocomposite, which consists of a core geonet layer with geotextile bonded to both sides. The CONTRACTOR shall furnish all labor, materials, transportation, handling, storage, supervision, tools, incidentals and other equipment that may be necessary install and test the drainage geocomposite as specified by the Contract Documents. All testing specified in this section is quality control (QC) testing and is the CONTRACTOR's responsibility unless otherwise noted.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARD TEST METHODS/PRACTICE:

ASTM D 792	Test Methods for Density and Specific Gravity of Plastics by Displacement
ASTM D 1505	Density of Plastics by the Density-Gradient Technique
ASTM D 1603	Carbon Black in Olefin Plastics
ASTM D 4218	Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4354	Practice for Sampling of Geosynthetics and Rolled Erosion Control (RECPs)
ASTM D 4355	Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
ASTM D 4751	Determining the Apparent Opening Size of a Geotextile
ASTM D 4873	Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples
ASTM D 5035	Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)

ASTM D 5199	Measuring Nominal Thickness of Geotextiles and Geomembranes
ASTM D 5261	Measuring Mass per Unit Area of Geotextiles
ASTM D 5321	Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 6241	Standard Test Method for Static Puncture Strengths of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D 6364	Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
ASTM D 7005	Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposite
ASTM D 7179	Standard Test Method for Determining Geonet Breaking Force
ASTM D 7238	Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembranes Using Fluorescent UV Condensation Apparatus

1.3 SUBMITTALS

1.3.1 Product Information

The CONTRACTOR or drainage geocomposite installer shall submit the following product information to the ENGINEER for approval at least 30 days (unless otherwise specified) prior to procurement of the product:

1.3.1.1 Prequalification

Independent laboratory test results demonstrating compliance with the material properties listed in Table 31 05 19.26 - 2; Table 31 05 19.26 - 3; and Table 31 05 19.26 - 4. The independent laboratory tests are to be performed once for each material. In addition, the manufacturer must provide a certificate of compliance which states that the material to be installed will use the same manufacturing techniques, resin type, and formulation as that for which test results are submitted.

1.3.1.2 Roll Layout Drawings

As a minimum, include a roll layout drawing and installation details. The roll layout drawing shall be drawn to scale, and shall be coordinated with the geomembrane panel layout. Installation details shall include cross sections of toe drains, temporary anchorage, key trench and other terminations, and pipe penetrations.

1.3.1.3 Protection from Wind and Weather

Submit plans to protect the drainage geocomposite from wind, dirt, and direct sunlight.

1.3.1.4 Material Data

Complete manufacturer's specifications, descriptive drawings, and literature for the geocomposite, including the product identification and suppliers of the polymer resin and recommended methods

for handling and storage of all materials prior to installation. Describe the manufacturer's methodology to comply with the requirements specified for manufacturing quality control.

1.3.1.5 Manufacturing Quality Control (MQC)

Complete description of the manufacturer's formal quality control/quality assurance programs for manufacturing, fabricating, handling, installing, and testing. The description shall include, but not be limited to, polymer resin supplier and product identification, acceptance testing, production testing, installation inspection, installation techniques, repairs, and acceptance. The document shall include a complete description of methods for both roll end and roll side joining.

1.3.1.6 Installation Instructions

Samples of the drainage geocomposite with a complete set of specifications, and manufacturer's complete written instructions for storage, handling, installation, and joining.

1.3.1.7 Qualifications

Manufacturer's qualifications for the drainage geocomposite, geotextile, and geocomposite.

1.3.1.8 Resin

The name of the resin supplier, the production plant, the brand name, and name of resin used to manufacture the product.

1.3.1.9 Factory Visit

Upon request, arrange with the geocomposite manufacturer to allow the OWNER or representative to visit to the manufacturing plant during the manufacture of material for this project, for the purpose of observing the manufacturing process and quality control procedures. Submit contact names, telephone numbers, addressed, and production schedule information.

1.3.1.10 Compatibility

Suppliers and/or manufacturers shall certify that geonet and geotextile are compatible with one another when bonded into the drainage geocomposite.

1.3.2 Manufacturing Quality Control

The CONTRACTOR shall submit quality control test reports within 48 hours of completion of tests. Submit the following manufacturing quality control information to the ENGINEER prior to material shipment:

1.3.2.1 Production Dates

Submit statement of production dates for the drainage geocomposite.

1.3.2.2 Test Reports

See Part 2 for tests and test frequencies.

1.3.3 Proof of INSTALLER'S Qualifications

The name or names of the field superintendents who will be proposed for the project and a list of completed facilities for which the field superintendent has installed drainage geocomposite totaling a minimum of 2,000,000 ft^2.

2.0 PRODUCTS

2.1 MANUFACTURER'S QUALIFICATIONS

Manufacturer shall have manufactured a minimum of 5,000,000 ft^2 of drainage geocomposite. The manufacturer of the drainage material described hereunder shall have previously demonstrated his ability to produce this geonet by having successfully manufactured similar material for hydraulic conductance installations.

2.1.1 Single Source

All HDPE drainage net (geonet) used for construction of the drainage geocomposite must be obtained from a single material supplier or manufacturer. All nonwoven geotextile fused to the geonet and used for the construction must be obtained from a single material supplier. All fusion of HDPE drainage net to non-woven geotextile must be accomplished by a single material supplier or manufacturer. Suppliers and/or manufacturers shall certify that the geonet and geotextile will be compatible with one another.

2.2 HDPE DRAINAGE NET

The HDPE drainage net component of the drainage geocomposite shall be manufactured by extruding strands of material into a counter-rotating die to form a three dimensional structure to provide planar water flow.

2.2.1 Material Properties

HDPE drainage net shall meet the requirements of Table 31 05 19.26 - 2.

2.2.2 Material Composition

The HDPE drainage net shall consist of new, first-quality products designed and manufactured specifically for the intended purpose designated in this contract, as satisfactorily demonstrated by prior use. The drainage net shall contain stabilizers to prevent ultraviolet light degradation. The HDPE shall be unmodified HDPE containing no plasticizer, fillers, chemical additives, reclaimed polymers, or extenders. Carbon black shall be added to the resin for ultraviolet resistance. The only other allowable compound elements shall be anti-oxidants and heat stabilizers, of which up to one (1) percent total, as required for manufacturing, may be added.

2.2.3 Defects

The net strands shall be so produced as to be free of holes, blisters, undispersed raw materials, or sign of contamination by foreign matter. Defects discovered in the field shall be repaired by cutting out the defect and joining a new piece of net material in its place. The joint shall be placed in accordance with the requirements for field joints.

2.2.4 Labels

Labels on each roll shall identify the thickness, length, width, and manufacturer's mark number. The roll shall also indicate the date, lot and batch number of the roll, the square feet in the roll, and the total roll weight as measured after manufacture.

2.2.5 Joints

Joints shall be made in the field by factory-trained technicians using approved methods. Edges of rolled material shall be trimmed at the factory to remove nonconforming material.

2.2.6 Warranty

The net material shall meet the specification values according to the specification sheet for HDPE geonet. It shall have a warranty of a minimum 20 years relative to materials, and 1 year on installation.

2.3 GEOTEXTILE

2.3.1 General

Geotextile shall be of the type specified on the drawings or an approved equal. Manufacturer shall submit a certificate to the Engineer stating the name of the manufacturer, the chemical composition of the filaments or yarns, and other pertinent information so as to fully describe the geotextiles. At a minimum the other pertinent data shall include Grab Strength, Elongation, Puncture Strength, and Apparent Opening Size.

2.3.2 Material Properties

The geotextile component of the composite geonet shall meet the requirements of Table 31 05 19.26 - 3.

2.4 DRAINAGE GEOCOMPOSITE

The material shall meet the requirements of Table 31 05 19.26 - 4. It is comprised of three layers: a lower geotextile, a middle HDPE drainage net (geonet), and an upper geotextile. The lower and upper geotextiles shall be heat bonded to the middle HDPE drainage net.

2.4.1 Manufacture

The drainage geocomposite shall be fabricated by heat bonding the geotextile to both sides of the HDPE drainage net. Heat bonding shall prevent flattening of filter fabric and surface. Glues and adhesives shall not be permitted to bond materials. No burn through of geotextiles will be permitted. No glue or adhesive shall be permitted. The bond between the geotextile and the HDPE drainage net shall meet the requirements of Table 31 05 19.26 - 4.

2.4.2 Labels

Drainage geocomposite shall be supplied in rolls, marked or tagged with the following information:

- Manufacturer's name
- Product identification

- Lot number
- Roll number
- Roll dimensions

2.4.3 Certification

Contractor shall provide the manufacturer's certificate prior to delivery of the material. The manufacturer shall certify in writing that the material supplied meets the minimum specifications. The certificate shall be signed by a person with authority to bind the manufacturer and shall be notarized.

2.4.4 Roll Dimensions

The HDPE drainage net shall be supplied as a continuous sheet with no factory seams. During installation, the roll length shall be maximized to provide the largest manageable roll for the fewest field seams. Rolls shall be wound on a core which shall be stable enough to support the rolls during handling and shipping.

2.5 MANUFACTURING QUALITY CONTROL TESTING

All of the specified tests are the CONTRACTOR's responsibility. Testing during manufacturing shall be accomplished by the manufacturer's laboratory.

HDPE resin shall be tested at a frequency of one test per resin batch for compliance with Table 31 05 19.26 - 1, HDPE Drainage Net Properties. One batch is defined as one rail car load of resin. The finished rolls of the drainage net shall be identified by a roll number corresponding to the resin batch used. The following minimum test frequencies shall be observed:

Table 31 05 19.26 - 1 HDPE Drainage Net Resin Properties

Properties	Test Method	Test Value	Testing Frequency (minimum)
Minimum Polymer Density, g/cm^3	D 1505 / D 792 Method B	0.950	per batch
Maximum Polymer Melt Index, g/10 max	D 1238, Condition E	1.0	per batch

HDPE drainage net shall be tested during manufacturing for compliance with Table 31 05 19.26 - 2. The minimum test frequencies in Table 31 05 19.26 - 2 shall be observed.

Table 31 05 19.26 - 2 HDPE Drainage Net Properties (before lamination)

Properties	Test Method	Test Value	Testing Frequency (minimum)
Thickness, mils (min. ave.)	D 5199	270	50,000 ft^2
Density[1], g/cc (min. ave.)	D 1505 / D 792 Method B	0.94	20,000 ft^2

[1] Density is of the formulated material; the base resin will be slightly lower.

Properties	Test Method	Test Value	Testing Frequency (minimum)
Carbon Black Content, % (range)	D 1603 / D 4218	2 to 3.5	40,000 ft^2
Tensile Strength[2], lb. (min. ave.)	D 7179	60	50,000 ft^2
Compressive Strength[3], lb/in.^{2} (min. ave.)	D 6364	120	100,000 ft^2

Geotextile shall be tested during manufacturing for the compliance with Table 31 05 19.26 - 3. The minimum test frequencies in Table 31 05 19.26 - 3 shall be observed.

Table 31 05 19.26 - 3 Geotextile Properties (before lamination)

Properties	Test Method	Test Value	Testing Frequency (minimum)
Mass/Unit Area, oz/sy (MARV)	D 5261	8	200,000 ft^2
Grab Strength, lb. (MARV)	D 4632	210	200,000 ft^2
Grab Elongation, % (MARV)	D 4632	50	200,000 ft^2
Tear Stength, lb. (MARV)	D 4533	80	200,000 ft^2
Puncture Strength, lb. (MARV)	D 6241	430	200,000 ft^2
Permittivity, sec^{-1} (MARV)	D 4491	0.2	200,000 ft^2
AOS, mm (MaxARV)	D 4751	0.30	200,000 ft^2
UV Stability, % ret. (500 hr.)	D 4355	70	200,000 ft^2

Drainage geocomposite shall be tested during manufacturing for compliance with Table 31 05 19.26 - 4. The minimum test frequencies in Table 31 05 19.26 - 4 shall be observed:

Table 31 05 19.26 - 4 Geocomposite Properties

Properties	Test Method	Test Value	Testing Frequency (minimum)
Transmissivity[4], m^2/sec (min.-ave.)	D 4716	4.5 x 10^{-4}	200,000 ft^2
Ply Adhesion[5], lb./in. (min. ave.)	D 7005	1	90,000 ft^2

The CONTRACTOR shall inspect every roll for bonding integrity between the HDPE drainage net and the geotextile. All poorly bonded and/or delaminated material shall be rejected.

[2] This is the average peak value for five equally spaced machine direction tests across the roll width.
[3] Test to be conducted using Section 6.3, the movable plate method.
[4] Drainage geocomposite should be tested using flexible boundaries at a hydraulic gradient of 1.0; a pressure of 10,000 lb./ft^2 , and a seating dwell time of 15 min.. Test values are for machine direction only.
[5] This is the average of five equally spaced machine direction tests across the roll width per side of the geocomposite.

2.6 SHOP DRAWINGS SUBMITALS

2.6.1 Material Properties

In order to qualify as an approved drainage material, the Contractor shall submit material samples, minimum specifications and warranty to the Engineer. The specification sheet shall give full details of minimum physical properties and test methods used, joining methods, and a certificate confirming compliance of the material with the minimum specifications. A list of similar projects completed in which the manufactured material has been successfully used shall be submitted to the Engineer.

2.6.2 Physical Requirements

The Contractor shall submit a certification from the manufacturer of the geonet, stating that the geonet meets physical property requirements for the intended application, and that the geonet meets the physical requirements for the manufacture and installation of HDPE landfill drainage media.

2.6.3 Minimum Specifications

At the time of delivery, the manufacturer shall certify in writing that the material supplied meets the minimum specifications. The certificate shall be signed by a person with authority to bind the manufacturer and shall be notarized.

2.6.4 Resin

The manufacturer shall submit results of confirmation testing showing that the material lot of the resin used in the geonet supplied meets the material requirements for the resin. A description of the quality control steps used during manufacture shall also be provided.

2.7 INSTRUCTIONS AND DRAWINGS REQUIRED AFTER CONTRACT AWARD

2.7.1 Storage, Handling, Installation, and Joining

The Contractor shall furnish complete written instructions for the storage, handling, installation, and joining of the net in compliance with this specification and the condition of his warranty.

2.7.2 Repair

The manufacturer shall furnish complete written instructions for the repair of HDPE geonet material.

2.7.3 Layouts

The manufacturer or his designated representative shall furnish layouts and details as required for the net installation. Details of placement around net penetrations such as pipes shall be provided as well. The above details must be approved by the CQA Engineer prior to net installation. Material left outside shall be covered to reduce accumulation of dust in the net and to protect it from ultraviolet light.

3.0 INSTALLATION

3.1 STORAGE

3.1.1 Storage Area

Storage of the rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry, and well drained. The Owner shall approve the storage area.

3.1.2 Stability

Rolls shall be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls shall be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

3.1.3 Protection

Stored materials must be off of the ground and be covered with a plastic sheet or tarpaulin until their installation.

3.1.4 Labels

The integrity and legibility of the labels shall be preserved during storage.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Joining

The CONTRACTOR shall inspect all roll end joints and roll edges. The results of these inspections shall be documented in the daily reports. Field joints shall comply with the requirements of Table 31 05 19.26 - 5.

Table 31 05 19.26 - 5 Drainage Geocomposite Joining Methods

Location	Layer	Joining Method	Minimum Overlap	Tying Frequency
Roll End	Upper Geotextile Geonet Lower Geotextile	Machine Sewing Nylon Ties Overlap	4" 12" 6"	N/A 2' on Center N/A
Roll Side	Upper Geotextile Geonet Lower Geotextile	Machine Sewing Nylon Ties Overlap	4" 4" 6"	N/A 5' on Center N/A
Repair of Minor Damage[6]	Upper Geotextile Geonet	Machine Sewing N/A	4" N/A	N/A N/A

[6] Minor damage is defined in paragraph 123.6.2

3.2.2 Quality Control Reporting Procedures

All information regarding the installation of the drainage geocomposite shall be recorded in the CONTRACTOR's daily report. This information shall include:

- Reference to product submittals, certifications, substitutions and approvals;
- Dates of installation;
- Location and quantity of materials installed;
- Statement whether materials were installed in accordance with the Technical Specifications;
- All product certifications, filed appropriately for future reference; and
- Additional information as required.

3.3 CLEANLINESS

Both drainage geocomposite and the underlying Geomembrane shall be clean, dry, and free of dirt and dust during installation. If dirt, dust, or water is present, the CONTRACTOR shall clean the work area. Drainage geocomposite which is wet, dirty or muddy shall be discarded and shall not be installed.

3.4 ROLL JOINING METHODS

Table 31 05 19.26 - 5 summarizes acceptable roll joining methods.

3.4.1 Lap Seams

The bottom layer of geotextile shall be lap seamed. Lap seaming is accomplished by overlapping adjacent geotextile a minimum of 6 inches.

3.4.2 Nylon Ties

The GDN material shall be overlapped and fastened with nylon ties. Nylon ties shall be yellow or white in color to facilitate inspection.

3.4.3 Machine Sewn Seams

Sewing shall be accomplished with a chain-stitching sewing machine. The thread shall be polymeric thread which complies with geotextile manufacturer's recommendations and is a color which contrasts with the color of the geotextile. The seam shall be placed a minimum of 4 inches from the geotextile edges. The finished seam shall be folded to one side ("J" seam) and be secured with a double row of stitches. There shall be no horizontal seams except at roll ends on slopes greater than 5 (horizontal) to 1 (vertical).

3.4.4 Roll Ends

At roll ends the material shall be overlapped a minimum of 1 foot. Roll ends shall be shingled; the uphill roll end shall be overlapped one foot over the downhill roll end. At roll ends, the drainage net

shall be tied every 2 feet (on centers) at a minimum. The bottom layer of geotextile shall be overlapped a minimum of six (6) inches. The upper layer of geotextile shall be machine sewn.

3.4.5 Adjacent Roll Sides

At roll sides the material shall be overlapped a minimum of 4 inches. The bottom geotextile shall be lap seamed. The HDPE drainage net shall be overlapped and tied a minimum of 5 feet on center. The upper layer of geotextile shall be machine sewn.

3.5 INSTALLATION

The Drainage geocomposite shall be installed in accordance with the manufacturer's recommendations and as specified herein. In case of a conflict between requirements, the more stringent shall apply.

3.5.1 Methods

The installation of the HDPE geonet shall be done with labor and equipment provided by an approved Contractor. The manufacturer shall provide the proper cutting equipment for the installation. Only installation methods approved by the manufacturer and the Engineer in accordance with this specification shall be used.

3.5.2 Instructions

The drainage geocomposite shall be installed in accordance with manufacturer's instructions.

3.5.3 Cleanliness

Drainage geocomposite shall be free of dirt and dust when installed. If dirt or dust is present, the Contractor shall wash the geonet until clean as directed by the QAO.

3.5.4 Grading

Drainage geocomposite shall be unrolled and installed to the lines and grades shown on the Drawings.

3.5.5 Anchoring

Drainage geocomposite shall be anchored at the top of slopes in an anchor trench as shown on the drawings. Care shall be taken not to entrap small stones, from the anchor trench excavation, in the net channels.

3.5.6 Wrinkles

After being secured in the anchor trench, the drainage geocomposite shall be stretched to minimize wrinkle formation.

3.5.7 Orientation

Drainage geocomposite shall be rolled down the slope in such a manner as to continually keep the material in tension. If necessary, the material shall be positioned by hand after unrolling to minimize wrinkles. The material shall not be unrolled horizontally (i.e., across the slope).

3.5.8 Wind

The CONTRACTOR shall provide sufficient ballast and temporary anchorage to protect the material from wind damage or displacement. The CONTRACTOR is responsible for protecting the material from damage due to weather at all times.

3.5.9 Physical Damage

3.5.9.1 Personnel Traffic

Personnel walking on the material shall not engage in activities or wear footwear that could damage the material. Smoking shall not be permitted on or near the geosynthetics.

3.5.9.2 Vehicular Traffic

Vehicular traffic shall not be permitted on the geosynthetics. Equipment shall not damage the material by handling, trafficking, or leakage of hydrocarbons. The surface shall not be used as a work area for preparing patches, storing tools and supplies, or other uses.

3.5.10 Bridging

The material shall be installed to avoid bridging.

3.5.11 Corners

In corners, where overlaps between rolls are staggered, an extra roll shall be installed from the top to the bottom of the slope to provide a smooth, protected surface.

3.5.12 Weather Protection

Drainage geocomposite shall be protected from direct sunlight or precipitation prior to installation. After installation this material shall have minimal exposure to direct sunlight and shall be completely protected from direct sunlight within 30 days of installation. Material which is exposed to direct sunlight for 30 days or more shall be replaced at the CONTRACTOR's expense.

It is the CONTRACTOR's responsibility to provide all labor and materials for protection of the drainage geocomposite during the period of time prior to installation of overlying materials. The CONTRACTOR's protection method is subject to the approval of the ENGINEER.

3.6 REPAIRS

3.6.1 Limitations

Damaged, soiled, or delaminated drainage geocomposite shall be removed and discarded.

3.6.2 Minor Damage

Minor damage is defined as a defect or hole in the material that is smaller than 2 inches in its lesser dimension. Minor damage may be repaired by snipping out any protruding drainage net and machine sewing a geotextile patch over the hole. The patch shall be a minimum of 24 inches larger that the damaged area in all directions.

3.6.3 Major Damage

Major damage is defined as a defect or hole in the material that is 2 inches or larger in its lesser dimension. Major damage shall be repaired by replacing the entire drainage geocomposite panel width. Geotextile fabric shall be continuously sewn on large repairs.

3.7 FIELD DAMAGE

3.7.1 Protection

The Contractor shall take every precaution to protect the net from damage due to natural and field conditions. As the panels are placed, they shall be secured to limit excessive movement.

3.7.2 Wind Damage

Panels moved by the wind shall be inspected and, if damaged, shall be replaced or repaired as required in the judgment of the QAO. Similarly, panels that have developed excessive wrinkles, particularly at the toe of slopes shall be inspected and repaired or replaced as necessary.

3.8 PLACEMENT OF COVER MATERIAL

3.8.1 Protection

Cover material such as soil, stone, or geomembrane liners that is placed over geonets shall be placed in such a manner as to verify that the geonet is not damaged.

3.8.2 Slippage

Care shall be taken to minimize slippage of the geonet and to verify that no tensile stress is induced in the geonet.

3.9 RECORDS AND QUALITY ASSURANCE

3.9.1 Records

The installation of the geocomposite shall be monitored by QAO provided by the Owner. The purpose of the third-party monitoring shall be to document the installation of the geonet. The following records shall be kept by the installer as part of the installation process:

- Panel Placement Checklist
- Repair and Patching Checklist

3.9.2 Documentation of Defects

The geocomposite may not be covered until defects, patched, etc. have been properly logged.

3.9.3 Report Submission

The reports shall be turned over to the QAO for review on a daily basis. Reports shall be complete within 24 hours of the installation of the panel, joint, repair, etc.

3.9.4 Warranty

The manufacturer/installer shall provide a written warranty for materials for a period of no less than 10 years. A written warranty for 1 year shall also be provided for quality of workmanship.

END OF SECTION 31 05 19.26

SECTION 31 10 00

CLEARING, GRUBBING, AND STRIPPING

1.0 GENERAL

1.1 SUMMARY

1.1.1 Scope

The CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required for site clearing work.

1.1.2 Section Includes:

- Removing surface debris.
- Removing designated trees, shrubs, and other plant life.
- Removing abandoned utilities.
- Excavating topsoil.

1.1.3 Work Specified Elsewhere

- Section 31 00 00 Earthwork
- Section 31 23 33 Trenching, Backfilling, and Compacting
- Section 31 25 00 Erosion and Sediment Control

1.2 DEFINITIONS

1.2.1 Clearing

Clearing shall consist of removing vegetation, including trees and brush, and debris that exists within the construction limits.

1.2.2 Grubbing

Grubbing shall consist of removing and disposing of stumps, roots larger than 1 inch in diameter, and matted roots from within the construction limits.

1.2.3 Topsoil

Topsoil shall consist of fertile natural, friable soil obtained or salvaged or manufactured from the surface of the site and which is suitable for support of vegetative growth. Topsoil shall have an organic content of between 1.5 and 10 percent by weight and be free from large stones, roots,

sticks, clay peat, weeds and sod. It shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth.

1.3 QUALITY ASSURANCE

1.3.1

All materials and labor furnished under this section shall comply with ASTM, AA, NEC, ANSI and all other applicable Federal, State and County codes and regulations including revisions to date of contract.

1.3.2

Perform Work in accordance with Virginia Department of Transportation Road and Bridge Specifications (2020) where applicable.

1.3.3

Conform to applicable Virginia code for environmental requirements, disposal of debris, and burning debris on site.

1.3.4

Coordinate Clearing Work with utility companies.

1.4 REQUIREMENTS INCLUDED

Provide personnel, equipment, materials and supplies to clear and grub necessary areas of the project site.

2.0 PRODUCTS

Not used.

3.0 EXECUTION

3.1 EXAMINATION

3.1.1

Verify existing plant life designated to remain is tagged or identified.

3.1.2

Identify waste area for placing removed materials. The waste/salvage area shall be approved by the ENGINEER or OWNER prior to placement of materials.

3.2 PROTECTION

3.2.1

Locate, identify, and protect utilities indicated to remain, from damage.

3.2.2

Protect bench marks, survey control points, wells, probes, and existing structures from damage or displacement.

3.3 REMOVAL

3.3.1

Clearing and grubbing of vegetative cover shall be performed in the required areas only. Required areas include the earthwork areas, stockpiles, and other areas as noted on the Contract Drawings. Vegetation in other areas shall be undisturbed.

3.3.2

Grassy vegetation and topsoil shall be stockpiled for later use by the landfill operator. The stockpile shall be located in a safe area identified by the landfill staff and be adequately protected by temporary seeding and mulching.

3.3.3

Trees and brush shall be taken down and stumps pulled. The wood shall be hauled to a permitted disposal or processing facility. Stumps and roots shall be removed with a root rake or similar equipment in such a manner that maximizes the separation of roots and topsoil or subsoil. Open burning of cleared debris is prohibited.

3.3.4

Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform to the original adjacent surface of the ground.

3.4 DUST CONTROL

The CONTRACTOR shall be responsible for controlling objectionable dust by his operation of vehicles and equipment during all land disturbing activities. The CONTRACTOR shall use methods, subject to the ENGINEER'S approval, that keep dust in the air to a minimum and to the satisfaction of the ENGINEER.

END OF SECTION 31 10 00

SECTION 31 23 33

TRENCHING, BACKFILLING AND COMPACTING

1.0 GENERAL

1.1 DESCRIPTION

The work in this section includes all labor, materials, equipment and incidentals required to perform all trenching-related earthwork including trench excavation, backfilling, compaction, grading, stockpiling, and disposing of earth and waste materials required for the purpose of erosion control, site grading, drainage pipe trenches and bedding, stormwater drainage structures, sediment basins and related structures, landfill gas system and appurtenances as shown on the PLANS, specified herein and General Conditions.

1.1.1 Related Work Specified Elsewhere

- Section 31 00 00 Earthwork
- Section 31 05 16 Aggregates

1.2 REQUIREMENT INCLUDED

Provide personnel, equipment, and materials to excavate and backfill trenches for all underground pipelines and related structures only.

1.3 REFERENCE SPECIFICATIONS

Reference specifications applicable to work under this section are referred to by abbreviation as follows:

1.3.1 American Society for Testing and Materials (ASTM)

- ASTM E11 Wire Cloth Sieves for Testing Purposes
- ASTM C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C131 Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM D75 Sampling Aggregates
- ASTM D698 Laboratory Compaction Characteristics Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

- ASTM D1556 Density and Unit Weight of Soil in Place by the Sand Cone Method
- ASTM D2434 Permeability of Granular Soils (Constant Head)
- ASTM D2487 Classification of Soils for Engineering Purposes
- ASTM D3740 Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- ASTM D5084 Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
- ASTM E329 Standard Practice for Use in Evaluation of Testing and Inspection Agencies as Used in Construction

1.4 GENERAL NOTES

1.4.1 OSHA

The CONTRACTOR shall perform all construction operations in accordance with the U.S. "Occupational Safety and Health Act of 1970," the Standards of the U.S. Department of Labor, Occupational Safety and Health Administration and the latest amendments thereto.

1.4.2 DOLI

The CONTRACTOR shall perform all construction operations in accordance with the "Rules and Regulations Governing the Safety and Health of Employees Engaged in Construction" as adopted by the Safety and Health Codes Commission of the Commonwealth of Virginia and all latest revisions thereto and issued by the Department of Labor and Industry.

1.4.3 Explosives

Use of explosives is not permitted unless authorized in writing by the Engineer. Store and use explosives in accordance with Federal, State and local regulations. The CONTRACTOR shall be responsible for and shall satisfactorily correct all damage resulting from use of explosives.

1.4.4 Existing Structures

Protect structures, roadways, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by trenching operations.

1.4.5 Subsurface Materials

All excavation is unclassified and no additional payment will be allowed regardless of materials encountered.

1.4.6 Owners Operations

The CONTRACTOR recognizes that this construction is adjacent to an existing municipal solid waste landfill. As such, there is the potential for methane gas and other gases to migrate from the landfill and concentrates in confined spaces such as trenches. The CONTRACTOR shall take all appropriate precautions and measures to protect his workforce from the dangers of this environment.

1.5 DEFINITIONS

1.5.1 General Fill Material

Soil materials obtained from on-site and off-site borrow sources having unspecified soil classification suitable for filling, backfilling, and grading within designated locations.

1.5.2 Select Backfill Material

Granular commercial sources having specified characteristics and designated or reserved for use for specified purposes.

1.5.3 Topsoil

A fertile, natural or amended soil, typical of locality, free from large stones, roots, sticks, clay, weeds, and sod, and suitable for use as a growing medium for vegetation.

1.5.4 Maximum Dry Density

Maximum Dry Density: Maximum dry weight in pounds per cubic foot (pcf) of a specific soil material as determined by ASTM D698 (Standard Proctor).

1.5.5 Optimum Moisture Content

The moisture content at which the maximum dry density of a soil material is determined by ASTM D698 (Standard Proctor).

1.6 QUALITY CONTROL

1.6.1 Qualifications

1.6.1.1

Products used in the work of this section shall be produced by those who are regularly engaged in the production and/or supply of similar items for at least five (5) years and which have a history of successful production, acceptable to the Engineer.

1.6.1.2

Use adequate number of skilled workmen who are thoroughly trained and experienced in the specified requirements and the methods needed for proper performance of the work in this Section.

1.7 SUBMITTALS

1.7.1 Compaction Equipment

The CONTRACTOR shall supply data on the compaction equipment to the ENGINEER not less than five (5) days prior to the intended use of this equipment and the equipment shall be approved by the ENGINEER prior to commencing compaction operations. The approval of the ENGINEER shall be construed merely to mean that at the time the ENGINEER knows of no good reason for objecting thereto; and no such approval shall release the CONTRACTOR from his full responsibility for the accurate and complete performance of the Work in accordance with the Contract Documents.

1.7.2 Materials

Refer to individual specification sections for material requirements.

1.7.3 Shop Drawings

Refer to individual specification sections for shop drawings requirements.

1.8 PROJECT CONDITIONS

1.8.1 Existing Structures

Shown on the PLANS are surface and underground structures adjacent to the work. Included, but not limited to, the active landfill area leachate manholes and trunk lines, groundwater monitoring well locations, utilities, and drainage culverts. This information has been obtained from existing records and is shown for the convenience of the CONTRACTOR. The CONTRACTOR shall explore ahead of the work to determine the exact location of all structures. They shall be supported and protected from injury by the CONTRACTOR. If they are broken or injured, they shall be restored immediately by the CONTRACTOR at his expense.

1.8.2 Dust Control

The CONTRACTOR shall conduct all operations and maintain the area of his activities, including sweeping and sprinkling of roadways, so as to minimize the creation and dispersion of dust.

1.8.3 Traffic

Traffic inside the site is anticipated. The CONTRACTOR shall coordinate with the OWNER regarding traffic control during construction. CONTRACTOR shall be responsible to maintain accessibility to the working face of the active landfill and for all landfill operations.

2.0 PRODUCTS

2.1 PIPE BEDDING FILL

Granular backfill shall meet requirements for coarse aggregates, Section 203 Virginia Department of Transportation Specification, Size No. 3.

2.2 SELECT BACKFILL

Clean earth fill shall be approved material free from debris, frozen materials, organic materials, rock or gravel larger than one inch in any dimension, or other harmful matter.

2.3 GENERAL FILL

2.3.1 Quality

General Fill shall be free of stone, rock or gravel larger than three (3) inches in any dimension, debris, waste, frozen materials, vegetation, organic materials, roots, and other deleterious matter. The satisfactory excavated soil material shall be capable of maintaining its stability on proposed slopes. Excess or unsatisfactory material shall be removed, disposed, and stabilized as approved by the ENGINEER to the designated areas on-site.

2.3.2 Placement

General Fill shall be used for backfilling and filling as shown on the PLANS, including 12-inch thick intermediate cover over waste in landfill top areas were waste excavation is required to obtain drainage channel slopes, and for other areas as directed by the ENGINEER.

2.4 OTHER MATERIALS

All other materials, not specifically described, but required for proper completion of the work shall be selected by the CONTRACTOR and approved by the ENGINEER.

3.0 EXECUTION

3.1 EXAMINATION

Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected and approved by the ENGINEER.

3.2 UTILITIES

Locate existing utilities, culverts, and structures above or below ground before any excavation starts. Coordinate work with Miss Utility and individual utility companies. Protect, maintain service, and prevent damage to utilities not designated to be removed. When utilities are encountered and are

not shown on the Contract Drawings, or when locations differ from those shown on the Contract Drawings, notify ENGINEER for instructions before proceeding.

3.3 HIGHWAY RIGHTS-OF-WAY

Work within existing or proposed Virginia State Rights-of-Way shall meet requirements of the Virginia Department of Transportation.

3.4 PREPARATION

Remove water to prevent softening of foundation bottom, and soil changes detrimental to stability of subgrades and foundations. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structure as a result of inadequate dewatering or other construction methods shall be removed, replaced, and compacted to a density equal to or greater than the requirements for the subsequent fill material at the CONTRACTOR's expense.

3.5 UNAUTHORIZED EXCAVATION

Where unauthorized excavations have been carried beyond points required, restore these areas to the elevations and dimensions shown on the plans with clean earth fill. Work shall be performed at no additional cost to the OWNER.

3.6 UNSATISFACTORY MATERIAL

Where removal of unsatisfactory material is due to fault or negligence of the CONTRACTOR, by inadequate shoring or bracing, dewatering, material storage or other failure to meet specified requirements, work shall be performed at no additional cost to the OWNER.

3.7 TRENCH EXCAVATION

3.7.1

Excavate to the dimensions and elevations shown on the plans.

Open trenches only so far in advance of pipe laying as permitted by ENGINEER. In no case shall more than 200 feet of trench be opened at one time. Trenches shall be backfilled at the end of each working day except where otherwise permitted.

3.7.2

Unless otherwise depicted on the plans, the width of the trench at and below the top of the pipe shall not exceed the outside diameter of the pipe plus 18 inches except that for pipe 12 inches or less in diameter, the trench width shall not exceed 33 inches. Where this width is exceeded, CONTRACTOR shall provide for increased pipe loading as directed by the ENGINEER. The minimum clear width of the trench, sheeted or unsheeted measured at the springline of the pipe should be one foot greater than the outside diameter of the pipe.

3.7.3

The trench walls above the top of the pipe may be sloped or the trench, above the top of the pipe, may be widened as necessary for bracing, sheeting and shoring. All trenching, bracing, shoring, and sheeting shall be performed in accordance with OSHA requirements.

3.7.4

Excavate trenches for gravity lines to elevations shown on Contract Drawings. Excavate trenches for pressure lines to elevations shown on Contract Drawings or to depths specified in other sections of this Division.

3.7.5

The bottom of the trench for gravity lines shall be as specified herein under "Pipe Bedding."

3.7.6

The bottom of the trench for pressure lines shall be shaped to fit the bottom of the pipe as specified herein under "Pipe Bedding."

- Excavate for bell holes at each joint.
- Where rock is encountered, excavate a minimum of 6 inches below the bottom of the pipe for bedding.

3.7.7

Dewater excavation as necessary to provide proper protection. If deemed necessary, the ENGINEER may require continuous dewatering 24 hours per day by adequate pumping or well-points until backfilling is completed. The method and equipment used for dewatering shall be subject to the approval of the ENGINEER.

3.7.8

Where unsuitable soil is encountered, excavate to depth determined by ENGINEER and replace with select backfill thoroughly and uniformly compacted. Material such as clay mass, frozen materials, cinders, ashes, refuse, and vegetable or organic material shall be construed as unsuitable material for backfill.

3.7.9

Where underground streams or springs are found, provide temporary drainage and notify ENGINEER.

3.7.10

Continuously remove from the project site and dispose of material unsatisfactory for backfill and all excess material with the progress of the Work.

3.7.11

Remove shoring and all form materials unless ordered to remain.

3.7.12

Where rock is encountered so that a manhole, vault, or other structure will bear on rock, it shall be used to support the foundation. Where only a part of the foundation will be on rock, at least 8 inches of compacted granular material shall be provided below bottom of footings.

3.7.13

Blasting for the excavation of trenches shall require prior written approval by the ENGINEER.

3.7.14

Provide a minimum of 8 inches between rock excavation and sides of structures.

3.8 SHEETING

3.8.1

Maintain trench walls in a safe condition at all times. Provide sheeting, shoring, and bracing as necessary to prevent cave-in of excavation or damage to existing structures on or adjoining the site.

3.8.2

Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

3.8.3

All costs of providing sheeting and shoring shall be borne by the CONTRACTOR.

3.8.4

Maintain sheeting, shoring and bracing in excavations regardless of time period excavation will be open. Carry down sheeting, shoring, and bracing as excavation progresses in accordance with the proper authority.

3.8.5

Sheeting, shoring and bracing left in-place shall be cut off to a depth of not less than 18 -inches below grade.

3.9 PIPE BEDDING

3.9.1

Bed all pipe in accordance with bedding details as shown on the Permit Drawings.

3.9.2

Except where otherwise shown on the Contract Drawings, all gravity lines using rigid pipe such as concrete, etc. shall be Class C bedding as a minimum.

3.9.3

Except where otherwise shown on the Contract Drawings, all gravity lines using flexible pipe such as HDPE, etc. shall be Class B-1 bedding as a minimum.

3.9.4

Compact pipe bedding by tamping or rodding to prevent settlement. Pipe bedding shall be an approved granular material compacted to a minimum 95% of theoretical maximum density as determined by ASTM D698. The bedding shall have a minimum thickness of six inches under the barrel and shall extend to four inches over the crown of the pipe.

3.9.5

Fine aggregate bedding shall meet requirements for fine aggregates, VDOT Road and Bridge Specifications, latest edition.

3.9.6

Coarse aggregate bedding shall meet requirements for coarse aggregates, VDOT Road and Bridge Specifications, latest edition.

3.10 TRENCHING BACKFILL

3.10.1

Trenches shall be backfilled immediately after the pipes and appurtenances are laid therein. Backfill trench to a compacted depth of 1 foot over the pipe with select backfill in accordance with the details shown on the Contract Drawings. Backfill shall be placed by hand, uniformly on each side of the pipe and compacted in layers not exceeding 6 inches in compacted thickness. Do not backfill on muddy or frozen soil, or with muddy or frozen soil.

3.10.2

Backfill trench from 1 foot above the pipe to grade with clean earth fill free of stones not larger than 5 inches or 1/2 the layer thickness, whichever is smaller. Layers shall not exceed 12 inches in compacted thickness, except that under road shoulders and under existing or future paved areas, layers shall not exceed 6 inches in compacted thickness. Backfill shall be compacted to the density

specified for the areas in which it is located except that minimum compaction in any area shall be to the density of the adjacent soil.

3.10.3

For excavation depressions caused by removal of stumps or other clearing operations to firm subgrade, fill with clean earth fill and compact as specified.

3.10.4

Place backfill materials evenly adjacent to structures. Take care to prevent wedging action of the backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.

3.10.5

Compact soil materials using equipment suitable for materials to be compacted in the specific work areas locations. Use power-driver hand tampers for compacting materials adjacent to structures.

3.10.6

Compact aggregate fill placed around manholes or other structures to required density.

3.10.7

For horizontal landfill gas trenches, backfill trench to within 12 inches of surface with stone. Backfill by machine.

3.10.8

Trenches for pressure lines shall include inert polyethylene locating tape having a metallic foil core. Tape shall be placed above the centerline of pipes at a depth not exceeding two feet below ground surface.

3.11 TRENCHING COMPACTION

Percentage of maximum density requirements.

- Compact each layer of fill or backfill no less than the following percentages of the maximum density at optimum moisture ± 3% content as determined by Standard Proctor ASTM D698 (AASHTO T99).
    - 95% beneath and within 25 feet of buildings and structures, including those shown for future construction.
    - 95% beneath pavements, walks, and road shoulders, including those shown for future construction.
    - 90% in all other unpaved areas unless otherwise indicated on the Contract Drawings.

3.12 GRADING

3.12.1

Uniformly grade all areas within the limits designated on the Contract Drawings, including adjacent transition areas. Finish surfaces within specified tolerances with uniform levels of slopes between points where elevations are shown and existing grades.

3.12.2

Finish all surfaces free from irregular changes. Lumber, earth clods, or rocks larger than four inches and other undesirable materials shall be removed from the site at the completion of construction.

3.12.3

Finish subgrade areas to receive topsoil to within 0.20 foot of required subgrade elevations.

3.12.4

All utility lines not in streets, shall be mulched with hay or straw and seeded within 15 days after backfill.

3.12.5

Any disturbed area not paved, sodded or built upon between within 14 days shall receive temporary seeding.

3.12.6

Protect graded areas from the action of the elements. Settlement or other damage that occurs prior to acceptance of the work shall be repaired and grades satisfactorily reestablished.

3.12.7

Repair after cleanup. Upon completion of construction work and after spoils and debris have been removed, regrade any areas disturbed by operations.

3.12.8

The CONTRACTOR shall return all gates, fences, culverts, lawn areas, paved areas, etc. to the same condition existing prior to construction. Any culverts damaged during construction shall be replaced with new culverts at no cost to the OWNER.

END OF SECTION 31 23 33

SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Scope

The Contractor shall provide sediment and erosion control devices to contain surface drainage from within the construction site, borrow, waste and storage areas where deemed necessary by the ENGINEER.

1.1.2 General Description

This work shall consist of the application of measures throughout out the life of the project to control erosion and to minimize the siltation of rivers, streams and impoundments (lakes reservoirs, etc.). The measures shall include, but not be limited to, the use of berms, dikes, dams sediment basins, sediment traps, filters, silt fence, fiber mats, netting, gravel or crushed stone, mulch, grasses, slope drains and other methods approved by the City of Bristol. Erosion and siltation control measures as described herein shall be applied to erodible material exposed by any activity on the project.

1.1.3 Related Work Specified Elsewhere

- Section 31 00 00 Earthwork
- Section 31 23 33 Trenching, Backfilling, and Compacting
- Section 31 05 16 Aggregates

1.2 REQUIREMENTS INCLUDED

1.2.1

Contractor shall provide personnel, equipment, materials, and supplies to reduce erosion and control sediment during the Project.

1.2.2

Contractor shall comply with local and state erosion control regulations, and comply (at a minimum) with erosion and sediment controls as set forth on the Drawings.

1.2.3

Contractor is solely responsible for control of erosion on site and is responsible for taking measures to reduce and control erosion. Measures may be necessary above and beyond those shown on the Drawings, and Contractor shall implement any additional measures that it deems necessary or as required by the City of Bristol Erosion Control inspection personnel.

1.2.4

Additional compensation will not be paid for measures installed in conjunction with the development and operations of borrow areas. Costs for these efforts are already included in the Contract Price.

1.2.5

Contractor is the Responsible Land Disturber for the project and required to obtain a Land Disturbance Permit from the local authority.

1.2.6

Contractor shall clean out all stormwater and erosion and sediment control BMPs prior to final acceptance and payment by the Owner that are to remain in place after closure or until final stabilization achieved.

1.3 RELATED REQUIREMENTS

- Virginia Erosion and Sediment Control Handbook, latest edition.
- Erosion and Sediment Control Regulations, 9-VAC 25-840.

1.4 PERMITS

1.4.1 Land Disturbance Permit

The Contractor shall be responsible for obtaining a Land Disturbance Permit and payment of the associated erosion and sediment control bond. Copies of all permits or approvals shall be provided to the ENGINEER prior to starting any work covered by the permits or approvals.

1.4.2 Off-Site Work

The Contractor shall be responsible for obtaining all necessary permits and approvals from the appropriate governmental agencies, including those located outside of the locality, for any off-site work as applicable for waste or spoil areas and borrow pits. Copies of all permits or approvals shall be provided to the ENGINEER prior to starting any work covered by the permits or approvals.

1.4.3 Conflicts

In the event of conflict between these requirements and pollution control laws, rules or regulations of other Federal, State or Local agencies, the more restrictive laws, rules or regulations shall apply.

1.4.4 Inspection of Off-Site Area

The ENGINEER shall have the right to inspect erosion control measures in off-site borrow pits and waste areas and to report violations of permit requirements to relevant agencies.

1.5 PROVISIONS

1.5.1 Contractor Compliance

In the event that erosion and pollution control measures are required due to the Contractor's negligence, carelessness or failure to install permanent control as part of the scheduled Work, the ENGINEER may order that Work to be performed by the Contractor at his own expense.

1.5.2 Work Suspension

The Contractor shall comply with the requirements specified herein and as shown on the Plans. Any violation of these requirements may result in the issuance of a written Notice of Suspension of the Work. The suspension of Work will not be lifted until the Contractor has completely corrected the violation. Time extensions requested as a result of delays occasioned by such suspensions will not be considered.

1.5.3 Revisions

Should conditions arise in the field that render the Erosion and Sediment Control Plans inadequate or inappropriate for Work included in the Contract, the Contractor shall immediately notify the ENGINEER and the OWNER. Where necessary, additional plans or modifications will be furnished by the OWNER and will become a condition of the SEDIMENT CONTROL PERMIT and the CONTRACT.

1.6 SUBMITTALS

1.6.1 Prequalification

Submit the material source, descriptions, and material specifications certified by the supplier to the Engineer for approval.

1.6.2 Certificate of Compliance

The CONTRACTOR shall submit to the ENGINEER for approval at least 14 days before procurement a Certificate of Compliance that the supplied materials meet the specifications herein.

2.0 PRODUCTS

2.1 GENERAL

All products used for erosion and sediment control will be as specified by the Virginia Erosion and Sediment Control Handbook unless otherwise listed herein.

2.2 EROSION CONTROL BLANKET AND MATTING

Erosion Control Blanket, Treatment 1 (equivalent to VDOT EC-2) or Treatment 2 (equivalent to VDOT EC-3), shall be in accordance with the Virginia Erosion and Sediment Control Handbook, latest edition. Treatment 1 shall be North American Green C125 or approved equal. Treatment 2 shall be North American Green S150 or approved equal.

3.0 EXECUTION

3.1 GENERAL

3.1.1

All activities shall be performed in accordance with the approved erosion control plan and stormwater pollution prevention plan.

3.1.2

Prior to significant disturbance of the Site, perimeter erosion control shall be established in order to reduce uncontrolled drainage from leaving the limits of construction or from reaching State waters. Sediment barriers shall be constructed as soon as possible.

3.2 INSTALLATION

Contractor shall be responsible for the following activities:

- All measures necessary to provide a continuous siltation barrier shall be down slope from construction activities as indicated on the Drawings or as necessary to reduce sediment runoff. Barriers shall be placed around stockpiled material subject to erosion.
- All other measures as indicated in the approved Erosion and Sediment Control Plan or as otherwise required.
- All measures shall be installed as per the manufacturer's directions and the Virginia Erosion and Sediment Control Handbook.

3.3 WORK SITE

The Engineer will limit the area of excavation and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make coordination unrealistic, erosion control measures shall be taken immediately. All construction shall be confined to the minimum area necessary to accommodate the Contractor, equipment and work force engaged in his work.

4.0 INSPECTION AND MAINTENANCE

4.1 GENERAL

Erosion and sediment control measures shall be inspected and maintained in accordance with the approved erosion control plan. At a minimum, erosion and sediment control measures will be checked weekly by the Contractor and after each significant rainfall.

4.2 REPAIRS AND MAINTENANCE

Upon finding that any measure requires repair or maintenance, Contractor shall repair or maintain the measure at no additional cost to Owner in accordance with the approved erosion control plan and the Virginia Erosion and Sediment Control Handbook. All erosion and sediment control devices that are disturbed during the construction operations shall be fully repaired by the end of the day on which they are disturbed. All erosion and sediment control devices shall be maintained when the project is closed down.

4.3 DUST CONTROL

It shall be the sole responsibility of Contractor to adequately control dust that is created as a result of construction on the project.

END OF SECTION 31 25 00

SECTION 32 15 40

CRUSHED STONE SURFACING

1.0 GENERAL

1.1 REQUIREMENTS

Provide personnel, equipment, and materials to construct and surface access roads as shown on the Drawings and in accordance with these specifications.

1.2 RELATED REQUIREMENTS

- Section 31 00 00 Earthwork

2.0 PRODUCTS

The wearing course shall consist of durable gravel, crushed gravel, crushed stone, or crushed slag, meeting Virginia Department of Transportation Standard Specifications, latest revision. The aggregate shall be VDOT No. 21A or approved alternative for the aggregate wearingcourse.

A geotextile shall be installed prior to placement of the wearing course.

3.0 EXECUTION

Upon completion of construction work and after spoils and debris have been removed, regrade any areas disturbed by the operations. If ruts are created in the wearing course due to construction traffic, they shall be filled with additional material, rather than blading adjacent material into the rut.

3.1 GRAVEL HAUL ROADS

After the subgrade has been properly prepared in accordance with these specifications, the aggregate shall be placed, shaped, and compacted. The grade and alignment shall be controlled during placement. Necessary shaping shall be performed prior to final compaction to ensure a rut- and bump-free surface and adequate drainage slopes. Depths of the aggregate shall be as shown on the Drawings.

For roads on the landfill, the soil shall consist of erosion control/protective cover material compacted to the requirements for that layer. For other roads, the soil shall be general fill material compacted to the requirements of that soil type.

Any deficiency of the total thickness of the wearing course in excess of one-half (1/2) inch shall be corrected. If consistent deficiencies occur, regardless of thickness, the entire deficient section of roadway will be corrected.

Aggregate shall be rolled with one pass immediately with a self-propelled steel wheel roller. The roller weight shall be between 6 and 8 tons for tandem type and between 8 and 10 tons for the three-wheel type.

END OF SECTION 32 15 40

SECTION 32 92 19

SEEDING

1.0 GENERAL

1.1 REQUIREMENT INCLUDED

1.1.1

Provide personnel, equipment, and materials to completely furnish, install, maintain, and guarantee seeding and seeding items shown on the drawings and specified in the specifications. Place mulch as specified. Place fertilizer and lime as required by soil testing. Apply organic soil amendments if required by soil testing.

1.2 RELATED REQUIREMENTS

1.2.1

Section 31 25 00	Erosion and Sediment Control
Section 31 05 13	Erosion Control and Vegetative Support Soil Layers

1.3 GUARANTEE

1.3.1

The Contractor shall be responsible for seeding as specified up to the final acceptance. Dependent upon the season, the Contractor may have to provide a temporary winter or summer cover crop that will eventually be incorporated into the soil prior to seeding in the appropriate spring and fall seasons.

1.3.2

Areas that fail to develop a successful stand following seeding will be reseeded at the Contractor's expense. The Contractor shall establish a permanent vegetative cover with a 90% uniform stand of specified grasses in seeded areas. Bare areas shall be reseeded every 21 days. Eroded areas shall be repaired prior to reseeding. Once grass has been successfully established, the Contractor shall maintain the area for 90 days.

1.4 SUBMITTALS

1.4.1

Submit three (3) hard copies or one (1) electronic copy of the following manufacturer's certificates of conformance for review and approval approximately 1 month before placement.

- Seed
- Fertilizer

1.4.2

The Contractor shall test soil to be used on the project to determine the proper application of lime and fertilizer. Representative samples shall be taken for existing soil and separate samples for each separate source of new soil to be brought into the job site.

1.4.3

A soil sample analysis report shall be submitted to the CQA Engineer prior to seeding operations. Lime, fertilizer requirements, phosphorus, potassium, calcium, magnesium and pH levels shall be tested for each sample and amendment recommendations provided in the soil analysis report. Contractor will apply organic soil amendments if necessary to establish vegetation.

1.4.4 Plant and Material Certifications

Seed vendor's certified statement for each seed mixture required, stating botanical and common name, percentages by weight, and percentages of purity, germination, and weed seed for each grass seed species.

1.4.5 Planting Schedule

CONTRACTOR to submit a proposed planting schedule, indicating dates for each type of landscape work and based on normal seasons for such work as outlined in this document. Correlate dates with specified maintenance periods to provide maintenance from date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

1.5 QUALITY ASSURANCE

1.5.1 Subcontractor

Subcontract landscape work to a single firm specializing in landscape work. Contracting firm to employ experienced personnel familiar with required work. Provide adequate supervision by qualified foreman.

1.5.2 Analysis and Standards

Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the State of Maryland, wherever applicable.

1.5.3 Inspection

Seed will be inspected upon arrival at the job site by the ENGINEER for conformity to type and quality in accordance with specifications. Other materials will be inspected for meeting specified requirements and unacceptable materials shall be removed from the job site. As applicable before seeding, ENGINEER reserves the right to inspect seed, amendments, topsoil, and application equipment either at the place of origin or at the site for compliance with requirements.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Packaged Materials

Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

1.6.2 Storage

All materials shall be stored in areas designated by the OWNER. Seed, lime and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment materials shall not be stored with other landscape materials.

1.6.3 Handling Materials

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles. Areas for off-loading bulk materials shall be designated by the CONTRACTOR and approved prior to delivery by the OWNER.

2.0 PRODUCTS

2.1 TEMPORARY SEEDING MIXTURE

Temporary seed mixture shall be in accordance with the latest edition of the Virginia Erosion and Sediment Control Handbook. The actual seed used will vary with the seasons, but shall be certified to be high in percent germination and a variety adapted to Virginia shall be used.

2.2 PERMANENT SEEDING MIXTURE

2.2.1

Permanent seed mixture shall be in accordance with the latest edition of the Virginia Erosion and Sediment Control Handbook. Use the “low-maintenance slope” seeding mixture for Appalachian/Mountain areas, which consist of the following:

- Kentucky 31 Tall fescue 108 lb/acre
- Red Top Grass 2 lb /acre
- Seasonal Nurse Crop 20 lb/acre

- Crownvetch1 20 lb/acre

Seeds shall be certified high in percent germination and a variety adapted to Virginia shall be used. Seed shall be of the latest season's crop with a minimum of 80% germination rate. Mix Seed on site or in the presence of the QAO. Weed seeds and inert matter shall not exceed 1.0% (one percent) of total seed content.

2.2.2

The Owner reserves the right to revise the seed mixture.

2.2.3

Seasonal nurse crop shall be in accordance with the following:

- March, April through May 15th Annual Rye
- May 16th though August 15th Foxtail Millet
- August 16th through September, October Annual Rye
- November through February Winter Rye

2.2.4

Seeds shall be certified high in percent germination and a variety adapted to Virginia shall be used. Seed shall be of the latest season's crop with a minimum of 80% germination rate. Mix Seed on site or in the presence of the QAO. Weed seeds and inert matter shall not exceed 0.25% (one fourth of one percent) of total seed content. Seed should be free of noxious weeds.

2.3 MULCH

2.3.1

Mulch shall be free of noxious weeds, molds, or other deleterious material. Mulch/straw should be cured and mulched from the stalks of oats, wheat, barley, or rice. Furnish in air-dry condition. Do not use rye straw. Other materials may be used with prior written approval by the Engineer. Mulch shall be well seasoned before bailing, free from mature seed-bearing stalks or roots of prohibited or noxious weeds.

2.3.2

Apply mulch at a rate of 2 tons per acre (approximately 89 45-pound bales per acre). Mulch weight shall be dry weight. Fiber mulch applied during hydroseeding operations shall not be considered as part of the 2 tons per acre.

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1 All legume seed must be properly inoculated. If Flatpea is used, increase to 30 lbs/acre. If Weeping Lovegrass is used, include in any slope or low maintenance mixture during warmer seeding periods, increase to 30 -40 lbs/acre.

2.3.3

Mulch, fertilizers, lime and inoculating bacteria shall comply with the Virginia Department of Transportation, Road and Bridge Specifications, Section 244.

2.4 FERTILIZER

2.4.1

Fertilizer shall be granular, commercial grade, dry, free flowing, uniform in composition, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.

2.4.2

Fertilizer shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Fertilizer that becomes caked or otherwise damaged, making it unsuitable for use, will not be accepted. No cyanamide or hydrated lime shall be permitted in mixed fertilizer.

2.4.3

The Contractor shall perform soil tests to determine the quantity and analysis of fertilizer required.

2.5 LIMESTONE

2.5.1

Ground limestone shall contain not less than 85% of total carbonates and shall be pelletized agricultural grade. Calcareous limestone shall contain at least 50% magnesium oxide and dolomitic limestone shall contain at least 40% magnesium oxide. Burned or slaked limestone is not permitted.

2.5.2

The Contractor shall perform soil tests to determine the quantity of lime required.

2.6 WATER

The Contractor shall be responsible for furnishing potable water free from substances harmful to seed growth. Contractor shall furnish related equipment such as hoses, sprinklers, tanks, or other methods of transportation.

3.0 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

3.1.1 Fertilizer and Lime

Deliver materials to the site in the original, unopened containers showing the weight, chemical analysis, and manufacturer's name. In lieu of containers, bulk fertilizer and lime can be used only if appropriate certificates accompany each delivery.

3.1.2 Seed

Deliver seed to the site in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures, purity, germination, weed content, and inert material. Wet, moldy, outdated, or otherwise damaged seed will be rejected.

3.1.3 Storage and Handling

Store lime, fertilizer, and seed in dry locations away from contaminants. Protect seed from drying out. When handling materials, do not drop or dump from vehicles.

3.2 TEMPORARY SEEDED AREAS

3.2.1

Areas designated on the plans as requiring temporary seeding and areas of the site not to be constructed within 14 consecutive calendar days of final grading shall be seeded as soon as possible after the disturbance in the area is completed. The temporary seeding shall be in accordance with the Virginia Erosion and Sediment Control Handbook.

3.2.2

Prior to seeding, the surface of the area to be seeded shall be prepared by removing depressions and ruts. Care shall be taken to avoid compaction of the surface. The area shall be prepared by breaking up the surface of the soil.

3.2.3

Areas that that fail to establish vegetative cover adequate to limit rill erosion will be reseeded as soon as such areas are identified.

3.3 PERMANENT SEEDED AREAS

3.3.1

Permanent seeding shall be accomplished on final grades, on cut and fill slopes, on access roads, surface water diversion ditches, rough-graded areas that will not be brought to final grade for a year

or more and other areas as required. The required seed mixture shall be applied as soon as possible after the area is brought to final grade as per the plans. No seeding shall occur between December 6th and February 1st unless so approved by the Owner.

3.3.2

The area to be seeded shall be prepared by removing large ruts or surface depressions and by breaking up the surface of the soil. The soil shall be tested and lime, fertilizer, and, if necessary, inoculate bacteria and organic soil amendments shall be incorporated into the vegetative support layer.

3.3.3

Areas that fail to establish vegetative cover adequate to limit rill erosion will be reseeded as soon as such areas are identified.

3.4 APPLICATION OF MATERIAL

3.4.1

In general, materials shall be applied by hand or with specialized equipment. If hydroseeding is used, mixing shall be done at the job site and care shall be exercised to avoid damaging the seeds during mixing or application.

3.4.2

Notify QAO at least seven working days prior to start of seeding operations.

3.4.3 Preparation

After areas required to be seeded have been brought to the required grade, thoroughly till to a minimum depth of 2 inches by scarifying, disking, harrowing, or other approved method. Remove debris and stones larger than one inch remaining on the surface after tilling. Tilling will be necessary prior to seeding as well as when the summer or winter species must be eradicated. Limit preparation to areas that will be immediately seeded.

3.4.4 Vegetative Support Layer

Areas shall have vegetative support layer soil uniformly distributed and evenly spread to a thickness of not less than six (6) inches.

3.4.5 Lime

Apply the rate and amount of lime necessary to maintain the areas at a pH level of 6 to 6.8. Soil analysis report of existing conditions and pH level will designate the amount of lime necessary to bring the soil to the acceptable levels.

3.4.6 Fine Grade

Fine grade seed areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag areas, remove ridges and fill depressions, as required to meet finish grades. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting seed. Do not create a muddy soil condition.

3.4.7 Fertilizer

Apply fertilizer at a uniform rate as determined by soil testing. Incorporate fertilizer and lime into the soil to a depth of at least 4 inches; this may be done as part of the subgrade tillage operation.

3.4.8 Installation

Seed immediately after preparation of bed. Seed areas disturbed as a result of construction activities. Mix seed on-site or in the presence of the QAO. Sow seed with approved sowing equipment. Cover seed by means of harrow, cultipacker, or other approved device. Perform seeding operations when the soil is dry and when winds do not exceed 5 miles per hour velocity.

3.4.9 Rolling

Immediately after seeding, firm entire area with a roller.

3.4.10 Mulch

Immediately mulch newly seeded areas. Chopped straw shall be evenly applied so as to provide a loose depth of not more than one half (1/2) inch with 75% coverage.

3.4.11 Tack Coat

Immediately following mulching, straw shall be secured in place by an EPA registered tackafier at a uniform applied rate as specified on the label. In lieu of tackafier, crimp straw into soil by mechanical means.

3.4.12 Precautions

Protect existing utilities, structures, pavements, plantings or trees from damage caused by seeding operations. Contractor will be held responsible for damages. Extreme caution must be given when tilling, liming, and fertilizing in the dripline of existing trees. Restrict traffic from seeded areas until grass is established.

3.4.13 Cleaning

Perform cleaning during installation of the work and upon completion of the work. Remove from site excess materials, debris, and equipment.

4.0 MAINTENANCE

4.1.1

Begin maintenance immediately after seeding.

4.1.2

Maintenance shall include, but not be limited to proper watering, refilling of rainwashed gullies and rutted areas, refertilizing, mowing, liming, disease and insect pest control, aerating, protective spraying, and other procedures consistent with good horticultural practice necessary to establish normal, vigorous, healthy lawns.

4.1.3

Ample soil moisture must be maintained during this period. A thorough watering to a minimum depth of 4 inches once every 3-5 days, depending upon soil type and drainage shall be accomplished to maintain ample soil moisture during the growing season.

4.1.4

The Contractor shall maintain seeded areas until final acceptance of the project and shall restore or replace the seeding work that is found defective or that becomes damaged prior to final acceptance. If winter or summer crops are planted, they must be maintained until spring or fall seeding schedules can be met. The Contractor will be responsible for planting, maintaining the temporary cover, eradicating the temporary cover crop by tilling and grading prior to spring or fall seeding seasons, and replanting the project based on the spring or fall planting selections, whichever comes first. The Contractor shall perform supplemental seeding when less than a 90% uniform stand of permanent grass is obtained. Restoration or replacement work shall include the re-establishment of the grade or profile of the area, replacement of topsoil, refertilization, reseeding or remulching as directed by the Engineer. Maintenance must be performed by the Contractor until the final acceptance of the spring or fall season grass is accomplished. There is no time limit in force.

END OF SECTION 32 92 19

SECTION 33 23 10

HORIZONTAL COLLECTOR WELLHEADS

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Scope of Work:

The CONTRACTOR shall provide all equipment and labor needed to connect horizontal collector wellheads as specified herein and as indicated on the Drawings.

1.1.2 Qualification

All work shall be performed by qualified workers in accordance with the best standards and practices available.

1.1.3 Leachate

The CONTRACTOR shall make provisions for containment of discharged leachate if emitting from borehole.

1.1.4 Housekeeping

The CONTRACTOR shall keep the premises free from accumulation of waste materials or rubbish caused by his operations. Upon completion of each day's work, he shall dispose of all drill tailings at the designated area for waste relocation at the landfill, as well as secure all his tools, construction equipment, machinery and surplus materials from the site.

1.1.5 Odors

CONTRACTOR shall make every attempt to minimize odors from the wells during construction, by covering borehole between active operations, and as soon as well is completed, by covering or removing any drill tailings and temporarily capping the well riser pipe.

1.1.6 Related Work Described Elsewhere

Section 33 51 10: LFG Pipe and Pipe Fittings

1.2 SUBMITTALS

1.2.1 Materials

The CONTRACTOR shall prepare and submit to the ENGINEER for review and approval catalog cuts on materials furnished, and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of wellhead assemblies and other appurtenances furnished.

1.2.2 Samples

The CONTRACTOR shall submit to the ENGINEER for review and approval samples of all backfill materials and the name of the vendor(s) and source of materials furnished.

1.2.3 Shop Drawings

The CONTRACTOR shall prepare and submit to the ENGINEER for review and approval Shop Drawings showing dimensions, materials, and configuration of the wellhead assembly.

2.0 PRODUCTS

2.1 MATERIALS

2.1.1 Rigid and Flexible PVC Pipe

Rigid and flexible PVC pipe shall be as specified in Section 33 51 10.

2.1.2 Wellhead Assembly

Wellhead Assembly consists of a 2-inch globe valve, 2-inch union disconnect, a quick change orifice plate housing with a collar and set of interchangeable orifice plates suitable for flow measurements, adapter bushing or Fernco reducer fitting, stabilizing well cap with support ring, temperature gauge, multiple barbed hose monitoring ports, and dust caps. Wellhead assembly is mounted to the horizontal collector adaptor and connected to lateral piping located within the waste limits as shown on the Drawings. Wellhead assembly is manufactured by QED Environmental Systems, Dexter, MI (800-810-9908).

The globe valve is constructed of Type 1, Grade 1, PVC with socket fittings stainless steel valve stem and handle. The valve meets the requirements of ASTM D-1784 for rigid PVC compounds. The "globe" is a tapered cylindrical plug design made of PVC, thickly lined with Viton material, flanged, stem with position high visibility indicator.

2.1.3 Well Caps

Well caps shall be dual extraction type with flexible couplings and adapter fittings that allow for connection of pneumatic supply and dewatering force main lines. Dual extraction well caps shall be manufactured by Pump One or approved equal.

2.2 SPARE PARTS

No spare parts are included in this work.

3.0 EXECUTION

3.1 JOINING OF PIPES

Pipes shall be joined as specified in Section 33 51 10. In addition, for PVC pipe, lag screws shall be installed at each coupling to secure vertical piping during placement in well boring. Four sheet metal screws per coupling or two screws per bell fitting shall be installed. The length of the lag screws shall equal the sum of the pipe and coupling (or bell fitting) wall thicknesses.

3.2 BACKFILLING

Backfilling of the well shall commence immediately after well trench is completed and the well piping has been installed. Backfill materials shall be placed carefully to the dimensions shown on the Drawings and as approved by the ENGINEER. The ENGINEER, on the basis of a visual examination, may reject gravel and soil backfill containing foreign material.

3.3 TEMPORARY CAP

The CONTRACTOR shall temporarily cap the riser pipe of the vertical extraction well to prevent direct venting of LFG through the riser pipe. The temporary cap shall be removed during the installation of the wellheads.

3.4 WASTE DISPOSAL

Excavated waste materials, including well cuttings shall be handled as specified in Section 31 00 00.

3.5 WELLHEAD INSTALLATION

3.5.1 Wellhead Assembly

Wellhead assembly shall be installed on the vertical wells in accordance with the manufacturer's recommendations. Care shall be taken not to damage the impact the orifice plate during installation. If an orifice plate is damaged during installation, CONTRACTOR shall replace it at no cost to the OWNER.

3.5.2 Wellhead Connection

The wellhead shall be connected to the lateral via flexible PVC pipe, as shown on the Drawings. Install flexible PVC pipe so that no sags are formed.

END OF SECTION 33 23 10

SECTION 33 49 00

STORMWATER DRAINAGE STRUCTURES, PIPING, AND FITTINGS

1.0 GENERAL

1.1 DESCRIPTION

Scope of Work: The work in this Section includes all the labor, materials, equipment and incidentals required to construct stormwater drainage channels, pipe downchutes, pipe gutters, pipe inlet and outlet structures, riprap, endwalls, and other drainage structures as shown on the PLANS, specified herein and in the General Conditions.

1.2 SUBMITTALS

Supplier information and product specifications shall be submitted to the ENGINEER for review and approval at least 30 days before product procurements. The CONTRACTOR shall be fully responsible for any construction delays due to failure to obtain submittal approval in a timely manner.

1.2.1 Shop Drawings

Shop drawings for the following items shall be submitted for approval at least 15 days before installation.

- Corrugated High Density Polyethylene (HDPE) pipe downchutes and all related details.
- HDPE pipe gutters and all related details.
- HDPE riser structures, manhole inlet structures, and all related details.
- Sediment Basins outlet structures, pipes, and all related details.
- HDPE Compression Release Joints.
- Concrete endwalls, headwalls, and corrugated HDPE pipe to endwall connections.
- Reinforced Concrete Principal Spillway Structures, and all related details.
- Centerline cross-sections/profiles of basin outfall pipes through basin embankments, depicting embankments, principal spillway structures, dewatering pipes, valves, headwalls, endwalls, pipes, pipe cradles, anti-seep collars, riprap aprons, etc., including vertical elevations and pipe slopes and horizontal locations.
- Centerline cross-sections/profiles of HDPE Downchutes, depicting locations of pipes, fittings, risers, headwalls, compression release joints, and riprap outfalls.

1.2.2 Certificate of Compliance

Certificate of Compliance for HDPE and concrete pipes; concrete outlet control structures; pipe cradles, anti-seep collars, valves, HDPE compression release joints, risers, and manhole inlets shall be submitted to the ENGINEER for approval at least 15 days before installation.

1.2.3 Related Work Specified Elsewhere

- Section 35 31 20 Concrete Block Erosion Control Mats
- Section 31 25 00 Erosion and Sediment Control

2.0 PRODUCTS

2.1 MATERIALS

2.1.1 Corrugated Metal Pipe

Corrugated metal pipe, coupling bands, and other special sections shall conform to the requirements of AASHTO M190. The pipe may be of riveted or non-riveted type. Special sections shall be of the same gauge as the conduit to which they are joined and shall conform to the applicable standards of AASHTO M36.

2.1.1.1

Fittings, connecting bands, and special sections shall be from the same manufacturer as the pipe to which they are joined.

2.1.1.2

Corrugated metal pipe furnished, including pipe coupling bands, shall be galvanized steel, bituminous coated, minimum 16 gauge. Corrugations shall have a pitch of 2 inches and a depth of 1/2 inch.

2.1.1.3

If helically formed pipe is used, the ends shall be rerolled a minimum of two angular corrugations where connecting bands or flared end sections are required.

2.1.2 Reinforced Concrete Pipe

Reinforced concrete pipe shall conform to ASTM C-76 Class III, unless otherwise indicated on the plans. The pipe interior shall be smooth and free from roughness, projections, or irregularities. Cracked or flaking pipe shall be rejected. Pipe with exposed reinforcement shall be rejected. Joints on RCP shall be tongue and groove or bell and spigot.

2.1.3 Corrugated HDPE Storm Pipes

Corrugated HDPE storm drain pipes shall conform to the following:

- Shall be of Class 100 or 63 for ring stiffness constant (RSC) as defined in ASTM F 894-89 - "Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe".
- Pipe material shall be Type III, Class C, Category 5, Grade P34 according to ASTM D 1248 - "Standard Specification for Polyethylene Plastics Molding and Extrusion Materials".
- Joints: Pipes shall be produced with Bell and Spigot end construction. Joints shall be accompanied by rubber gaskets meeting all ASTM F 477 requirements and as shown on the PLANS.
- Perforations shall be per manufacturer's standards.
- Visible defects such as cracks, creases, splits, obstructions to flow in perforations or in tube, uncolored or "pale" tubing, and obvious thin spots are not permissible.

2.1.4 HDPE Pipes, Risers, and Fittings

Shall be as shown on the PLANS.

2.1.5 Polyethylene (PE) Tubing

Shall comply with all requirements in ASTM F 667.

2.1.6 HDPE Manholes and Fittings

Shall be of Class 160 for ring stiffness constant (RSC) as defined in ASTM F 894 - "Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe".

2.1.7 Concrete Manholes, Pipe, Endwalls, and other structures

Manholes, pipe, endwalls, and other concrete structures shall be provided and installed in accordance with VDOT standards and specifications (Section 302) unless otherwise noted on the drawings.

2.1.8 Gaskets

Rubber gaskets shall comply with all ASTM F 477 requirements and shall have a minimum internal and external hydrostatic pressure rating of 10 psi gage.

2.1.9 Lubricants

The lubricant used for assembly shall have no detrimental effect on the gaskets or on the pipes.

2.1.10 Compression Release Joints

Compression Release Joint shall be designed and fabricated by the pipe Manufacturer. The Joint shall be as shown in the PLANS or equal and be capable of withstanding an internal and external hydrostatic pressure of 5 psi gauge. The design of the joint shall be approved by the ENGINEER prior to fabrication.

2.1.11 HDPE Pipe Embedments

HDPE Pipe Embedments for Concrete Headwall Structures: HDPE Embedments shall be a standard product of the pipe manufacture. Installation and casting of HDPE embedment into concrete structures shall be in accordance with pipe manufacturer's installation instructions.

2.2 STORMWATER DIVERSION BERMS

Surface runoff collection and perimeter surface berms shall be promptly seeded following construction.

2.3 RIPRAP

Riprap shall be in accordance with VDOT Road and Bridge Standards Section 204, and shall be sized as indicated on the PLANS.

2.4 CHANNEL LINING

Line stormwater channels and open downchutes as noted on the drawings.

3.0 EXECUTION

3.1 HDPE PIPE INSTALLATION

3.1.1 General

3.1.1.1

Proper implements, tools, and facilities shall be provided and used for the safe and convenient performance of the work. Pipe, fittings, and appurtenances shall be lowered carefully into the trench by means of a derrick, rope, or other suitable tools or equipment, in such a manner as to prevent damage to materials and protective coatings and linings. Under no circumstances shall pipe materials be dropped or dumped into the trench. The trench shall be dewatered prior to installation of the pipe.

3.1.1.2

Pipes, risers, fittings and accessories shall be installed in accordance with the Manufacturer's recommendations and with lines and grades and details shown on the PLANS. Manufacturer's recommendations for installation shall be the minimum requirements.

3.1.1.3

Pipe and fittings shall be strung out along the route of construction where it will cause least interference with traffic. Commence at the lowest point in the system. Laying of pipe shall be commenced immediately after the excavation is started and every measure must be used to keep pipe laying closely behind trenching. No more than 10 feet of trench shall remain open at the end of each working day. Required connections to existing lines shall be made in accordance with local

standards and requirements. Observe extreme care to prevent debris from entering lines. Check carefully the invert elevations of existing lines to which connections are to be made and inform the Engineer immediately if there is a discrepancy with the Contract Drawings. Each pipe shall be inspected for defects prior to being lowered into the trench and swabbed or brushed out to verify that no dirt or foreign material gets into the finished line.

3.1.1.4

Where culvert pipe is to be laid on existing ground and on or under fill the CONTRACTOR shall construct the embankment to a height to the top of pipe and then excavate a trench to receive the pipe. Trench shall be no wider than necessary to permit proper compaction of embankment around the pipe.

3.1.1.5

The interior of all pipes, fittings, and accessories shall be thoroughly cleaned of all foreign matter prior to being installed. Before jointing, all joint contact surfaces shall be cleaned, if necessary, and kept clean until jointing is completed.

3.1.1.6 HDPE Manholes

Manholes shall be installed according to the Manufacturer's recommendations and the details shown on the PLANS. Manufacturer's recommendations for installation shall be the minimum requirements.

3.1.1.7

Whenever the pipe laying is discontinued, such as end of workday or weekend, the unfinished work shall be protected from displacement due to caving of the banks, runoff, or other damages.

3.1.2 Examination of Products

Pipe fittings, valves, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Owner, who may prescribe corrective repairs or reject the materials.

3.2 CONCRETE PIPE INSTALLATION

3.2.1 Lines and Grades

All pipes, fittings and accessories shall be installed in accordance with the lines and grades and details shown on the PLANS. Any deviation from the design alignment or grade which would displace the gasket as much as 1/4-inch from the normal position, or which produce a gap exceeding 1/2-inch between sections of pipe for more than 1/3 of the circumference of the inside of the pipe is not acceptable. In case of these unacceptable practices, the CONTRACTOR shall relay the pipe at no cost to the OWNER.

3.2.2 Gasket

The gasket, surface of the pipe joint, and gasket recess shall be thoroughly cleaned of all foreign matter prior to being installed. If necessary, industry accepted lubricant can be used to facilitate joining.

3.2.3 Placement

All pipes shall be laid with bells or grooves uphill. The interior of all pipes, fittings, and accessories shall be thoroughly cleaned of all foreign matters prior to and during installation. Pipe defection per joint shall not exceed 2 degrees.

3.2.4 Embedment

The first length of pipe shall be thoroughly embedded in place. No length of pipe shall be laid until two preceding lengths have been thoroughly embedded in place so as to prevent any movement or disturbance of the finished joint. Whenever the pipe laying is discontinued, such as end of workday or weekend, the unfinished end shall be protected from displacement due to caving of the banks, runoff, or other damages.

3.2.5 Installation of concrete manholes, pipes, endwalls, and other structures

Manholes, pipe, endwalls, and other concrete structures shall be provided and installed in accordance with VDOT standards and specifications (Section 302) unless otherwise noted on the drawings.

END OF SECTION 33 49 00

SECTION 33 51 10

LFG PIPE AND PIPE FITTINGS

1.0 GENERAL

1.1 DESCRIPTION

The CONTRACTOR shall supply all materials, equipment, and labor needed to install complete and ready for use all pipe, pipe fittings, and valves as specified herein and as indicated on the PLANS for the Landfill Gas Collection System.

Related Work Described Elsewhere:

Section 31 00 00:	Earthwork
Section 31 23 33:	Trenching, Backfilling, and Compacting

1.2 SUBMITTALS

1.2.1 Certification

The CONTRACTOR shall prepare and submit to the ENGINEER, for review and approval, certificates of compliance on materials furnished and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, inspection, maintenance, and repair of each type of pipe and pipe fitting furnished.

1.2.2 Shop Drawings

The CONTRACTOR shall prepare and submit Shop Drawings to the ENGINEER for review and approval. The Shop Drawings shall show all dimensions, slopes, and invert elevations at connections. All tie-ins to the existing system shall be field-verified and shown on the Shop Drawings. The CONTRACTOR shall show coordination between proposed piping and all existing and proposed features.

1.3 REFERENCE

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.3.1 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARD TEST METHODS/PRACTICE:

- ASTM D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials
- ASTM D 1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- ASTM D 1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- ASTM D 2321 Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
- ASTM D 2466 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Sch 40.
- ASTM D 2467 Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- ASTM D 2513 Specification for Thermoplastic Gas Pressure Pipe Tubing and Fittings
- ASTM D 2564 Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- ASTM D 2774 Practice for Underground Installation of Thermoplastic Pressure Piping
- ASTM D 2855 Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- ASTM D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

1.3.2 AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

- ANSI B 31.8 Code for Pressure Piping, Appendix N

1.3.3 PLASTICS PIPING INSTITUTE (PPI)

- PPI TR-31/9-79 Technical Report

2.0 PRODUCTS

2.1 SCHEDULE 80 PVC PIPE

All PVC pipe and pipe fittings shall be Schedule 80 PVC conforming to ASTM D 1784, ASTM D 1785 (for pipe), and ASTM D 2467 (for fittings). Perforated pipe shall be slotted in accordance with the PLANS. Acceptable manufacturers include Plastinetics, Inc. Chemtrol, CertainTeed, ASAHI/America, or approved equal.

The pipe shall be Schedule 80 PVC conforming to ASTM D 1785, PVC 1120. Pipe joints shall be solvent welded.

2.1.1 PVC Fittings

Fittings shall be of the same material and manufacturer as the pipe they are to be attached to. PVC fittings shall conform to ASTM D 2466.

2.1.2 PVC Flanges

2.1.2.1 Type

Flanges shall be Schedule 80 PVC and shall be plate type, ANSI Class 150 pounds.

2.1.2.2 Hardware

The bolts, studs, nuts, and washers for the flanges shall be hot dipped galvanized steel. Below-grade flanges shall be wrapped in 5-mil polyethylene sheeting, just after installation and prior to backfilling, to help prevent corrosion.

2.1.2.3 Gaskets

Flange gaskets shall be full-face Neoprene. Other elastomers, such as Nitrile or Buna-N may be submitted to the ENGINEER for consideration.

2.1.3 Flexible PVC Pipe

2.1.3.1 Manufacturer

Flexible PVC pipe shall be as manufactured by Kanaflex Corporation, Compton, California (310-637-1616), Series 101-PS, or approved equal.

2.1.3.2 Fasteners

Fasteners for flexible PVC pipe shall be Kanaflex 101-PS power lock clamps, or approved equal.

2.1.4 Compound Properties

PVC pipe and pipe fittings shall be manufactured from a compound which meets the requirements of Type 1, Grade 1, Polyvinyl Chloride PVC 1120, Class 12454-B, as outlined in ASTM D 1784. A Type 1, Grade 1 compound is characterized as having the highest requirements for mechanical properties and chemical resistance.

- Compound from which pipe is produced shall have a design stress rating of 2000 psi at 73 degrees F, listed by the Plastic Piping Institute.
- Materials from which pipe and pipe fittings are manufactured shall have been tested and approved by NSF International.
- Pipe shall conform to the requirements of ASTM D-2241. Pipe shall be homogenous throughout and shall be free from cracks, holes, foreign inclusions, and other defects.

2.1.5 PVC Pipe Storage:

PVC pipe shall be stored or stacked so as to prevent damage by marring, crushing, or piercing. Maximum stacking height shall be limited to 6 feet. For storage over 5 days, a location shall be chosen out of direct sunlight or the piping and fittings will be covered.

2.2 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

All HDPE pipe and fittings greater than 3-inch-diameter as indicated on the Drawings shall be at least Standard Dimension Rating (SDR) 17 high density polyethylene pipe using a 3408 type resin, or approved equal. Thicker SDR pipe may be specified on the drawing. HDPE pipe and fittings that are 3-inch-diameter and less shall be SDR 11.

Pipe shall be extruded from a Type III, Class C, Category 5, Grade P34 compound as described in ASTM D 1248. It shall be classified as cell 345434C according to ASTM D 3350 and have the material designation of PE 3408. The pipe shall be manufactured to meet the requirements of ASTM D 2513. Manufacturer's literature shall be adhered to when "manufacturer's recommendations" are specified. All pipe and fittings shall be provided by one manufacturer. Acceptable manufacturers include Plexco (630-350-3700), Driscopipe (800-527-0662), or approved equal.

Perforations shall be 1/2 inch in diameter at ¼ points around the perimeter of the pipe. Rows of holes shall be space approximately 6 inches along the length of the pipe. Every other row shall be offset by 3 inches.

3.0 EXECUTION

3.1 PVC PIPE HANDLING

PVC pipe and pipe fittings shall be handled carefully in loading and unloading. They shall be lifted by hoists and lowered on skidways in such a manner as to avoid shock. Derricks, ropes, or other suitable equipment shall be used for lowering the pipe into the extraction well borings. Pipe and pipe fittings shall not be dropped or dumped.

3.2 PVC PIPE INSTALLATION

PVC pipe installation shall conform to these specifications, the manufacturer's recommendations, and as outlined in ASTM D 2774.

3.3 JOINING OF PVC PIPE

Joining of pipe shall be in accordance with ASTM D 2855.

3.3.1 Preparation

All pipe shall be inspected for cuts, scratches, or other damage prior to installation. Pipe with imperfections shall not be used. All burrs, chips, etc. shall be removed from pipe interior and exterior. All loose dirt and moisture shall be wiped from the interior and exterior of the pipe end and the interior of the fitting. All pipe cuts shall be square, perpendicular to the center line of pipe. Pipe

ends shall be beveled prior to applying primer and solvent cement so that the cement does not get wiped off during insertion into the fitting socket.

3.3.2 Solvent Welding

A coating of primer as recommended by pipe supplier shall be applied to the entire interior surface of the fitting socket and to an equivalent area on the exterior of the pipe prior to applying solvent cement. The solvent cement shall comply with the requirements of ASTM D 2564 and shall be applied in strict accordance with manufacturer's specifications. Pipe shall not be primed or solvent welded when it is raining, when atmospheric temperature is below 40 degrees F, or above 90 degrees F.

3.3.3 Curing

After solvent welding, the pipe shall remain undisturbed until cement has thoroughly set. As a guideline for joint setting time, use 1 hour for ambient temperatures 60-90 degrees F, or 2 hours when ambient temperature is 40-60 degrees F.

3.3.4 Alignment

Pipe and pipe fittings shall be selected so that there will be as small a linear deviation as possible at the joints, and so that inverts present a smooth surface. Pipe and fittings which do not fit together to form a tight fitting will be rejected.

3.4 FLEXIBLE PVC PIPE CONNECTIONS

Connections to pipe shall be made with clamps as indicated on the PLANS and in accordance with manufacturer's recommendations and step by step procedures. Connections to PVC pipe shall be solvent welded in accordance with Paragraph 3.03 above.

3.5 HDPE PIPE HANDLING

HDPE pipe shall not be bent more than the minimum radius recommended by the manufacturer for type, grade, and SDR. Care shall be taken to avoid imposing strains that will overstress or buckle the HDPE piping or impose excessive stress on the joints.

Joining HDPE Pipe:

Only two methods shall be utilized to joining HDPE pipe: heat fusion and mechanical joining.

3.5.1 Mechanical Joining

Mechanical Joining shall be accomplished with HDPE flange adapters, neoprene gaskets, and ductile iron back-up flanges, and shall be used only where shown on the Drawings. Refer also to Part 3.7.

3.5.2 Heat Fusion

Heat Fusion joints shall be made in accordance with manufacturer's step by step procedures and recommendations. Fusion equipment and a trained operator shall be provided by the Contractor. Pipe fusion equipment shall be of the size and nature to adequately weld all pipe sizes and fittings

necessary to complete the project. Branch saddle fusions shall be made in accordance with manufacturer's recommendations and step by step procedures. Branch saddle fusion equipment will be of the size to facilitate saddle fusion within the pipe trench. Heat fusion shall be performed outside of the trench whenever practical. Before heat fusing pipe, each length shall be inspected for the presence of dirt, sand, mud, shavings, and other debris. Any foreign material shall be completely removed. At the end of each day, all open ends of fused pipe shall be capped or otherwise covered to prevent entry by animals or debris.

3.5.3 Shelter

As per the manufacturer's instructions, no fusion shall be performed in precipitation unless a shelter is provided.

3.6 HDPE PIPE INSTALLATION

Pipe installation shall comply with the requirements of ASTM D 2321, PPI TR-31/9-79, and the manufacturer's recommendations. Lengths of fused pipe to be handled as one segment shall not exceed 400 feet. The Engineer shall be notified prior to any pipe being installed in the trench in order for him/her to have an opportunity to inspect the following items:

- All butt and saddle fusions.
- Pipe integrity.
- Trench excavation for rocks and foreign material.
- Proper trench slope.
- Trench contour to ensure the pipe will have uniform and continuous support.

Any irregularities found by the Engineer during this inspection must be corrected before lowering the pipe into the trench. Pipe shall be allowed sufficient time to adjust to trench temperature prior to any testing, segment tie-ins, and/or backfilling.

Tie-ins shall be made out of the trench whenever possible. When tie-ins are to be made only in the trench, a bell hole shall be excavated large enough to ensure an adequate and safe work area.

Below grade piping shall be marked with metallic locator/warning tape to be buried in the trench above the pipe as indicated on the drawings.

3.7 SEGMENT TESTING

3.7.1 Test Method

The HDPE pipeline shall be subjected to an air test per ASTM F-1417 and as described herein to detect any leaks in the piping. Testing shall be performed above grade. The CONTRACTOR shall accept the responsibility for locating, uncovering (if previously backfilled), and repairing any leaks detected during testing.

3.7.2 Test Segment

Like sizes of polyethylene piping shall be butt welded together into testing segment not to exceed 1000 feet. Segments shall be connected to a testing apparatus on one end and fitted with fusion-welded caps on all openings. The segment to be tested should be allowed time to achieve constant and/or ambient temperature before initiating the test.

3.7.3 Timing

The test should be performed during a period when the pipe segment will be out of direct sunlight when possible; i.e., early morning, late evening, or cloudy days. This will minimize the pressure changes which will occur during temperature fluctuations.

3.7.4 Pressure

The test pressure shall be 5 psig.

3.7.5 Pressure Drop

Pressure drop during the test shall not exceed one percent of the testing gauge pressure over a period of one hour. The testing gauge will have adequate sensitivity and incrementation to observe a one percent pressure drop. This pressure drop shall be corrected for temperature changes before determining pass or failure. (See Section 3.10 for test failures). The ENGINEER shall sign off on a test form to indicate test compliance.

3.7.6 Notification

The ENGINEER shall be notified prior to commencement of the testing procedure and shall be present during the test.

3.7.7 Equipment

Equipment for this testing procedure will be furnished by the CONTRACTOR. This shall consist of a polyethylene flange adaptor with a PVC blind flange. Polyethylene reducers shall be utilized to adapt test flange to size of pipe being tested. Tapped and threaded into the blind flange shall be a temperature gauge 0 to 100 degrees C, a "Schraeder tire valve" to accommodate an air compressor hose, a ball valve to release pipe pressure at completion of test, and a pressure measuring device. The pressure measuring device shall be a digital manometer capable of measuring positive pressures of air and other non-corrosive gases over a range of 0 to 199.9 in-w.c. Model No. 475-3 as manufactured by Dwyer Instruments, Inc. (770-427-9406), or approved equal.

3.8 TEST FAILURE

3.8.1 Remedial Actions

The following steps shall be performed when a pipe segment fails the one percent - 1 hour test described in this Section.

3.8.2 Inspection

The pipe and all fusions shall be inspected for cracks, pinholes, or perforations.

3.8.3 Terminations

All blocked risers and capped ends shall be inspected for leaks.

3.8.4 Location

Leaks shall be located and/or verified by applying a soapy water solution and observing soap bubble formation.

END OF SECTION 33 51 10

SECTION 33 51 20

LFG SYSTEM VALVES

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Scope of Work

The CONTRACTOR shall provide all materials, equipment, and labor needed to install and make ready all valves as specified herein and as indicated on the Drawings.

1.1.2 Related Work Described Elsewhere

Section 33 23 10: Horizontal Collector Wellheads

Section 31 51 10: LFG Pipe and Pipe Fittings

1.2 SUBMITTALS

1.2.1 Certification

The CONTRACTOR shall prepare and submit to the ENGINEER, for review and approval, manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, inspection, maintenance, operation, and repair of each type of valve furnished. Shop drawings shall be submitted for butterfly valve assemblies requiring spacers per these SPECIFICATIONS.

2.0 PRODUCTS

2.1 GENERAL

2.1.1 Components

All valves shall be complete with all necessary operators, actuators, handwheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, wrenches, and other accessories or appurtenances which are required for the proper completion of the work. Operators, actuators, and other accessories shall be sized and furnished by the valve supplier and factory mounted.

2.1.2 Intended Service

Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein.

2.1.3 Installation Conditions

Valves and operators shall be suitable for buried or exposed conditions, as applicable. Valves shall have all safety features required by OSHA.

2.1.4 Sizing

Unless otherwise shown on the Drawings, valves shall be the same size as the adjoining pipe.

2.1.5 Monitoring

Monitoring parts and hoses shall be provided at each buried isolation valve. Ports threaded into header shall be Swagelock 1/4" SS-420-1-4 x1/4" MPT, or approved equal. Monitoring hose shall be stainless steel teflon-lined hose with Swagelock tube ends, model SS-4BHT-36, or approved equal, of adequate length to extend above grade (above-specified length is for 3-foot long tubing section). Sampling end shall have a 1/4" female connector SS-420-7-4 with a quick-connect polypropylene monitoring port by Ryan Herco, Part No. 0812-002.

2.2 BUTTERFLY VALVES

Header isolation valves shall be butterfly bubble tight, wafer design, with a PVC body, nitrile seat, and compatible with a flat face flange, as manufactured by Asahi/America or equal. Stem extensions shall be stainless steel in an epoxy coated carbon steel outer housing with a gear box assembly and visual valve position indicator mounted on top and equipped with a removable manual operating wheel. Monitoring ports at the butterfly valves shall be quick-connects as specified above and shown on the Drawings.

3.0 EXECUTION

3.1 INSTALLATION

3.1.1 Methods

Valves shall be installed in accordance with the manufacturer's recommendations and the following:

3.1.1.1 Butterfly Valves

Butterfly valves shall be installed between two flanges as shown on the Drawings; care shall be taken to avoid stripping bolts when tightening.

3.1.1.2 Flanges

Flanges shall be joined with hot dipped galvanized steel studs and nuts. All below grade studs and nuts shall be coated with anti-seize compound, or approved equivalent, after installation and prior to backfilling. Stud and nut diameters shall be sized as recommended by the manufacturer for each size valve. Stud lengths shall accommodate the required distance between flanges including spacers, if necessary.

3.1.2 Protection

The CONTRACTOR shall wrap and tape the valve, flanges, and bolts in 5-mil polyethylene sheeting prior to backfilling to help protect the valve assembly from corrosion.

3.1.3 Spacers and Adapters

Flanged butterfly valves may require spacers between the flange adapters and the valve body in order to allow full travel of the internal disk. If spacers are necessary for any butterfly valve, the CONTRACTOR will install valve spacers subject to the approval by the ENGINEER.

END OF SECTION 33 51 20

SECTION 35 31 20

CONCRETE BLOCK EROSION CONTROL MATS [FLEXAMAT®]

1.0 GENERAL

1.1 REQUIREMENTS INCLUDED

1.1.1

A type of Articulating Concrete Block Revetment System consisting of a matric of interconnected concrete bloc units used for erosion protection. Concrete units are connected by a geometric interlock of geosynthetic cables or grids and include a geotextile underlayment for retention of soil.

1.1.2

Concrete block erosion control mats as used in place riprap for stone-lined waterways in accordance with Virginia Erosion and Sediment Control Handbook (VESCH) Section 3.17.

1.1.3

Contractor shall furnish and place tied concrete block erosion control mats (Flexamat® or approved equal) to conform to the lines, grades, design and dimensions as shown in the drawings and in accordance with this specification.

1.1.4

Contractor shall install permanent erosion control mats immediately following completion of the final channel grading and placement of permanent seeding.

1.1.5

Contractor shall follow the Erosion and Sediment requirements, guidelines, and schedule for installation of erosion control mats.

1.2 RELATED REQUIREMENTS

- Virginia Erosion and Sediment Control Handbook, latest edition. Section 3.17-Stormwater Conveyance Channel & Section 3.32 Permanent Seeding.
- Erosion and Sediment Control Regulations, 9-VAC 25-840.

2.0 PRODUCTS

2.1 GENERAL

2.1.1

Concrete block erosion mat is manufactured from individual concrete blocks tied together with high strength polypropylene bi- axial geogrid. Each block is tapered, beveled and interlocked and includes connections that prevent lateral displacement of the blocks within the mats when they are lifted for placement.

2.1.2

Concrete Block Erosion Mats for permanent stormwater conveyance channel lining shall be Flexamat® Plus, as manufactured by Motz Enterprises, Inc., or approved equal.

2.1.3

Product information per https://www.flexamat.com/

2.1.4

Concrete blocks with a minimum compressive strength of 5,000 psi at 28 days. Blocks shall have a minimum average weight of three pounds per block and tied at a maximum spacing of two inches from the adjoining blocks.

2.1.5

Concrete blocks shall be tied and cast together at the base of each block with a polypropylene Geogrid material. The geogrid material shall meet an Ultimate Tensile strength of 2055 lb/lf.

2.1.6

Concrete block matting shall have permanent underlayment consisting of non-degradable polyester Geotextile material. Underlayment mat may consist of new or post-consumer recycled polyester. Underlayment material shall be packaged within the roll of the Flexamat Tied Concrete Blocks.

2.2 SUBMITTALS

2.2.1

Submit general product data, specifications, roll widths, and product type as required for the Flexamat product to be used for channel lining.

2.2.2

If alternate products are intended, contractor shall submit additional information. Including:

- Erosion mat dimensions. Flexamat is manufactured in standard widths of 4', 5.5', 8', 10', 12, & 16'. Lengths can be cut to order per project requirements. Stocked lengths are 30', 40', & 50'. 4' x 4' mats stacked on pallets are also available. Submit the intended roll widths for each channel as determined to meet the drawings and the site conditions.
- Concrete block dimensions, weight and compressive strength
- Geogrid tie materials, specifications, and strength
- Underlayment material specifications weight, and strength

2.2.3

Additional information related to alternate products may be required by the Engineer

2.3 ALTERNATE PRODUCTS

2.3.1

The Engineer may approve alternate products for concrete block channel lining if proven to be equal to Flexamat® Plus.

2.3.2

Alternate materials or products shall meet the material and performance specifications of the Flexamat® Plus.

2.3.3

Materials or products as an alternate to Flexamat® Plus must be pre-approved in writing by the Engineer.

2.4 SAMPLES

CONTRACTOR will provide samples of product to ENGINEER for independent testing upon owns request.

3.0 EXECUTION

3.1 GENERAL

All activities shall be performed in accordance with the approved plans and details.

3.2 HANDLING AND STORAGE

3.2.1

Concrete mats should be stored in a location protected from cement, paint, excessive mud, chemicals, sparks and flames, temperatures in excess of 160 degrees F, and any other environmental condition that may degrade the physical properties. If stored outdoors, the rolls shall

be elevated from the ground surface and protected with an opaque waterproof cover. Geotextiles shall be delivered to the site in a dry and undamaged condition.

3.2.2

Geotextile rolls should be handled and unloaded by hand, with load carrying straps, or a fork lift with a stinger bar. Rolls should not be dragged, lifted by one end, lifted by cables or chains, or dropped to the ground.

3.2.3

Cover the concrete mats during long periods of storage to protect against degradation of the backing material as recommended by the manufacturer.

3.3 INSTALLATION

In general concrete block erosion mats shall be installed to the line and grade shown on the plans and per the manufacturer's guidelines. Contractor is responsible for the following activities:

- Prior to installing concrete block erosion control mats, the contractor shall prepare the channel subgrade as shown in the drawings. Subgrade surfaces shall be free of all debris, rocks, stones, sticks, roots, or any items that may penetrate the bloc mats.
- The contractor shall ensure the prepared subgrade provides a smooth and firm foundation for the mats. The stormwater channel subgrade shall be graded to a vee or trapezoidal shape as required.
- Contractor shall provide and install seed and fertilizer as shown in the drawings to the prepared subgrade prior to installation of the concrete mats in accordance with the specifications.
- Concrete block erosion control mats shall be installed immediately following completion of final channel grading and placement of permanent seed and mulch.
- Provide a minimum 18 in. deep concrete mat embedment toe trench at all edges exposed to concentrated flows. Recess exterior edges subject to sheet flow a minimum of 3 in.
- Provide and install soil anchoring as recommended by the manufacturer or engineer for the site conditions.
- For seams parallel to the flow line in ditch or channel applications, center a minimum 3 ft. wide strip of soil retention blanket under the seam. Fasten along the seam at 5 ft. maximum spacing. Parallel seams in the center of the ditch shall be avoided when possible.
- Shingle seams perpendicular to the flow line with the downstream mat recessed a minimum of 2 blocks under the upstream mat and fastened together along the seam at 2 ft. maximum spacing if required by manufacturer or engineer.

4.0 INSPECTION AND MAINTENANCE

4.1 GENERAL

4.1.1

Ensure that delivered products are equivalent to the approved product.

4.1.2

All mats to be inspected upon delivery. Inspect that blocks are sound and free of defects that would interfere with placement or that would limit the strength or intended life cycle of the material. Discard blocks with defects as described below.

4.1.3

Assure that all units are sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction.

4.1.4

Chipping or missing concrete resulting in a weight loss exceeding 15% of the average weight of a concrete unit is grounds for rejection by the engineer. Replace, repair or patch the damaged areas per the manufacturer's recommendations.

4.1.5

Minor cracks, incidental to the manufacturing, or small chips that have occurred as a result of normal shipping, and placement should not be rejected.

4.1.6

Concrete mats are shipped in rolls and are packaged with handling straps. These handling straps shall only be used for lifting below 2 ft. to place heavy duty lifting straps under rolls. Upon delivery, rolls may be left exposed for up to 30 days. If exposure will exceed 30 days, cover or tarp the rolls to minimize UV exposure.

4.2 REPAIRS AND MAINTENANCE

Upon finding that any measure requires repair or maintenance, Contractor shall repair or maintain the measure at no additional cost to Owner in accordance with this specification.

END OF SECTION 35 31 20