APPENDIX VI-I

EROSION AND SEDIMENT CONTROL PLAN

APPENDIX VI-I. EROSION AND SEDIMENT CONTROL PLAN

The site currently has an approved Erosion and Sediment Control Plan No. 2005-007, Ext #2, Rev. #4. The Plan was prepared by Geosyntec Consultants in 2004 as part of the Cell 6 Expansion, and revised by Golder Associates Inc. in the October 2015 Application for Permit Renewal.

Because the footprint of the landfill is not being expanded with this application for Vertical Expansion, DRPI will continue to operate under the current approved plan. The existing plan will be updated as needed upon expiration in March 2019.

APPENDIX VI-J

TECHNICAL SPECIFICATIONS

Prepared for

DELAWARE RECYCLABLE PRODUCTS, INC.
246 Marsh Lane
New Castle, Delaware 19720

PERMIT MODIFICATION APPLICATION

APPENDIX VI-J – TECHNICAL SPECIFICATIONS

for

VERTICAL EXPANSION
DRPI Industrial Landfill
New Castle, Delaware

Prepared by

Geosyntec consultants
10211 Wincopin Circle, 4th Floor
Columbia, Maryland 21044

Geosyntec Project No.: ME1571

March 2019

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TECHNICAL SPECIFICATIONS

The technical specifications presented herein were prepared by Golder Associates, Inc. (Golder) in April 2015 as part of the Solid Waste Facility Permit SW-05/01 permit renewal and were approved by DNREC as part of DRPI's current permit SW-15/02. Updated specifications, approved as part of the recent construction and design variances associated with the Cells 1-3 overlay, dated February, April, and November 2018, are included as appropriate.

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SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

This Contract will include the construction of Cell 1-3 Overlay construction. Each item below shall be required for the construction, unless otherwise indicated. This Contract includes all personnel, supervision, services, labor, home office technical and administrative support, materials, tools, equipment and supplies for the following:

A. Mobilization and demobilization and the preparation of work plans required by these specifications;

B. Provide all field engineering and temporary facilities, including the design thereof, required to perform the Work;

C. Provide required labor and equipment for storm water control for the duration of the project;

D. Install and maintain the required temporary and permanent erosion control features as described in, or required by, the Contract Documents;

E. Provide required labor and equipment for dust control for the duration of the project;

F. Clearing and grubbing of identified areas within the limits of work.

G. Excavation and removal of soil cover and/or waste to obtain the design subbase elevation;

H. Preparation of the existing soil subgrade following ;

I. Furnish and installation of the 24-inch thick structural fill material;

J. Installation of the below cap HDPE or AdvanEdge® gas collection system, including the furnishing and supply of ASSHTO No. 57 aggregate;

K. Exposing existing geosynthetic liner components for tie-in of the proposed liner system.

L. Excavation and backfilling of the overlay geosynthetic anchor trench, including the furnishing and installation of the low permeability soil;

M. Installation of the temporary stormwater diversion channel, including the supply and installation of the turf reinforcement mat;

N. Furnish and install the 24-inch thick drainage layer/protective cover;

O. Installation and connection of the 8-inch diameter HDPE leachate collection pipe;

P. Installation and connection of 6-inch diameter HDPE gas header;

Q. Installation and connection of remote gas wellhead(s);

R. Provide required bonding;

S. Provide required health and safety equipment / monitoring, as well as monitoring and control of nuisances such as noise, dust, and odor for site workers and the surrounding community;

T. Prepare progress reports, submittals, and Contract Record Documents.

The Owner will supply all the geosynthetic lining components and the straight length of all HDPE piping, including all fittings, flanges, elbows, reducers, tees, etc. 12 inches or greater in diameter.

All Work described above shall be performed in strict accordance with the Contract Documents and the CONTRACTOR's Health and Safety Plan. Guidance on Site hazards which must, at a minimum, be addressed in the CONTRACTOR's Health and Safety Plan is provided in the Health and Safety Specifications for Construction (Section 01564).

1.02 QUANTITIES

The OWNER reserves the right to alter, increase or decrease the quantities of Work to be performed at any time when and as found necessary, and the CONTRACTOR shall perform the Work as altered, increased or decreased. Payment for such increased or decreased quantity will be made in accordance with the Contract. No allowance will be made for any change in anticipated profits nor shall such changes be considered as waiving or invalidating any conditions or provisions of the Contract.

1.03 PRELIMINARY CONSTRUCTION SCHEDULE

Each Bidder shall prepare and submit its anticipated construction schedule with its bid.

1.04 STOCKPILE AND STAGING AREAS

Possible areas for the CONTRACTOR's staging and stockpile area shall be proposed by the CONTRACTOR for approval by the OWNER.

1.05 REGULATORY REQUIREMENTS

The CONTRACTOR shall comply with all local, state, and federal laws and regulations. This shall include but not be limited to local, Commonwealth of Pennsylvania and federal laws and regulations that govern the construction of the landfill cells and stormwater management systems.

In addition to adhering to these laws and regulations, the CONTRACTOR shall prepare, submit and gain approval of permits or permit equivalencies required for construction and initial operation of the system.

The OWNER will provide the CONTRACTOR with the necessary access approvals for work to be performed on land not owned by the OWNER. The CONTRACTOR shall

notify the OWNER if any additional access approvals are required and if access is denied to the CONTRACTOR during construction.

The following activities, permits, and/or approvals will be the responsibility of the CONTRACTOR:

1. Compliance with substantive requirements of Local Development and Zoning Ordinances;
2. Any temporary utility hook ups and permits.
3. Any permanent local building or permanent utility permits.

The OWNER will reimburse CONTRACTOR for permit fees paid to government agencies for permanent works.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

A. In case of conflicts between various parts of the Contract Documents, the ENGINEER shall be notified to initiate resolution.

B. "Related Sections" which are listed in the individual Specifications of the Contract Documents are not comprehensive and all inclusive. It is the CONTRACTOR's responsibility to become familiar with the Contract Documents and interrelationships. Any inconsistencies in the Contract Documents identified by the CONTRACTOR shall be brought to the OWNER to resolve.

*****END OF SECTION*****

SECTION 01015

DEFINITIONS

PART 1 - GENERAL

1.01 PARTICIPANTS

A. OWNER: The word "OWNER" means Delaware Recyclable Products, Inc. (DRPI), 246 Marsh Lane, New Castle, Delaware 19720.

B. CONTRACTOR: The word "CONTRACTOR" means the individual, partnership, firm, corporation or any combination thereof, including SUBCONTRACTORs, contracting with the OWNER for work covered by these Specifications.

C. ENGINEER: The word "ENGINEER" means Golder Associates Inc., 10 Canal Street, Suite 217, Bristol, Pennsylvania 19007.

D. CONSTRUCTION QUALITY ASSURANCE (CQA) CONSULTANT: To be determined.

E. SUBCONTRACTOR: The word "SUBCONTRACTOR" means the individual, partnership, firm, corporation or any combination thereof, contracting with the CONTRACTOR for work covered by these Specifications.

F. MANUFACTURER: The word "MANUFACTURER" means the individual, partnership, firm, corporation or any combination thereof, which produces or supplies materials used to complete the Work.

1.02 CONTRACT DEFINITIONS

A. Addenda: Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Documents or the Contract Documents.

B. Application for Payment: The form accepted by the OWNER which is to be used by the CONTACTOR in requesting progress or final payments, and which is to include such supporting documentation as required by the Contract Documents.

C. Bidding Documents: Includes the Advertisement for Proposals, Information for Proposers, Form of Proposal, Form of Contract, Specifications, and the "Contract Documents" (including all Addenda issued prior to receipt of Bids).

D. Bid Proposal: A document submitted by an interested party in response to the OWNER's request for proposal which includes the proposed methods, schedule, and costs for the interested party to perform the Work.

E. Bonds: Bid, performance and payment bonds, and other instruments of security.

F. Change Order: A document required by the OWNER, which is signed by the CONTRACTOR and the OWNER authorizing an addition, deletion or revision in the Work, and/or an adjustment in the Contract Price or the Contract Time, issued on or after the Effective Date of the Agreement.

G. Competent Person: The words "Competent Person" mean an individual provided by the CONTRACTOR, and approved by OWNER and ENGINEER, who is qualified and experienced to implement, supervise, and inspect the Work.

H. Contract Documents: The Contract Documents include Specifications, all Addenda, the Form of Agreement, General and Supplemental Conditions, Bid Proposal documents and Contract Drawings.

I. Contract Price: The amount payable by the OWNER to the CONTRACTOR under the Contract Documents. Minor changes to the Contract Price ($10,000 or less) may be approved by the OWNER.

J. Construction Quality Assurance (CQA) Consultant: To be determined. Consultant hired by the OWNER to provide CQA services during construction in accordance with approved CQA Plan.

K. Contract Time: The number of days or the time period stated in the Form of Agreement for completion of the Work. The OWNER may approve minor changes to the Contract Time (14 days or less), as long as the total number of days beyond the contact does not exceed 30 days. Major schedule changes; i.e. greater than 14 days for a single task and greater than 30 days for all tasks, must be approved by the OWNER.

L. Defective Work: Work that is unsatisfactory, faulty or deficient, or does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to the OWNER's recommendation of final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion).

M. Deficiency: An element of completed work which has been identified as Defective.

N. Drawings/Contract Drawings: The drawings which show the character and scope of the Work to be performed, which have been prepared or approved by the ENGINEER, and which are included in the Contract Documents.

O. Field Order: A written order issued by the ENGINEER that orders minor changes in the Work but does not involve changes in the Contract Price nor the Contract Time, and does not require approval by the OWNER.

P. Form of Agreement: A legal contract between the CONTRACTOR and the OWNER which includes, but is not limited to the Contract Price and Contact Time for the Work.

Q. General Specifications: Sections contained in Division 1 of the Specifications.

R. Install: Provide and install, unless otherwise noted.

T. Laws and Regulations/Laws or Regulations: Laws, rules, regulations, ordinances, codes, and/or orders of any governmental entity having jurisdiction over the Work. The State of Delaware shall be the jurisdiction for any and all disputes.

U. Notice of Award: The written notice by the OWNER to the apparent successful Bidder stating that, upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein and, within the time specified, the OWNER will sign and deliver the Agreement.

V. Notice to Proceed: A written notice given by the OWNER to the CONTRACTOR fixing the date on which the Contract Time will commence to run, and on which the CONTRACTOR shall start to perform the CONTRACTOR's obligations under the Contract Documents.

W. Products: The term “material” or “products” shall include products, equipment, assembly methods, manufacturer, brand, trade name, or other description. References to “equivalent,” “approved equivalent,” or similar terms mean that approval from the ENGINEER is required. All materials shall be new and specifically purchased for the Work under this Contract, unless as otherwise accepted by the OWNER or specified in the Contract Documents. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

X. Provide or Provided: Means “furnish and install” to the satisfaction of the OWNER.

Y. Quality Assurance (QA): Means measures taken by the CQA Consultant to independently assess if the contractor is in compliance with the Contract Documents for the project.

Z. Quality Control (QC): Means measures taken by the CONTRACTOR to determine compliance with the requirements for materials and workmanship as stated in the Contract Documents.

AA. Record Documents: A complete set of Contract Documents marked such that any field changes are readily identified. These Record Documents shall be maintained by the CONTRACTOR on-Site, and upon Contract completion, shall be sealed and provided to the OWNER.

AB. Referenced Standard: A recognized standard which is identified in a Specification and incorporated by reference.

AC. Schedule of Values: The CONTRACTOR’s itemized listing of activities of the Work, set forth, in a form acceptable to the OWNER, which describes the CONTRACTOR’s allocation of the Contract Price by activity. These same activities shall be identical to those listed in the CONTRACTOR’s progress schedule.

AD. Shop Drawings: All drawings, diagrams, illustrations, schedules, and other data which are specifically prepared by or for the CONTRACTOR to illustrate some portion of the Work; and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams, and other information prepared by a Supplier, and submitted by the CONTRACTOR to illustrate material or equipment for some portion of the Work, and that must be maintained on-site.

AE. Substantial Completion: The Work (or a specified part thereof) has progressed to the point where, in the opinion of the OWNER as evidenced by the OWNER’s definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that final payment is due. The terms “substantially complete” and “substantially completed” as applied to any Work refer to Substantial Completion thereof.

AF. Successful Bidder: The Bidder to whom the OWNER makes an award.

AG. Supplier: A manufacturer, fabricator, distributor, material man, or vendor.

AH. Technical Specifications/Specifications: Those portions of the Bidding Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto. In particular, Technical Specifications includes all Divisions, inclusive, of the Contract Documents.

AI. Transportation and Handling: All material shall be shipped, delivered, and stored in the manufacturer’s undamaged crating and packaging, except as otherwise approved by the ENGINEER. All materials shall be protected and stored off the

ground on blocking, or pallets, and shall be covered as appropriate. All material shall be protected from damage due to weather, vandalism, etc.

AJ. Work: The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, as required by the Contract Documents.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

*****END OF SECTION*****

SECTION 01041

PROJECT COORDINATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Management of the Project (Work) shall be through the use of a logical method of construction planning, inspection, scheduling, and cost value documentation.

B. The Work under this section includes all inspections and coordination by the CONTRACTOR necessary for the proper and complete performance of the Work.

C. This Section applies to the Work of every division and every section of these Specifications.

1.02 SITE CONDITIONS

A. Inspection

1. Prior to performing any Work under a Section, the CONTRACTOR shall carefully inspect the installed Work of other trades, and shall verify that all such Work is complete to the point where the Work under that Section may properly commence.
2. The CONTRACTOR shall verify that all materials, equipment, and products to be installed under a section will be installed in accordance with the Contract Documents and pertinent reviewed Shop Drawings.

B. Discrepancies

1. In the event of a discrepancy, immediately notify the OWNER and ENGINEER.
2. Do not proceed with installation in areas of discrepancy until all related discrepancies have been fully resolved.

C. Mobilization

1. Cooperate with the OWNER and CQA Consultant in allocation of mobilization areas, field offices, sheds, access, traffic, and parking facilities.
2. During construction, coordinate use of Site and facilities through the OWNER and CQA Consultant.
3. Comply with the Contract Documents, and coordinate with the OWNER and CQA Consultant for intra-project communications, submittals, reports and records, schedules, coordination, drawings, and resolution of ambiguities and conflicts.
4. Comply with the instructions of the OWNER and CQA Consultant for use of temporary utilities and construction facilities.
5. The CONTRACTOR shall provide field engineering, including surveying, and layout in accordance with Section 01050, and shall coordinate such activities with the CQA Consultant.

1.03 COORDINATION WITH OTHERS

A. Carefully schedule and coordinate the Work with all suppliers, utility companies, SUBCONTRACTORs, and other trades to ensure proper and adequate interface

of the Work of other trades and SUBCONTRACTORs with the Work of every Section of these Specifications.

B. The CONTRACTOR shall coordinate operations with all utility companies in, or adjacent to, the area of the CONTRACTOR's Work. The CONTRACTOR shall require said utility companies to identify their property in the field, and to provide drawings as necessary to locate them.

C. The CONTRACTOR shall coordinate operations with the INSTALLER working under separate contract to the OWNER.

D. The CONTRACTOR shall coordinate the Work with the requirements for quality control and quality assurance testing by the CQA Consultant. The CONTRACTOR shall provide access to the Work for inspection, and shall stop portions of the Work as necessary to allow for inspection.

1.04 SCHEDULES

A. The CONTRACTOR shall submit the initial Construction Schedule to the OWNER and ENGINEER for review in accordance with Section 01300 of these Specifications. After review, the CONTRACTOR shall revise and resubmit, if necessary, the Construction Schedule to the OWNER for approval.

B. During the progress of the Work, the CONTRACTOR shall revise and resubmit the Construction Schedule as requested by the OWNER, ENGINEER, and/or CQA Consultant and in any case, at least monthly. Submit a revised Construction Schedule with each Application for Payment.

C. The CONTRACTOR shall prepare all schedules using Microsoft Project, or equivalent software program, as favorably reviewed by the OWNER. The CONTRACTOR's schedule shall be resource (labor and equipment) loaded, show critical path, start and end dates, and float time of various stages of the work. Copies shall be provided in hard copy and electronically (i.e., via e-mail and/or computer file), as requested by the OWNER.

1.05 OTHER COORDINATION

A. CONTRACTOR shall submit requests for clarification of the Contract Documents through the ENGINEER. The ENGINEER may provide further coordination with the CQA Consultant.

B. Process requests for Change Orders through the OWNER.

C. Deliver closeout submittals for review, and preliminary inspection reports for transmittal, to the OWNER.

D. Notify the OWNER when the Work is considered substantially complete. Accompany the OWNER and CQA CONSULTANT on a preliminary final inspection.

E. Comply with the instructions of the OWNER for completion of any items of the Work determined not to be substantially complete by the preliminary final inspection.

F. Provide Record Documents in accordance with Section 01720 of these Specifications.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

*****END OF SECTION*****

SECTION 01050

FIELD ENGINEERING/SURVEYING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Work under this Section includes all surveying necessary for accurate location of all features of construction, establishing all proposed grades, reporting of data in hard copy, and Professional Land Surveyor (PLS) certification.

B. The CONTRACTOR shall be responsible for all surveys and calculations for layout of Work. The OWNER will provide the CONTRACTOR with an electronic version of the Contract Drawings for use by the CONTRACTOR to establish survey control, grades stakes, and other required control in the field. Any additional pre-construction documentation needed by the CONTRACTOR to properly perform the Work shall be provided by the CONTRACTOR at the CONTRACTOR's expense.

C. The CONTRACTOR shall employ a surveyor licensed in the Commonwealth of Pennsylvania to provide the surveying functions necessary for the proper construction of the Work. The CONTRACTOR shall be responsible for the layout of all required control points, lines, grades, and levels necessary for the proper construction and testing of the work called for by the Contract Drawings and Specifications, at no additional cost to the OWNER. Survey control shall include, but shall not be limited to maintaining appropriate trench and pipe alignments and slopes and the placement of specified thicknesses of embedment and backfill materials.

D. The OWNER shall contract directly an independent surveyor to verify the CONTRACTOR's surveyor's layout as needed for construction quality assurance, to perform record survey of each completed layer or Work item, and to calculate quantities for payment.

1.02 SUBMITTALS

A. CONTRACTOR shall submit for approval the name, address, and telephone number of the Surveyor to the OWNER prior to initiation of survey work. The CONTRACTOR's surveyor shall be qualified, have previous experience in this type of construction, and shall be a Professional Land Surveyor registered in the State of Delaware. The surveyor shall also have a minimum of two years experience in construction surveying layout with a successful record of performing horizontal and vertical control requirements as stated in the Contract.

B. The CONTRACTOR shall submit documentation verifying the accuracy of the survey and Work to the OWNER upon request.

C. Upon completion of the Work, a complete set of Record Documents for all construction work must be submitted by the CONTRACTOR to the OWNER for review and acceptance under the provisions of Section 01700. Copies of all required survey data, calculations, and summary tables shall be submitted, as requested, signed by a Professional Land Surveyor licensed in the State of Delaware. If insufficient detail is provided to document proper completion of the Work, the CONTRACTOR shall provide additional record survey information at no additional cost to the OWNER.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 SURVEY REQUIREMENTS

A. Provide field engineering services. Use recognized engineering survey practices.

B. Establish elevations, lines, and levels. Locate and layout by instrumentation and similar appropriate means:

1. Existing underground pipes and/or structures to be modified or connected to; or are located in such manner as to affect any portion of the Work. Include depths to pipe to assist with the progression of excavation.
2. Line and grade for construction stakeout to verify the quantities included in Applications for Payment.

C. All horizontal and vertical control coordinates (i.e., Northings, Eastings, and elevations) of benchmarks and survey control points shall be determined (and recorded) with a maximum permissible error of ±0.01 foot in any horizontal coordinate, and ±0.01 foot in any vertical coordinate.

3.02 CONSTRUCTION LAYOUT

A. The OWNER's surveyor will provide a survey base line and bench marks for construction purposes as required for each area of work. The CONTRACTOR shall preserve and protect all permanent benchmarks and control points during construction operations. Should any of these bench marks or control points be destroyed during construction, the CONTRACTOR shall replace the damaged item at no cost to the OWNER and shall provide new survey information to the OWNER's surveyor. The CONTRACTOR shall assume the entire expense of rectifying work improperly constructed due to failure to maintain and protect such established survey points and bench marks.

B. The CONTRACTOR shall reference all survey and data reference points to permanent benchmarks and record the locations of survey control points, with horizontal and vertical data, on the Record Documents.

C. The CONTRACTOR is responsible for verification of the information provided by the OWNER before proceeding with layout the Work. If discrepancies are discovered, notify the OWNER immediately. The CONTRACTOR shall verify layouts periodically during construction by the same means as the original layout.

D. The CONTRACTOR shall be responsible for the layout of all grid coordinate locations, lines, grades, and levels necessary for the proper construction and testing of the Work called for by the Drawings and Specifications, at no cost to the OWNER. Survey control shall include, but not limited to, maintaining appropriate slopes within each disposal cell and the placement of specified thicknesses of soils.

E. The CONTRACTOR is advised that over-excavation areas may be below groundwater and should take this into account during layout.

F. The CONTRACTOR shall be responsible for removing and accounting for all grade stakes located within the area designated for installation of geosynthetics. Any areas which, in the opinion of the CQA Consultant, may contain unremoved grade stakes shall be investigated by excavating and repairing the area in question, at the CONTRACTOR's expense, regardless of the investigation results.

3.03 RECORD SURVEYS

A. The OWNER shall employ a Professional Landfill Surveyor licensed in the State of Delaware to provide all surveys necessary for the preparation of Record Drawings for inclusion in the Final Certification of Construction Report to be submitted to the Delaware Department of Natural Resources and Environmental Conservation (DNREC). The CONTRACTOR shall cooperate fully with the OWNER's surveyor for this Work.

B. The CONTRACTOR shall cooperate fully with OWNER's surveyor to allow for verification and record surveying. The CONTRACTOR shall be responsible for notifying the OWNER and/or CQA Consultant, as agreed to prior to construction, to schedule required record surveys by the OWNER's surveyor in advance of completion of a Work item or layer.

C. No Work shall be covered until the record survey has been performed, and the lines and grades are determined to meet the requirements of the Contract Drawings and Specifications. If the Work has been covered before surveying has taken place, this portion of the Work shall be uncovered, surveyed, and recovered at the CONTRACTOR's sole expense. Any damages to Work that occur as a result of uncovering the material for survey shall be at the CONTRACTOR's sole expense.

D. The following surveys shall be performed at a minimum:

1. Pre-existing conditions plan prior to all earth disturbance activities;
2. Post-excavation grades for limits of over-excavation;
3. Top of compacted structural fill subgrade;
4. Top of drainage layer/protective cover;
5. Centerline of anchor trenches and liner system tie-in locations;
6. All installed stormwater management structures.
7. All gas and leachate collection piping, including connections to existing lines, valve locations and any reducers, elbows, tees, flanges, etc..

3.04 SURVEY TOLERANCES

A. The following survey tolerances shall apply:

1. Top of compacted subgrade: -0.0 to + 0.1 feet with minimum slopes and dimensions as defined on the Contract Drawings;
2. Top of structural backfill grade: the Contract Drawings
3. Top of drainage layer/protective cover: -0.0 to + 0.1 feet with minimum slopes and dimensions as defined on the Contract Drawings;
4. For all gas and leachate collection piping (buried or exposed), a minimum construction survey tolerance of 0.01 foot for invert elevations with minimum slopes and dimensions as defined on the Contract Drawings; and,
5. For channels, a minimum construction survey tolerance of 0.01 foot for invert elevations with minimum slopes and dimensions as defined on the Contract Drawings.

B. The CONTRACTOR shall amend/adjust any areas which are found to be out of tolerance until survey indicates that the tolerances have been satisfied.

3.05 SURVEYS FOR MEASUREMENT FOR PAYMENT

A. Method of measurement and payment for unit prices are specified below.
   1. Final measurement of bid items for contractual payment will be determined by a survey performed by the OWNER's surveyor, licensed in the State of Delaware or as agreed to by the OWNER and CONTRACTOR.
   2. All payment items bid on a lineal foot basis shall be measured along the centerline of the installed structure. For trenches, the payment length will be measured to the blind flanges installed at the termination point or to the connection point with another trench type. For channels, the payment length will be measured from the upstream and downstream channel terminations.
   3. All payment items bid on an area basis shall be determined from the measured true areas of the completed survey.
   4. All payments items bid on in cubic yards shall be based on the difference between pre and post construction surveys performed by the OWNER's surveyor.

B. Basis of Payment.
   1. The basis of payment shall be on a unit price basis per bid item as supplied by the CONTRACTOR on the Schedule of Values with additions or deletions for non-lump sum items calculated from the aforementioned surveys and respective unit prices.
   2. Any requests for additions or deletions of work not defined in the Contract Documents which may result in an addition or deletion to the Contract price must have prior approval from the OWNER as evidenced by a fully completed Work Directive Change signed by both parties. The CONTRACTOR shall accept payment in full at the Contract unit prices for the actual quantities of work performed. No allowance will be made for the anticipated profits.
   3. The OWNER may eliminate any items from the Contract should it be found unnecessary for the proper completion of the contracted work. Such action shall in no way invalidate the Contract, and no allowances will be made for eliminated items in the final payment to the CONTRACTOR.

*****END OF SECTION*****

SECTION 01200

PROJECT MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Work under this Section includes all scheduling and administering of Pre-Construction and Progress Meetings, as specified herein, as necessary, for the proper and complete performance of the Work.

B. Scheduling and administration by the CQA Consultant shall include the following:

1. Prepare an agenda for each meeting;
2. Make time arrangements for the meetings;
3. Preside at the meetings;
4. Record minutes, and include significant proceedings and decisions; and,
5. Distribute copies of the minutes to participants within five (5) working days after each meeting.

C. The CONTRACTOR shall make physical arrangements for meetings. Representatives of the CONTRACTOR, subcontractors, installers, and suppliers attending the meetings shall be qualified and authorized to act on behalf of the entity each represents. The OWNER and/or CQA Consultant will ascertain that the Work is expedited consistent with the Contract Documents and the Construction Schedule.

1.02 PRE-CONSTRUCTION MEETING

A. The OWNER, ENGINEER, and/or CQA Consultant shall schedule the Pre-construction meeting following issuance of the Notice to Proceed.

B. Representatives of the following parties are to be in attendance at the meeting:

1. OWNER;
2. CONTRACTOR and Superintendent;
3. Major subcontractors;
4. Representatives of governmental or regulatory agencies, as appropriate;
5. ENGINEER; and,
6. CQA Consultant.

C. The agenda for the Pre-construction meeting shall include, at a minimum, the following:

1. Distribute and discuss a list of major subcontractors/suppliers and a tentative Construction Schedule;
2. Identification of critical path work sequencing;
3. Designation of responsible personnel and emergency telephone numbers;
4. Processing of Field Orders and Change Orders;
5. Schedule for submission of Shop Drawings, product data and samples;
6. Format for Application for Payment, submittal cutoff date, pay date and retainage;
7. Procedures for maintaining Record Documents;
8. Use of premises, including office and storage areas, and the requirements of the OWNER, and regulatory agencies;

9. Major equipment deliveries and priorities;
10. Site-specific Health and Safety Plan requirements;
11. Security procedures;
12. Housekeeping procedures;
13. Work hours; and,
14. Site access, traffic maintenance and control, and laydown/storage areas.

1.05 PROGRESS MEETINGS

A. The OWNER shall schedule regular weekly (or other appropriate frequency) meetings to be held on-Site.

B. Hold meetings as the progress of the Work dictates.

C. The meetings shall be held at the Site in offices provided by the CONTRACTOR.

D. Representatives of the following parties are to be in attendance at the progress meetings:

1. OWNER;
2. CONTRACTOR and Superintendent;
3. Major subcontractors as pertinent to the agenda;
4. ENGINEER, as necessary;
5. CQA Consultant; and,
6. Representatives of governmental or other regulatory agencies, as appropriate.

E. The minimum agenda for Progress Meetings shall include the following:

1. Review and approve minutes of previous meetings;
2. Review Work progress since last meeting;
3. Discuss field observations, problems, and decisions;
4. Review proposed changes for their effect on the Construction Schedule and completion date;
5. Review off-Site fabrication problems and product delivery schedule;
6. Review the CONTRACTOR's measures and procedures for correction of defective work, if applicable;
7. Review submittal schedule; expedite as required to maintain Construction Schedule;
8. Review QC and QA test results;
9. Status of record survey documentation;
10. Review with the CQA Consultant the anticipated days during the upcoming work period that the Contractor's surveyor will be on-site;
11. Maintenance of quality and work standards; and,
12. Review construction safety issues.

1.06 APPLICATION FOR PAYMENT MEETINGS

A. Schedule meeting for Applications for Payment as required by the Contract Documents, or as requested.

B. Representatives of the following parties are to be in attendance at the meetings:

1. OWNER;
2. CONTRACTOR;
3. CQA Consultant, as appropriate; and,
4. Subcontractors, as appropriate.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

*****END OF SECTION*****

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Submittals required hereunder and elsewhere in the Contract Documents, shall be submitted by the CONTRACTOR to the ENGINEER.

B. Prior to mobilization to the Site and within ten (10) business days after the date of commencement as stated in the Notice to Proceed (except where noted otherwise in these Specifications), the CONTRACTOR shall submit to the ENGINEER:

1. Detailed Site-specific Health and Safety Plan developed in accordance with all applicable laws and regulations, OSHA 29 CFR 1910 and 1926, and Section 01564 of these Specifications.
2. Construction Schedule that indicates the starting and completion dates of the various stages of the Work, resource (labor and equipment) loading, float time, and critical path analysis using Microsoft Project, or equivalent software program as favorably reviewed by the OWNER.
3. A preliminary schedule of submittals. The schedule should include Shop Drawing, sample, and proposed substitute or “or equivalent” submittals. The CONTRACTOR shall thoroughly read each section of the Specifications, carefully review the Contract Drawings, and reference the appropriate section of the Specifications for each submittal. Submittals comprising the schedule shall indicate revision number and date.
4. List of potential applicable permits and approvals, which may be required to perform the Work.
5. Erosion and Sedimentation Control Plan in accordance with Section 02370 of these Specifications.
6. Qualifications of all subcontractors and Materials Testing Laboratories.
7. Qualifications of the CONTRACTOR, including the Project Manger and Superintendent, and all major subcontractors.
8. A separate listing of the substitutions the CONTRACTOR proposes.

C. Any details deemed by the CONTRACTOR to be required for the Work, but not indicated in the Contract Documents, shall be submitted by the CONTRACTOR for review by the ENGINEER at least 25 calendar days prior to the construction of that portion of the Work. Identifying any such details is the responsibility of the CONTRACTOR.

D. All submittals must be provided to the ENGINEER for favorable review within 60 calendar days of the Notice to Proceed.

1.02 SUBMITTAL PROCEDURES

A. Furnish at least five (5) copies for each Submittal. The ENGINEER will retain four copies, and return one (1) copy of the submittal to the CONTRACTOR. If the CONTRACTOR wishes to receive more than one (1) copy of the reviewed submittal, submit additional copies beyond the minimum five (5) copies, up to a maximum of eight (8) copies.

B. Submittals, as used herein, shall be understood to include detailed signed calculations; fabrication, installation, and erection drawings; lists; graphs; operating instructions; catalog sheets; data sheets; information from manufacturer or fabricator; and all other similar items.

C. All Shop Drawing submittals shall be accompanied by a submittal transmittal form acceptable to the ENGINEER. Any submittal not accompanied by such a form, or where all applicable items on the form are not completed, will be returned to the CONTRACTOR without review.

D. The OWNER may elect to establish a secure, password-protected, project web page for the project. If this web page is established, the CONTRACTOR's submittals shall be provided to the ENGINEER in electronic (.pdf) format, in addition to the paper copies required by Article 1.02.A.

1.03 GENERAL REQUIREMENTS FOR SUBMITTALS

A. A separate transmittal form shall be used for each specific item or class of material or equipment for which a submittal is required. Transmittal of a submittal of various items using a single transmittal form will be permitted only when the items taken together constitute a manufacturer's "package" or are so functionally related that expediency indicates review of the group or package as a whole. A multiple-page submittal shall be collated into sets, and each set shall be stapled or bound, as appropriate, prior to transmittal to the ENGINEER.

B. Submittals must be clearly legible. When only a particular portion of a standard-issue material, such as a manufacturer's catalog or data sheet, is relevant to a submittal, the relevant portion(s) must be clearly indicated on all copies and all non-relevant portion(s) must be struck through on all copies.

C. At a minimum, submittals should contain the following information on the submittal title block or label:

1. Project name;
2. Date of submittal;
3. Name and address of ENGINEER;
4. Name and address of CONTRACTOR;
5. Name and address of SUBCONTRACTOR;
6. Name and address of supplier;
7. Name and address of manufacturer;
8. Submittal number or other unique identifier, including revision identifier;
9. Number and title of appropriate specification section(s);
10. Drawing number and detail references, as appropriate;
11. Location(s) where product is to be installed, as appropriate, and;
12. Other necessary identification.

D. Except as may otherwise be provided herein, the ENGINEER will return each submittal to the CONTRACTOR with its comments noted thereon, within 15 calendar days following their receipt by the ENGINEER. One (1) copy will be returned to the CONTRACTOR, plus any extra copies submitted by the CONTRACTOR, as described in Article 1.02A above. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable submittal to the ENGINEER by either the first or second submission of a submittal item. The OWNER reserves the right to withhold monies otherwise due the CONTRACTOR to cover additional costs of the review beyond the second submittal. Any

consequences or delays due to unacceptable submittals or resubmittals will not be cause for extensions in schedule or additional cost to the OWNER.

E. If the submittal is returned to the CONTRACTOR marked “NO EXCEPTIONS TAKEN,” formal revision and resubmission of said submittal will not be required.

F. If the submittal is returned to the CONTRACTOR marked “MAKE CORRECTIONS NOTED,” formal revision and resubmission of the submittal will not be required. Record Documents must reflect corrections.

G. If the submittal is returned to the CONTRACTOR marked “AMEND-RESUBMIT,” the CONTRACTOR shall revise the submittal and/or provide additional information as requested, and resubmit the required number of copies of the revised submittal to the ENGINEER.

H. If the submittal is returned to the CONTRACTOR marked “REJECTED-RESUBMIT,” the CONTRACTOR shall revise the submittal and resubmit the required number of copies of the revised submittal to the ENGINEER.

I. Fabrication of an item may begin only after the ENGINEER has favorably reviewed the pertinent submittals, and returned the applicable submittals to the CONTRACTOR marked either “NO EXCEPTIONS TAKEN” or “MAKE CORRECTIONS NOTED.” Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents, and shall not be taken as the basis of claims for extra work, additional payment, or delays. Payment for fabricated items will not be made prior to favorable review of associated submittals by the ENGINEER.

J. All CONTRACTOR submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR, prior to submission to the ENGINEER. Each submittal form shall be dated, signed, and certified by the CONTRACTOR, as being correct and in conformance with the Contract Documents, unless indicated otherwise. In the case of Shop Drawings, each copy shall be so dated, signed, and certified. The ENGINEER will not review any CONTRACTOR submittals, which have not been so certified by the CONTRACTOR, or are incomplete, or not well-organized or indexed. All non-certified, incomplete, or unorganized submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

K. The ENGINEER’s favorable review of CONTRACTOR’s Shop Drawing submittals shall not relieve the CONTRACTOR of the entire responsibility for the correctness of details and dimensions, and for the overall adequacy of the submitted design, product, method, process, or appurtenance. The CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in the CONTRACTOR’s submittals. The CONTRACTOR shall be responsible for the dimensions and the design of adequate connections and details, and for provision of all items and appurtenances necessary for complete and satisfactory Work.

1.04 CONTRACTOR’S PROGRESS SCHEDULE SUBMITTALS

A. All Construction Schedule submittals by the CONTRACTOR shall include paper plots and electronic files, for use in schedule analysis by the OWNER, ENGINEER and/or CQA Consultant.

B. The CONTRACTOR shall revise the Construction Schedule, as required, and resubmit the schedule with each Application for Payment. Any Application for Payment submitted without an up-to-date Construction Schedule will not be processed.

C. The CONTRACTOR shall show the complete sequence of construction by activity, identifying the Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, critical path, and duration.

D. The CONTRACTOR shall indicate the estimated percentage of completion for each activity with each Application for Payment.

E. The CONTRACTOR shall indicate the submittal dates required for Shop Drawings, product data, samples, and product delivery dates, including those furnished by the OWNER, if any.

1.05 PROPOSED SUBSTITUTES OF "OR EQUIVALENT" ITEMS

A. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item, or the name of a particular supplier, the naming of the item is intended to establish the type, function, and quality required. If the words "or equal" or "or equivalent" are not present, no substitutes will be allowed, whether or not such disallowance is specifically stated. If the name is followed by the words "or equal" or "or equivalent" indicating that consideration of a substitution is permitted, materials or equipment of other suppliers may be accepted by the ENGINEER if sufficient information is submitted by the CONTRACTOR to allow the ENGINEER to determine that the material or equipment proposed is equivalent, or equal to, that named, subject to the following requirements:

1. The burden of proof as to the type, function, and quality of any such substitute material or equipment shall be upon the CONTRACTOR.
2. The ENGINEER will be the sole judge as to the appropriateness and type, function, and quality of any such substitute material or equipment and the ENGINEER's decision shall be final.
3. The ENGINEER may require the CONTRACTOR to furnish, at the CONTRACTOR's expense, additional data about the proposed substitute.
4. The OWNER may require the CONTRACTOR to furnish, at the CONTRACTOR's expense, a special performance guarantee, or other surety, with respect to any substitution.
5. Acceptance by the OWNER and/or ENGINEER of a substitute item proposed by the CONTRACTOR shall not relieve the CONTRACTOR of the responsibility for full compliance with the Contract Documents, and for adequacy of the substitute item.
6. The CONTRACTOR shall be responsible for any resultant changes and all additional costs which the accepted substitution requires in the CONTRACTOR's work, the work of its subcontractors and of others, and shall effect such changes at the CONTRACTOR's expense. Such changes include, but are not limited to, changes in dimensions, locations, piping, fittings, clearances, electrical connections, sizing of equipment and appurtenant items, controls, alarms, and instrumentation.
7. All proposed substitutions shall be listed at the time of bidding and in the schedule of submittals as required by Article 1.01.B (3).

B. The procedure for review by the ENGINEER shall consist of the following:

1. If the CONTRACTOR wishes to furnish or use a substitute item of material or equipment, the CONTRACTOR shall make written application to the ENGINEER.
2. Unless otherwise provided by law or authorized in writing by the OWNER or ENGINEER, the substitution request shall be submitted with the Bid Proposal and again within the twenty (20) business day period after receiving Notice to Proceed.
3. Wherever a proposed substitute material or equipment has not been submitted within said period, or wherever the submission of a proposed substitute material or equipment has been judged to be unacceptable by the ENGINEER, the CONTRACTOR shall provide the material or equipment specified in the Contract Documents.
4. The CONTRACTOR shall certify that the proposed substitute will adequately perform the functions and achieve the results intended by the general design, be similar and of equal substance to that specified, and be suited to the same use as that specified.
5. The ENGINEER shall be allowed a reasonable time within which to evaluate each proposed substitute, which can be longer than the time period set forth in Article 1.03C herein above without providing any basis for an extension of time or additional costs. In any event, the ENGINEER will endeavor to complete his review in no more than twenty-five (25) calendar days from receipt of submittal.
6. As applicable, no Shop Drawing submittals will be made for a substitute item nor shall any substitute item be ordered, installed, or utilized without the ENGINEER's prior written favorable review of the CONTRACTOR's substitution request.
7. The ENGINEER will record the time and expenses required by the ENGINEER to evaluate substitutions proposed by the CONTRACTOR and to make changes in the Contract Documents occasioned thereby. Whether or not the ENGINEER favorably reviews a proposed substitute, the CONTRACTOR shall, if requested, reimburse the OWNER for the charges of the ENGINEER for evaluating each proposed substitute, except to the extent that there is a net savings in cost to the OWNER following adoption of the substitution.

C. The CONTRACTOR's application for a proposed substitute shall contain the following statements and/or information that will be considered by the ENGINEER in evaluating the proposed substitution:

1. The evaluation and acceptance of the proposed substitute will not prejudice the CONTRACTOR's achievement of substantial completion on time.
2. Whether acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitute.
3. Whether incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty.
4. The OWNER may determine that the proposed substitute requires approval of the Pennsylvania Department of Environmental Protection or other regulatory agency. Any delays resulting from the regulating agency's review and approval or failure to approve the proposed substitute shall not be the basis for CONTRACTOR claim for additional compensation and/or time.
5. All variations of the proposed substitute from that specified shall be identified.
6. Available maintenance, repair, and replacement service shall be indicated.

7. Itemized list of all costs that will result directly or indirectly from acceptance of such substitute, including cost of redesign and claims of other contractors affected by the resulting change.

D. Any tests performed by the ENGINEER or the CQA Consultant to verify acceptability of substitutes shall be at the CONTRACTOR's sole expense.

1.06 SAMPLES SUBMITTAL

A. As specifically required by the Contract Documents, the CONTRACTOR shall submit, at his expense, three (3) sets of samples (unless specified otherwise) of each such item or material to the ENGINEER.

B. Samples, as required herein, shall be submitted for acceptance a minimum of 30 calendar days prior to ordering such material, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.

C. All samples shall be individually, legibly, and indelibly labeled or tagged, indicating thereon all specified physical characteristics and Supplier's name. Upon receiving acceptance of the ENGINEER, one (1) set of the samples will be stamped and dated by the ENGINEER and returned to the CONTRACTOR and the remaining two (2) sets will be retained by the ENGINEER with one (1) set retained at the Site until completion of the Work.

D. Unless otherwise specified, all colors and textures of specified items will be selected by the OWNER from the manufacturer's standard colors and standard materials, products, or equipment lines.

1.07 RECORD DOCUMENTS

A. The CONTRACTOR shall keep and maintain at the Site, one set of Record Documents. The Record Documents shall document conditions encountered during construction that differ from those shown on the Contract Documents and as-constructed locations of elements of the project, as determined by survey. The CONTRACTOR shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the details represented in the Contract Documents, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or that were not indicated in the Contract Documents. Record Documents shall be supplemented by detailed sketches, as necessary or directed to fully indicate the Work as actually constructed. The Record Documents are the CONTRACTOR's representation of as-constructed conditions, including all revisions made necessary by Addenda, Change Orders, and the like, and shall be maintained up-to-date during the progress of the Work.

B. Record Documents shall be accessible to the OWNER, ENGINEER, and CQA Consultant at all times during the construction period and shall be delivered to the CQA Consultant upon completion of the Work.

1.08 MANUFACTURER'S INSTRUCTIONS

A. For all equipment, special items, and materials as specified in individual Sections of these Specifications, submit five (5) copies of the manufacturer's printed warranties, instructions for delivery, storage, assembly, installation, start-up,

adjusting, finishing, and spare parts list. All warranties shall be in the OWNER's name where applicable.

B. Identify conflicts between manufacturer's instructions and the Contract Documents.

1.09 MANUFACTURER'S CERTIFICATES

A. When specified in individual Sections of these Specifications, submit five (5) copies of manufacturer's certificates to the ENGINEER for review.

B. Indicate that the material or product conforms to or exceeds the specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product, if acceptable to the OWNER, unless current test results are called for in the Contract Documents.

D. For all equipment and specialist materials, submit manufacturer's Warranties and Certifications together with vendor confirmation of assignment of all warranty rights to the OWNER, including full warranty period commencing from the date of final completion and acceptance of the Work by the OWNER.

1.10 TECHNICAL MANUAL SUBMITTAL

A. The CONTRACTOR shall furnish the ENGINEER with five (5) identical sets of Technical Manuals, for all mechanical, electrical, and instrumentation equipment. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose leaf, and vinyl plastic hard cover binder suitable for bookshelf storage. A binder's ring size shall not exceed 3 inches. The contents of the Technical Manual(s) shall be well organized to the satisfaction of the OWNER, ENGINEER, and CQA Consultant. Subsections of the Technical Manual shall be separated by dividers. A table of contents shall be provided which indicates all equipment and related information bound in the Technical Manuals. An electronic copy shall be provided in the latest version of Microsoft Word or other standard software as appropriate.

B. For each item requiring submittal of a Technical Manual, the CONTRACTOR shall include the following:

1. Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.
2. Lubrication schedules, including the lubricant SAE grade and type, temperature range of lubricants, and including frequency of required lubrication.
3. Preventative maintenance procedures and schedules.
4. Parts lists, by generic title and identification number, complete with exploded views of each assembly.
5. Instructions for disassembling and reassembling.
6. Name and location of nearest supplier and spare parts warehouse.
7. Recommended troubleshooting procedures.
8. Electronic files of the Record Drawings, including all survey drawings in AutoCAD 2007 or more recent version.

C. All Technical Manuals shall be submitted in final form to the CQA Consultant not later than the 75 percent construction completion date. The CONTRACTOR shall correct all discrepancies or deficiencies identified by the OWNER, ENGINEER or CQA Consultant, in the Technical Manual(s) and shall resubmit the documents within twenty-eight (28) calendar days from the date of written notification of the deficiencies.

1.11 SPARE PARTS LIST SUBMITTALS

A. The CONTRACTOR shall furnish the OWNER with five (5) identical sets of Spare Parts Lists for all mechanical, electrical, and instrumentation equipment, two (2) of which shall be transmitted to the operator. The Spare Parts Lists shall include the current list price of each spare part. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to facilitate the operator in ordering. The CONTRACTOR shall cross-reference the spare parts list(s) to the equipment numbers designated in the Contract Documents. The spare parts list(s) shall be bound in standard size, 3-ring, loose leaf, and vinyl plastic hard cover binders suitable for bookshelf storage. A binder's ring size shall not exceed 3 inches.

1.12 EXCAVATION SUPPORT PLAN SUBMITTAL

A. Prior to commencement of any Work requiring excavation to a depth in excess of the threshold limits of the OSHA regulations, the CONTRACTOR shall submit a detailed Excavation Support Plan to the ENGINEER for review. This plan shall be designed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania. The Plan should include the design of any sheeting, shoring, bracing, sloping, or equivalent support method, in accordance with the requirements of Section 02220 of these Specifications. If so required, the Plan shall include appropriate measures to provide dewatering. Excavation requiring support shall not be initiated until the ENGINEER has favorably reviewed the CONTRACTOR's Plan. Favorable review of this Plan by the ENGINEER shall not alleviate the CONTRACTOR of responsibility for all aspects of safety and compliance with applicable regulations during excavations.

1.13 LIST OF EQUIPMENT AND PERSONNEL

A. The CONTRACTOR shall provide the OWNER with a listing of all construction equipment and construction personnel tabulated by day.

1. The list of construction equipment shall include the manufacturer, model number, hours used, and component of the Work performed for all equipment on-Site. The initial submittal shall include hourly and weekly rental rates for each piece of equipment, as well as the hourly operating costs thereof.
2. The list of construction personnel shall include employee name, job classification, hours worked, and component of the Work performed for all of the CONTRACTOR's employees and subcontractors that are not otherwise considered Site overhead.
3. Health and Safety training certifications in accordance with the requirements of Section 01564 of these Specifications.

B. The listing of construction equipment and construction personnel shall be submitted with each Application for Payment or submitted to the OWNER for review prior to mutual agreement regarding the Application for Payment. Any Applications for Payment without a complete listing of equipment and personnel will not be processed.

1.14 DAILY REPORTS

A. The CONTRACTOR shall prepare daily reports summarizing on-Site activities.

B. Daily reports shall include as a minimum the following information:

1. Weather conditions;
2. Active work area;
3. Crew description;
4. Subcontractor activity;
5. Equipment operating;
6. Hours worked;
7. Work performed;
8. Problems and resolutions;
9. Health and safety issues;
10. Visitors;
11. Photographs taken;
12. Sampling/testing performed; and,
13. Air monitoring data.

C. Daily reports shall be submitted to the OWNER the first working day following the report day.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

*****END OF SECTION*****

SECTION 01400

QUALITY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Work under this Section describes the CONTRACTOR's responsibility for providing all Quality Control testing and inspection as necessary for the proper and complete performance of the Work.

B. The CONTRACTOR shall comply with the Quality Control testing and inspection requirements herein, and as otherwise specified in individual Sections of these Specifications.

1.02 SUBMITTALS

A. CONTRACTOR shall provide the qualifications of the subcontractor/personnel providing quality control for the Work.

B. The results of the quality control testing data shall be provided in accordance with the requirements of Specification 01300.

1.03 RELATED SECTIONS

A. 01300 – Submittals

B. 02055 – Soils

C. 02071 – Geotextile

D. 02072 – Geosynthetic Clay Liner

E. 02075 – Geomembrane

F. 02081 – Landfill Gas High Density Polyethylene (HDPE) Pipe and Fittings

G. 02220 – Excavation

1.04 QUALITY CONTROL OF INSTALLATION

A. The CONTRACTOR shall monitor Quality Control over products, services, Site conditions, and workmanship for conformance with the Contract Documents.

B. The CONTRACTOR shall comply fully with manufacturer's instructions, including each step in any prescribed sequence.

C. Should the manufacturer's instructions conflict with the Contract Documents, the CONTRACTOR shall request clarification from the ENGINEER prior to proceeding.

D. The CONTRACTOR shall comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. The CONTRACTOR shall perform Work with persons qualified to produce workmanship of specified quality.

1.05 REFERENCES

A. Conform to the referenced standards that are in effect as of the date for receiving bids.

B. Obtain copies of referenced standards when required by the Contract Documents.

C. Should specified referenced standards conflict with the Contract Documents, request clarification from the ENGINEER before proceeding.

D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by either mention or inference in any referenced standard.

1.06 INSPECTION AND TESTING LABORATORY SERVICES

A. The CONTRACTOR is responsible for performing and documenting all Quality Control tests. The OWNER will appoint, employ, and pay for services of a CQA CONSULTANT to perform quality assurance inspection and testing.

B. The CQA CONSULTANT and the CONTRACTOR will perform inspections, tests, and services as required by these Specifications.

C. Reports will be submitted by the CONTRACTOR to the OWNER and CQA CONSULTANT, indicating observations and results of tests and indicating compliance or non-compliance with the Contract Documents.

D. The CONTRACTOR shall cooperate with the CQA CONSULTANT to furnish samples of materials, design mixes, equipment, tools, storage and assistance as requested.

1. Notify the CQA CONSULTANT at least 24 hours prior to the expected time for operations requiring quality assurance services.
2. Make arrangements with the CQA CONSULTANT, and pay for additional samples and tests required for the CONTRACTOR's use.

E. Re-testing or re-inspection required because of deficiencies in the Work, shall be performed by the CONTRACTOR on instructions by the OWNER or CQA CONSULTANT. Payment for re-testing or re-inspection may be charged by the OWNER to the CONTRACTOR by deducting inspection or testing charges from the Contract Price.

F. The CONTRACTOR is responsible for the coordination of the sequence of activities to accommodate the CQA CONSULTANT with a minimum delay and to avoid the necessity of removing and replacing construction to accommodate testing and inspection. This includes scheduling time for tests, inspections, collection of samples, and other similar activities which are required by the Specifications.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION

A. In general, the CONTRACTOR shall upon completion of testing, inspecting, sample collection, and similar services will repair any damage construction surfaces. The CONTRACTOR shall provide the necessary materials and comply with installation requirements specified in other Specification Sections.

B. Protect construction exposed by or for quality assurance service activities.

C. Any defective or substandard work or materials furnished by the CONTRACTOR which is discovered before the final acceptance of the Work, or during the subsequent guarantee period, shall be removed immediately by the CONTRACTOR even if it had been initially overlooked by the ENGINEER and recommended for payment. The CONTRACTOR shall substitute satisfactory work or materials for that rejected.

D. The CONTRACTOR is ultimately responsible for the repair and protection of the Work, regardless of the assignment of responsibility for quality control services.

*****END OF SECTION*****

SECTION 01562

DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall employ means and methods that keep airborne particulates to the minimum during construction. This includes providing all labor, equipment, machinery, and materials for the application of water or other appropriate preventative means or methods to maintain dust control and to minimize the potential for complaints from the public.

B. The CONTRACTOR shall comply will all applicable codes, ordinances, rules, regulations and laws of local, State, and Federal authorities having jurisdiction.

C. The CONTRACTOR shall provide a Competent Person to implement, supervise, and inspect all Work. The CQA CONSULTANT shall monitor implementation of the Work.

1.02 HEALTH AND SAFETY

A. Site workers shall not be exposed to respirable particulates caused by the performance of the Work in excess of applicable Federal and State standards.

B. Airborne particulates shall be monitored in accordance with the Site-specific Health and Safety Plan, and the requirements of Section 01564 of these Specifications.

1.03 RELATED SECTIONS

A. 01564 - Health and Safety Specifications for Construction

B. 02055 - Soils

C. 02100 - Site Preparation

D. 02110 - Site Clearing and Grubbing

E. 02210 - Site Grading

F. 02220 – Excavation

G. 02370 – Erosion and Sediment Control

PART 2 - PRODUCTS

2.01 GENERAL

A. Clean water shall be used for dust control. The CONTRACTOR is required to provide equipment to apply water for dust control that shall be obtained from on-site locations designated by the OWNER.

B. Dust control shall be applied immediately when conditions warrant and as directed by the OWNER or the CQA Consultant. A sufficient quantity of clean water and appropriate equipment shall be maintained on-site for immediate dust control use.

C. The use of calcium chloride or other chemical dust suppressants for dust control is not permitted on the Site.

PART 3 - EXECUTION

3.01 GENERAL

A. Watering equipment shall be used to minimize airborne particulate concentrations and shall consist of pipelines, tanker trucks, or other devices acceptable to the OWNER. This equipment shall be capable of applying a uniform spread of water over the ground surface. A suitable device for a positive shut-off and for regulating the flow rate of water shall be located so as to afford unhindered operator control.

B. The CONTRACTOR shall implement strict dust control whenever possible, including all temporary and permanent routes used for access to the work area. All haul roads used during execution of the Work shall be maintained by the CONTRACTOR.

C. Soil stockpiles shall be watered as necessary to prevent dust.

*****END OF SECTION*****

SECTION 01590

FIELD OFFICE AND STORAGE SPACE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall provide a field office (i.e., trailer) for the CONTRACTOR's own needs. The CONTRACTOR shall also provide secured storage space for the CONTRACTOR's needs.

B. The size of the CONTRACTOR's field offices and capacity of the storage areas shall be the responsibility of the CONTRACTOR, and shall be such that daily operations can be conducted without restrictions. Storage areas shall allow for access and orderly provision for maintenance and for inspection of products. The locations of the CONTRACTOR administrative, staging, and laydown areas shall be coordinated in the field by the OWNER.

C. The CONTRACTOR shall be responsible for all costs to install, maintain/service, and remove all temporary utilities for the duration of the project, including normal costs associated with electricity, telephone, facsimile machine, water, sewer, equipment maintenance, and maintenance service. The CONTRACTOR should arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

D. Costs or use charges for temporary facilities shall be included in the overall cost of the project, but considered as incidental for which payment is not measured or made.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All equipment, building materials, furnishings, and fixtures must be adequate for the required purposes.

B. Temporary Utility Installation

1. Arrange with the utility company and OWNER, for time when service can be interrupted, if necessary, to make connections for temporary services.
2. Connect temporary power service to OWNER's existing power source, as directed by the OWNER.

C. The CONTRACTOR shall be responsible for providing temporary toilets, wash facilities, and drinking water for use by the construction personnel. The CONTRACTOR shall be responsible for upkeep, cleaning, and supply of the sanitary and drinking facilities.

D. The CONTRACTOR shall provide temporary lighting, as required, that provides adequate illumination for construction operations, inspections, and traffic conditions, and should construction extend beyond daylight hours.

PART 3 - EXECUTION

3.01 PREPARATION

A. Field offices shall be placed at the staging area location shown on the Contract Drawings or as otherwise approved by the OWNER.

B. Prior to the placement or construction of the field offices, the areas shall be graded and covered with a layer of coarse aggregate as necessary to promote surface drainage away from the field offices in a manner approved by the OWNER.

3.02 INSTALLATION

A. The field office shall be installed on an adequate foundation and shall be level. Portable trailers shall be adequately anchored to prevent uplift in accordance with the supplier's recommendation or local building codes.

B. A parking area shall be located adjacent to the field office.

3.03 CONSTRUCTION

A. Portable or mobile buildings with raised floors shall be equipped with steps and landings at entrance doors including steps and handrails constructed in accordance with applicable Federal, State and local regulations.

B. Temperature transmission resistance of the office walls, ceiling, floors, and roof shall be compatible with occupancy and storage requirements.

C. The exterior materials shall be weather-resistant and acceptable to the OWNER.

D. The offices shall have adequate interior lighting and exterior lighting at the entrances and within the parking area.

E. CONTRACTOR shall keep the field trailer in presentable condition and perform routine cleaning.

3.04 CONTRACTOR OFFICE AND FACILITIES

A. The CONTRACTOR's office shall be large enough for the CONTRACTOR's needs, and shall provide adequate space for project meetings.

3.05 STORAGE AREA AND SHEDS

A. Size storage areas based on requirements of products to be stored. Allow for access and orderly provision for maintenance and for inspection of products.

3.06 TEMPORARY CONTROLS INSTALLED

A. The CONTRACTOR should maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the OWNER.

B. The CONTRACTOR should construct and maintain temporary roads adequate for construction operations. Follow the designated access routes to the work area(s) as indicated on the Construction Drawings.

C. The CONTRACTOR shall control dust generated during the performance of the Work. Water for dust control will be provided from an on-site source as directed by the OWNER or ENGINEER. Chemical dust suppressants will not be used.

D. The CONTRACTOR shall protect existing site structures to remain, including curbs, pavement, and utilities. Use the designated site limits on the Construction Drawings.

E. The CONTRACTOR shall provide temporary parking areas for construction personnel within the area designated site limits on the Construction Drawings.

F. The CONTRACTOR shall maintain excavations free of water, protect the site from puddling or running water, and furnish and install all required temporary erosion control facilities to comply fully with the Delaware Department Natural Resources and Environmental Conservation (DNREC) requirements and as called for in the Contract Documents.

G. The CONTRACTOR shall supply waste collection containers in sizes adequate to handle waste from construction operations. All waste is to be disposed of on-site in the areas designated by the OWNER. The CONTRACTOR shall maintain that area outside of the limits of work free from any waste materials, debris, and rubbish that are a direct result of work performed by the Contractor.

H. Temporary Erosion and Sedimentation Control: The CONTRACTOR shall provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties. The CONTRACTOR shall protect installed work, provide special protection where specified in individual specification sections, and provide temporary and removable protection for installed products. It shall be the responsibility of the CONTRACRTOR to minimize erosion of fugitive dust resulting from placed materials or material stockpiles by providing the proper materials and equipment to adequately seal the surface of such materials. At the request of the Engineer, the CONTRACTOR shall immediately install additional temporary protection including, but not limited to, additional silt fence, hay bales, or straw mulch a deemed necessary by the ENGINEER.

3.07 OPERATION, TERMINATION, REMOVAL

A. The CONTRACTOR shall enforce strict discipline in the use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintain facilities in good operating condition throughout the Project to achieve indicated results and avoid the possibility of damage.

C. Remove each temporary facility when need for its service has ended, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have delayed because of interference with temporary facilities. Repair any damaged areas, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

D. At completion of Work, remove buildings, utility services, trailers, and debris as directed by the OWNER and prior to the Substantial Completion inspection. Restore areas in accordance with instructions from the OWNER.

*****END OF SECTION*****

SECTION 01666

CLEANING AND TESTING OF HDPE PIPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish all labor, materials, tools, equipment and appurtenances required for the cleaning and testing of solid piping for the primary and secondary leachate collection pipes, leachate force main pipe, gas header line, waterline, and condensate pump station, and other piping systems installed by the CONTRACTOR as specified herein and in other Sections of these Specifications.

1.02 REFERENCES

A. National Fire Protection Association (NFPA)

1. NFPA 54 - National Fuel Gas Code
2. American Water Works Association Standard C600-77.

1.03 SUBMITTALS

A. Submittals shall include proposed testing procedures, including test medium and pressure, line segments and equipment included in the test, methods of isolating sections of the system, pressure monitoring techniques, and the certification form to be submitted to the ENGINEER.

PART 2 - PRODUCTS

2.01 GENERAL

A. Detergents, solvents, and other cleaning or testing materials shall be compatible with the materials of fabrication of the systems in which they are used. They shall not adversely affect the materials or mechanisms in the systems, and they shall be acceptable to equipment manufacturers/vendors. Detergents, solvents, and other cleaning agents shall also be non-flammable and compatible with the process streams to be handled by the systems in which they are used and shall not contain any chlorinated solvents.

B. Materials including blinds, gaskets, bolts, flanges, caps, gauges, and other equipment used in isolating segments of systems shall be compatible with the systems being cleaned or tested.

C. The CONTRACTOR may test piping using pneumatic or hydrostatic methods.

2.02 TEST MEDIUMS

A. The CONTRACTOR shall furnish all equipment, pipe connections, necessary piping, air supply, required labor and expenses to test piping systems. Test medium shall be as specified herein.

B. Provide bulkheads, flanges, valves, bracing, blocking, or other temporary sectionalizing devices that may be required.

2.03 TEST EQUIPMENT

A. The CONTRACTOR shall furnish all labor and equipment, including:

1. Polyethylene flange adaptor with PVC blind flange equal in size to the diameter of the inlet to the blower at the flare station.
2. Temperature gauge (0°C to 100°C) tapped and threaded into the blind flange.
3. Pressure gauge (0 to 15 psi) for testing of gas header piping.
4. Tire valve to release pipe pressure hose or water hose (for hydraulic testing).
5. Ball valve to release pipe pressure at test completion.
6. Polyethylene reducers to be used to adapt test flange to size of pipe being tested.
7. Air compressor shall provide adequate air supply for testing.
8. Pressurizing equipment shall include regulator set to avoid over-pressurizing and damaging otherwise acceptable pipe.

B. Gauges and chart recorders shall be calibrated to a National Bureau of Standards traced standard. Gauges and chart recorders shall have divisions not exceeding 2% of the test pressure. Provide verification and results of gauge calibration prior to (less than 60 days) and after Project completion.

PART 3 - EXECUTION

3.01 CLEANING

A. The CONTRACTOR shall provide and install temporary connections, strainers, and other equipment to thoroughly clean the piping systems before start-up. Cleaning shall include a thorough rinsing with water or blowout with air to remove sediments of HDPE shavings and other debris. The ENGINEER and CQA Consultant shall visually observe a clean piping system free of HDPE shavings and/or other debris prior to start-up. The CONTRACTOR shall minimize shavings and sediments to be cleaned from piping prior to start-up by following proper storage, handling, and installation procedures as specified in Section 02081 of these Specifications.

B. Piping shall be cleaned just prior to installation in accordance with Section 02081 of these Specifications and again prior to start-up. Cleaned piping material shall be protected against contamination by sealing open ends with pipe plugs, clear plastic sheets, metal foil, or other approved materials.

3.02 TESTING

A. General

1. The entire length of all pressurized piping and gravity lines shall be tested for tightness as described hereinafter.
2. The timing and sequence of testing shall be scheduled by the CONTRACTOR, subject to the favorable review by the ENGINEER and CQA CONSULTANT. The CONTRACTOR shall provide the ENGINEER and CQA Consultant two (2) working days notice prior to all testing.

B. The testing can commence when the following conditions are meet.

1. Pipe section to be tested is clean and free of dirt, sand, or other foreign material.
2. Plug pipe outlets with test plugs. Brace each plug to prevent blowouts.
3. Install temporary piping, fittings, and equipment. Add test fluid (air or water) slowly.
4. The section that is to be tested is placed in the trench location designated on the Contract Drawings.

B. The CONTRACTOR shall repair any leaks discovered during the testing sequence. All leaks shall be repaired, whether or not the leakage rate is within allowable limits. All repairs will be observed by the CQA Consultant.

C. All tests shall be made before piping is painted, covered, or otherwise concealed. The CONTRACTOR, at the CONTRACTOR's own expense, shall be uncover and retest any piping not satisfactorily tested in the presence of the CQA Consultant. Testing shall be conducted after laying or modifying of the piping systems and prior to backfilling and then repeated after final grading.

D. The CONTRACTOR may test no more than 1,000 foot long segments during each testing sequence fit one end of the pipe with a cap and the other end with the test apparatus.

E. The testing requirements for the respective systems shall include all those of NFPA 54, and applicable Laws and Regulations. All code-required inspection certificates shall be furnished to the ENGINEER and CQA Consultant.

F. Where the piping system is connected to equipment or components designed for operating pressures less than the test pressure, such equipment or components shall be isolated from the piping system by disconnecting them and capping the outlets.

G. The CONTRACTOR shall collect and dispose of liquids used for testing in a location approved by the OWNER.

3.03 PIPE TEST SCHEDULE

A. Environment for performing the required tests pre-installation.

1. Lay test segment in trench and allow pipe to reach constant or ambient temperature before commencing test.
2. Perform test during period when the pipe segment will be out of direct sunlight to minimize pressure changes as a result of temperature fluctuations.

B. Pneumatic Test

1. Apply test pressure of 10 psig to test segment for gas piping or 1.5 times the operating pressure of pump for the leachate force main, gas header, and primary and secondary leachate collection pipes.
2. Observe test pressure for 1 hour.
3. Pressure drop over 1 hour period shall not exceed 1%.
4. Correct pressure drop for temperature.
5. The maximum operating pressure is 35 psi, testing pressure is 53 psi.

C. Hydrostatic Test

1. Follow manufacturer's recommendations.
2. Apply test pressure of 10 psig to test segment for gas piping or 1.5 times operating pressure for leachate force main, gas header, and primary and secondary leachate collection pipes.
3. Observe test pressure for 1 hour.
4. Pressure drop over 1 hour period shall not exceed 1%.
5. Correct pressure drop for temperature.

D. Upon completion of each piping system or sub-system, clean and test the lines. All piping shall be tested:

1. After completion of a section or subsection prior to backfilling of trench.
2. After completion of entire system and after backfilling of trench.

3.04 TEST FAILURE

A. Perform the following when a pipe segment fails pre-installation testing.

1. Check the entire length of the pipe and fusions for cracks, pinholes, perforations, or other possible leakage points.
2. Check blocked risers and capped end for leakage.
3. Verify leaks by applying soap water solution and observe for bubble formation.

B. Repair and retest any piping system found to be leaking until results are satisfactory to the CQA CONSULTANT.

3.04 REPAIRS

A. All leaks shall be repaired regardless of whether or not the leakage rates are within allowable limits. The point or points of leakage shall be sought out and remedied by the CONTRACTOR at the CONTRACTOR's expense.

B. Repair methods must be satisfactory to the CQA Consultant.

3.05 FINAL ACCEPTANCE

A. No pipeline installation or hydraulic structure will be accepted until all leaks have been repaired. All repairs will be observed by the CQA Consultant.

B. All pressure testing will be performed in the presence of the CQA Consultant.

C. Testing for the final system test shall be performed on installed pipeline.

1. Perform in accordance with procedures for pre-installation testing.
2. Temporarily cap driplegs and perforated segments with fused polyethylene cap.
3. Locate test apparatus at inlet for blower for gas systems.
4. Locate test apparatus at treatment plant for leachate force main.

D. The CONTRACTOR shall provide the ENGINEER and CQA Consultant with written certification and test charts clearly identifying location of pipe being tested of equipment/system cleaning and testing in accordance with this Section. All

test data and documentation shall be provided to the CQA Consultant as part of the written certification.

E. Report each test in writing on the attached form included with this section and include the following information:

1. Location of failure segment.
2. Nature of leaks.
3. Details of repairs performed.
4. Retest results.

*****END OF SECTION*****Error! Bookmark not defined.

ATTACHMENT 1 TO SECTION 01666
FORM
PE PIPE PRESSURE TEST REPORT

PROJECT NAME/NO:	TIME:
CONTRACTOR:	DATE:

PERSON PERFORMING TESTS:

DESCRIPTION/LOCATION OF TEST SEGMENT (Pipe Diameter, Length, and SDRs):

T_i = Initial temperature in °C = _____ °C
P_I = Initial test pressure in psig = _____ psig
P_c = Initial pressure in psig corrected for temperature (T_t) at time 't'
t = Time in minutes from initiation of test
T_t = Temperature in °C at time 't'
P_t = Test pressure in psig at time 't'

$$P_c = \frac{(P_i + 14.7)(T_t + 273) - 14.7}{(T_i + 273)}$$

$$\text{Percent Pressure Drop} = \frac{P_c - P_t \times 100}{P_c}$$

TIME (min.)	T_t TEMP READING (°C)	P_t GAUGE READING (psig)	P_c CORRECTED PRESSURE (psig)	PRESSURE DROP (%)
0				
20				
30				
40				
50				
60				

PASS/FAILURE:	RETEST (yes/no):

DESCRIPTION/NATURE OF LEAKS AND REPAIRS OF RETEST SEGMENT:

EXAMPLE CALCULATION SHEET

GIVEN:

P_i = 10 psig
T_i = 21.1 ºC = 70 ºF

and at time t = 60 minutes

P_t = 10.05 psig
T_t = 23.0 ºC = 73 ºF

Calculated Corrected Initial Pressure

$$P_c = \frac{(10.0 + 14.7)\,(23.0 + 273)}{(21.1 + 273)} - 14.7$$

P_c = 24.85 - 14.7 = 10.15 psig

Calculate Percent Pressure Loss

$$\% \text{ Pressure Loss} = \frac{10.15 - 10.05}{10.15} \times 100 = \underline{0.98\% < 1\% \text{ ok}}$$

NOTE: The difference between the corrected pressure reading (P_c) and the gauge reading (P_t) cannot differ by more than 1% of the corrected pressure reading (P_c) (i.e., 0.105 @ 10.5 psig) over a time interval of 60 minutes.

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Work under this Section includes, but is not limited to, the maintenance, recording, and submittal of appropriate documents for closeout of the Work.

1.02 SUBSTANTIAL COMPLETION

A. The CONTRACTOR shall submit written notice to the OWNER that the Work, or designated portion of the Work, is substantially complete.

B. The CONTRACTOR shall submit a list of major items to be completed or corrected.

C. The OWNER and CQA Consultant will review the Work after receipt of notice, together with the CONTRACTOR.

D. Should the OWNER consider the Work tentatively substantially complete:

1. The CONTRACTOR shall prepare and submit to the OWNER, a list of items to be completed or corrected, as determined by the review.
2. The CONTRACTOR shall complete aspects of the Work listed for completion or correction, within designated time.

E. Should the OWNER or CQA Consultant consider the Work <u>not</u> substantially complete:

1. The OWNER shall notify the CONTRACTOR within two (2) working days, in writing, stating the reasons why the Work is not considered substantially complete.
2. The CONTRACTOR shall complete the Work, and send second written notice to the OWNER, certifying that the Work, or designated portion of the Work, is substantially complete.
3. The OWNER and CQA Consultant will again review the Work.

1.03 FINAL CLEANING

A. Execute final cleaning prior to the final inspection.

B. Clean any debris from the Work areas.

C. Clean the remainder of the Site of any deleterious material as directed by the OWNER.

D. Remove waste and surplus materials, rubbish, and construction facilities and offices from the Site.

E. It shall be the CONTRACTOR's responsibility to dispose of all excess materials resulting from construction operations. Excess materials consisting of soil, rock, or boulders shall be disposed of by the CONTRACTOR in on-site areas designated by the OWNER.

F. Restore all disturbed areas to “as-was” or “better” conditions to the satisfaction of the OWNER and CQA Consultant.

G. The CONTRACTOR shall do all incidental work not otherwise specified but obviously necessary for the proper completion of the Contract in accordance with the Drawings and Specifications.

1.04 FINAL REVIEW

A. The CONTRACTOR shall submit written certification that:

1. The Work has been completed in accordance with the Contract Documents.
2. Equipment and systems have been tested in the presence of the CQA Consultant and/or the OWNER and are operational.
3. All inspections by local or regional agencies have been satisfactorily completed.
4. The Work is complete and ready for final review.
5. The Project Record Documents have been maintained in accordance with Section 01720 of these Specifications and accurately describe the completed Work.

B. The CQA Consultant shall verify the information contained in Article 1.04A herein for accuracy.

C. Should the CQA Consultant consider the Work <u>not</u> finally complete:

1. The CQA Consultant shall notify the CONTRACTOR within five (5) working days, in writing, stating the reasons why the Work is not considered finally complete.
2. The CONTRACTOR shall take immediate steps to remedy the stated deficiencies and send second written notice to the ENGINEER certifying that the Work is complete.
3. The CQA Consultant will again review the Work.

1.05 CLOSEOUT SUBMITTALS

Contractor shall submit to the CQA Consultant for review and acceptance:

A. Approved final Technical Manual(s) (i.e., O&M Manuals) in accordance with requirements of Section 01300, Article 1.09, of these Specifications.

B. Deliver evidence of compliance with requirements of governing authorities:

1. Certificates of Acceptance, if required.
2. Certificate of Occupancy, if required.

C. Deliver Certificate of Insurance for Products and Completed Operations.

D. Applicable requirements of Federal, State, and local agencies having jurisdiction.

E. Written warranties and/or guaranties from manufacturers for components, materials, and equipment that constitutes the Work.

F. Project Record Documents in accordance with Section 01720 of these Specifications within thirty (30) days of substantial completion.

1.06 EVIDENCE OF PAYMENTS AND RELEASE OF LIENS

A. The CONTRACTOR's Affidavit of Payment of Debts and Claims.

B. The CONTRACTOR's Affidavit of Release of Liens; with:

1. Consent of Surety to Final Payment.
2. The CONTRACTOR's release or waiver of liens (to be reviewed by the OWNER prior to final Payment Certification).

C. Separate releases or waivers of liens for subcontractors, suppliers, and others with lien rights against property of OWNER, together with list of those parties.

D. All submittals shall be duly executed before delivery to the OWNER.

1.07 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit the final Application for Payment to the OWNER for verification and acceptance of the information provided.

B. Application for Payment shall reflect all adjustments, including:

1. Original Contract Price.
2. Additions and deductions resulting from:
   a. Previous Change Orders;
   b. Unit Prices;
   c. Other adjustments;
   d. Deductions for uncorrected work; and,
   e. Deductions for Re-review/Re-inspect payments.
3. Total Contract Price, as adjusted.
4. Previous payments.
5. Amount remaining due.

1.08 POST-CONSTRUCTION REVIEW

A. Prior to expiration of one (1) year from the Date of Substantial Completion, the OWNER will make visual review of the Work, in the company of the CONTRACTOR, to determine whether correction of the Work is required. The CONTRACTOR shall correct the deficiencies in a timely manner.

B. The OWNER will promptly notify the CONTRACTOR, in writing, of any observed deficiencies.

PART 2- PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

*****END OF SECTION*****

SECTION 01720

RECORD DOCUMENTS

PART I - GENERAL

1.01 DESCRIPTION OF WORK

A. The Work under this Section includes, but is not necessarily limited to, the maintenance, recording, and submittal of Record Documents as herein specified.

B. The CONTRACTOR shall maintain, in designated locations at the Site for the OWNER, one (1) record copy of each of the following items as Record Documents:

1. Contract Drawings and Addenda;
2. Contract Specifications and Addenda;
3. Change Orders and other modifications to the Contract;
4. OWNER Field Orders or written instructions;
5. Reviewed submittals Shop Drawings, product data, and samples;
6. Field test records;
7. Manufacturer's certificates; and
8. Daily work activity reports, including, if existing:
   a. Field test records,
   b. Photographs,
   c. Reports on emergency response actions,
   d. Records of all Site work,
   e. Chain-of-custody documents,
   f. Laboratory test records,
   g. Meteorological records,
   h. Daily inspection records,
   i. Reports on all safety and accident incidents,
   j. Reports on all spill incidents,
   k. Air monitoring reports and data,
   l. Manifest documents, truckload tickets, and shipping papers,
   m. Other items that may be required by OWNER, and
   n. Log of control and survey work.

C. Other Documents: Manufacturer's certifications, inspection certifications, and field-test records required by individual Sections of these Specifications.

D. The OWNER and CQA Consultant shall verify the Items listed in Article 1.01 (Parts A, B, and C herein) for accuracy during the course of the Work.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Storage

1. Store documents and samples in the CONTRACTOR's field office apart from documents used for construction.
2. Provide files and racks for storage of documents.
3. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with the format of these Specifications.

C. Maintenance

1. Maintain documents in a clean, dry, legible condition, and in good order.
2. Do not use the Record Documents for construction purposes.

D. Make documents and samples available at all times for inspection by the OWNER, CQA Consultant, and the ENGINEER.

1.03 RECORDING

A. Label each document “Project Record” in neat, large-printed letters.

B. Recording

1. Record information concurrently with construction progress.
2. Do not conceal any work until required information is recorded.

C. Drawings: Record Drawings shall have a title block indicating that the drawings are Record Drawings, the name of the company preparing the Record Drawings, and the date the Record Drawings were prepared. Legibly mark drawings to record actual construction:

1. Field changes of dimension and detail.
2. Changes made by request for clarification of the Contract Documents, Field Order, or by Change Order.
3. Details not on the original Contract Drawings.
4. Horizontal and vertical locations of underground utilities and appurtenances.

D. Specifications: Legibly mark 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 request for clarification of the Contract Documents, Field Order, or by Change Order.

E. Additional Record Documents shall be prepared as required by individual Sections of these Specifications or the Contract Documents.

F. The CONTRACTOR shall mark all changes on the Contract Documents upon construction of that item of work. The CONTRACTOR shall record information concurrently with construction progress and shall not cover any work until the required information has been recorded on the Contract Drawings.

1.04 SUBMITTALS

A. At Contract closeout, the CONTRACTOR shall prepare and deliver five (5) complete sets and one (1) electronic copy of the Record Documents to the CQA Consultant for review.

Record Drawings shall be certified and stamped by a Professional Engineer licensed in the State of Delaware. Survey data and plans shall be certified by a Professional Land Surveyor licensed in the State of Delaware.

B. Accompany the submittal with transmittal letter, in duplicate, containing:

1. Date;
2. Project title and number;
3. The CONTRACTOR’s name, address, and telephone number;
4. Title and number of each record document; and,

5. Signature of the CONTRACTOR's authorized representative.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

PART 4 - CONTRACT CLOSE OUT

A. CLOSE OUT PROCEUDRES

1. The CONTRACTOR shall comply with the procedures in the Standard General Conditions of the Construction Agreement for issuance of the Certificate of Substantial Completion.
2. The CONTRACTOR shall submit a written certification that the Contract Documents have been reviewed and that the work is complete in accordance with the Contract Documents and ready for inspection.
3. The CONTRACTOR shall submit a statement of accounting giving the total adjusted Contract Sum, previous payments, and the sum remaining due.

B. FINAL CLEANING

1. The CONTRACTOR shall perform the final cleaning prior to the final site inspection by the OWNER and/or CQA Consultant. Final cleaning shall consist of removal and relocations, as directed by the ENGINEER, of temporary, construction materials and any and all removal of all waste and surplus materials arising from the action of the CONTRACTOR within the Site.

C. WARRANTIES

1. For items of work delayed materially beyond the date of substantial completion, the CONTRACTOR shall provide an updated submittal within ten days after acceptance of the delayed items of work, listing the date of acceptance as the start of the warranty period.

*****END OF SECTION*****

SECTION 02055

SOILS

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to place and compact soil as specified in this Section, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. Soil described in this Section shall be used for construction as follows.

1. Structural fill shall be the primary soil used to construct the perimeter berm, intercell berms, access roads, prepared subgrade, trench backfill, and general grading purposes.
2. Granular fill may be used as an alternative material for the drainage layer protective cover material if a geocomposite drainage layer is not used.
3. Aggregate shall be used for the leachate collection system.
4. Drainage layer / Protective cover material shall be used to construct the soil component of the liner system.

C. CONTRACTOR shall be prepared to place and compact soil in conjunction with the construction of other components of the Work.

D. The Work of this Section shall include, but not necessarily be limited to:

1. Furnishing and testing of soil; and,
2. Disposal and stockpiling of surplus soil.

E. Soil placed and compacted shall conform to the dimensions, lines, grades, and sections indicated on the Drawings.

F. Contractor shall be responsible to ensure that the soil meets the requirements of this Section. Any soil that does not conform to this Section will be rejected by ENGINEER and/or the CQA Consultant and shall be replaced by CONTRACTOR with soil that conforms to this Section at no cost to the Owner.

G. CONTRACTOR shall retain a Construction Quality Control (CQC) Consultant to perform the required field and laboratory tests described in this Section. The CQC Consultant shall be acceptable to OWNER and ENGINEER.

1.02 SUBMITTALS

A. At least 14 days prior to the delivery of soil to the Site, CONTRACTOR shall submit the following information to the ENGINEER:

1. The proposed material source or sources (either on-site of off-site); and,
2. Laboratory test data in conformance with the requirements of Part 2.01.

B. At least 14 days prior to delivery of the soil to the Site, CONTRACTOR shall submit to Engineer information describing the qualifications and capabilities of the CQC Consultant.

C. At least 14 days prior to starting soil placement and compaction, CONTRACTOR shall submit to ENGINEER the following:

1. List of all earthmoving equipment to be used for the Project;
2. Date and time that soil delivery operations will start;
3. Date and time that soil placement and compaction operations will start; and,
4. Name of CONTRACTOR's representative that will be in charge of this phase of construction.

D. As soon as the information is available, CONTRACTOR shall submit to Engineer and the CQA Consultant the results of field and laboratory tests performed on soil. Test reports of field tests are to be submitted no later than the following morning.

E. If Work is interrupted for reasons other than inclement weather, then CONTRACTOR shall notify ENGINEER a minimum of 24 hours prior to the resumption of WORK.

1.03 CONSTRUCTION QUALITY ASSURANCE

A. Construction and testing of soil shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

PART 2 – PRODUCTS

2.01 GENERAL

A. CONTRACTOR shall employ an independent geotechnical testing laboratory acceptable to OWNER and ENGINEER to perform the following pre-qualification tests (at a frequency of one set of tests per source) on each soil borrow source and/or soil type that is proposed for use and shall submit the test results to ENGINEER.

1. Particle-Size Analysis, with hydrometer - ASTM D422.
2. Atterberg Limits - ASTM D4318.
3. Standard Proctor – ASMT D698

B. Additional geotechnical tests on select soil materials shall be performed by CONTRACTOR's geotechnical testing laboratory as described in this Section.

C. All soil delivered to the Site shall meet the following chemical specifications:

1. Toxicity Characteristics Leaching procedure (TCLP): the soil shall contain no constituents that exceed its respective regulatory level;
2. Ignitability: the soil shall not be ignitable;
3. Corrosivity: the soil shall not be corrosive;
4. Reactivity: the soil shall not non-reactive;
5. Total Petroleum Hydrocarbons (TPH): the soil shall not have a TPH of greater than 1,000 parts per million (PPM); and,
6. Benzene, Toluene, Ethylbenzene, and Xylene (BTEX): the soil does not have a concentration greater than the following:
   a. Benzene: 0.5 ppm;
   b. Toluene: 10 ppm;
   c. Ethylbenzene: 5 ppm; and,
   d. Xylene: 5 ppm.

D. The final approval of the soil source will be at the sole discretion of the CQA Consultant.

2.02 STRUCTURAL FILL

A. Structural fill shall consist of relatively homogeneous, natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Structural fill shall meet the Unified Soil Classification System (USCS) classification for GC, GM, SW, SW-SM, SM, SM-SC, SC, SP-SM, CL-ML, or CL according to ASTM D2487, and shall have a maximum PI of 15, as determined in accordance with ASTM D4318.

C. Structural fill shall have a maximum particle size dimension of 6-inches.

D. Structural fill placed above Environmental Cap geosynthetic shall have a minimum internal friction angle of 30°.

E. Structural fill shall no more than 15 percent organic matter when tested in accordance with ASTM D2974, Method C.

2.03 GRANULAR FILL

A. Granular fill shall consist of relatively homogenous natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Granular fill shall meet the USCS classification for GC, GM, GP, or SP, according to ASTM D2487.

C. Granular soil shall have a maximum particle size dimension of 2-inches.

D. Granular soil shall exhibit a coefficient of permeability of $1x10^{-2}$ cm/s or greater, as determined by ASTM D24334 at 100 percent relative density.

E. Granular fill shall have no more than one percent organic matter when tested in accordance with ASTM D2974, Method C.

2.04 AGGREGATE

A. Gravel to be placed in the leachate collection sump, leachate collection corridor and leachate riser pipe trench shall meet the gradation and material requirements of AASHTO No. 57.

2.05 DRAINAGE LAYER / PROTECTIVE COVER MATERIAL

A. Leachate collection zone material shall consist of relatively homogenous, natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Leachate collection zone material shall meet the USCS classification of GP, GC, GM, SM, SC, or SP-SM, according to ASTM D2487.

C. Leachate collection zone material shall have a maximum PI of 15, as determined in accordance with ASTM D4318.

D. Leachate collection zone shall have angular, sub-angular, sub-rounded, or rounded particles that are no larger than 1.5–inch in largest diameter.

E. The drainage layer / protective cover material shall exhibit a coefficient of permeability of $1x10^{-2}$ cm/s or greater as determined ASTM D2434 at 100 percent relative density.

F. The drainage layer / protective cover material shall meet the following grain size distribution requirements based on the apparent opening size (O_{95}) of the underlying geotextile:
   1. $O_{95}/d_{85} < 2$
   2. $O_{95}/d_{15} > 2$

2.06 EQUIPMENT

A. CONTRACTOR shall only use equipment that has been approved by the OWNER and/or ENGINEER for this Work.

B. CONTRACTOR shall furnish, operate, and maintain grading equipment as is necessary to produce uniform layers, sections, and smoothness of grade for compaction and drainage.

C. CONTRACTOR shall furnish, operate, and maintain compaction equipment as is necessary to produce the required in-place soil density and moisture content.

D. CONTRACTOR shall furnish, operate, and maintain tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable surface widths, if moisture conditioning of soil is required to achieve the specified in-pace density and moisture content.

E. CONTRACTOR shall furnish, operate, and maintain soil-spreading equipment that travels on the material being spread without traveling directly on the surface of the underlying compacted soil surface layer.

F. CONTRACTOR shall furnish, operate, and maintain miscellaneous equipment such as scarifiers, disks, spring tooth, or spike tooth harrows, earth-hauling equipment, and other equipment necessary for earthwork construction.

PART 3 – EXECUTION

3.01 GENERAL

A. Prior to placing and compacting soils, CONTRACTOR shall become thoroughly familiar with the Site, the Site conditions, and all patrons of the Work of this Section and other relevant Sections related to specific uses of soil.

B. Prior to placing and compacting soil, CONTRACTOR shall carefully inspect the installed Work of all other sections and verify that all Work is complete to the point where Work of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed work of other sections, then CONTRACTOR shall immediately notify ENGINEER prior to the initiation of soil placement. Failure to notify ENGINEER in writing shall be constructed as CONTRACTOR's acceptance of the relative Work of all other Sections.

C. Soil shall be placed and compacted to the line and grades shown on the Drawings.

D. Soil shall be placed on dry, unfrozen subgrade surfaces.

E. Soil shall be placed in loose lifts that result in a compacted lift thickness of 6-inches. Compaction shall be performed using a static smooth-drum roller or padded-foot compactors as specified elsewhere in this Section. Hand compaction of material shall be used in locations where larger compaction is inappropriate due to limited area.

F. Unless otherwise specified, each soil lift shall be compacted to at least 95 percent of the maximum dry density and at a moisture content between -7 to +3 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). At CONTRACTOR's request, ENGINEER may consider revising the range of acceptable moisture contents based on the field and laboratory test results submitted by CONTRACTOR.

G. Prior to continuing construction from the previous day's work, CONTRACTOR shall scarify the surface to provide a bond between the layers.

3.02 BACKFILL OF TRENCHES

A. Backfill shall not be placed in trenches until the pipe installation and related Work have been favorably reviewed by the CQA Consultant and the appropriate survey has been performed by the surveyor in accordance with the Specifications.

B. The CONTRACTOR shall comply with the following trench backfill procedures:
   1. Pipes shall be bedded and backfilled as required or directed by the CQA Consultant and shown on the Contract Drawings. Care shall be taken to place and compact bedding material under the pipe haunches to ensure continuous contact with, and support of, the pipe.
   2. All trenches shall be backfilled as soon as possible after the pipes have been installed to assure protection against damage.
   3. Backfill shall be placed to the required elevations as shown on the Contract Drawings.
   4. Trench bedding and backfill materials shall be placed in uniform lifts of 8-inch maximum loose thickness. Compact each lift as required and in a

method that will not damage the pipes. Each layer shall be compacted prior to the next layer being is placed.

5. Ensure that during backfilling of pipe, that fill material is filling in around the pipe haunches. Handwork backfill material if necessary.
6. For HDPE piping ensure there is a minimum 12-inches above and around the pipe.
7. Where pipes cross, protect piping at higher elevations by backfilling trenches within higher pipe influence zone down to bedding of lower pipe with fine aggregate.
8. Where pipe leaves structures, protect by backfilling pipe influence zone down to the undisturbed soil with fine aggregate.

3.03 STRUCTURAL FILL

A. Structural Fill shall be placed and compacted within Perimeter Berm, Intercell Berm, Prepared Subgrade and Access Roads, as specified by the lines and grades shown on the Drawings. The subbase shall be proof rolled prior to placement of the 24-inch structural fill layer. Incompatible materials that may potentially be the cause of differential settlements can be spotted at this time and removed from the site prior to placement of structural fill. Large objects that may be on the surface will also be removed from the site and disposed of in the landfill.

B. Subgrade surface shall be prepared to remove all noticeable debris which could potentially damage the liner system. All areas shall be proof-rolled with no surface protrusions or debris.

3.04 GRANULAR FILL

A. Granular fill may be placed over the geomembrane to serve as the drainage layer / protective cover to the lines and grades shown on the Drawings.

B. Granular fill shall be placed to a thickness of 24-inches using low-ground pressure equipment.

3.05 AGGREGATE

A. Aggregate shall be placed in leachate collection trenches and sumps.

3.06 DRAINAGE LAYER / PROTECTIVE COVER MATERIAL

A. Drainage Layer / Protective Cover material shall be placed over the geotextile as shown on the Drawings.

B. Drainage Layer / Protective Cover material shall be placed to a thickness of 24-inches using low-ground pressure equipment.

3.07 FIELD QUALITY CONTROL

A. CONTRACTOR shall perform field quality control testing of soil during placement and compaction, as described below.

1. The minimum testing frequencies for material evaluation and construction quality evaluation are presented on tables 02055-1 and 02055-2.

2. Sampling locations will be selected by CONTRACTOR and will be reviewed when necessary by ENGINEER or the CQA Consultant.
3. A special testing frequency by CONTRACTOR will be used at the discretion of ENGINEER or the CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing will be considered when:
   a. the rollers slip during operations;
   b. the lift thickness is greater than specified;
   c. the soil is at improper and/or variable moisture content;
   d. fewer than the specified number of roller passes is made;
   e. dirt-clogged rollers are used to compact the material;
   f. the rollers do not have optimum ballast; or
   g. the degree of compaction is doubtful.
4. During construction, the frequency of testing by CONTRACTOR may also be increased by ENGINEER or the CQA Consultant in the following situations:
   a. adverse weather conditions;
   b. breakdown of equipment;
   c. at the start and finish of grading;
   d. if the material fails to meet specifications; or,
   e. the work area is reduced.

B. Perforations:

1. Perforations in the compacted soil that must be filled shall include, but not be limited to:
   a. nuclear density test probe locations;
   b. drive cylinder test locations; and,
   c. sand cone test locations.
2. Perforations in the compacted soil shall be backfilled with similar soil. The soil shall be hand-tamped by CONTRACTOR to the satisfaction of the CQA Consultant.

C. Defective Areas:
1. If a defective area is discovered in the compacted soil, then the CQA Consultant will notify CONTRACTOR who shall proceed to determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, then CONTRACTOR will determine the extent of the defective area by additional tests, observations, a review of records, or other means that CONTRACTOR deems appropriate. If the defect is related to adverse site such as overlay wet soils or surface desiccation, then CONTRACTOR will define the limits and nature of the defect.
2. After the extent and nature of a defect has been determined the CONTRACTOR shall correct the deficiency to the satisfaction of the ENGINEER and the CQA Consultant. The cost of corrective actions shall be borne by the CONTRACTOR.
3. Additional testing will be performed by the CONTRACTOR to verify that the defect has been corrected. This additional testing will be performed before any additional work is allowed in the area of deficiency.

3.08 FIELD QUALITY ASSURANCE

A. The CQA Consultant will monitor the placement and compaction of soils in accordance with the CQA Plan.

3.09 TOLERENCE

A. The soils shall be constructed to within + 0.1-feet of the thickness indicated on the Drawings unless otherwise directed by the ENGINEER.

TABLE 02055-1

MINIMUM TESTING FREQUENCIES FOR LABORATORY SOIL EVALUATION (1)

COMPONENT	TEST	METHOD	MINIMUM FREQUENCY OF TESTING
STRUCTURAL FILL	Grain Size Analysis (Sieve and Hydrometer) and Unified Classification	ASTM D422/ ASTM D2488	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Moisture Content	ASTM D2216	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Atterberg Limits	ASTM D4318	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Standard Proctor	ASTM D698	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Organic Content	ASTM D2974	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Internal Angle of Friction (2)	ASTM D2166 or ASTM D3080	1 per 10,000 yd^3 (minimum 1 test per material type and source)
GRANULAR FILL	Grain Size Analysis (Sieve and Hydrometer) and Unified Classification	ASTM D422/ ASTM D2488	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Moisture Content	ASTM D2216	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Atterberg Limits	ASTM D4318	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Organic Content	ASTM D2974	1 per 10,000 yd^3 (minimum 1 test per material type and source)

	Hydraulic Conductivity	ASTM D2434 or ASTM D5084	1 per 10,000 yd^3 (minimum 1 test per material type and source)
AGGREGATE	Grain Size Analysis (Sieve and Hydrometer) and Unified Classification	ASTM D422/ ASTM D2488	1 per 10,000 yd^3 (minimum 1 test per material type and source)
DRAINAGE LAYER/ PROTECTIVE COVER	Grain Size Analysis (Sieve and Hydrometer) and Unified Classification	ASTM D422/ ASTM D2488	1 per 10,000 yd^3 (minimum 1 test per material type and source)
	Hydraulic Conductivity	ASTM D2434 or ASTM D5084	1 per 10,000 yd^3 (minimum 1 test per material type and source)

Notes: (1) Tests to be performed by CONTRACTOR's CQA Consultant on samples of bulk soil samples collected from soil to be placed. These tests will be performed in addition to the pre-qualification tests to be performed by CONTRACTOR's CQC Consultant.

(2) Internal friction angle shall be obtained only for structural fill and submitted to the ENGINEER.

TABLE 02055-2

MINIMUM FIELD TESTING FREQUENCIES(1)

COMPONENT	TEST	METHOD	MINIMUM FREQUENCY OF TESTING
STRUCTURAL FILL	Moisture Content (Nuclear Gauge)	ASTM D3017	1 per 10,000 ft^2 (minimum of six per lift)
	In-Place Dry Density (Nuclear Gauge)	ASTM D2922	1 per 10,000 ft^2 (minimum of six per lift)
	In-Place Dry Density (2) (Drive Cylinder Method or Sand Cone)	ASTM D2937 ASTM D1556	If necessary (2)

Notes: (1) Field tests are to be performed by the CONTRACTOR's CQC Consultant on in-place compacted material.

(2) In-place density test shall be used to verify nuclear gauge data.

*****END OF SECTION*****

SECTION 02071

GEOTEXTILE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all geotextile, labor, incidental materials, tools supervision, transportation, and installation equipment necessary for the installation of geotextile, and as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall obtain the geotextile from a Geotextile Manufacturer that has the demonstrated experience with geotextile manufacturing as stated in Part 1.02.A of this Section.

C. CONTRACTOR shall install all geotextile and shall be responsible for field handling, storing, deploying, seaming or connecting, temporary restraining, anchoring, and other site aspects of geotextile installation.

1.02 QUALIFICATIONS

A. The Geotextile Manufacturer shall have successfully manufactured a minimum of 20,000,000 ft^2 of the same type of geotextile a specified for this Project.

B. At Geotextile Manufacturer shall have sufficient manufacturing capacity and qualified personal to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.

1.03 SUBMITTALS

A. At least 14 days prior to shipping any geotextile, the CONTRACTOR shall provide the ENGINEER with the following documentation on the proposed geotextile:

1. manufacturer and product name;
2. minimum property values of the proposed geotextile and corresponding test procedures;
3. proposed geotextile delivery dates; and,
4. a statement from the Geotextile Manufacturer that the geotextiles will retain their structure during handling, placement, and long-term service; and be capable of withstanding direct exposure to sunlight for a minimum of 30 days with no measurable deterioration.

B. At least seven (7) days prior to deploying the geotextile, the CONTRACTOR shall submit to the ENGINEER the following documentation on geotextile production:

1. a list of geotextile roll numbers delivered to the Site;
2. lot, batch and/or roll numbers and identification; and,
3. results of quality control tests, including a description of the test methods, signed by a responsible party employed by the Geotextile Manufacturer (e.g., Production Manager).

1.04 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geotextile shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the construction schedule.

PART 2 - PRODUCTS

2.01 GEOTEXTILE PROPERTIES

A. Geotextile shall conform to the material requirements specified on Table 02071-1.

B. The geotextile provided shall be stock products. Products specifically manufactured to meet the Specifications of the Project shall not be used unless authorized by the OWNER and ENGINEER.

2.02 MANUFACTURING QUALITY CONTROL

A. The Geotextile Manufacturer shall sample and test the geotextile as indicated on Table 02071-1.

B. Sampling shall, in general, be performed on sacrificial portions of the material such that repair of the material is not required.

C. Any geotextile sample that does not comply with the requirements of this Section shall result in the rejection of the roll from which the sample was obtained. The Geotextile Manufacturer shall replace any rejected rolls at no cost to the OWNER.

D. If a geotextile sample fails to meet the quality control requirements of this Section, then the CONTRACTOR shall require that the Geotextile Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll, at no cost to the OWNER. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

E. Additional sample testing may be performed at the Geotextile Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

F. The Geotextile Manufacturer shall comply with the certification and submittal requirements of this Section.

2.03 PACKING AND LABELING

A. Geotextile shall be supplied by the Geotextile Manufacturer in rolls wrapped in relatively waterproof and opaque protective covers.

B. Geotextile rolls shall be marked or tagged with the following information:
   1. manufacturer's name;
   2. product identification;
   3. lot number
   4. roll number; and,
   5. rill dimensions.

2.04 TRANSPORTATION

A. Transportation of geotextile is the responsibility of the Geotextile Manufacturer. The Geotextile Manufacturer shall be liable for all damage to the materials incurred prior to and during transportation.

B. Geotextile shall be delivered to the Site at least seven (7) days before the scheduled date of deployment to allow the CQA Contractor adequate for taking inventory and obtaining additional conformance samples, if needed.

2.05 HANDLING AND STORAGE

A. The CONTRACTOR shall be responsible for handling, unloading, storage, and care of the geotextile prior to, during, and following installation. The CONTRACTOR shall be liable for all damages to the geotextile incurred prior to final acceptance by the OWNER and ENGINEER.

B. The CONTRACTOR shall be responsible for storage of the geotextile at the Site after the material is delivered and shall protect the geotextile from moisture, long-term direct exposure to sunlight, puncture, or other damaging or deleterious conditions (e.g., mud, dirt, dust). The CONTRACTOR shall be responsible for any additional storage procedures required by the Geotextile Manufacturer.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any Work described in this Section, the CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work of this Section, the CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all such Work is complete to the point where the Work of this Section may properly commence without adverse impact.

C. If the CONTRACTOR has nay concern regarding the installed Work of other Sections, then the CONTRACTOR shall notify the ENGINEER in writing prior to the start of the Work of this Section. Failure to inform the ENGINEER in writing prior placing any geotextile will be constructed as the CONTRACTOR's acceptance of the related Work of all other Sections.

3.02 HANDLING AND PLACEMENT

A. The geotextile shall be handled in such a manner as to ensure that it is not damaged in anyway.

B. Precautions shall be taken to prevent damage to underlying materials during placement of the geotextile.

C. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the ENGINEER. Approval may be based on a formal demonstration from the Geotextile Manufacturer that the geotextile is stabilized against ultraviolet degradation for a period in excess of 30 days.

D. If white colored geotextile is used, then precautions shall be taken against “snow blindness” of personnel.

E. The Contractor shall examine the surfaces to be covered with geotextile before deployment to ensure there are no potentially harmful foreign objects. Foreign objects shall be removed prior to deploying the geotextile.

F. All geotextile shall be anchored with ballast during windy conditions. Such ballast shall be installed during placement and shall remain until the geotextile is covered.

G. The CQA Consultant shall examine the deployed geotextile surface after installation to ensure that no potentially harmful foreign objects are present either above or below the geotextile.

H. Geotextile shall not be placed on saturated or frozen subgrade or standing water.

3.03 SEAMS AND OVERLAPS

A. On slopes steeper than 10 horizontal to 1 vertical, geotextile shall be continuous down the slope; that is, no horizontal seams are allowed. Horizontal seams shall be considered as any seam having an alignment exceeding 20 degrees from being perpendicular to the slope contour lines, unless otherwise approved by the ENGINEER. No horizontal seams shall be allowed within 5-feet of the top or toe of the slopes.

B. Geotextiles shall be overlapped as indicted on the Drawings.

C. When specified on the Drawings, geotextile shall be continuously sewn (i.e., spot sewing is not allowed) using a “single prayer” seam, with the stitching a minimum of 1.5-inches from the edge of the geotextile. Stitching shall be two-thread, double-locked, 7 stitched per inch.

D. Geotextile shall be sewn with polymeric thread, having similar strength characteristics as the geotextile.

3.04 REPAIR

A. Any holes or tears in the geotextile shall be repaired using a patch made from the same geotextile. Geotextile patches will be sewn into place no closer than 1-inch from any panel edge. Should any tear exceed 50 percent of the width of the roll, that roll shall be removed and replaced.

B. Where geosynthetic materials underlie the geotextile being placed, care shall be taken to remove any soil or other material that may have penetrated the torn geotextile.

3.05 MATERIALS IN CONTACT WITH GEOTEXTILE

A. The CONTRACTOR shall place all soil or aggregate on top of geotextile such that:
   1. the geotextile and underlying materials are not damaged;
   2. minimum slippage occurs between the geotextile and underlying layers; and,
   3. excess stresses are not induced in the geotextile.

B. Equipment shall not be driven directly on the geotextile. Unless otherwise specified by the ENGINEER, all equipment operating on the earthen materials overlying the geotextile shall comply with the following:

Allowable Equipment Ground pressure (psi)	**Thickness of Overlying Compacted Soils (ft)**
<5	1.0
<10	1.5
<20	2.0
>20	3.0

3.06 PRODUCT PRTOECTION

A. The CONTRACTOR shall use all means necessary to protect all prior Work and materials and completed Work of other Sections.

B. IN the event of damage, the CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of the ENGINEER or the CQA Consultant and at no cost to the OWNER.

TABLE 02071-1

NONWOVEN GEOTEXTILE PROPERTIES AND CONFORMANCE TESTING SUMMARY

Properties	All Geotextiles			Units	Required Test Values				
	Test Method	Manufacturer QC Test Frequency(2)	Conformance QA test Frequency		6 oz/sy	8 oz/sy	10 oz/sy	12 oz/sy	16 oz/sy
Mass/Unit Area (min. avg.)	ASTM D5261	1 per 100,000 sf	1 per 250,000 sf	oz/sy	5.5	7.2	9.1	11.1	15.1
Apparent Opening Size (max.)	ASTM D4751	1 per 540,000 sf	1 per project(1)	mm	0.3	0.25	0.25	0.212	0.18
Grab Strength (min. avg.)	ASTM D4632	1 per 100,000 sf	1 per 250,000 sf	lbs	150	190	230	300	370
Puncture Strength (min. avg.)	ASTM D4833	1 per 100,000 sf	1 per 250,000 sf	lbs	70	90	120	140	170
UV Resistance	ASTM D4355	1 per resin formulation	N/A	%(3)	70	70	70	70	70
Permittivity (min.)	ASTM D4491	1 per 540,000 sf	1 per project(1)	1 per project(1)	1.1	1.0	0.9	0.7	0.5

Notes:

(1) AOS and Permittivity shall only be tested for geotextiles used in filter applications
(2) Manufacturer may elect to provide certification of values for geotextiles
(3) After 500 hours of exposure

*****END OF SECTION*****

SECTION 02072

GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, incidental materials, tools, supervision, transportation, and installation equipment necessary for installation of geosynthetic clay liner (GCL) as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall retain the services of a Geosynthetics Installer to install the approved GCL in conjunction with other components of the Project. The Geosynthetics Installer shall be approved by the GCL Manufacturer.

C. Installation of the GCL shall be performed by the Geosynthetics Installer approved under Section 02075, and shall be responsible for field handling, storing, deploying, overlapping, temporary restraining, anchoring, maintaining the GCL in an un-hydrated state, and all other aspects of GCL installation.

D. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be held responsible for any defects.

1.02 QUALIFICATIONS

A. The GCL Manufacturer shall have successfully manufactured a minimum of 20,000,000 ft^2 of the same GCL as specified for this Project for use in at least ten landfill projects in the past five years,

B. The GCL Manufacturer shall have sufficient manufacturing capacity and qualified personal to meet the requirements of the Section and the demands (e.g., quantity production and quality control) of this Project.

1.03 SUBMITTALS

A. At least 14 days prior to shipping any GCL to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the GCL Manufacturer that will supply the GCL.
   1. Corporate background and information.
   2. Manufacturing capabilities, including:
      a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
      b. daily production quantity available for this Contract;
      c. manufacturing quality control procedures; and
      d. list of material properties, including certified test results, to which are attached samples.
   3. A list of at least ten landfill projects within the last five years that the GCL Manufacturer has manufactured a minimum of 20,000,000 ft^2 of the same GCL as specified for this Project. The following information shall be provided for each facility:
      a. name, location, and pm-pose of facility, and date of installation;
      b. names of OWNER, ENGINEER, and CONTRACTOR; and
      c. surface area of GCL manufactured.

4. Origin (resin supplier's name, resin production plant) and identification (brand, name, number) of the resin for the vapor barrier.

B. Prior to shipping GCL rolls, CONTRACTOR shall provide ENGINEER with the following documentation on GCL roll production.
   1. Manufacturing quality control certificates for each shift's production, signed by responsible parties employed by the Manufacturer (such as the Production Manager).
   2. The quality control certificates shall include:
      a. roll numbers and identification;
      b. sampling procedures; and
      c. results of quality control tests, including description of test methods used.
   3. The GCL Manufacturer quality control tests to be performed are outlined in Part 2.02 of this Section.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the GCL shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the GCL manufacturing facility in order to expedite the conformance testing and approval process.

PART 2 - PRODUCTS

2.01 GCL PROPERTIES

A. The GCL shall meet the property values listed on Table 02072-1.

B. If the GCL consists of sodium bentonite granules, then the bentonite shall be adhered to the backing material in a manner that prevents it from being dislodged when transported, handled, and installed in a manner specified by the GCL Manufacturer. The bentonite will be held in place by using adhesives. The method used to hold the bentonite in place shall not be detrimental to other components of the liner system.

C. The GCL shall have the following minimum dimensions:
   1. the minimum roll width shall be 15 ft; and
   2. the liner length shall be long enough to conform to the requirements specified in this Section.

D. The bentonite used to fabricate the GCL shall have at least 90 percent sodium montmorillonite.

2.02 MANUFACTURING QUALITY CONTROL

A. The GCL Manufacturer shall sample and test the GCL to demonstrate that the material complies with Part 2.01 of this Section.

B. The GCL Manufacturer shall sample and test the GCL for the properties listed on Table 02072-1 at the minimum frequencies indicated on Table 02072-1.

C. Sampling shall, in general, be performed on sacrificial portions of the GCL such that repair is not required.

D. Any GCL sample that does not comply with the requirements of this Section shall result in the rejection of the roll from which the sample was obtained. The GCL Manufacturer shall replace any rejected rolls at no cost to OWNER.

E. If a GCL sample fails to meet the quality control requirements of this Section, then CONTRACTOR shall require that the GCL Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll, at no cost to OWNER. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

F. Additional sample testing may be performed, at the GCL Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

G. The GCL Manufacturer shall comply with the certification and submittal requirements of this Section.

2.03 PACKING AND LABELING

A. GCL shall be supplied by the GCL Manufacturer in rolls wrapped in watertight and opaque protective covers.

B. GCL shall be marked or tagged by the GCL Manufacturer with the following information.
   1. Manufacturer’s name;
   2. Product identification;
   3. Lot number;
   4. Roll number; and
   5. Roll dimensions.

2.04 TRANSPORTATION

A. Transportation of the GCL shall be the responsibility of the GCL Manufacturer. The GCL Manufacturer shall be liable for all damage to the GCL incurred prior to and during transportation, including pre-mature hydration of the GCL.

B. GCL shall be delivered to the Site at least seven days before the scheduled date of installation to allow the CQA Consultant adequate time for taking inventory and obtaining additional conformance samples, if needed.

2.05 HANDLING AND STORAGE

A. The GCL shall be stored and handled in accordance with ASTM D 5888.

B. CONTRACTOR shall be responsible for handling, storage, and care of the GCL prior to and following installation at the Site. CONTRACTOR shall be liable for all damages to the GCL incurred prior to final acceptance by ENGINEER.

C. CONTRACTOR shall be responsible for storage of the GCL at the Site after the material is delivered.

2.06 CONFORMANCE TESTING

A. After the GCL have been received at the Site, CONTRACTOR shall assist the CQA Consultant in obtaining conformance samples.

B. GCL conformance samples shall be sent to the CQA Laboratory for testing required by the CQA Plan. Passing test results are required before any GCL is deployed.

C. Samples shall be taken at a minimum frequency rate shown in Table 02072-1, with a minimum of one sample per lot. If the GCL Manufacturer provides material that requires conformance sampling at a higher frequency (due to lot size, shipment size, etc.) than that listed on. Table 02072- 1 then CONTRACTOR shall pay the cost for all additional testing.

D. The CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Part 2.01 of this Section until passing conformance test results are obtained for all GCL that is received at the Site. This additional testing shall be performed at the expense of CONTRACTOR.

E. Any GCL that is not certified by the GCL Manufacturer in accordance with Part 1.03 of this Section, or that has a hydraulic conductivity greater than that specified in Part 2.01, shall be rejected and replaced by the GCL Manufacturer, at no cost to OWNER.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, the Geosynthetics Installer shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work of this Section, the Geosynthetics Installer shall carefully inspect the installed Work of all other Sections and verify that all such Work is complete to the point where the Work of this Section may properly commence without adverse impact.

C. If Geosynthetics Installer has any concern regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing prior to the start of the Work of this Section. Failure to inform ENGINEER in writing or commencement of installation of the GCL will be construed as Geosynthetics Installer's acceptance of the related Work of all other Sections.

3.02 SURFACE PREPARATION

A. The Geosynthetics Installer shall provide certification in writing that the surface on which the GCL will be installed is acceptable. This certification of acceptance shall be given to the CQA Consultant prior to commencement of GCL installation in the area under consideration.

B. Special care shall be taken to maintain the prepared soil surface in a smooth, dry condition.

C. No GCL shall be placed onto an area which has been softened by precipitation or which has cracked due to desiccation. The soil surface shall be observed daily to evaluate the effects of desiccation cracking and/or softening on the integrity of the subgrade.

D. Any damage to the soil surface caused by installation activities shall be repaired at CONTRACTOR's expense.

3.03 ANCHORAGE

A. The anchor trench shall be excavated prior to GCL placement to the lines, grades, and configuration shown on the Drawings and as specified in the Specifications.

B. No loose soil shall be allowed in the anchor trench beneath the GCL.

C. Slightly rounded corners shall be provided in the trench where the GCL adjoins the trench to avoid sharp bends in the GCL.

D. The anchor trench shall not be backfilled until after all geosynthetics have been installed in the trench.

3.04 HANDLING AND PLACEMENT

A. GCL shall be handled in such a manner as to ensure that it is not damaged or prematurely hydrated in any way.

B. GCL shall be not be allowed to hydrate greater than a moisture content of 30 percent.

C. GCL rolls that have a moisture content of greater than 30 percent shall be removed and replaced by the Geosynthetics Installer at no cost to OWNER.

D. GCL shall be cut using a utility blade in a manner so as not to damage adjacent materials.

E. During placement, care shall be taken not to entrap stones, or moisture under the GCL. Care shall be taken not to walk on or drag equipment across the exposed GCL.

F. Any GCL damaged by stones, other foreign objects, or installation activities shall be repaired by the Geosynthetics Installer in accordance with Part 3.07 of this Section.

G. GCL shall not be installed on a saturated subgrade or on standing water. The GCL shall be installed in a .way that prevents hydration prior to completion of construction, including placement of overlying geosynthetics and soil/aggregate.

H. The GCL shall not be installed during precipitation or other conditions that may cause hydration of the GCL.

3.05 OVERLAPS

A. On slopes steeper than 10 horizontal to 1 vertical, GCL shall be continuous down the slope; that is, no horizontal seams shall be allowed on the slope.

B. GCL shall be overlapped in accordance with the GCL Manufacturer's recommended procedures and as indicated on the Drawings. A t a minimum, the overlaps shall be 6 in. along the length of the panel and 12 in. along the width of the panel.

C. The overlaps shall not be nailed or stapled to the subgrade.

3.06 MATERIALS IN CONTACT WITH GCL

A. Geomembrane installation shall immediately follow the GCL installation and shall be performed in accordance with Section 02075.

B. Geomembrane shall not be placed on GCL that is hydrated. If GCL under the geomembrane is suspected to be hydrated, it shall be removed and replaced at no cost to OWNER.

C. GCL that is placed during a day's work shall be covered with geomembrane before the Geosynthetics Installer leaves the Site at the end of the day.

D. All geomembrane seams overlying the installed GCL shall be welded after each geomembrane panel is placed in accordance with the requirements of Section 02075. Heat-sealing of the seam alone is not acceptable.

E. All defects in the geomembrane overlying the GCL and destructive sample locations shall be immediately repaired in accordance with the requirements of Section 02075.

3.07 REPAIR

A. Any holes or tears in the GCL shall be repaired by placing a GCL patch over the hole. The patch shall overlap the edges of the hole or tear by 2 ft in all directions. The patch shall be secured with a water-based adhesive approved by the GCL Manufacturer.

B. Care shall be taken to remove any soil or other material that may have penetrated the torn GCL.

C. All repairs shall be made at no additional cost to OWNER.

D. The patch shall not be nailed or stapled.

3.08 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior work and all materials and completed Work of other Sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of ENGINEER and the CQA Consultant and at no cost to OWNER.

TABLE 02072-1

REQUIRED GCL PROPERTY VALUES (1)

Properties	Qualifiers	Units	Specified Values	Test Method	Manufacturer QC Test Frequency	Conformance QC Test Frequency
Bentonite Content(2)	Minimum	lb/ft^2	0.75	ASTM D 5993	1 per 50,000 sf	1 per 250,000 sf
Permeability	Maximum	cm/s	5×10^{-9}	ASTM D 5887	1 per 100,000 sf	1 per 250,000 sf
Bentonite Fluid Loss	Maximum	mL	18	ASTM D 5891	1 per 50,000 sf	1 per 250,000 sf
Moisture Content (Bentonite)	Maximum	percent	30	ASTM D 5993	1 per 50,000 sf	1 per 250,000 sf
Internal Shear Strength(3)	Minimum		23°	ASTM D 6243	1 per project	N/A

Notes: (1) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed these values).

(2) The sodium bentonite component shall be applied at an average concentration of 0.75 lb/ft^2 when measured at a water content of zero percent.

(3) Internal friction angle shall be measured between textured geomembrane, GCL, and the structural fill used for the liner subgrade. Additional testing may be required if different material is used, GCL shall be hydrated after applying a continuing pressure of 240 psf. Maximum applied pressure shall be 8,000 psf.

*****END OF SECTION*****

SECTION 02075

GEOMEMBRANE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of geomembrane as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. Textured high-density polyethylene (HDPE) geomembrane shall be used as the geomembrane for this Project. The approved geomembrane will have properties that comply with the requirements specified on Table 02075-1.

C. CONTRACTOR shall obtain the specified geomembrane from a qualified Geomembrane Manufacturer that has the demonstrated experience with geomembrane manufacturing as stated in Part 1.02.A of this Section.

D. CONTRACTOR shall retain the services of a Geosynthetics Installer to install the approved geomembrane in conjunction with the other components of the Project. The Geosynthetics Installer shall be approved by the Geomembrane Manufacturer and have the demonstrated experience with installation of the geomembrane as stated in Part 1.02.B of this Section.

1.02 QUALIFICATIONS

A. Geomembrane Manufacturer:
   1. The Geomembrane Manufacturer shall be capable of manufacturing geomembrane rolls from resin and shall have sufficient production capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.
   2. The Geomembrane Manufacturer shall have successfully manufactured a minimum of 20,000,000 ft^2 of HDPE geomembrane for use in at least ten landfill projects in the past five years.

B. Geomembrane Installer:
   1. The Geosynthetics Installer shall be responsible for field handling, storing, deploying, seaming, temporarily restraining (against wind), and other site aspects of the geomembrane and other components of the liner system, and shall provide qualified installation personnel, as outlined in this Section. The Geosynthetics Installer may also be responsible for anchoring systems.
   2. As a firm, the Geosynthetics Installer shall have successfully installed a minimum of 10,000,000 ft^2 of HDPE geomembrane for at least ten landfill projects in the past five years.
   3. The superintendent assigned to this project shall have supervised the installation of a minimum of 2,000,000 ft^2 of HDPE geomembrane on at least ten different landfill liner systems.
   4. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests.

a. At least one seamer shall have experience seaming a minimum of 1,000,000 lineal ft of HDPE geomembrane seams using the same type of seaming apparatus to be used at this Site. Seamers with such experience will be designated "master seamers" and shall provide direct supervision over less experienced seamers.

b. Seaming personnel shall have seamed at least 100,000 lineal ft of HDPE geomembrane seams using the same type of seaming apparatus to be used at this Site.

C. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be held responsible for any defects.

1.03 WARRANTY

A. CONTRACTOR shall provide a written warranty from the Geomembrane Manufacturer to OWNER and ENGINEER for a 20-year period against defects in material from the date the installation of the geomembrane is accepted.

B. CONTRACTOR shall provide a written warranty from the Geosynthetics Installer to OWNER and ENGINEER for a one-year period against defects in workmanship from the date the installation of the geomembrane is accepted.

C. Warranty conditions concerning limits of liability will be evaluated and must be acceptable to OWNER and ENGINEER.

1.04 SUBMITTALS

A. At least 14 days prior to shipping any geomembrane to the Site, CONTRACTOR shall provide ENGINEER with the following documentation concerning the Geomembrane Manufacturer that will supply the geomembrane.

1. Corporate background and information.
2. Manufacturing capabilities, including:
   a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
   b. daily production quantity available for this Contract;
   c. manufacturing quality control procedures; and
   d. list of material properties, including certified test results, to which are attached liner samples.
3. A list of at least ten landfill projects within the last five years that the Geomembrane Manufacturer has manufactured a minimum of 20,000,000 ft^2 of HDPE geomembrane. The following information shall be provided for each facility:
   a. name, location, and purpose of facility, and date of installation;
   b. names of OWNER, ENGINEER, and CONTRACTOR; and
   c. thickness and surface area of geomembrane manufactured.
4. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the resin.

B. At least 14 days prior to shipping any geomembrane to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the resin used to manufacture the geomembrane.

1. Copies of quality control certificates issued by the resin supplier including the production dates, brand name, and origin of the resin used to manufacture the geomembrane for the Project.

2. Results of tests conducted by the Geomembrane Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the Project.
3. Certification that no reclaimed polymer is added to the resin during the manufacturing of the geomembrane to be used for this Project, or, if recycled polymer is used, then the Geomembrane Manufacturer shall submit a certificate signed by the Production Manager documenting the quantity of recycled material, including a description of the procedure used to measure the quantity of recycled polymer.

C. Prior to the shipping the geomembrane rolls, CONTRACTOR shall provide ENGINEER with the following documentation on geomembrane roll production.
1. Manufacturing certificates for each shift's production of geomembrane, signed by responsible parties employed by the Geomembrane Manufacturer (such as the Production Manager).
2. The quality control certificate shall include:
   a. roll numbers and identification;
   b. sampling procedures; and
   c. results of quality control tests, including descriptions of the test methods used.
3. The Geomembrane Manufacturer quality control tests to be performed are outlined in Part 2.03 of this Section.

D. At least 14 days prior to the scheduled date of geomembrane installation, the Geosynthetics Installer shall submit to ENGINEER the following:
1. Corporate background and information.
2. Copy of Geomembrane Installer's letter of approval or license by the Geomembrane Manufacturer.
3. Installation capabilities, including:
   a. information on equipment and personnel;
   b. average daily production anticipated for this Project; and
   c. quality control procedures;
4. A list of at least ten landfill projects within the last five years that the Geomembrane Installer has installed a minimum of 10,000,000 ft^2 of HDPE geomembrane. The following information shall be provided for each facility:
   a. the name and purpose of the facility, its location, and dates of installation;
   b. the names of OWNER, ENGINEER, and CONTRACTOR;
   c. name and qualifications of the installer's supervisor(s);
   d. thickness and surface area of installed geomembrane;
   e. type of seaming and type of seaming apparatus used; and
   f. duration of installation.
5. Resumes of all personnel who will perform seaming operations on this Project, including dates and duration of employment.
6. A drawing showing the installation layout identifying field seams, as well as any variance or additional details that deviate from the Drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.
7. Installation schedule
8. A Certificate. of Calibration less than 12 months old for the field tensiometer referenced in Parts 3.05.I and K of this Section.

E. At least 14 days prior to transporting welding rod to the Site, the Geosynthetic Installer shall submit the following documentation on welding rod to ENGINEER:

1. quality control documentation, including lot number, welding rod spool number, and results of quality control tests on the welding rod; and
2. certification that the welding rod is compatible with the geomembrane and this Section.

F. During the installation, the Geosynthetics Installer shall be responsible for the timely submission to ENGINEER the following:
1. quality control documentation; and
2. subgrade acceptance certificates, signed by the Geosynthetics Installer, for each area to be covered by geomembrane.

G. Upon completion of the installation, CONTRACTOR shall submit to ENGINEER the following:
1. required warranties as specified in Part 1.03 of this Section; and
2. record drawings of the installation as specified in Section 01721.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of geomembrane shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR and the Geosynthetics Installer shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the geomembrane manufacturing facility in order to expedite the conformance testing and approval process.

PART 2 - PRODUCTS

2.01 RESIN

A. The geomembrane shall be manufactured from new, first-quality resin, and shall be designed and manufactured specifically for use in geomembrane. Reclaimed polymer shall not be added to the resin. However, the use of polymer recycled during the manufacturing process shall be permitted if performed with appropriate cleanliness and if the recycled polymer does not exceed 2 percent by weight of the total polymer weight.

2.02 GEOMEMBRANE PROPERTIES

A. The manufacturer shall furnish geomembrane with properties that comply with the required property values provided below and on Table 02075-1.

B. In addition to the property values listed on Table 02075-1, the geomembrane shall:
1. contains a maximum of 1 percent by weight of additives, fillers, or extenders (not including carbon black);
2. not have striations, pinholes, or bubbles on the surface or in the interior;
3. be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter; and

4. are manufactured in a single layer (thinner layers shall not be welded together to produce the final required thickness).

2.03 MANUFACTURING QUALITY CONTROL

A. Rolls.

1. The Geomembrane Manufacturer shall continuously monitor the geomembrane during the manufacturing process for inclusions, bubbles, or other defects. Geomembrane that exhibits any defects will not be accepted.
2. The Geomembrane Manufacturer shall continuously monitor the geomembrane thickness during the manufacturing process. Geomembrane that fails to meet the specified minimum thickness will not be accepted.
3. The Geomembrane Manufacturer shall sample and test the geomembrane in accordance with the test frequency stated in GRI Test Method GM13 for HDPE geomembrane to demonstrate that its properties conform to the values specified on Table 02705-1.
4. Samples of the geomembrane shall be taken across the entire width of the roll.
5. At a minimum, the following manufacturing quality control tests shall be performed:

TEST	PROCEDURE
Thickness	ASTM D 5994
Asperity Height	ASTM D 7466
Density	ASTM D 792 or ASTM D 1505
Tensile Properties	ASTM D 6693 Type IV
Puncture Resistance	ASTM D 4833
Carbon Black Content	ASTM D 4218
Carbon Black Dispersion	ASTM D 5596

6. Any geomembrane sample that does not comply with the requirement of this Section shall result in rejection of the roll from which the sample was obtained. The Geomembrane Manufacturer shall replace any rejected rolls at no additional cost to OWNER.
7. In the case of the rejection of a roll of geomembrane, the Geomembrane Manufacturer shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
8. Additional testing may be performed at the Geomembrane Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.
9. In addition to the tests listed under Paragraph 2.03.B.5 of this Section, CONTRACTOR and/or Geomembrane Manufacturer must provide laboratory test data that demonstrates that the geomembrane supplied meets the specifications for environmental stress crack (ASTM D 5397) and interface friction (ASTM D 5321) as listed on Table 02075-1. This testing shall be performed on geomembrane manufactured at the same time, from the same type of resin, and exhibiting the same material properties as the geomembrane to be used for this Project. The Geomembrane Manufacturer shall provide the test results as part of his quality control documentation.

B. Manufacturing Plant Visit

1. The Geomembrane Manufacturer shall allow OWNER, ENGINEER, and/or the CQA Consultant to visit the manufacturing plant for project specific visits. If possible, then the visits will be prior to or during the manufacturing of the geomembrane rolls for this Project.
2. During the visit, OWNER, ENGINEER, or CQA Consultant may:
   a. review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;
   b. verify that properties guaranteed by the manufacturer comply with these Specifications;
   c. verify that the measurements of properties by the manufacturer are properly documented and the test methods used are acceptable;
   d. check select geomembrane rolls for evidence of holes, blisters, or any sign of contamination by foreign matter;
   e. review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane; and
   f. verify that roll packages are labeled in compliance with Part 2.05 of this Section.

2.04 GEOMEMBRANE SUPPLY

A. The geomembrane shall be supplied to the Site in rolls or as factory panels. A factory panel is comprised of one or more rolls that have been seamed together in a factory.

2.05 LABELING

A. Geomembrane and fabricated panels shall be labeled with the following information:

1. thickness of the material;
2. length and width of the roll or factory panel;
3. names of manufacturer;
4. directions to unroll the material;
5. product identification;
6. lot number; and
7. roll or factory panel number.

2.06 TRANSPORTATION

A. Transportation of the geomembrane is the responsibility of the Geomembrane Manufacturer. The Geomembrane Manufacturer shall be liable for all damages to the geomembrane incurred prior to and during transportation to the Site.

B. Geomembrane shall be delivered to the Site at least seven days before the scheduled date of installation to allow the CQA Consultant adequate time for taking inventory and obtaining additional conformance samples, if needed.

2.07 HANDLING AND STORAGE

A. CONTRACTOR shall be responsible for handling, storage, and care of the geomembrane prior to and following installation at the Site. CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance by OWNER and ENGINEER.

B. CONTRACTOR shall be responsible for storage of the geomembrane at the Site. During storage, the geomembrane shall be protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall be stored in accordance with any additional requirements of the Geomembrane Manufacturer.

2.08 CONFORMANCE TESTING

A. Samples of the geomembrane will be removed by the CQA Consultant at the factory and sent to an independent geosynthetics laboratory (i.e., different than the Geomembrane Manufacturer) for testing to ensure conformance with the requirements of this Section.

B. Conformance sampling and testing will be performed in accordance with the CQA Plan.

C. Samples will be taken at a minimum frequency of one sample per 250,000 ft^2 with a minimum of one sample per lot. If the Geomembrane Manufacturer provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) higher than necessary, then CONTRACTOR shall pay the cost for all.

D. The CQA Consultant may direct CONTRACTOR to increase the frequency of sampling in the event that test results do not comply with requirements of Part 2.02 of this Section until passing conformance test results are obtained for all material that is received at the Site. This additional testing shall be performed at the expense of CONTRACTOR.

E. Any geomembrane roll or panel that is not certified in accordance with Part 1.04 of this Section, or that conformance testing indicates do not comply with Part 2.02 of this Section, will be rejected by the CQA Consultant. The Geomembrane Manufacturer shall replace the rejected material with new material, at no additional cost to OWNER.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any Work described in this Section, the Geomembrane Installer shall become thoroughly familiar with all portions of the Work required by Section.

B. The Geosynthetic Installer shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the Work of this Section may properly commence without adverse impact to the project.

C. If the Geosynthetic Installer has any concerns regarding the installed Work of other Sections, then he should notify ENGINEER in writing prior to the start of the Work of this Section. Failure to inform ENGINEER in writing or commencing geomembrane installation will be construed as the Geosynthetic Installer's acceptance of the related Work of other Sections.

3.02 SURFACE PREPARATION

A. The Geosynthetics Installer shall provide certification in writing that the surface on which the geomembrane will be installed is acceptable. The surface shall be free

of stones, litter, organic matter, irregularities, protrusion, loose soil, and any abrupt changes in grade that could damage the geomembrane. The certification of acceptance shall be given to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration.

B. Special care shall be taken to maintain the prepared subgrade.

C. No geomembrane shall be placed onto an area which has been softened by precipitation or which has cracked due to desiccation. The soil surface shall be observed daily to evaluate the effects of desiccation cracking and/or softening on the integrity of the subgrade.

D. Any damage to the soil surface caused by installation activities shall be repaired at the CONTRACTOR's expense.

E. The CONTRACTOR or Geosynthetics Installer shall be responsible for dewatering areas that have been accepted for geomembrane deployment, including anchor trenches.

3.03 ANCHORAGE

A. The anchor trench shall be excavated prior to geomembrane placement to the lines, grades, and configuration shown on the Drawings and as specified in the Specifications.

B. No loose soil shall be allowed in the anchor trench beneath the geomembrane.

C. The anchor trench shall be backfilled and compacted after the geomembrane has been installed in the trench. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane.

D. Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane.

3.04 GEOMEMBRANE DEPLOYMENT

A. The Geosynthetics Installer shall prepare a geomembrane installation layout drawing(s) prior to geomembrane deployment. These drawings shall indicate the geomembrane configuration, dimensions, details, locations of seams, etc. Field seams shall be differentiated from factory seams (if any) on the drawings. Field seams shall be oriented up or down slope and not across slope. ENGINEER must approve the layout drawings prior to the installation of any geomembrane. The layout drawings, as modified and/or approved by ENGINEER, shall become part of the Contract Documents.

B. Field Panel Identification
   1. A geomembrane field panel is defined as follows:
      a. If the geomembrane is not fabricated into factory panels, then a field panel is a roll or a portion of roll cut in the field.
      b. If the geomembrane is fabricated into factory panels, then a field panel is a factory panel or a portion of factory panel cut in the field.
   2. Each field panel must be given an identification code (number or letter-number). This identification code shall be agreed upon by the CQA Consultant and Geosynthetics Installer. The field panel identification

code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.

C. Field Panel Placement

1. Field panels shall be installed as approved or modified at the location and positions indicated in the layout drawings.
2. Field panels shall be placed one at a time, and each field panel shall be seamed to adjacent panels the same day that it is placed.
3. Geomembrane may only be deployed daylight hours between one hour after sunrise and one hour before sunset.
4. Geomembrane shall not be placed when the ambient temperature is below 32°F or above 104°F, unless otherwise authorized by ENGINEER.
5. Geomembrane shall not be placed during any precipitation, in the presence of excessive moisture (e.g., frost, ice, fog, dew), in an area of ponded water, or in the presence of winds exceeding 20 miles per hour.
6. The Geosynthetics Installer shall employ placement methods consistent with the following:
   a. no vehicular traffic shall be allowed on the geomembrane.
   b. equipment used shall not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.
   c. personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
   d. the method used to unroll the panels shall not scratch or crimp the geomembrane and shall not damage the supporting soil.
   e. the prepared surface underlying the geomembrane shall not be allowed to deteriorate after acceptance of the surface, and shall remain acceptable up to the time of geomembrane placement.
   f. the method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).
   g. temporary loads and/or anchors (e.g., sand bags, tires), not likely to damage the geomembrane, may be placed on the geomembrane to prevent uplift by wind (in high winds, continuous loading is recommended along panel edges to minimize the risk of wind flow under the panels).
7. Any field panel or portion thereof that becomes seriously damaged (tom, twisted, or crimped) shall be replaced with new material at no cost to OWNER. Less serious damage may be repaired at the CQA Consultant's sole discretion and at no cost to OWNER. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area.
8. Placement of geomembrane shall not damage the underlying geosynthetic clay liner.

3.05 FIELD SEAMING

A. In general, seams shall be oriented parallel to the line of maximum slope, (i.e., oriented down, not across, the slope). In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seam shall be made within 5 ft of any toe of the slope, except where approved by ENGINEER and/or the CQA Consultant. No seams shall be located in an area of potential stress concentration, as defined by ENGINEER.

B. All personnel performing seaming operations shall be qualified as indicated in the CQA Plan and in this Section. No seaming shall be performed unless a "master seamer" (as defined in the CQA Plan and in this Section) is present.

C. The geomembrane shall have field seams that equal or exceed the strength requirements presented on Table 02075-2.

D. Weather Conditions for Seaming:

1. Seaming shall not be attempted at ambient temperatures below 32°F or above 104°F or when wind velocity exceeds 20 miles per hour. At ambient temperatures between 32°F and 50°F, seaming shall be allowed if the geomembrane is preheated either by the sun or a hot air device, and if there is no excessive cooling from wind. At ambient temperatures above 50°F, no preheating will be required. In all cases, the geomembrane shall be dry and protected from excessive wind.
2. If the Geosynthetics Installer wishes to use methods that allow seaming at ambient temperatures below 32°F or above 104°F, then he shall demonstrate that the seam so produced is equivalent to those produced under normally approved conditions, and that the overall quality of the geomembrane is not adversely affected. In addition, an addendum to the Contract between OWNER and the Geosynthetics Installer shall be required that specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane.
3. To minimize geomembrane contraction stresses, seaming should ideally be carried out in the morning and late evening when the geomembrane is relatively contracted and during the middle of the day if overcast conditions prevail. If the geomembrane must be seamed in the middle of a sunny day, then the Geosynthetics Installer shall ensure that the panels to be seamed are at the same temperature and that there is sufficient slack in the geomembrane to prevent the generation of excessive stresses or trampolining when the geomembrane contracts as cooler temperatures prevail. The Geosynthetics Installer shall determine the required amount of slack and it should not be so much so as to cause significant wrinkling of the geomembrane. If trampolining of the geomembrane is observed, then the Geosynthetics Installer will be required to make repairs so that the problem is eliminated.
4. Ambient temperatures shall be measured within 6 in. above the geomembrane surface.

E. Overlapping and Temporary Bonding

1. Geomembrane panels shall be overlapped a minimum of 3 in. for extrusion welding and 5 in. for fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.

2. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. The temperature of the air at the nozzle of spot welding apparatus shall be controlled such that the geomembrane is not damaged.
3. No solvent or adhesive shall be used unless OWNER has approved the product in writing. Samples of any proposed solvent or adhesive shall be submitted to CONTRACTOR for testing and evaluation at the Geosynthetics Installer's expense.

F. Seam Preparation
1. Prior to seaming, the seam area shall be cleaned and made free of moisture, dust, dirt, debris of any kind, and foreign material.
2. If seam overlap grinding is required, then the process shall be completed according to the Geomembrane Manufacturer's instructions within 20 minutes of the seaming operation and in a manner that does not damage the geomembrane. The grind depth shall not exceed ten percent of the geomembrane thickness. Grinding marks shall not appear beyond 0.25 in. of the extrudate after it is placed.
3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

G. General Seaming Requirements
1. Seaming shall extend to the outside edge of panels, including those panels placed in the anchor trench.
2. If required to provide a firm substrate, then a board, or similar hard surface, placed directly under the seam overlap may be used to achieve proper support.
3. Fishmouths or wrinkles at the seam overlaps shall be removed by cutting the geomembrane along the ridge of the wrinkle. At the end(s) of the cut, cut a circle in the geomembrane to achieve a flat overlap. The cut shall be seamed as described in the Section. Any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane that extends a minimum of 6 in. beyond the cut in all directions.

H. Seaming Process
1. Approved processes for field seaming are extrusion welding and fusion welding. Seaming equipment shall be operated in a manner that does not cause damage to the geomembrane. Only apparatus that ENGINEER has specifically approved by make and model shall be used. Proposed alternate seaming processes shall be documented and submitted to ENGINEER.
2. Extrusion Equipment and Procedures:
   a. The Geosynthetics Installer shall maintain at least one spare operable extrusion seaming apparatus on site at all times.
   b. Extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus.
   c. Prior to beginning a seam, the extruder shall be purged until all heat- degraded extrudate has been removed from the barrel.
   d. The electric generator used for power supply to the welding machines shall he placed outside the area to be lined or mounted on soft tires such that no damage occurs to the geomembrane. The electric generator shall be equipped with a grounding rod that is driven into the ground outside the lined area. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

3. Fusion Equipment and Procedures:
   a. The Geosynthetics Installer shall maintain at least one spare operable seaming apparatus on site at all times.
   b. Fusion-welding apparatus shall be automated vehicular-mounted devices equipped. with gauges giving the instantaneous temperatures and pressures of the machine.
   c. The edges of cross seams shall be abraded to a smooth incline (top and bottom) prior to welding.
   d. A movable protective layer may be used directly below each geomembrane overlap to be seamed to prevent the buildup of moisture between the sheets.
   e. The electric generator used for power supply to the welding machines shall be placed outside the area to be lined or mounted on soft tires such that no damage occurs to the geomembrane. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

I. Trial Seams
1. Trial seams shall be made prior to production seaming by all seamers and by all equipment to be used during production seaming. The trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each seaming apparatus used that day. In addition, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual production field seams. The trial seam sample shall be at least 3.5-ft long by 1-ft wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as specified in Part 3.05.E of this Section.
2. Four adjoining specimens, each 1.0-in. wide, shall be cut from the trial seam sample by the Geosynthetics Installer. The specimens shall be tested in peel (both tracks for fusion welds) using an electronic readout field tensiometer and the specimen shall fail by film tear bond (FTB) (i.e., failure in the parent material) rather than in the seam. The Geosynthetics Installer shall test the specimens in the presence of the CQA Consultant. Testing using the field tensiometer shall be performed in accordance with ASTM D 6392, at a strain rate of 2 in./minute. Ideally, the samples shall be conditioned at 73°F at a relative humidity of 50 percent for two hours prior to testing. If test conditions vary from this requirement, then a 1 in. wide specimen of the parent geomembrane (no weld) shall be tested in the same manner as the seam specimens to determine the break strength at this condition. At no time shall the specimens be soaked in water.
3. If a specimen fails to comply with the properties stated on Table 02075-2, then the entire operation shall be repeated. If the additional specimen fails to meet these requirements, then the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

4. After completion of the above described tests, the remaining portion of the trial seam sample can be discarded. If a trial seam sample fails a test, then a destructive test seam sample may be taken from the seams completed by the seamer during the shift related to the considered trial seam at the discretion of ENGINEER of the CQA Consultant. These samples shall be forwarded to CQA geosynthetics laboratory and, if they fail the tests, the procedure indicated in Part 3.05.K.5 of this Section shall apply. The results of all testing shall be reported to the CQA Consultant. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam.

J. Nondestructive Seam Continuity Testing

1. The Geosynthetics Installer shall nondestructively test all field seams over their full length using a vacuum test, air pressure test (for double fusion seams only), or other approved method. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The installer shall complete any required repairs in accordance with Part 3.05.L of this Section. The following procedures shall apply to locations where seams cannot be nondestructively tested:
   a. If the seam is accessible to testing equipment prior to final installation, then the seam shall be nondestructively tested prior to final installation.
   b. If the seam cannot be tested prior to final installation, then the seaming operations must be observed in their entirety by the CQA Consultant for uniformity and completeness.
2. Vacuum testing of extrusion field seams and repairs shall be performed in accordance with ASTM D 5641.
3. Air pressure testing shall be performed on double fusion seams only, and shall be performed in accordance with ASTM D 5820 and the following:
   a. Energize the air pump to a pressure between 25 and 30 psi, close valve, allow two minutes for pressure to stabilize, and sustain the pressure for not less than 5 minutes.
   b. If loss of pressure exceeds 4 psi, or if the pressure does not stabilize, then locate faulty area and repair in accordance with Part 3.05.L of this Section.
   c. Cut opposite end of air channel from pressure gauge and observe release of pressure to ensure that the entire channel is not blocked.
   d. Remove needle, or other approved pressure feed device, and seal repair in accordance with Part 3.05.L of this Section.
4. ENGINEER may allow spark testing in accordance with ASTM D 6365 if the seam cannot be tested using other nondestructive methods.

K. Destructive Testing

1. Destructive testing of field seams shall be performed on samples collected from selected locations to evaluate seam strength and integrity according to the requirements for seam strength presented on Table 02075-2. Destructive testing shall be carried out as the geomembrane installation progresses, not at the completion of all field seaming.
2. Sampling

a. Field seam samples shall be collected for destructive testing at a minimum average frequency of one test location per 500 ft of seam length. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The CQA Consultant will be responsible for choosing the locations. The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples will be taken. ENGINEER or the CQA Consultant reserves the right to increase the sampling frequency.

b. Samples of the field seams shall be cut with rounded corners by the Geosynthetics Installer at the locations designated by the Geosynthetics CQA Consultant as the seaming progresses. Passing laboratory test results must be obtained before the field seams are covered by another material. All holes in the geomembrane resulting from the field seam sampling shall be immediately repaired in accordance with the repair procedures described in Part 3.05.L of this Section. The continuity of the new seams in the repaired areas shall be tested according to Part 3.05.J of this Section.

c. Two strips, 1-in. wide and 12-in. long with the seam centered parallel to the width, shall be taken. The strips shall be spaced a clear distance of 42- in. apart. These samples shall be tested using the field tensiometer in accordance with Prut 3.05.I.2 of this Section. If these samples pass the field test, then a laboratory sample shall be taken. The laboratory sample shall be at least 1-ft wide by 42-in. long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

i. one 1-ft long portion to the Geosynthetics Installer.

ii. one 1-ft long portion to OWNER for archiving;

iii. one 1.5-ft long portion to the CQA Consultant laboratory testing.

3. If any field test sample fails to meet the required seam strength properties presented on Table 02075-2, then the procedures outlined in Part 3.05.K.5 of this Section shall be followed.

4. Samples shall be tested in the laboratory in accordance with the requirements of this Section and the CQA Plan.

5. Destructive Test Failure

a. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the CQA laboratory, the Geosynthetics Installer's laboratory, or by a field tensiometer. The Geosynthetics Installer shall have two options, as described in b and c below.

b. The Geosynthetics Installer can reconstruct the seam (e.g., remove the old seam and reseam) between two passing destructive test locations. The welding path of the seaming apparatus shall be tracked (in each direction).

c. The Geosynthetics Installer can trace the welding path to an intermediate location, a minimum of 10 ft from the location of the failed test (in each direction) and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory samples shall be taken. If these laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases where the length of reconstructed seam exceeds 150 ft., a destructive sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, the CQA Consultant may require additional tests for seams that were formed by the same seamer and/or seaming apparatus or seamed during the same time shift.

L. Defects and Repairs

1. All seams and non-seam areas of the geomembrane will be examined by the CQA Consultant and the Geosynthetic Installer for evidence of defects, holes, blisters, undispersed raw materials and any sign 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 Geosynthetics Installer if surface contamination inhibits examination. The Geosynthetics Installer shall ensure that this examination of the geomembrane precedes any seaming of that section.
2. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described Part 3.05.J of this Section, as appropriate. Each location that fails nondestructive testing shall be marked by the CQA Consultant and repaired by the Geosynthetics Installer. Work shall not proceed with any materials that will cover the defective area until the suspect location is repaired and passing nondestructive test are obtained. In addition, passing destructive test results shall be achieved prior to placing any material over geomembrane.
3. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall identify excessive geomembrane wrinkles. The Geosynthetics Installer shall cut and reseam the wrinkle areas so identified. The seams thus produced shall be tested like any other seams.
4. Repair Procedures.
   a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics Installer. Several repair procedures are specified below. The final decision as to the appropriate repair procedure shall be agreed upon between the CQA Consultant and the Geosynthetics Installer. The procedures available include:
      i. patching (used to repair large holes, small tears, undispersed raw materials, and contamination by foreign matter);
      ii. abrading and reseaming (used to repair small sections of extruded seams);

iii. spot seaming (used to repair pinholes, or other minor, localized flaws);

iv. capping (used to repair long lengths of failed seams);

v. removing failed seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams) and/or extrusion seams.

b. In addition, the following shall be satisfied:

i. surfaces of the geomembrane that are to be repaired shall be abraded no more than 20 minutes prior to the repair;

ii. all surfaces must be clean and dry at the time of repair;

iii. all seaming equipment used in repair procedures must be approved by ENGINEER or the CQA Consultant;

iv. the repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the CQA Consultant and Geosynthetics Installer;

v. patches or caps shall extend at least 6 in. beyond the edge of the defect, and all corners of holes and patches shall be rounded with a radius of at least 3 in.; and

vi. the geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

5. Each repair shall be numbered and logged and shall be nondestructively tested using the methods described in this Section. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test result is achieved. At the discretion of the CQA Consultant, destructive testing may be required on large caps.

3.06 MATERIALS IN CONTACT WITH GEOMEMBRANE

A. The Geosynthetics Installer shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or during the installation of other components of the liner system or by other construction activities. Installation on rough surfaces, such as concrete, shall be performed carefully.

B. Equipment shall not be driven directly on the geomembrane. Unless otherwise specified by ENGINEER, all equipment operating on materials overlying the geomembrane shall comply with the following:

Allowable Equipment Ground Pressure (psi)	Thickness of Overlying Compaction Soil (ft)
<5	1.0
<10	1.5
<20	2.0
>20	3.0

C. In heavily trafficked areas such as access ramps, and in areas trafficked by rubber tire vehicles, the thickness of overlying compacted soil shall be at least 3 ft.

D. Installation of the geomembrane in sump areas, and connection of the geomembrane to appurtenances shall be made according to these Specifications and as shown on the Drawings. Extreme care shall be taken while seaming around sumps and appurtenances since neither nondestructive nor destructive testing may be feasible in these areas. The Geosynthetics Installer shall ensure that the geomembrane has not been visibly damaged while making connections to sumps and appurtenances. Because of the difficulty of vacuum testing seams in the sump area, fusion seams should be made at all possible locations in the sump.

E. Placement of soils above the geomembrane will not proceed at an ambient temperature below 32°F nor above 104°F unless otherwise specified, or approved by ENGINEER.

3.07 GEOMEMBRANE ACCEPTANCE

A. The Geosynthetics Installer shall retain all ownership and responsibility for the geomembrane until accepted by OWNER and ENGINEER.

B. The geomembrane will not be accepted by OWNER and ENGINEER until all of the following conditions are met:
   1. the installation is finished;
   2. all documentation of installation is completed including the CQA Consultant's final report;
   3. verification of the adequacy of all field seams and repairs, including associated testing, is complete; and
   4. written certification documents, including record drawings, sealed by a professional land surveyor licensed in the State of Delaware, have been received by OWNER and ENGINEER, in accordance with Section 01721.

3.08 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work and all materials and completed Work of other Sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to OWNER.

TABLE 02075-1

REQUIRED TEXTURED GEOMEMBRANE PROPERTY VALUES (1)

Properties	Qualifiers	Units	Specified Values		Test Method
			60 mil	40 mil	
Thickness	Nominal	Mils	60	40	ASTM D 5994
	Minimum Average	Mils	57	38	ASTM D 5994
Asperity Height	Minimum Average	Mils	20	20	ASTM D 7466
Density	Minimum	g/cc	0.94	0.94	ASTM D 792 or ASTM D 1505
Tensile Properties (each direction)					
1. Yield Strength	Minimum	Lb/in.	126	84	ASTM D 6693 Type IV
2. Break Strength	Minimum	Lb/in.	90	60	ASTM D 6693 Type IV
3. Yield Elongation	Minimum	%	12	12	ASTM D 6693 Type IV
4. Break Elongation	Minimum	%	100	100	ASTM D 6693 Type IV
Tear Resistance	Minimum	Lb.	42	28	ASTM D 1004
Puncture Resistance	Minimum	Lb.	90	60	ASTM D 4833
~~Interface Friction (see Note 2)~~Interface Peak Shear Stress	Minimum	~~Degrees~~psf	101~~23~~(3)	101~~23~~(3)	ASTM D 5321
Interface Peak Shear Stress	Minimum	psf	1926(4)	1926(4)	ASTM D 5321
Carbon Black Content	Range	%	2 - 3	2 - 3	ASTM D 4218
Carbon Black Dispersion	N/A	None	See Note 5	See Note 5	ASTM D 5596
Stress Crack Resistance [see Note (6)]	Minimum	hours	500	500	ASTM D 5397

Notes:
(1) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed these values).
(2) Interface friction testing shall be performed by CONTRACTOR on the entire liner system cross section using the proposed liner system materials (i.e., structural fill, GCL, geomembrane, geotextile, and aggregate). The testing shall be performed at the normal stresses indicated.
(3) Testing shall be performed at normal stresses of 240 psf.
(4) Testing shall be performed at normal stresses of 6,300 psf.
(5) Carbon black dispersion (on near spherical agglomerates) for 10 different views:
- 9 in categories 1 or 2; and
- 1 in Category 3.

(6) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

TABLE 02075-2

REQUIRED TEXTURED GEOMEMBRANE SEAM PROPERTIES

Properties	Qualifiers	Units	Specified Values		Test Method
			60 mil	40 mil	
Gauge	Nominal	Mils	60	40	
Shear Strength(1) at yield point	Minimum	Lb/in	120	80	ASTM D 6392
Peel Adhesion FTB(2) Fusion	Minimum	Lb/in	91	60	ASTM D 6392
Extrusion		Lb/in	78	52	ASTM D 6392

Notes: (1) Also called "Bonded Seam Strength".
(2) In addition to the minimum passing values, passing seams shall exhibit film tear bond (FTB) and the seam shall not separate more than 10 percent.
(3) Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values

TABLE 02075-3

GEOSYNTHETIC INTERFACE FRICTION VALUES FOR ENVIRONMENTAL CAP

Interface	Normal Loading(1)	Interface Friction Angle
Structural Fill/Geocomposite	500, 1,000 and 1,500 psf	24°
Geocomposite/40 mil textured HDPE geomembrane	500, 1,000 and 1,500 psf	24°
40 mil textured HDPE geomembrane/Structural Fill	500, 1,000 and 1,500 psf	24°

(1) For direct shear, three (3) separate normal loading are required to develop the failure envelope (Mohr's Circle).

*****END OF SECTION*****

SECTION 02081

LANDFILL GAS HIGH DENSITY POLYETHYLENE (HDPE)
PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of all (HDPE) pipe, fittings and appurtenances as specified herein, as shown on the Drawings.

B. CONTRACTOR shall coordinate the installation of the HDPE pipe and fittings with other construction activities and subcontractors at the Site.

1.02 SUBMITTALS

A. CONTRACTOR shall submit to ENGINEER complete, detailed shop drawings of all HDPE pipe and fittings, a list of materials to be furnished, the names of the suppliers and the proposed dates of delivery of the materials to the Site.

B. Upon delivery of pipe materials to the Site, CONTRACTOR shall submit to ENGINEER the HDPE pipe manufacturer's certification of compliance with these Specifications for all materials delivered to the Site, and shall comply with the HDPE pipe manufacturer's recommendations for handling, storing, and installing HDPE pipes and fittings.

C. Prior to transporting any HDPE pipe or fittings to the Site, CONTRACTOR shall submit to ENGINEER in writing the following documentation from the HDPE pipe Manufacturer on the raw materials used to manufacture the HDPE pipe and fittings:
   1. Certificate stating the specific resin, its source and the information required by ASTM D 1248; and
   2. Certification that no recycled compound has been added to the resin.

D. Prior to transporting any HDPE pipe or fittings to the Site, CONTRACTOR shall submit to ENGINEER certification from the HDPE pipe manufacturer that stress regression testing has been performed on the specific product in accordance with ASTM D 2837.

1.03 WARRANTY

A. CONTRACTOR shall furnish OWNER written warranties obtained from the Manufacturer and the Installer against defects in materials and workmanship in accordance with ASTM D 3350 and ASTM F 714 and effective for a one-year period. Warranty conditions proposed by the manufacturer or installer concerning limits of liability will be evaluated and must be acceptable to OWNER.

1.04 RESPONSIBILITY

A. CONTRACTOR shall provide the services of a HDPE pipe and fittings manufacturer and installer. CONTRACTOR shall, however, accept and retain full

responsibility for all materials and installation and shall be held responsible for any defects in the completed HDPE pipe and fittings.

B. The pipe manufacturer shall be responsible for the production and delivery of the HDPE pipe and fittings and shall be a well-established firm with more than two years experience in the manufacture of HDPE pipe and fittings.

C. CONTRACTOR shall be responsible for field handling, storing, installing, and other site aspects of the installation of the HDPE pipe and fittings.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. CQA monitoring of the installation of HDPE pipe and fittings shall be conducted by OWNER.

B. CONTRACTOR shall be aware of and shall account for these CQA activities in the installation schedule.

PART 2 - PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE COMPOUND

A. The HDPE pipe and fittings shall be manufactured from new, high performance, high molecular weight, HDPE resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P 34), ASTM D 3350 (Cell Classification PE 345434C), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. The resin shall be pre-compounded. In plant blending of non-compounded resins shall not be permitted.

B. The polyethylene compound shall contain a minimum of 2 percent carbon black.

C. The polyethylene compound shall have a minimum resistance of 125 hours when tested for environmental stress crack in accordance with requirements of ASTM D 1693, Procedure B.

2.02 HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS

A. The HDPE pipe shall have a minimum Hydrostatic Design Basis (HDB) of 1,600 psi, in accordance with ASTM D 2837.

B. All HDPE pipe and fittings shall comply with the ASTM F 714.

C. All HDPE pipe shall have a Standard Dimension Ratio (SDR) of 17 unless otherwise stated on the Drawings. All HDPE fittings shall have an SDR of 17.

D. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 ft.

E. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index and other physical properties.

F. HDPE pipe shall be furnished non-perforated or perforated as shown on the Drawings. Perforations shall be drilled into the pipe after manufacture, prior to delivery to the Site. Perforations shall be in accordance with the Drawings.

2.03 IDENTIFICATION

A. The following shall be continuously offset printed or indent printed on the pipe, or spaced at intervals not exceeding 5 ft.:
   1. name and/or trademark of the pipe manufacturer
   2. nominal pipe size;
   3. standard dimension ratio (SDR);
   4. the letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design Stress in psi (e.g., PE 3408);
   5. manufacturing Standard Reference (e.g., ASTM F-714-1); and
   6. a production code from which the date and place of manufacture can be determined.

2.04 PIPE LOCATING SYSTEM

A. A pipe locating system consisting of detectable marker tape and plastic coated copper wire shall be installed with all solid HDPE pipe (existing and new) to be buried. The detectable marker tape shall be placed 1 ft below the ground surface. The copper wire shall be installed directly above the pipe, with the ends of the wires anchored and exposed.

2.05 PIPE BEDDING MATERIAL

A. Pipe bedding material shall conform to the requirements of structural fill as specified in Section 02055.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of the Site inspection. Failure to inform ENGINEER in writing or proceeding with installation of the polyethylene pipes and fittings will be construed as CONTRACTOR'S acceptance of the related work of all other Sections.

3.02 HANDLING AND PLACEMENT

A. CONTRACTOR shall exercise care when transporting, handling and placing HDPE pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

B. Ropes, fabric or rubber-protected slings and straps shall be used when handling HDPE pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

C. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches, or dragged over sharp and cutting objects.

D. HDPE pipe shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. The pipes should be stored out of direct sunlight.

E. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of HDPE pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. Sections of pipe with excessive cuts, gouges or scratches shall be removed and the ends of the pipe rejoined at no cost to OWNER.

F. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

3.03 INSTALLATION

A. General:

1. All HDPE pipe and fittings shall be installed in accordance with the pipe manufacturer's instructions.
2. CONTRACTOR shall carefully examine all pipe and fittings for cracks, damage or defects before installation. Defective materials shall be immediately removed from the Site and replaced at no cost to OWNER
3. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.
4. Field-cutting of pipes, where required, shall be made with a machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cutter ends shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed.
5. All pipe and fittings shall be laid or placed to the lines and grades shown on the Drawings with bedding and backfill shown on the Drawings and as specified in this Section.
6. No pipe shall be laid until the CQA Consultant has approved the bedding conditions and the trench layout.
7. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.
8. Blocking under piping shall not be permitted unless specifically accepted by ENGINEER for special conditions.
9. CONTRACTOR shall provide all necessary adapters and/or connection pieces requited when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers

B. CONTRACTOR shall obtain custom fabricated fittings as needed. No field modification to enable use of standard, rather than custom, fittings may be made without the approval of ENGINEER.

C. CONTRACTOR shall exercise extreme care when working with piping that contained or contains landfill gas. Landfill gas pipes shall be purged with nitrogen and monitored for explosion hazard prior to any fusion being performed. In addition, CONTRACTOR shall protect against static electric discharges by placing a wet rag with a grounded wire attached over the HDPE piping.

D. Installation of 6-in. diameter gas branch lines between gas branch control valves and the gas header at Cell 3 will require uncovering 15 to 20 ft of existing branch line, removal and storage of existing passive flares, and installing new pipe lengths to tie in to valves and headers. The passive flares shall remain in service for as long as possible and should be removed and stored by CONTRACTOR at a location selected by OWNER

E. Installation of the gas main outside of the waste placement will require locating existing leachate and electrical lines and conduits, and moving or regrading these lines and/or adjusting the grade of the gas main to be installed, such that the slope requirements for the new gas main are not compromised.

3.04 JOINTS AND CONNECTIONS

A. HDPE pipe shall be joined with thermal butt-fusion joints. All joints shall be made in strict compliance with ASTM D 2657 and the pipe manufacturer's recommendations, and shall be performed by pipe manufacturer's authorized, trained fusion personnel.

B. Mechanical connections of HDPE pipe to auxiliary equipment such as valves, flow meters, pumps and tanks shall consist of the following unless otherwise specified by ENGINEER.
   1. An HDPE flange shall be butt-fused to the HDPE pipe. Outside diameter and drillings shall comply with ANSI B 16.1.
   2. A 316 stainless steel back up shall be provided if buried within limits of waste. Outside diameter and drillings shall comply with ANSI B 16.5.
   3. Epoxy-coated steel back-up rings shall be used in valve boxes, manholes, and beyond the limits of waste.

C. Polyethylene stub ends and flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene. Bolts shall be drawn up evenly and in line.

3.05 TESTING OF HDPE PIPE AND FITTINGS

A. General:
   1. CONTRACTOR shall pressure test all solid pipe and fittings.
   2. The CQA Consultant shall be notified a minimum of 24 hours in advance of any testing.
   3. CONTRACTOR shall provide all testing apparatus, including pumps, hoses, gauges, taps, plugs, temporary connections, and fittings.
   4. All tests shall be performed in the presence of the CQA Consultant.
   5. For landfill gas system pipes, testing shall be performed in accordance with ASTM F 1417.

B. Repair:
   1. Installed pipes or pipe joints that leak, according to the test results, shall be either repaired to the satisfaction of the CQA Consultant or replaced at no cost to OWNER.
   2. Repaired or replaced pipe shall be successfully pressure tested prior to filling over the pipe.

3.06 SURVEY REQUIREMENTS

A. Prior to backfilling any pipe trench, CONTRACTOR's surveyor shall determine the location and elevation of the pipe invert at points spaced no greater than 25 ft apart. The survey may be performed on the compacted bedding material prior to pipe placement.

3.07 TOLERANCES

A. The minimum slope on any installed gas main or branch line shall be 3 percent or as indicated on the Drawings.

3.08 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior work and materials and completed work of other Sections.

B. In the event of damage to prior work or work completed as specified in this Section, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of ENGINEER, and at no cost to OWNER.

*****END OF SECTION*****

SECTION 02083

LANDFILL GAS WELLHEADS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supply all labor, materials, tools, supervision, transportation, and installation equipment necessary for the manufacture, delivery, storage, installation, and testing of the landfill gas wellheads (wellheads), including installation as specified herein and as shown on the Drawings.

1.02 SUBMITTALS

A. At least 14 days prior to any wellhead installation, CONTRACTOR shall submit to ENGINEER the following:
   1. wellhead manufacturer's installation instructions;
   2. wellhead manufacturer's operation and maintenance (O&M) manual (seven copies in addition to the number required for submittals);
   3. wellhead manufacturer's warranty information;
   4. Shop Drawings showing the layout and details of all features of gas management system; and
   5. a copy of the piping schematic.

1.03 WARRANTY

A. CONTRACTOR shall furnish OWNER with one-year written warranties obtained from the wellhead manufacturer against defects in materials and workmanship. Warranty conditions proposed by the wellhead manufacturer concerning limits of liability will be evaluated and must be acceptable to OWNER.

1.04 RESPONSIBILITY

A. CONTRACTOR shall provide the services of a wellhead manufacturer. CONTRACTOR shall, however, accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the completed wellhead.

B. Handling, storage, and care of the wellhead prior to and following installation at the Site are the responsibility of CONTRACTOR. During storage, the wellhead shall be protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The wellhead shall be stored in accordance with additional requirements of the wellhead manufacturer. CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance of the work by OWNER.

PART 2 - PRODUCTS

2.01 GAS EXTRACTION WELLHEAD

A. The wellhead shall be a nominal 2-in. SOILTEC Model GFC 2000B wellhead with orifice plate (0 to 30 scfm) or approved equal and shall consist of well head piping, flow control gate valve, gas temperature gauge, gas sampling port with

quick- connect fitting, static and impact pressure ports with quick-connect fittings, flexible connector, union disconnect, and dust cap. Wellhead piping and fittings shall be HDPE, PVC, or polypropylene.

B. The equipment shall be capable of withstanding the rigors of landfill gas recovery application including internal high vacuum, weathering, gas constituents, and ultraviolet light exposure.

C. The wellhead shall be leak free and shall be height adjustable in the field using adapter bushings.

D. The wellhead to well pipe connection shall be using procedures and materials approved by OWNER. A single 4-in. by 2-in. rubber reducing coupling is not acceptable. A two-piece rubber connection with a 4-in. straight coupling and a 4-in. by 2-in. bushing insert, or other connections recommended by the wellhead manufacturer, will be acceptable.

E. The wellhead shall be capable of being used with the LANDTEC GEM-500™ Gas Extraction Monitor (GEM-500) incorporating all GEM-500 monitoring functions.

F. It is the intent of this Specification that the wellhead shall be supplied as a complete manufactured unit.

G. The gas flow rate measurement assembly shall be pre-calibrated and lab certified. The measurement assembly shall have an accuracy and repeatability of ± 5 percent through the recommended flow range when used and maintained in accordance with the wellhead manufacturer's instructions and recommendations.

H. The gas temperature gauge shall be bi-meter thermometer with minimum 2-in. dial and 0 to 200 °F operating range.

2.02 FLEXIBLE CONNECTOR

A. A flexible connector shall be used to connect the wellhead to the header.

B. The flexible connector shall be Kanaflex 101-PS PVC hose with Kanaflex Powerlock PS clamps or approved equal.

2.03 NUTS, BOLTS, AND GASKETS

A. For above ground installation, nuts and bolts shall be cadmium plated or galvanized steel.

B. For below ground installation, nuts and bolts shall be type 304 stainless steel.

C. Gasket for flange installation shall be neoprene rubber.

2.04 SPARE PARTS

A. CONTRACTOR shall provide five complete spare gas extraction wellheads to OWNER.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all work is complete to the point where the installation of this section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of the Site inspection. Failure to inform ENGINEER in writing or proceeding with installation of the wellhead will be construed as CONTRACTOR's acceptance of the related work of all other Sections.

3.02 LOCATION OF EXISTING HORIZONTAL GAS LINES

A. The precise location of the existing and new horizontal gas lines to which each of the wellheads will be tied-in needs to be determined. Once located, these gas lines shall be excavated as appropriate, cut to allow connection to the wellhead piping, backfilled, tested, and the finished connections and grades surveyed.

3.03 INSTALLATION INSTRUCTIONS

A. Work shall be performed in accordance with the wellhead manufacturer's written instructions and installation detail drawings.

3.04 INSTALLATION

A. The wellhead shall be lifted and handled according to written instructions supplied by the wellhead manufacturer.

B. The wellhead and 2-in. connector line shall be installed within 0.25 percent of vertical.

C. The wellhead shall be installed such that the flow measurement assembly is concentric with the well casing.

D. Where the wellhead connects directly to the header, a branch saddle shall be installed on the header in accordance with accepted methods and standards. The wellhead shall be connected to the header branch fitting in accordance with the wellhead manufacturer's written instructions. Adapters shall be used as recommended by the wellhead manufacturer.

E. The wellhead shall be installed on the well casing in accordance with the wellhead manufacturer's written instructions.

F. Install the wellhead as high as practical above the coupling to the well casing. Install the flex hose with at least 1 ft of slack to allow for landfill settlement. Wellhead valves must be at least 3 ft., but not greater than 5 ft above ground.

3.05 LABELING

A. Each wellhead will be permanently labeled with the well number using an approved method.

3.06 TESTING

A. At the time of system start up, CONTRACTOR shall demonstrate to the satisfaction of OWNER that all wellheads are fully operational. Using the LANDTEC GEM-500 and other gas monitoring instruments as required, CONTRACTOR shall demonstrate that components and connections are leak free, the temperature gauge is accurate, the flow measurement assembly is accurate, and the control valve is fully operable.

3.07 ACCEPTANCE

A. CONTRACTOR shall retain responsibility for the wellhead until accepted by OWNER.

B. The wellhead shall be accepted by OWNER when:

1. the installation is finished;
2. verification that the wellhead has passed the tests specified in Section 3.05; and
3. verification of the adequacy of all repairs, including associated testing, is complete.

*****END OF SECTION*****

SECTION 02085

LANDFILL GAS CONDENSATE DRAINS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all materials, equipment, and labor needed to install the landfill condensate drains in accordance with the Drawings.

1.02 SUBMITTALS

A. At least 14 days prior to installing the landfill condensate drains, CONTRACTOR shall submit to ENGINEER manufacturer's literature and Shop Drawings with detailed parts lists.

B. At least 14 days prior to installing the landfill condensate drains, CONTRACTOR shall submit to ENGINEER Shop Drawings showing the piping schematics and layout, orientation, dimensions, and details of all connections to the condensate traps.

C. CONTRACTOR shall submit to ENGINEER a 1-year written warranty for all condensate traps.

PART 2 - PRODUCTS

2.01 CONDENSATE TRAPS

A. The condensate traps shall be fabricated according to the dimensions and material specifications supplied in the Drawings.

B. The entrained condensate in the landfill gas header pipes shall be drained to the existing leachate riser pipes and shall be such that flow of gas through the traps is prevented.

C. The condensate drains will have an extended section such that it is at least 2 ft above the final grade. The extended section shall have an access port to allow for maintenance of the condensate drains.

PART 3 – EXECUTION

3.01 INSTALLATION

A. CONTRACTOR shall completely install and backfill each condensate drain in one day.

B. Installation of the condensate drains shall be in accordance with the manufacturer's recommendations.

C. The condensate drains shall be tested following manufacturer's recommendations which will include manually filling the traps and drip leg with

water and observing the drainage operation. The liquid must be released to the waste mass or leachate collection system.

D. An approved identification label shall be prepared and securely attached to each condensate drain cleanout at a location and in a manner approved by OWNER.

*****END OF SECTION*****

SECTION 02100

SITE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all permits, materials, labor, equipment, tools and appurtenances required to complete the Work as described herein. The CONTRACTOR shall provide a "Competent Person" to implement, supervise, and inspect all Work.

B. This Section describes materials and equipment to be utilized, and requirements for their use in preparing the Site for construction.

C. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, State or Federal authorities having jurisdiction.

D. The CONTRACTOR shall remove, transport, and dispose of cleared and grubbed materials at on-Site areas designated by the OWNER. The CONTRACTOR shall provide all equipment, materials, and personnel necessary to remove and transport these materials to the designated areas.

E. Protect and maintain existing monitoring wells, vents, structures, fences, benchmarks, monuments, and other reference points. Re-establish, at no cost to the OWNER, any such reference points if disturbed or destroyed. The CONTRACTOR's surveyor shall conduct a survey of all monuments and property markers within proposed Work areas prior to any disturbance so that they can be re-established if disturbed by the CONTRACTOR as part of this Contract.

F. Protect and maintain all existing groundwater monitoring wells, gas extraction wells, stormwater control features, and all other facilities to remain in place as indicated on the Contract Documents.

G. Protect any existing facilities, utilities, and structures from damage due to construction.

1.02 RELATED SECTIONS

A. 01564 - Health and Safety Specifications for Construction

B. 02055 - Soils

C. 02110 - Site Clearing and Grubbing

D. 02110 – Site Grading

E. 02220 - Excavation

F. 02370 - Erosion and Sediment Control

PART 2 – PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

*****END OF SECTION*****

SECTION 02110

SITE CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work as described below. The CONTRACTOR shall provide a “Competent Person” to implement, supervise, and inspect all Work.

B. Site clearing includes, but is not limited to, removing from the construction area, hauling to disposal areas approved by the OWNER, and disposing of trees, stumps, roots, brush, structures, abandoned utilities, trash, debris and all other materials found on or near the surface of the ground within construction areas. Precautionary measures that prevent damage to existing features to remain are part of the Work.

C. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, State, and Federal authorities having jurisdiction.

D. No clearing and grubbing shall be allowed without adequate erosion and sedimentation control measures in-place to the satisfaction of the OWNER, and as described in the Contract Documents.

1.02 RELATED SECTIONS

A. 01564 - Health and Safety Specifications for Construction

B. 02100 - Site Preparation

C. 02210 - Site Grading

D. 02220 - Excavation

E. 02370 - Erosion and Sediment Control

1.03 JOB CONDITIONS

A. Location of Work: Areas to be cleared and grubbed include all areas designated for over-excavation, the limits of the initial works pad, laydown area(s), on-site and off-site borrow areas, designated access roads, construction of stormwater management system, and all areas identified in the Contract Documents associated with the construction.

PART 2 - PRODUCTS

A. The CONTRACTOR shall furnish equipment of the type normally used in clearing and grubbing operations including, but not limited to, dozers, shears, skidders, loaders, root rakes, chipping equipment and stump grinders.

PART 3 - EXECUTION

3.01 SCHEDULING OF CLEARING

A. Clearing and grubbing shall not commence prior to the CONTRACTOR installing erosion and sedimentation control measures to the satisfaction of the OWNER, and as described in the Contract Documents.

B. The OWNER may permit clearing of additional areas provided that temporary erosion and sedimentation controls are in-place in accordance with Section 02370 of these Specifications.

3.02 CLEARING AND GRUBBING PROCEDURES

A. Materials to be cleared, grubbed, and removed from the construction areas include, but are not limited to, trees, stumps, roots, brush, trash, organic matter, and debris.

B. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all graded areas, so that surface material is free of roots and debris. Surface material is to be left sufficiently clean so that further picking and raking will not be required.

C. Stumps, roots, foundations and planking embedded in the ground shall be removed and properly disposed at a location approved by the OWNER.

D. Surface rocks and boulders greater than 6 inches in diameter shall be grubbed from the soil and removed to a designated on-Site location approved by the OWNER.

E. Where tree limbs interfere with utility wires, or where trees to be felled are in proximity to utility wires, these trees shall be taken down in sections to reduce the possibility of damage to the utility wires. The CONTRACTOR shall be responsible for damages to utilities and consequential damages to the OWNER and third parties, and shall replace or repair damaged utilities at no cost to the OWNER.

F. Any Work pertaining to utility poles and guy wires shall comply with the requirements of the appropriate utility.

G. Stumps and roots shall be grubbed and removed to a depth not less than two (2) feet below subgrade as indicated on the Contract Drawings. All holes or cavities which extend below the subgrade elevation of the proposed work shall be backfilled with soil or other suitable material, compacted to a similar density as the surrounding material. Roots ½-inch in diameter and greater shall be removed to a depth not less than 6 inches below subgrade.

H. The CONTRACTOR shall be held liable for any direct or consequential damage to property outside of the designated Work area(s).

I. Where present the CONTRACTOR will remove the existing asphalt surface including subbase course to competent ground.

J. The CONTRACTOR shall be responsible for all damages to existing structures and/or improvements resulting from the Work.

K. The CONTRACTOR shall protect existing wells and fencing, and any other facilities or structures to remain from damage due to construction activities. Damaged items shall be repaired or replaced at no cost to the OWNER.

3.03 DISPOSAL OF DEBRIS

A. Debris (i.e., stumps, roots, branches, leaves etc.) resulting from the Site clearing and grubbing operations shall be removed to the approved on-Site relocation area(s) designated by the OWNER.

B. All trees and shrubs from the clearing operation shall be chipped on-Site. Chipped material from portions of trees and shrubs above grade (trunks, branches) may be composted and used as mulch on revegetated areas, or for temporary erosion control measures. Mulch made from chipping and shredding on-site materials shall meet the applicable mulch requirements listed in Section 02370 of these Specifications.

C. Large debris (i.e., stumps, etc.) shall be cut, shredded, or crushed into pieces no greater than 6 inches in any dimension, and properly disposed at a location approved by the OWNER.

*****END OF SECTION*****

SECTION 02210

SITE GRADING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the Work of rough and finished site grading for areas to receive fill, temporary stormwater management structures, site drainage, site access roads, and general grading necessary for restoration of the overall Site. The CONTRACTOR shall provide a “Competent Person” to implement, supervise, and inspect the Work.

B. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, State, and Federal authorities having jurisdiction.

1.02 SUBMITTALS

A. Submittals shall be made by the CONTRACTOR in accordance with Section 01300.

1.03 RELATED SECTIONS

A. 01050 - Field Engineering/Surveying

B. 01562 - Dust Control

C. 01564 - Health and Safety Specifications for Construction

D. 02055 - Soils

E. 02100 - Site Preparation

F. 02110 - Site Clearing and Grubbing

G. 02220 - Excavation

1.04 GENERAL

A. Notify corporations, companies, individuals or authorities owning above- or below-ground conduits, wires, pipes, or other utilities running to the property prior to the start of the Work in order to verify their locations and protect them from damage. CONTRACTOR should arrange for underground utility mark-outs prior to any excavation or grading work.

B. Cap, or remove and relocate, utility services in accordance with instructions by the OWNER and/or utility company.

C. Protect, support, and maintain conduits, wires, pipes or other utilities that are to remain in accordance with the requirements of the Contract Documents, and/or as required by the OWNER, and/or utility company.

1.05 QUALITY ASSURANCE

A. Testing shall be provided by the CONTRACTOR in accordance with applicable Sections of these Specifications as outlined in Article 1.03.

B. Tolerances in accordance with those specified in individual Sections of these Specifications as outlined in Article 1.03 herein.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall be in accordance with applicable Sections of these Specifications as outlined in Article 1.03 herein.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine surfaces to receive fill to determine existence of areas loosened by frost action, softened by precipitation or flooding, or of unsuitable materials.

B. Fill settled areas that were previously filled and where excavations or trenches were backfilled and holes made by demolition, tree removal, and other Site preparation work.

C. Natural soils or compacted fill softened by frost, precipitation or flooding shall be removed, replaced with soils of similar characteristics, and compacted.

D. Remove unsuitable material discovered during grading activities and backfill with compacted structural fill material as outlined in Section 02055.

E. Maintain adequate drainage of the Site. Remove ponded water prior to grading.

3.02 FILLING AND GRADING

A. Perform in accordance with Section 02055 of these Specifications.

B. Stockpile material suitable for backfill where indicated on the Contract Drawings or designated by the OWNER.

C. Place and grade materials not suitable for backfilling or grading, and unsuitable materials in designated relocation areas or as directed by the OWNER.

D. Grade to the elevations specified by the Contract Documents.

3.03 CLEANING

A. Excess materials shall be removed, stockpiled, or otherwise disposed by the CONTRACTOR at the direction of the OWNER. Excess excavation beyond the Contract limits, shall be discussed and approved by the OWNER prior to proceeding.

***** END OF SECTION *****

SECTION 02220

EXCAVATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all labor, materials, equipment, tools, and appurtenances required to complete all excavation related activities, including, but not limited to, excavations, removal of excess and/or unsuitable materials, relocation of excavated and/or unsuitable soils to designated areas, below cap gas collection system installation, and other related and incidental work within the designated areas and as required for the construction of other aspects of the Work, as shown, specified or required by the Contract Documents. The CONTRACTOR shall provide a “Competent Person” to implement, supervise, and inspect the Work.

B. The Work of this Section includes, but is not limited to, excavation associated with the removal of unsuitable materials and the construction of the initial works pad.

C. The CONTRACTOR shall locate all existing active and abandoned utilities and structures in designated Work areas prior to commencing any excavation activities. The CONTRACTOR shall also protect from damage those utilities and structures which are to remain in place.

D. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, State, or Federal authorities having jurisdiction.

E. The CONTRACTOR shall perform dewatering of excavations, if necessary.

1.02 RELATED SECTIONS

A. 01050 - Field Engineering/Surveying

B. 01562 - Dust Control

C. 01564 - Health and Safety Specifications for Construction

D. 02110 - Site Clearing and Grubbing

E. 02210 - Site Grading

F. 02223 - Backfill and Fil

G. 02370 - Erosion and Sediment Control

1.03 SUBMITTALS

A. CONTRACTOR shall submit all necessary certifications, design, and description of construction methods for excavations made without shoring and bracing as required by Article 1.05D below.

B. CONTRACTOR shall submit all necessary certifications, designs, and description of construction methods for excavations where shoring and bracing is proposed as required by Article 1.05E below.

1.04 DEFINITIONS

A. Excavation includes trenching and shall mean the removal from in-place of all materials including, but not limited to, topsoil, soil, cover soil, refuse, structures above and below ground, boggy waste, rubbish, tree stumps, boulders, logs, metal, ashes, cinders or organic material such as peat, humus or organic silt. Excavation of rock is not envisioned as part of this Contract.

B. Mucking or mucking-out shall mean excavation, as defined herein before, without prior dewatering, of soils that are super-saturated and unstable.

1.05 PROTECTION OF PEOPLE AND PROPERTY

A. The CONTRACTOR shall be responsible for the stability and safety of all of the CONTRACTOR's excavations at all times regardless of the requirements of this subsection.

B. The CONTRACTOR shall plan and conduct his operations and take all necessary precautions so as to prevent damage to existing utilities, structures, roads, grades, slopes, surface water drainage features, underground piping, manholes, monitoring wells, and other site features, safeguard people and property, minimize traffic inconvenience, minimize dust and odors, and provide safe working conditions. The CONTRACTOR shall repair, to the OWNER's satisfaction, and at no additional expense or delay to the OWNER, any and all damage which occurs as a result of the excavation work.

C. Excavations, except as specified hereinafter, shall be adequately shored and braced. The CONTRACTOR will submit information relating to shoring and bracing to the ENGINEER for review prior to implementation. Where the installation of shoring and bracing is impractical or might cause damage as a result of, but not limited to, vibrations, settlements and/or lateral movements, the CONTRACTOR shall utilize other alternate methods. Excavations shall be adequately covered with temporary measures or adequately barricaded to prevent unwanted or inadvertent intrusion.

D. Excavations may be made without shoring and bracing within the limitations and requirements of applicable governmental agencies having jurisdiction, provided that:

1. Hazards, such as described herein, do not exist in the proximity of the excavation;
2. Excavation depth does not exceed 4 feet, or the OSHA standards for work performed without the use of shoring and bracing, whichever is less; and,
3. CONTRACTOR shall submit a certification by a Professional Engineer licensed in the Commonwealth of Pennsylvania, indicating the maximum excavation side slopes proposed, and that said side slopes will remain stable under all weather and working conditions over the entire period that the excavation will be exposed. Such certification shall be based on CONTRACTOR's own subsurface exploration and consideration of available options and related work requirements, including but not limited to, dewatering, construction equipment, location of underground piping, and proximity of stockpiles. Any review and/or comments provided to

CONTRACTOR by the OWNER, ENGINEER, or CQA CONSULTANT shall not relieve CONTRACTOR of its responsibility arising from excavation operations.

E. In cases where excavations without shoring and bracing are not permissible because of worker safety, space limitations, or the need to minimize the disturbance of refuse, sheet piles, trench boxes, or other equivalent shoring or bracing may be used by CONTRACTOR provided that CONTRACTOR shall submit a certification by a Professional Engineer licensed in the Commonwealth of Pennsylvania, indicating the design and methods of constructing and maintaining shoring and bracing such that the shored and braced excavations will remain stable under all weather and working conditions over the entire period that the excavation will be exposed. Such certification shall be based on CONTRACTOR's own subsurface exploration and consideration of available options and related work requirements including but not limited to, dewatering, construction equipment, location of underground piping, and proximity to stockpiles. Any review and/or comments provided to CONTRACTOR by OWNER, ENGINEER, or CQA Consultant shall not relieve CONTRACTOR of its responsibility arising from excavation operations.

F. CONTRACTOR shall haul or place all excavated materials to designated stockpile locations. Stockpile locations shall be accepted by the OWNER prior to stockpiling materials. At a minimum, stockpiles shall be placed 15 feet back and upslope from the excavation area. CONTRACTOR shall provide appropriate dust control measures in accordance with Section 01562, and sediment and erosion control as per Section 02125. All stockpiled materials placed outside of the landfill cell area. The CONTRACTOR will be responsible for maintenance and upkeep of excavated soil stockpiles.

G. Prior to excavation, Work areas shall be surrounded by soil berms, or other approved measures, to contain surface water runoff accumulation within the Work areas, and to exclude surface water run-on from adjacent areas. The CONTRACTOR shall employ excavation methods that minimize the need to remove accumulated water from excavations. Control of surface water shall be by methods referenced in Article 3.03 of Section 02370 of these Specifications.

H. Excavations which become affected by surface water runoff will have the water removed prior to the construction continuing in the area. No water shall be trapped beneath.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 LIMITS OF EXCAVATION

A. Stability of Excavations. Excavation side slopes shall comply with local codes and ordinances having jurisdiction. The CONTRACTOR shall comply with all applicable OSHA and other, related safety requirements. Maintain excavation side slopes to be safe condition until completion of backfilling.

B. Additional Excavation. When excavation has reached required subgrade elevations, notify CQA Consultant who will make a review of conditions. If unsuitable bearing materials are encountered at required subgrade elevations,

carry excavations to develop suitable bearing and replace excavated material as directed by the OWNER or CQA Consultant.

C. Unauthorized excavations consist of removal of materials beyond subgrade elevations indicated on Contract Documents or dimensions without specific direction by the OWNER or CQA Consultant. Unauthorized excavations shall be remedied at the CONTRACTOR's sole expense. The CONTRACTOR shall backfill and compact unauthorized excavations in the same manner as specified for authorized excavations of same classification at the CONTRACTOR's sole expense, unless otherwise directed by the OWNER.

3.02 REMOVAL OF UNSUITABLE MATERIAL

A. All wet, soft, frozen or otherwise unsuitable material as determined by the ENGINEER shall be excavated and stockpiled in accordance with Article 3.03 hererin.

B. The limits and depths of excavations to remove unsuitable materials prior to placement of material shall be advanced until suitable subgrade materials consisting of compact to very dense sands or medium stiff to hard clays are encountered, or as approved by the ENGINEER.

3.03 STOCKPILES

A. Stockpile excavated materials where directed by the OWNER, for potential on-Site reuse.

B. Place, grade, shape, and maintain stockpiles to provide proper drainage. Cover and install appropriate erosion and sediment control devices, in accordance with Section 02370, around stockpiles when requested by CQA Consultant and/or OWNER.

C. Provide and maintain separate stockpiles for riprap, cover soils, refuse, grading fill, topsoil, drainage stone, and other materials.

D. Locate and retain stockpiled materials at least 15 feet away from edge of excavations and upslope of excavations, or further as determined by the CONTRACTOR, so that the weight of the stockpiled materials will not create excessive loading conditions on excavation edges, shoring and bracing, and underground piping.

E. All stockpiles of excavated materials shall be protected against excess dust. Control dust from stockpiles in accordance with Section 01562.

F. Utilize excess material in accordance with Section 02055 of these Specifications for materials meeting the requirements of fill.

3.04 EXCAVATION INSTRUCTIONS

A. Excavation for Structures: Conform to elevations and dimensions required within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate to the elevations and dimensions necessary to complete construction as shown on the Contract Drawings.
2. Keep excavations free of runoff and ponded water.
3. Remove and replace or compact soils softened by frost, flooding or weather.
4. Remove unsuitable material from within influence zones of footings and slabs, and within trenches and replace with embedment soil.
5. Maintain a dewatering system if necessary.

B. Excavation for Trenches: Excavate trenches to the minimum widths required for particular items to be installed. Slope or bench the sides of trenches greater than 4 feet deep in accordance with OSHA 1926 Subpart P requirements and other applicable regulations. Provide appropriate access (ladders, etc.) at minimum frequencies specified in these regulations. Trenches shall be sufficiently wide to provide ample working room and as otherwise required for proper installations. All trench excavations shall be sufficiently wide to accommodate mechanical compaction equipment (minimum 6 inches) on both sides of pipes.

1. Excavated trenches with depths greater than 4 feet shall be considered confined spaces and shall be excavated and utilities installed in conformance with the requirements of the CONTRACTOR's Site-specific Health and Safety Plan prepared in accordance with Section 01564 of these Specifications.
2. All excavated materials shall be removed and hauled from the Work areas at the time of excavation, and stockpiled for reuse as backfill at designated on-Site areas or disposed of, at the CONTRACTOR's expense, as directed by the OWNER or CQA Consultant.
3. Barricades and signs warning of open trench excavations shall be erected to protect personnel working in the area.
4. Excavate trenches to the depths indicated on the Contract Documents or as required. Carry depth of trenches for piping, ducts, or conduit to establish indicated flow lines and invert elevations, without sags or humps, as shown on the Contract Drawings. Excavations shall be at straight and uniform grade.
5. Where unsuitable bedding subgrade surface is encountered, stabilize the trench bottom and replace unsuitable material with specified bedding material prior to the installation of bedding and pipe. All visible sharp protruding objects shall be removed or covered with a minimum of 12 inches of compacted fill prior to placement of pipes or other structures.
6. Bedding and backfilling shall be in accordance with Section 02055 of these Specifications.
7. Maximum width of the excavation at the top of the pipe shall be as shown on the Contract Drawings. When stringers and sheathing is required, width of trench may be increased to allow or their use, provided provisions for this excess width of trench are met.
8. Where trench width for that portion of trench depth between trench bottom and outside top of pipe barrel, for any reason within

CONTRACTOR's control, exceeds specified limits, the CONTRATCOR shall furnish pipe with strength adequate for actual trench width.

9. Maximum width at surface of ground shall not exceed width of trench at top of pipe by more than 2 feet without approval of ENGINEER and/or CQA Consultant, unless specifically shown on the Contract Drawings.
10. All trench excavations shall be backfilled at the end of the work day.
11. Do not advance excavation of trenches more than 800 feet ahead of the completed pipe installation.
12. Do not backfill trenches until tests and inspections have been made, record surveying has been performed, and backfilling has been authorized by the CQA Consultant. The CONTRACTOR shall use care in backfilling to avoid damage or displacement of pipe systems.

C. Do not excavate for manholes, vaults, sumps, and other structures until scheduled for construction.

D. Following the excavation for swales, channels, concrete structures, outlets, outfalls, pipes, aprons, etc., the CONTRACTOR shall re-grade and add compacted backfill as needed to achieve the required surface for placement of materials as shown on the Contract Drawings, or as otherwise required by the Contract Documents.

END OF SECTION

SECTION 02230

ANCHOR TRENCH

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all labor, equipment, tools and appurtenances required to complete portions of the Work required for the excavation and backfilling of the anchor trench as shown, specified, or required by the Contract Documents.

B. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, State, and Federal authorities having jurisdiction. The CONTRACTOR shall provide a "Competent Person" to implement, supervise, and inspect the Work.

C. The CONTRACTOR is responsible for following all health and safety precautions applicable to trenches during backfilling of trenches.

D. The CQA CONSULTANT will perform quality assurance testing in accordance with these Specifications and Construction Quality Assurance (CQA) Plan for the placement and testing of anchor trench backfill. CONTRACTOR shall cooperate fully with CQA Consultant in obtaining the required samples.

1.02 RELATED SECTIONS

A. 01050 – Field Engineering/Surveying

B. 02055 - Soils

C. 02210 – Site Grading

D. 02220 – Excavation

1.03 SUBMITTALS

A. Submittals shall be made by the CONTRACTOR in accordance with Section 01300 of these Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. The OWNER will provide access to off-site borrow sources for anchor trench backfill/plug covered under this section. The CONTRACTOR shall manage the borrow areas and shall be responsible for construction and maintenance of haul roads, stockpiles, and erosion and sediment control. The CONTRACTOR shall operate the borrow areas in a safe manner, and shall maintain excavations and side slopes in a stable configuration. The OWNER and/or CQA CONSULTANT will visit the borrow areas prior to and periodically during excavation of borrow soils to verify that the CONTRACTOR is complying with these requirements.

B. Fill for the anchor trench backfill/plug and shall consist of earthen material supplied by the OWNER OR CONTRACTOR and obtained from on-site stockpiles or off-site borrow areas. This fill shall be classified according to the USCS as GM, GP-GM, GC-GM, GW, GC, SP-SM, SW, SW-SM, SP, GP, GW-GM, SM, SC, ML, CL, CL-ML.

C. The anchor trench backfill/plug shall have a maximum particle size of 1 inch. The OWNER will endeavor to provide material which will generally meet these maximum particle size requirements. However, the CONTRACTOR may be required to remove occasional particles exceeding these maximum dimensions. Such particles will be removed when observed and stockpiled outside the fill area at a location designated by the OWNER.

PART 3 - EXECUTION

3.01 STORAGE

A. Stockpile excavated and imported materials where directed by the OWNER until required for backfill and fill placement. Place, grade and shape stockpiles to provide proper drainage. Seal stockpiles with a smooth drum roller to avoid excessive moisture retention. Install appropriate erosion and sediment control devices around stockpiles.

B. Do not combine stockpiles of fill for the anchor trench backfill/plug with other soil stockpiles on-site. Stockpiles should be clearly separated in the field to prevent mixing.

C. Locate and retain stockpiled soil materials in a location where the weight of the stockpiled materials will not create surcharge loading conditions on the edges of excavations as specified in Section 02055.

D. Material not suitable for backfilling or site grading and other unsuitable materials shall be placed in designated spoil stockpiles. Spoil stockpiles shall be graded and have erosion control measures in place as outlined in Section 02370.

3.02 PREPARATION

A. Do not excavate within the influence zone of existing footings or foundations, or similar structures such as monitoring wells without prior approval of the ENGINEER.

B. Excavate the subgrade to provide smooth surface free from loose soil, stones, rocks, and construction related debris.

C. CONTRACTOR shall excavate anchor trenches, unless otherwise specified, to the lines and grades shown on the Drawings, prior to geomembrane placement. Anchor trench shall be drained to prevent ponding or softening of adjacent soils while the trench is open.

D. Provide slightly rounded corners in anchor trenches to avoid sharp bends in the geosynthetic baseliner.

E. If the anchor trench is excavated in material susceptible to desiccation, minimize the amount of trench open at any time.

3.03 PLACEMENT OF FILL

A. Fill materials shall not be placed until the subgrade has been inspected in place, surveyed, and favorably reviewed by the CQA Consultant.

B. Employ a placement method that does not disturb or damage other completed Work.

C. Make gradual grade changes. Blend slope into surrounding areas.

D. Place fill in relatively uniform horizontal lifts not exceeding 9 inches before compaction, or as shown on the Contract Drawings.

E. Place fill in a manner which prevents sand or other soil types from blending with other soil types or from forming seams in the soil plug.

F. Material distribution and gradation throughout plug shall be such that the material is free from lenses, pockets, streaks or layers of material differing substantially in texture or gradation from surrounding material. Blend prior to compaction.

G. Do not place material at moisture content less than the site established “window.” No additional payments will be made for drying materials.

H. Place layers of materials to form continuous monolithic material. Condition excessively dry or wet soil before placement of additional lifts. Knead each trench lift into previously placed lift with a small sheepsfoot roller, or similar kneading type compactor.

I. Do not place material below air temperature of 32° F, unless the CONTACTOR can demonstrate fill material temperature is above freezing. No frozen materials shall be used for backfill, fill, or any other materials specified herein. Snow, ice, and frozen soil shall be removed from fill and backfill material prior to placement.

J. All fill and backfill materials shall be free from organic materials, wood, trash, broken concrete, masonry rubble, and all deleterious and objectionable materials which may be degradable or which cannot be properly compacted. Backfill and fill materials shall have physical properties such that they can be readily spread and compacted.

K. CONTRACTOR shall backfill the anchor trench as soon as practical after the geosynthetic base liner installation is completed. The compacted material plug above the anchor trench will be constructed immediately after the base liner installation is completed.

L. The tolerance for layers having a specified minimum thickness shall be -0.0 to +0.1 feet of the specified thickness. The CONTRACTOR shall ensure that materials placed meet or exceed the minimum specified thickness but do not exceed maximum thicknesses as required by the Contract Documents.

3.04 COMPACTION REQUIREMENTS

A. Backfill and fill shall be placed and compacted to achieve a minimum density of 95 percent of maximum dry density and within the established site boundaries for

compaction moisture content as determined by the Standard Proctor test (ASTM D698).

3.05 FIELD QUALITY ASSURANCE

A. The CQA Consultant shall perform compaction testing of the I anchor trench backfill/plug in accordance with the Soils CQA Plan. Testing shall include density and moisture (ASTM D6938) performed at a minimum frequency of one test per lift per 100 linear feet of berm/trench.

B. Any areas that do not meet the requirements specified herein shall be reworked by the CONTRACTOR by providing additional compaction effort until acceptable test results are obtained. The CONTRACTOR shall not proceed with a new lift of material until the CQA Consultant has confirmed that the previous lift has attained the required compaction. The CONTRACTOR shall rework by wetting, drying, or recompacting backfill/fill material that is not in compliance with the compaction and moisture content requirements of this section. At his sole expense, the CONTRACTOR may remove and replace fill materials with prior approval from the CQA Consultant.

C. In areas where the degree of compaction is not obtained or the uniformity of materials is not maintained in the opinion of the CQA Consultant, additional tests and/or compactive effort will be made as directed by the CQA Consultant at no additional cost to the OWNER.

D. The CQA Consultant shall verify the thickness of each lift after the compaction and prior to the placement of the next lift.

E. The CONTRACTOR shall be responsible for conducting any and all quality control testing necessary for the CONTRACTOR's purposes to satisfy the Contract Documents.

*****END OF SECTION*****

SECTION 02370

EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to install the erosion and sediment control features show on the drawings, including: (i) erosion control mat; (ii) silt fence; and (iii) temporary stabilization, as specified herein and as shown on the Drawings.

B. CONTRACTOR shall furnish all labor, material, tools, supervision, transportation, installation equipment, and incidentals required to install erosion and sediment controls not shown on the Drawings, but required to prevent sedimentation or pollution to waters of the State or Federal waterways.

C. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to maintain all soil erosion and sediment control features and structures throughout the duration of the Project and removal of temporary measures and structures, where and when necessary, as directed by OWNER or ENGINEER.

D. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to construct and maintain soil stockpiles on site.

E. CONTRACTOR shall not disturb wetland areas.

1.02 SUBMITTALS

A. At least ten days prior to the Preconstruction Meeting, CONTRACTOR shall submit to ENGINEER the proposed product material data sheets, and manufacturer recommended method of installation for:
   1. Erosion control mat; and
   2. Silt fence.

B. At least seven days prior to applying any temporary stabilization, CONTRACTOR shall submit to ENGINEER information of:
   1. Seed mixture, quantity, and application rate;
   2. Mulch type and application rate;
   3. Fertilizer type and application rate; and
   4. Seed bed preparation.

C. At least seven days prior to installing a sediment control feature not addressed in this Section, CONTRACTOR shall submit to ENGINEER Shop Drawings and/ or product information on the proposed feature, along with calculations necessary to verify the proper functioning of the feature for the intended purpose.

1.03 CONSTRUCTION QUALITY ASSURANCE

A. The installation, use, and maintenance of the erosion and sediment control feature shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these when preparing the project schedule.

C. At the discretion of OWNER or ENGINEER, the Work of this Section may be subjected to CQA monitoring.

PART 2 - PRODUCTS

2.01 EROSION CONTROL MAT

A. Erosion Control mat shall have an allowable tractive stress of 6 lbs/ft^2 and an allowable velocity of 16 ft/sec.

2.02 SILT FENCE

A. Silt fence shall meet the requirements for Silt Fence as described in the Delaware Erosion and Sediment Control Handbook, most recent version, and as shown on the Drawings.

2.03 TEMPORARY STABILIZATION

A. Temporary stabilization shall consist of placing seed, mulch, fertilizer, and/or soil amendments as needed, for the area to be stabilized.

B. Seed, mulch, fertilizer, and soil amendments shall comply with the material requirements specified in Sections 734 and 735 of the August 2001 edition of the State of Delaware Department of Transportation *"Standard Specifications for Road and Bridge Construction"* (DELDOT Standard Specifications), as appropriate.

2.04 OTHER EROSION AND SEDIMENT CONTROL FEATURES

A. CONTRACTOR shall select appropriate erosion and sediment control features from Delaware Erosion and Sediment Control Handbook, most recent version, and DELDOT Division 200.

B. CONTRACTOR may use erosion and sediment control features presented in other published erosion and sediment control guidance documents or manufacturers recommendations as approved by ENGINEER

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of its site inspection. Failure to inform ENGINEER in writing or installation of the Work of this Section will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

3.02 EROSION CONTROL MAT

A. Erosion control mat shall be installed either prior to or within 48 hours after seeding operations have been completed in the work areas.

B. The mat shall be placed on a smooth surface that is free of trash, ruts, and rocks.

C. Erosion control mat shall be placed flat and shall conform to the contours of soil surface.

D. Placement on Slopes;
   1. Anchor trenches shall be located at the crest and the toe of the terrace. Anchor trenches shall be a minimum of 6 in. deep. The anchor trench at the crest shall be located at 1 ft from the edge of the slope. The geometry of the anchor trench, type of fastener, fastener spacing, and method of construction of the anchor trenches shall be in accordance with the manufacturer's instructions.
   2. Erosion mat shall be unrolled as directed by the manufacturer. Adjacent panels of erosion mat shall be installed with a minimum overlap of 4 in. Fastening of the erosion mat shall begin in the toe anchor trench and shall progress upslope to the crest anchor trench. Spacing of fasteners shall be in intervals of 3 to 5 ft vertically upslope. Horizontal spacing of fasteners shall be in accordance with the manufacturer's instructions. Backfill shall be placed in anchor trenches over fasteners as construction proceeds.

3.03 SILT FENCE

A. CONTRACTOR shall install silt fence on a level grade downslope of all disturbed areas as shown on the Drawings. Both ends of the silt fence section must extend at least 8 ft upslope at 45 degrees to the main fence alignment.

B. Sediment accumulated against the silt fence shall be removed when it reaches one-half of the above ground height of the fence.

3.04 TEMPORARY STABILIZATION

A. CONTRACTOR shall install temporary stabilization over disturbed areas, as needed, to minimize the potential for erosion.

B. The selection of temporary stabilization shall be agreed to between CONTRACTOR and ENGINEER based on season, weather conditions, and anticipated time area will be left undisturbed.

C. Temporary stabilization shall be applied over any disturbed are that will be left bare for more than three days.

D. CONTRACTOR shall prepare a seedbed prior to seeding and shall apply soil amendments and fertilizers to the seedbed.

E. CONTRACTOR shall apply mulch and mulch binding immediately after placing seed, soil amendments, and fertilizer.

3.05 OTHER EROSION AND SEDIMENT CONTROL FEATURES

A. CONTRACTOR shall install, operate, and maintain erosion and sediment control features in accordance with published literature and/or manufacturers recommendations throughout the duration of the Contract and direction by OWNER and ENGINEER.

3.06 STOCKPILING

A. Stockpiles sideslopes shall be no steeper than 3H: 1V (horizontal: vertical), graded to drain, sealed by tracking parallel to the slope with a dozer or other means, and dressed daily during periods when material is taken from the stockpile. CONTRACTOR shall stabilize stockpiles as described in Part 3.04 of this Section.

*****END OF SECTION*****

SECTION 02715

GEOCOMPOSITE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary for the installation of a geocomposite for the gas collector trench for the below-liner gas system as specified herein, and as shown on the Drawings.

B. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary for the installation of the geocomposite as specified herein, as shown on the Drawings, and in accordance with the CQA Plan.

C. The CONTRACTOR shall be prepared to install the geocomposite in conjunction with the aggregate, pipe and other components of the gas collector trench.

1.02 SUBMITTALS

A. Prior to the shipment of any geocomposite rolls to be furnished by The CONTRACTOR, the CONTRACTOR shall submit to the OWNER's Construction Manager the following documentation on geocomposite production.

1. Resin quality control certificates for each batch of resin. The resin certificates shall identify the manufacturer and origin of the resin and the polymer composition of the resin.
2. A statement listing:
   a. certified minimum roll property values of the proposed geocomposite and the tests used to determine those properties; and
   b. production capacity available and projected delivery dates for this project.
3. Manufacturing quality control certificates for each shift's production. The certificates shall be signed by responsible parties employed by the manufacturer (such as the production manager). The quality control certificates shall include:
   a. roll numbers and identification; and
   b. results of quality control tests, including a description of the test methods used.
4. A description of the sampling procedures used for the manufacturing quality control testing.

Geocomposite Manufacturer quality control tests to be performed are outlined in Part 2.02 of this Section.

B. The Geocomposite Manufacturer shall submit documentation that the geocomposite meets the property values listed on Table 02715-1 and that the geocomposite will:
   1. retain structure during handling, placement, and long-term service; and
   2. be capable of withstanding direct exposure to sunlight for a minimum of 30 days with no measurable deterioration

1.03 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geocomposite shall be monitored and tested by the CQA Consultant as outlined in the CQA Plan.

B. Installed material that does not conform to these specifications, whether tested by the CONTRACTOR or the CQA Consultant, shall be rejected and shall be repaired by the CONTRACTOR at no cost to the OWNER.

C. The CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

1.04 RESPONSIBILITY

A. The CONTRACTOR shall furnish all geocomposite. The CONTRACTOR shall retain a Geocomposite Manufacturer who shall be responsible for production and delivery of the geocomposite and shall be a well-established firm with experience in the manufacture of geocomposite.

B. The CONTRACTOR shall install the geocomposite. The Geosynthetic Installer shall be responsible for field handling, storing, deploying, seaming or joining, temporary restraining (against wind), anchoring systems, and other site aspects of the geocomposite.

C. The CONTRACTOR shall accept and retain full responsibility for installation of the geocomposite and shall be held responsible for any defects in the completed system.

PART 2 - PRODUCTS

2.01 GEOCOMPOSITE MATERIAL

A. The geocomposite shall exhibit "Minimum Roll Values", as defined by the Federal Highway Administration (FHWA), meet or exceed the criteria specified on Table 02715-1. The Geocomposite Manufacturer shall provide test results for these procedures, as well as a certification that the material meet or exceed the specified values. The geocomposite provided by the Geocomposite Manufacturer shall be stock products. The Geocomposite Manufacturer shall not furnish products specifically manufactured to meet the Specifications of the Project unless authorized by the OWNER and the OWNER's Construction Manager.

B. The geocomposite shall be composed of a high-density polyethylene drainage net with a nonwoven, needle-punched geotextile bonded to both sides of the drainage net. The geotextile shall not be glued or bonded to the geonet in any manner other than heat bonding. Along edges, six inches of the geotextile shall not be heat bonded to the geonet to allow connection in the field.

2.02 MANUFACTURING QUALITY CONTROL

A. The geocomposite shall be manufactured with quality control procedures that meet generally accepted industry standards.

B. The Geocomposite Manufacturer shall sample and test the geocomposite, at a minimum, once every 100,000 ft^2 to demonstrate that the material conforms to all requirements on Table 02715-1.

C. Sampling shall, in general, be performed on sacrificial portions of the material such that repair of the material is not required.

D. If a geocomposite sample fails to meet the quality control requirements of this section, then the Geocomposite Manufacturer shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Geocomposite rolls not meeting the required specifications will be rejected.

E. Additional sample testing may be performed at the Geocomposite Manufacturer's discretion and expense to more closely identify the noncomplying rolls and/or to qualify individual rolls.

2.03 PACKING AND LABELING

A. Geocomposite material shall be supplied in rolls wrapped in waterproof and opaque protective covers.

B. Geocomposite rolls shall be labeled with the following information:
   1. Manufacturer's name;
   2. Product identification;
   3. Lot number;
   4. Roll number; and
   5. Roll dimension.

2.04 TRANSPORTATION

A. The CONTRACTOR shall be responsible for transportation of all geotextiles. Geocomposite Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the Site. The CONTRACTOR shall be responsible and held liable for all damages to the material once the material is on site.

B. Geocomposite material shall be delivered to the Site at least 14 days before scheduled date of deployment to allow the CQA Consultant adequate time to inventory and sample the geocomposite rolls and perform conformance testing on the samples.

2.05 HANDLING AND STORAGE

A. The CONTRACTOR shall be responsible for handling, storing, and caring for the geocomposite material prior to and following installation at the Site. The CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance of the cover system by the OWNER

B. The CONTRACTOR shall be responsible for storage of the geocomposite material at the Site. The geocomposite shall be protected from moisture, long-term direct exposure to sunlight, puncture, or other damaging or

deleterious conditions. The geocomposite material shall be stored off the ground and out of direct sunlight, and shall be protected from mud, dirt, and dust. Any additional storage procedures required by the Manufacturer or CQA Consultant shall be The CONTRACTOR's responsibility

PART 3 – EXECUTION

3.01 HANDLING AND PLACEMENT

A. The CONTRACTOR shall handle all geocomposite material in such a manner as to ensure the geocomposite material is not damaged in any way.

B. The CONTRACTOR shall take all necessary precautions to prevent damage to underlying layers during placement of the geocomposite layers.

C. The CONTRACTOR shall ballast the geocomposite layers with sandbags to prevent displacement of the geocomposite by wind. Such sandbags shall be installed during placement and shall remain on the geocomposite until it is covered with soil. Care shall be exercised when handling sandbags, to prevent rupture or damage of the sandbags.

D. The geocomposite shall be-rolled down the slope in such a manner as to continually keep the geocomposite in tension.

E. The geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

F. Care shall be taken during placement of geocomposite material not to trap dirt or excessive dust in the geonet that could cause clogging of the drainage system, and/or stones that could damage the adjacent cover. If dirt or excessive dust is entrapped in the geocomposite layer, then it should be cleaned prior to placement of the next material on top of it.

G. Geocomposite materials shall only be cut using scissors or a hook blade utility knife.

H. Geocomposite materials shall not be welded to covers.

I. Tools shall not be left on or in the geocomposite.

J. After unwrapping the geocomposite material from its opaque cover, the geocomposite material shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the OWNER's Construction Manager. Such approval shall be based on a formal demonstration from the Manufacturer that the geotextile component of the composite is stabilized against ultraviolet degradation for a period in excess of 30 days.

3.02 SEAMS AND OVERLAPS

A. The components of the geocomposite (i.e., geotextile-geonet-geotextile) are not to be bonded together at the ends and edges of the rolls. Each component will be secured or seamed to the like component at overlaps.

B. Geonet Components

1. The geonet components shall be overlapped by at least 4-in. These overlaps shall be secured by tying.
2. Tying shall be achieved by plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices shall not be used.
3. Tying shall be every 5 ft along the slope, every 2 ft across the slope, every 6-in. in the anchor trenches and on end-to-end seams, and every 10 ft on horizontal surfaces

C. Geotextile Components

a. The bottom and top layers of geotextile shall be overlapped a minimum of 6-in. prior to seaming.

3.03 REPAIR

A. Any holes or tears in the geocomposite material shall be repaired by placing a patch extending 2-ft beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet components of the geocomposite needing repair. The patch shall be secured every 6-in. with approved tying devices. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, then the entire damaged geocomposite panel shall be removed and replaced:

3.04 PLACEMENT OF SOIL MATERIALS

A. The CONTRACTOR shall place all soil materials on top of geocomposite such that:

1. The geocomposite and underlying materials are not damaged;
2. Minimum slippage occurs between the geocomposite and underlying layers; and
3. Excess stresses are not induced in the geocomposite.

B. Equipment shall not be driven directly on the geocomposite. Unless otherwise specified by the OWNER's Construction Manager, all equipment operating on earthen materials overlying the geocomposite shall comply with the following.

Allowable Equipment Ground Pressure (psi)	Thickness of Overlying Compaction Soil (ft)
<5	1.0
<10	1.5
<20	2.0
>20	3.0

3.05 PRODUCT PROTECTION

A. The CONTRACTOR shall use all means necessary to protect all prior work and all materials and completed work of other sections:

B. In the event of damage, the CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to the OWNER:

TABLE 02715-1

GEOCOMPOSITE PROPERTY VALUES (1)

Properties	Qualifiers	Units	Values	Test Method
Geonet Component				
Density(2)	Minimum	g/cc	0.94	ASTM D 792
Carbon Black Content	Range	%	2.0 – 3.0	ASTM D 4218
Thickness	Minimum	Mils	250	ASTM D 5199
Tensile Strength		Lb/in	55	ASTM D 638
Geotextile Component				
Construction			Nonwoven	
Apparent Opening Size	maximum	Mm	O95≤0.18 mm	ASTM D 4751
Flow Rate	Minimum	Gpm/ft^2	110	ASTM D 4491
Puncture Strength	Minimum	Lb.	110	ASTM D 4833
Grab Strength	Minimum	Lb	200	ASTM D 4632
Geocomposite				
Transmissivity(3)				
Gradient of ~~0.1~~0.02	Minimum	m^2/s	~~2×10^{-3}~~ 4.3×10^{-4}	ASTM D 4716

Notes: (1) All values represent minimum roll values (i.e., test results tor samples collected from any roll in a lot should meet or exceed these values).

(2) The density of the net resin shall not exceed that of the geomembrane (see Section 02075).

(3) Transmissivity to be measured using water at 68°F (20°C), under a confining pressure of at least 8,000 lb/ft2 for a liner system and 500 psf for the final closure system. The environmental cap shall be tested under a confining pressure of 1,500 psf. The geocomposite shall be placed in the testing device between the selected and approved textured geomembrane and cover system soil. Measurements are taken one hour after application of confining pressure.

(4) Minimum of values measured in machine and cross machine directions with 1 in. clamp on Constant Rate of Extension (CRE) machine.

*****END OF SECTION*****

APPENDIX VI-K

CONSTRUCTION QUALITY ASSURANCE PLAN

Prepared for

DELAWARE RECYCLABLE PRODUCTS, INC.
246 Marsh Lane
New Castle, Delaware 19720

PERMIT MODIFICATION APPLICATION

APPENDIX VI-K – CONSTRUCTION QUALITYASSURANCE PLAN

for

VERTICAL EXPANSION PROJECT
DRPI Industrial Landfill
New Castle, Delaware

Prepared by:

Geosyntec consultants

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Geosyntec Project No: ME1571

July 2018

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1 INTRODUCTION

1.1 Purpose of the Construction Assurance Quality Plan

This Construction Quality Assurance Plan (CQA Plan) establishes the construction quality assurance monitoring and documentation activities that will be implemented during construction of the liner and final cover systems, and related facilities (erosion control structures, leachate transmission and landfill gas management systems, access roads, etc.) at the Delaware Recyclable Products, Inc. (DRPI) Landfill, located in New Castle, Delaware (Site). The purpose of the CQA Plan is to provide specific procedures that will be followed by CQA personnel in order to assure the Owner that the construction was performed in accordance with the Drawings and Technical Specifications. This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geomembrane, and other geosynthetic components.

1.2 Construction Quality Assurance and Construction Quality Control

This CQA Plan is a site-specific document which addresses the following: (i) CQA personnel responsibilities and authorities; (ii) monitoring and testing activities that will be performed during construction; and (iii) CQA documentation requirements. In the context of this document, Construction Quality Assurance and Construction Quality Control are defined as follows:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA personnel to assure conformity of the construction with the requirements of the Drawings, Technical Specifications, and CQA Plan. CQA is provided by a consultant who is independent of the Owner, Contractor, Manufacturer, and Geosynthetics Installer.
- Construction Quality Control (CQC) refers to those actions taken by the Contractor, Manufacturers, or Suppliers, including their designated representatives, to ensure that the materials and workmanship meet the requirements of the Drawings, Technical Specifications, CQA Plan, and all components of the Contract Documents.

1.3 Applicable References

Organizations whose standards are referenced in the CQA Plan and Technical Specifications include: (i) American Association of State Highway and Transportation Officials (AASHTO); (ii) American Society for Testing and Materials (ASTM); (iii) Geosynthetic Research Institute (GRI); (iv) Delaware Department of Transportation (DELDOT); (v) Occupational Safety and Health Administration (OSHA); (vi) Plastic Pipe Institute (PPI); and (vii) American Concrete Institute (ACI).

1.4 Organization of this Construction Quality Assurance Plan

The remainder of this CQA Plan is organized as follows:

- Section 2 introduces the project participants and their duties;
- Section 3 discusses project meetings involved with the CQA;
- Section 4 describes CQA surveying requirements;
- Section 5 presents CQA documentation;
- Section 6 describes CQA for erosion and sediment controls;
- Section 7 describes CQA for earthwork construction;
- Section 8 describes CQA for high-density polyethylene geomembrane;
- Section 9 describes CQA for geotextile;
- Section 10 describes CQA for geosynthetic clay liner;
- Section 11 describes CQA for geocomposite installation; and
- Section 12 describes CQA for pipe installation.

2 PROJECT PARTICIPANTS AND RESPONSIBILITIES

2.1 Overview

The general duties and responsibilities of the CQA individuals are described below. These duties may be modified during construction to address specific project needs.

2.2 Owner

In this CQA Plan and Technical Specifications, the term "Owner" refers specifically to DRPI.

2.3 Project Manager

The Project Manager is the official representative of the Owner (i.e., Owner's Representative) and is responsible for the coordination and management of activities associated with construction of the Project.

2.4 Engineer

The Engineer is the firm that prepared the Drawings, Technical Specifications, and CQA Plan for the Project. Geosyntec Consultants Inc. (Geosyntec) of Columbia, Maryland, is the Engineer for the Project. The Engineer shall be responsible for review and preparation of modifications to the design plans and technical specifications as necessary during the project.

2.5 Contractor

The Contractor is responsible for constructing the facility in accordance with the Drawings and Technical Specifications. The Contractor may retain the services of specialty subcontractors (e.g., material suppliers, Geosynthetics Manufacturer, Geomembrane Installer). The Contractor must have experience in successful geosynthetic installation, general earthwork, and shall have current local, state, and federal licenses as appropriate.

2.6 Geosynthetics Manufacturer

The Geosynthetics Manufacturer is the firm or firms responsible for the production of geosynthetics (i.e., geomembrane, geosynthetic clay liner, geogrid, etc.) to be used in the development of the DRPI Landfill and its delivery to the Site. The Geosynthetics Manufacturer(s) must be approved by the Project Manager and Engineer. The qualifications required of the Geosynthetics Manufacturer are listed in the Technical Specifications.

2.7 Geosynthetics Installer

The Geosynthetics Installer is responsible for performing all aspects of the geosynthetics installation. The Geosynthetics Installer may also be responsible for specialized construction tasks (e.g., field construction of pipe boots, etc.). The Geosynthetics Installer must be approved and/or licensed (as applicable) by the various Geosynthetics Manufacturer(s) for installation of the various geosynthetic components. Further, the Geosynthetics Installer must be approved by the Project Manager and Engineer. The qualifications required of the Geosynthetics Installer are listed in the Technical Specifications.

2.8 Surveyor

The Surveyor must be a registered Land Surveyor in the State of Delaware, independent from the Owner and the Contractor. Surveyor may be retained by either the Owner or as a subcontractor of the Contractor. The Surveyor is responsible for construction layout and producing as-built documentation (record drawings) for the Project. The qualifications required of the Surveyor are provided in the Technical Specifications.

2.9 CQA Consultant

2.9.1 Overview

The CQA Consultant is a party, independent from the Owner, the Contractor, the Manufacturer(s), and the Geosynthetics Installer. The CQA Consultant will be a team of individuals who are experienced in the provision of CQA services for similar projects. The CQA team must be experienced in monitoring the construction of the various components of the Project.

The CQA team will include the CQA Managing Engineer, a CQA Site Manager, and the CQA Soils and Geosynthetics Monitor(s). The CQA Managing Engineer will lead the CQA team. The CQA team may utilize the services of other qualified individuals to assist with the assignments. Together, the CQA team will perform CQA for earthwork construction, geosynthetics installation, and all other related components of the Project. The CQA team is responsible for observing and performing field testing and documentation activities related to the performance of the various components of the design. Field and laboratory testing are to be performed in accordance with applicable standards and technical specifications. The CQA Consultant is also responsible for issuing a final report to the Delaware Department of Natural Resources and Environmental Control (DNREC) after the completion of work for the Project.

2.9.2 CQA Managing Engineer

The CQA Managing Engineer will be and will manage the CQA activities. He will review all clarifications and changes that may affect the design and will serve as technical reviewer of the final report. He will also be directly accessible to the Project Manager, Engineer, and CQA personnel for technical direction during construction. The qualifications required of the CQA Managing Engineer include: (i) being a registered Professional Engineer in the State of Delaware; and (ii) demonstrating CQA experience on at least five previous landfill projects.

Responsibilities of the CQA Managing Engineer include:

- becomes familiar with the Drawings, Technical Specifications, and CQA Plan;
- attends the preconstruction meetings, progress meetings, and any resolution meetings when requested;
- administers the CQA program (i.e., assigns and manages all CQA personnel, reviews all field reports, and provides engineering review of all CQA-related issues);
- provides quality control of the CQA personnel, including site visits;
- reviews all changes to the Drawings, Technical Specifications, and CQA Plan; and
- with assistance from the CQA Site Manager, prepares the final report, including a review of the as-built record drawings provided by the Contractor.

2.9.3 CQA Site Manager

The CQA Site Manager will interact on a frequent basis with all project personnel, and will have authority over the field CQA personnel. To be qualified, the CQA Site Manager must demonstrate CQA experience on at least three previous landfill projects.

The responsibilities and duties of the CQA Site Manager include the following:

- becomes familiar with the concepts used to develop the Drawings and Technical Specifications;
- acts as the on-site (resident) representative of the CQA Consultant;
- evaluates conformance of materials and construction with the requirements of the Drawings and Technical Specifications;
- supervises the CQA Monitors when they are on-site;
- performs the functions of the CQA Monitors when no other CQA personnel are on-site;
- reports any unresolved deviations from the CQA Plan to the CQA Managing Engineer and/or Project Manager;

- manages the daily activities of the CQA Monitors;
- attends the CQA-related meetings (e.g., resolution, preconstruction, daily, weekly);
- assists the Project Manager in preparing documentation for Requests for Information (RFI) or other clarifications to the Drawings and/or Technical Specifications;
- administers the CQA program (i.e., assigns and manages CQA personnel, reviews field reports, and provides review of CQA-related issues);
- reviews the as-built survey information submitted by the Contractor;
- verifies the calibration and condition of CQA equipment;
- reviews CQA Monitors' daily reports and logs;
- reports to the Project Manager, and logs in his daily reports and relevant observations reported by the CQA Monitors;
- prepares his own daily reports;
- oversees the collection and shipping of laboratory test samples;
- reviews and reports results of laboratory testing;
- periodically checks stockpile or borrow pit sources for variability of the soils, and ensures that conformance testing is performed;
- reviews the work for the Contractor's equipment operators, to ensure that care is taken to protect other portions of the work;
- establishes additional test requirements beyond those required in the CQA Plan, when necessary;
- reviews all Supplier, Manufacturer, and Installer certifications, when necessary;
- reviews the Geosynthetics Installer's personnel qualifications for conformance with those pre-approved for work on-site;
- notes any on-site activities that could result in damage to the geosynthetics;
- designates a senior CQA Monitor to act on his behalf whenever he is absent from the Site while operations are on-going; and
- prepares the final report with the CQA Managing Engineer.

2.9.4 CQA Monitors

CQA Soil Monitor(s) and CQA Geosynthetic Monitor(s) are assigned on an as-needed basis by the CQA Site Manager and include monitoring, logging, and/or documenting associated earthwork construction and geosynthetics installation.

The duties to be performed and activities to be monitored by the CQA Soils Monitor(s) specifically include:

- observing soil delivery, stockpiling, and placement;
- observing and documentation of soil moisture content and moisture conditioning, if required;
- collection of soil samples for laboratory testing;
- testing and documenting the in-situ moisture and density of compacted earthen materials;
- observing operations to protect completed areas before the covering materials are placed;
- examining of the soil surfaces for signs of excessive wetting, desiccation, or other disturbance prior to placement of any other cover materials; and
- observing and documentation of scarification, rewetting, recompaction, or proof rolling required to repair deteriorated areas.

The operations to be monitored by the CQA Geosynthetic Monitors include, for all geosynthetics:

- observing and documentation of material delivery;
- observing material unloading and on-site transport and storage;
- observing geosynthetic placement and documentation of geomembrane panel placement logs;
- observing and documentation of joining and/or seaming operations;
- observing the condition of geosynthetic panels as placed;
- sampling for material conformance testing by the Geosynthetics CQA Laboratory;
- marking samples for conformance testing; and
- observing and documentation of repair operations.

The duties of the CQA Monitors may be performed by the CQA Site Manager depending upon the number of CQA personnel and construction activities occurring at any given time.

2.10 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in the physical testing of soils and concrete, and be familiar with, and properly equipped to perform the geotechnical testing required by the CQA Plan. The Soils CQA Laboratory must be certified by the American Association of State Highway and Transportation Officials (AASHTO).

2.11 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory will have experience in testing the types of geosynthetics to be used on the Project, and be familiar with, and properly equipped to perform the testing required by the CQA Plan. The Geosynthetics CQA Laboratory must be certified by the Geosynthetic Research Institute (GRI).

2.12 CQA Surveyor

A CQA Surveyor will be a Professional Land Surveyor registered in the State of Delaware with an established office in one of the following states: Delaware, Maryland, Pennsylvania, or New Jersey. The Surveyor will provide survey data to verify as-built documentation of the Contractor's work. Responsibilities of the CQA Surveyor are presented in Section 4.

3 PROJECT MEETINGS

3.1 Introduction

Meetings with key project personnel are necessary to assure a high degree of quality during construction, and promote clear, open channels of communication. Therefore, preconstruction meetings shall be held for at least the project kickoff and before geosynthetics installation. If the Project includes other major components, additional preconstruction meetings may be held. The preconstruction and progress meetings are described below.

The preconstruction meeting should include discussion of the following activities:

- reviewing the responsibilities of each party;
- confirming the lines of authority and communication;
- communicating to all parties any relevant documents;
- reviewing critical design details of the Project;
- addressing any appropriate modifications to the Drawings or Technical Specifications so that the fulfillment of design or performance standards can be achieved;
- establishing an understanding by the parties of the CQA Plan, and CQA and CQC procedures to be followed during the Project;
- establishing work area security and safety protocol in accordance with the Owner's and the Contractor's health and safety plans;
- describing material sources and stockpile locations;
- confirming the methods for documenting and reporting, and for distributing documents and reports;
- confirming acceptance and approval process for task completion prior to schedule sequence advancement; and
- establishing procedures for processing applications for payment.

Items discussed during the preconstruction meeting will be documented by a person designated at the beginning of the meeting, and minutes will be transmitted to within one week of the meeting.

3.2 Progress Meetings

A progress meeting (via teleconference or at the Site) will be held at a minimum of every other week during construction between select CQA personnel, the Contractor, and the Project Manager. More frequent meetings may be scheduled at the discretion of the Project Manager. The CQA

Managing Engineer and Engineer will participate in the weekly meetings when appropriate. Minutes will be prepared, and will include the following information:

- the date, project name, location, and other identifying information;
- the name and organization of those in attendance;
- a summary of work activities during the progress reporting period;
- a summary of CQA activities during the progress reporting period, including a summary of testing and results;
- a summary of construction issues, problems, decisions, or questions occurring during the progress reporting period;
- a summary of actions to be taken to address issues, problems, or questions during the progress reporting period;
- planned activities for the upcoming period; and
- any new business associated with the Project.

Minutes of the progress meetings will be recorded by a member of the CQA team. Any matters requiring action that are raised in this meeting will be reported to the appropriate parties. Minutes of progress meetings will be distributed to each party present at the meeting and other designated parties and will be transmitted to all parties within one week days of the meeting.

3.3 Problem or Work Deficiency Meetings

Special meetings will be held by the Project Manager when and if problems or deficiencies are present or judged likely to occur. At a minimum, these meetings will be attended by the Contractor, the Project Manager, and select CQA personnel. The purpose of these meetings will be to define and resolve the problem or work deficiency as follows:

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

Items discussed during these meetings will be documented by the Project Manager, and if deemed necessary, minutes will be transmitted to the appropriate parties.

4 CQA SURVEYING

Surveying of lines and grades will be performed on an on-going basis during construction to independently verify the work for the Contractor, as descrived in the Technical Specifications and as requested by the Project Manager and/or CQA Consultant. The overall responsibilities of the Surveyor are described in the Technical Specifications. The Surveyor will use existing control monuments at the Site and any additional control established during construction.

The scope of CQA surveying will include, but not necessarily be limited to:

- verifying the location and horizontal limits of construction components, including liner, final cover, landfill gas, and leachate systems;
- verifying layer thickness, especially of soil components of the liner system or final cover system;
- verifying information regarding the horizontal alignment and vertical profile of leachate-collection pipes, leachate transmission piping, and site drainage features, etc.; and
- providing sufficient survey information of interim conditions such that, if requested by the Project Manager, material quantities can be calculated.

It will be the responsibility of the CQA personnel and the Surveyor to coordinate the CQA surveying work such that areas are promptly surveyed, interim results are reviewed, and approval is granted for the Contractor to proceed with subsequent work in the areas. The CQA Site Manager will report any non-conformances or inconsistencies to the Project Manager and Contractor promptly to minimize delays in the construction.

5 DOCUMENTATION

5.1 Introduction

An effective CQA Plan depends largely on assigning responsibilities for the monitoring of construction activities and documentation of quality assurance. The CQA Consultant will document that the quality assurance requirements have been addressed and satisfied.

The CQA Site Manager will provide the CQA Managing Engineer and Project Manager with reports, data sheets, and logs to verify that the monitoring activities have been performed. The CQA Site Manager will also maintain at the job site a complete file of the Drawings, Technical Specifications, CQA Plan, checklists, test procedures, daily logs, and other pertinent documents. The CQA Site Manager will also ensure that the Contractor maintains a current set of red-line drawings and Contract Documents. These red-line drawings and Contract Documents will be kept up-to-date by the Contractor, at all times, with the latest changes to the Drawings and Technical Specifications. The red-line drawings and Technical Specifications will be transmitted to the Project Manager at the conclusion of the Project.

5.2 Daily Recordkeeping

5.2.1 Overview

Standard reporting procedures will include preparation of a daily CQA report which, at a minimum, will consist of: (i) field notes, including a description of major issues addressed with the Contractor, Geosynthetics Installer, or the Project Manager; (ii) CQA monitoring logs and testing data sheets; and (iii) construction problem and solution summary sheets. This information will be regularly submitted to and reviewed by the CQA Managing Engineer.

Daily coordination will occur between the CQA Site Manager and the Contractor during completion of work. The purpose of this communication will be to review the previous day's activities, review the upcoming day's activities, and identify any needs or potential construction problems. Major issues will be documented in the CQA Site Manager's daily field reports.

5.2.2 Daily Field Reports

The CQA Site Manager and CQA Monitors will prepare a daily field reports summarizing activities performed by the Contractor and/or Geosynthetics Installer as well as CQA activities. Daily field reports will include the following information:

- arrival and departure time of CQA personnel;

- general weather conditions (temperature, sky conditions, precipitation, etc.);
- descriptions and locations of on-going construction;
- equipment and personnel in each work area, including subcontractors;
- a description of work observed by CQA personnel;
- a description of major issues discussed with the Contractor, Project Manager, or CQA Managing Engineer (as applicable);
- delivery schedule of off-site materials received, including quality control documentation (as applicable);
- a description of material samples taken for laboratory testing (as applicable); and
- decisions made regarding acceptance of work, and/or corrective actions to be implemented for instances of substandard quality.

5.2.3 Monitoring Logs and Test Data Sheets

Monitoring logs and test data sheets will be prepared daily when CQA field testing is ongoing. At a minimum, these logs and data sheets will include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- a reduced-scale site plan showing the approximate location of the work area and test locations;
- description of the testing being performed and documented;
- approximate locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- decisions made regarding acceptance of units of work, and/or retesting for instances of substandard quality; and
- signature of the CQA Site Manager and/or the CQA Monitor(s).

Logs must be completely filled out with no items left blank.

5.2.4 Deficiencies, Problems, and Repairs

The CQA Consultant will report any deficiencies or noncompliance in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or

other means deemed appropriate by the CQA Site Manager and CQA Managing Engineer. After defining the extent and nature of a defect, the CQA Site Manager will notify the Contractor and will schedule appropriate retests after the area with the deficiency is corrected. Repairs will be suitable for the type of deficiency. Typical techniques to address earthwork deficiencies include recompacting the area, moisture conditioning the soil, and removing and replacing soils. Typical techniques to address geosynthetic deficiencies include spot repairs, patches, and replacement of defective or damaged materials. Additional techniques may be used following coordination between the Project Manager, Contractor, and CQA Consultant.

The Contractor will correct the deficiency to the satisfaction of the CQA Site Manager. If a Technical Specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Site Manager will develop and present to the Project Manager and Engineer suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the CQA Site manager must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

In cases when recurring non-conformance problems arise, data sheets will be prepared describing special construction situations cross-referenced with specific observation logs and testing data sheets. These data sheets will include the following information, when available:

- an identifying sheet number for cross-referencing and document control;
- a description of the situation or deficiency;
- the approximate location and probable cause of the situation or deficiency;
- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of any responses;
- any measures taken by the Contractor to prevent a similar situation from occurring in the future; and
- the signature of the CQA Site Manager and/or CQA Monitor, and signature of the CQA Managing Engineer indicating concurrence.

The Project Manager and CQA Managing Engineer will be made aware of any significant recurring non-conformance with the Technical Specifications. The Project Manager and/or CQA Managing Engineer will then evaluate the cause of the non-conformance. If the solution to the non-conformance is a potential Design clarification or change to the Technical Specifications, then these changes will be submitted to the Engineer for approval. When this type of evaluation is made, the results will be documented, and any revision to the Design or Technical Specifications will be approved by the Project Manager and Engineer.

A summary of the supporting data sheets, along with final testing results and the CQA Site Manager's approval of the work, will be required upon completion of construction in which the construction situation, deficiency and/or defect was satisfactorily repaired and completed.

5.3 Photographic Documentation

Photographs will be taken in order to serve as a pictorial record of work progress, problems, and mitigation activities. The file will contain electronic files of color photographs. Files will be maintained in chronological order, and in some cases, further organized by construction activity. These records will be provided to the Project Manager upon completion of the Project. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s).

5.4 Design and/or Technical Specifications Changes

Changes to the Design and/or Technical Specifications may be required during construction. In such cases, the CQA Site Manager will notify the Project Manager and Engineer. Design and/or Technical Specifications changes will be made only with the written agreement of the Project Manager and Engineer, and will take the form of a Design Clarification or Request for Information.

5.5 Progress Summary Reports

If requested by the Project Manager, the CQA Consultant will prepare a progress summary report at the time intervals requested. The progress summary report may include the following information as applicable:

- the date, project name, location, and other information;
- a summary of Contractor work activities during the reporting period;
- a summary of construction issues, problems, and/or deficiencies occurring during the reporting period;
- a summary of actions to be taken to address issues, problems, or questions during the reporting period;
- a summary of CQA and CQC test results, failures and retests; and
- the signature of the CQA Managing Engineer and the CQA Site Manager.

5.6 Final Report

At the completion of the work, the CQA Consultant will submit to the Owner a signed and sealed final report. The final report will certify: (i) that the work has been performed in substantial compliance with the Drawings, Technical Specifications, and CQA Plan; (ii) physical sampling and testing, except as properly authorized, have been performed at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting documentation.

At a minimum, this final report will include: (i) a narrative of construction activities; (ii) observation logs and testing data sheets including sample location plans; (iii) a photo log documenting major construction activities; (iv) construction problems and solutions data sheets; (v) changes from the Design and Technical Specifications; (vi) a description of instances of non-conformance with the Design and Technical Specifications; (vii) record drawings; and (viii) a summary statement sealed and signed by a Professional Engineer registered in the State of Delaware.

The record drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thickness, etc.). All surveying and base maps required for development of the record drawings will be prepared the Surveyor in accordance with the Technical Specifications. The CQA Consultant will include these record drawings as part of the final report.

5.7 Storage of Records

Original handwritten data sheets, especially those containing signatures, must be stored by the Project Manager and/or CQA Consultant or his designee in a safe on-site repository. Other reports may be stored by any standard method that allows easy access.

6 EROSION AND SEDIMENT CONTROLS

6.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to erosion and sediment controls. The following CQA activities are discussed in the remainder of this section:

- Preconstruction Qualifying of Material Sources;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

6.2 Preconstruction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the CQA Site Manager and/or Engineer with quality control information and/or certification from the supplier(s) of temporary seed, mulches or matting, and silt fence required in the Technical Specifications and/or the Drawings.

The CQA Site Manager and/or Engineer will examine the suppliers' certifications to verify that the property values listed on the certifications meet or exceed the Technical Specifications, and that proper and complete documentation has been provided by the Contractor for the temporary and permanent erosion and sedimentation materials that will be used at the Site. The CQA Site Manager will report any deviations from the above requirements to the Contractor prior to approving installation of the materials.

6.3 Monitoring of Erosion and Sediment Control Devices

The CQA Site Manager will observe the Contractor's work activities and will verify that, prior to initiating work in any given area, temporary erosion and sediment controls, as required in the Drawings and Technical Specifications have been installed. The CQA Site Manager will routinely verify that the Contractor keeps the site free from excessive sediment and in as neat a condition as possible. This includes the project area, haul roads, borrow areas, stockpile areas, and the entrance area of the facility. The CQA Site Manager and/or Engineer will verify that the Contractor selects the appropriate erosion and sediment controls from the "*Delaware Erosion and Sediment Control Handbook*", most recent version.

The Contractor, Owner, or CQA Consultant will perform inspections of temporary erosion and sediment controls as required by Delaware Erosion and Sediment Control Regulations. The inspection shall be performed by qualified personnel having a valid Blue Card certification from

DNREC, using the standard forms provided by DNREC. The Contractor may be present during these inspections. The CQA Site Manger will be responsible for reviewing the DNREC erosion and sediment control inspection forms. The Contractor will promptly correct any deficiency to the satisfaction of the CQA Site Manager, or as directed by the Project Manager.

7 EARTHWORK

7.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to general earthwork. General earthwork consists of placement and compaction of all soil or aggregate components of the work. The following CQA activities are discussed in this section:

- Preconstruction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

7.2 Preconstruction Qualifying of Material Sources

Prior to construction with any given soil or aggregate material, the CQA Consultant will receive test results from the Contractor for a sample of each material taken from the proposed source. The CQA Consultant will review the test results to ensure that each material meets the requirements of the Technical Specifications. Results of the preconstruction tests may be counted toward the conformance testing frequency requirements, provided the results meet the specified material properties. The CQA Consultant may also request that the Contractor provide a sample of each material for additional testing if further preconstruction qualification testing by the CQA Consultant is warranted.

If a preconstruction qualifying sample fails to meet the requirements of the Technical Specifications, then the CQA Consultant will notify the Contractor. Use of the material will not be allowed until the material is pre-qualified by further tests. Additional tests, if necessary, will be performed by the CQA Consultant at the request of the Project Manager and/or CQA Managing Engineer.

7.3 Material Conformance Testing

During construction, a conformance testing program will be implemented by the CQA Consultant to verify that the physical properties of the earthwork materials meet the specified material properties. The CQA Consultant will be responsible for submitting enough samples to the Soils CQA Laboratory to meet the minimum testing frequency in the Technical Specifications. Preferably, the CQA Consultant will obtain soil samples for conformance testing from the borrow source or off-site stockpiles before delivery to the Site, however, obtaining samples from on-site stockpiles or sampling from trucks as they unload material in the work area is acceptable.

Conformance sampling and laboratory testing of soil and aggregate will be performed in accordance with the frequencies and testing parameters described in the Technical Specifications.

If a sample fails a conformance test, then the CQA Consultant will notify the Contractor and use of the material represented by that sample will not be allowed. Additional tests will be performed by the CQA Consultant as directed by the Project Manager, or the Contractor will use material from a different source. If non-conforming material has already been placed, it will be removed unless the Engineer reviews the circumstances and prepares a sealed document justifying why leaving the non-conforming material is acceptable.

7.4 Monitoring of Earthwork

The CQA Consultant will monitor earthwork activities. Monitoring the construction work for the earthwork materials will include the following:

- monitoring the thickness of lifts as loosely placed and after being compacted;
- documenting the type of construction equipment and methods used to place and compact the material;
- observing the action of the compaction and heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking, etc.) to detect inadequate compaction;
- verifying that proper equipment and methods are used to place soil or aggregate over geosynthetic components of the liner system or final cover system, and that wrinkles or excess tensile stresses to underlying geosynthetics are minimized; and
- verify that only low-ground pressure equipment traverses over lined areas unless an approved thickness of protective soil is first placed.

7.5 Field Testing of Earthwork

7.5.1 Routine Field Testing

Conformance field testing (primarily density and moisture content testing) of placed/compacted earthwork will be performed by the CQA Consultant during construction to confirm that the requirements of the Technical Specifications are met. Conformance field testing will be performed according to the frequency and test methods provided in the Technical Specifications. The CQA Consultant will select the test locations.

Moisture/density testing will be performed primarily using a nuclear gauge (in accordance with ASTM D 3017 and ASTM D 2922). The CQA Consultant will perform several oven moisture content tests (ASTM D 2216) on any given material at the outset of construction to evaluate

requirements for moisture offsets for the nuclear gauge. Should the test results indicate that a moisture offset is required, oven moisture content testing will continue during the use of the material at a minimum frequency of one test per week. The CQA Consultant will also verify the dry density calibration of the nuclear gauge throughout construction using methods such as Sand Cone (ASTM D 1556) and/or Drive Cylinder (ASTM D 2937) density testing at a frequency of once per month.

It is also the responsibility of the CQA Consultant to monitor placement and compaction of soil in the geosynthetics anchor trench. The CQA Consultant will verify that the backfilling techniques do not damage the geosynthetics in or near the anchor trench. Moisture and density testing of anchor trench backfill is not required.

7.5.2 Additional Testing

Additional testing will be used at the discretion of the CQA Consultant when initial testing or visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the compactor rollers slip during compaction operations;
- the lift thickness is greater than specified;
- the material is at a highly variable moisture content;
- dirt-clogged rollers are used to compact the material;
- the materials properties are highly variable;
- the degree of compaction is doubtful; or
- as directed by the CQA Consultant or Project Manager.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- if the material initially fails to meet compaction requirements; or
- the work area is reduced.

8 GEOMEMBRANE

8.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to installation of the high-density polyethylene (HDPE) geomembrane. Detailed geomembrane installation requirements are presented in Section 02075 of the Technical Specifications. The geomembrane will be supplied and installed by the Geosynthetics Installer, who may be retained by the Owner or as a subcontractor to the Contractor.

8.2 Geomembrane Monitoring

The CQA Consultant will monitor geomembrane installation. Specific monitoring activities include, but are not limited to:

- review the required submittals to verify that the Geomembrane Manufacturer and the geomembrane meet the requirements of the Technical Specifications;
- collect conformance samples of the geomembrane at the manufacturing facility or after delivered to the Site and forwarding the samples to an approved off-site testing laboratory for testing;
- collect and review the Geosynthetic Manufacturers' quality control (MQC) documentation to verify that the certifications comply with the requirements of the Technical Specifications;
- track inventory of the geomembrane rolls delivered to the Site;
- observe geomembrane rolls that had been delivered to the Site to observe whether the materials had been damaged during transportation and, if damaged, marking damaged locations for repair or replacement;
- observe material unloading and on-site transport and storage;
- review and evaluate laboratory CQA conformance test results for the geomembrane to verify that the test results met the requirements of the Technical Specifications;
- monitor deployment and installation of geomembrane and mark locations for replacement or repair;
- monitor overlapping of adjacent geomembrane panels;
- monitor geomembrane trial seaming operations and field testing of trial seams (both fusion and extrusion);
- monitor geomembrane production seaming operations (both fusion and extrusion);
- monitor and document nondestructive testing (both air pressure and vacuum) of geomembrane seams and repairs;

- select geomembrane destructive seam sample locations, monitor sample collection, distribute samples to the Geosynthetics Installer and Owner, and destructively testing the samples at an approved off-site laboratory to verify compliance with the requirements of the Technical Specifications and CQA Plan;
- monitor and document repairs to portions of the geosynthetics that were observed to have defects or that failed the criteria for destructive or nondestructive testing;
- observe and document repair operations;
- note on-site activities that could result in damage to the geomembrane; and
- monitor placement of the geosynthetics in the anchor trench.

8.3 Geomembrane Conformance Testing

Conformance sampling of the geomembrane may be performed by the CQA Consultant either at the manufacturing facility or upon delivery of the rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the Geomembrane Manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant across the entire width of the roll and will not include the first 3 ft. of material. Unless otherwise specified, samples will be 3-ft. long by the roll width. Conformance tests will be performed in accordance with laboratory test methods and at the frequency presented in the Technical Specifications.

The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

The CQA Consultant will review all CQA and MQC conformance test results before approving deployment of the geomembrane. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a geomembrane sample fails a conformance test performed by the CQA Consultant.

- The Geosynthetic Installer will be required to replace all of the rolls of geomembrane within the lot/batch from which the nonconforming sample was obtained.

- Alternatively, if the Geosynthetic Installer, Geomembrane Manufacturer, and the Project Manager all agree, the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance test requirements. If either of these samples fails to meet the requirements, then samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the CQA Consultant. These ten samples must pass the above conformance tests. If any of these samples fail, then a sample from every roll of geomembrane from the batch/lot on-site maybe conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the Geomembrane Manufacturer has identified all rolls of geomembrane with the following information:

- name of manufacturer;
- product identification;
- thickness;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record the above information for each roll delivered to the Site using a Material Inventory Log form for the geomembrane.

9 GEOTEXTILE

9.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the installation of the geotextile. Detailed geotextile installation requirements are presented in Section 02071 of the Technical Specifications. The geotextile will be supplied and installed by the Geosynthetics Installer, who may be retained by the Owner or as a subcontractor to the Contractor.

9.2 Geotextile Unloading and Storage

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the geotextile off unprepared ground and protect the geocomposite from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Technical Specifications require that the geotextile rolls be shipped in opaque and watertight wrappings and stored on a prepared surface of at least 6-inches of a compacted clean sand, pea gravel, or AASHTO No. 57 stone.

The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Geosynthetics Installer. Any damaged rolls will be rejected by the Project Manager and CQA Consultant and required to be repaired or replaced by the Geosynthetics Installer.

9.3 Geotextile Monitoring

The CQA Consultant will monitor geotextile installation. Specific monitoring activities include, but are not limited to:

- review the required submittals to verify that the geotextile meets the requirements of the Technical Specifications;
- collecting conformance samples of the geotextile at the manufacturing facility or after delivered to the Site and forwarding the samples to an approved off-site testing laboratory;
- collecting and reviewing the Geosynthetic Manufacturers' quality control (MQC) documentation to verify that the certifications comply with the requirements of the Technical Specifications;
- tracking inventory of the geotextile rolls delivered to the Site;
- observing geotextile rolls that had been delivered to the Site to observe whether the materials had been damaged during transportation and, if damaged, marking damaged locations for repair or replacement;
- observe and document material unloading and on-site transport and storage;

- reviewing and evaluating laboratory CQA conformance test results for the geotextile to verify that the test results met the requirements of the Technical Specifications;
- immediately prior to geotextile placement, the subgrade is free of sharp protrusions or other obstructions that could potentially damage the geotextile;
- in the presence of wind, the geotextile is weighted with sandbags (or equivalent ballast weight approved by the CQA Consultant), and that sandbags remain until replaced with an overlying layer;
- efforts are made to minimize the presence of wrinkles in the geotextile, and if necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles;
- a visual examination of the geotextile is performed over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geotextile is not left exposed for longer that the maximum allowable period (as set forth in the Technical Specifications) after placement unless a longer exposure period is approved by the Engineer.

The CQA Consultant will verify that the Contractor places all soil and aggregate materials on top of the geotextile such that:

- the geotextile and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geotextile.

9.4 Geotextile Conformance Testing

Conformance sampling of the geotextile will be performed by the CQA Consultant upon delivery of rolls to the Site, unless otherwise directed by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant across the entire width of the roll and will not include the first 3 ft. of material. Unless otherwise specified, samples will be 3-ft. long by the roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and

- CQA Consultant personnel identification.

Conformance testing will be performed in accordance with the test methods presented in the Technical Specifications, but at one-half of the frequency.

All conformance test results will be reviewed by the CQA Consultant before installation of the geotextile. Any nonconformance of the material's physical properties will be promptly reported to the Contractor and/or Geosynthetic Installer. The following procedure will apply whenever a geotextile sample fails a conformance test performed by the CQA Consultant.

- The Contractor and/or Geosynthetic Installer will be required to replace all of the rolls of geotextile within the lot/batch from which the non-conforming sample was obtained.
- Alternatively, if the Contractor and/or Geosynthetic Installer, Geotextile Manufacturer, and the Project Manager all agree, then the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, then samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, then a sample from every roll of geotextile from the batch/lot on-site may be conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the Geotextile Manufacturer has identified all rolls of geotextile with the following information:

- name of manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record the above information for each roll delivered to the Site using a Material Inventory Log form for the geotextile.

10 GEOSYNTHETIC CLAY LINER

10.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the geosynthetic clay liner (GCL). Detailed GCL material and installation requirements are presented in Section 02072 of the Technical Specifications. The GCL will be supplied and installed by the Geosynthetics Installer, who may be retained by the Owner or as a subcontractor to the Contractor.

10.2 GCL Unloading and Storage

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the GCL off the ground and protect the GCL from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Technical Specifications require that the GCL rolls be shipped and stored in opaque and watertight wrappings.

GCL shall be unloaded from trucks using a “stinger” bar, spreader bar, or manufacturer-supplied straps. If GCL is lifted using straps, the Contractor shall take care during unloading to prevent damage or thinning of GCL due to point loads applied by lifting straps. If thinning occurs, the Contractor shall be required to remove and discard the outermost two layers of the roll. Unloading GCL by forklift, or dragging GCL rolls out of the truck by chains or straps is prohibited.

The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Geosynthetic Installer. Any damaged rolls may be rejected by the CQA Consultant and the Project Manager, and be repaired or replaced by the Geosynthetic Installer.

10.3 GCL Monitoring

Prior to GCL deployment directly on the subgrade, the CQA Consultant will observe the area, and will confirm that the soil subgrade surface has been approved by the Geosynthetic Installer. During installation, the CQA Consultant will verify compliance, including but not be limited to:

- immediately prior to GCL placement, the underlying subgrade is free of moisture or obstructions that could potentially damage the GCL;
- efforts are made to keep the GCL placed to minimize the presence of wrinkles in the GCL, and if necessary, the GCL is positioned by hand after being unrolled to minimize wrinkles;
- excessive amounts of bentonite do not ravel out along the edges of the GCL;

- care is taken by the Geosynthetic Installer not to entrap stones, soil, dust, or moisture that could damage the GCL;
- in the presence of wind, the GCL is weighted with sandbags (or equivalent ballast weight approved by the CQA Consultant), and that sandbags remain until replaced with the overlying geomembrane;
- a visual examination of the GCL is performed over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present;
- verify that any holes or tears in the GCL are repaired in accordance with the Technical Specifications, and that care is taken by the Contractor and/or Geosynthetic Installer to remove any soil or other material, which may have penetrated the torn GCL;
- no more GCL is deployed during each day than can be covered by the end of the day with seamed geomembrane; and
- the GCL is not left exposed for longer than the maximum allowable period (as set forth in the Technical Specifications) after placement unless the Engineer approves a longer exposure period.

The CQA Consultant will verify that the GCL panels are overlapped as required in the Technical Specifications. The CQA Consultant will also confirm that the Engineer is made aware of any end-to-end GCL seams on slopes, and that any special overlapping or connecting methods required by the Engineer are implemented by the Geosynthetic Installer.

The CQA Consultant will verify that the Geosynthetics Installer places the geomembrane on top of the GCL such that:

- the GCL and underlying materials are not damaged;
- wrinkles are minimized;
- excess tensile stresses are not produced in the GCL; and
- the geomembrane extends at least 2 ft. beyond the underlying GCL, and the leading edge of the geomembrane has adequately ballast to avoid wind uplift and reduce the likelihood of surface water running under the geomembrane and hydrating the GCL.

10.4 GCL Conformance Testing

Conformance sampling of the GCL may be performed by the CQA Consultant either at the manufacturing plant or upon delivery of rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for

testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the Geosynthetic QAC across the entire width of the roll and will not include the first 3 ft. along the length of the roll. Unless otherwise specified, samples will be 3-ft. long by the full roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA Consultant personnel identification.

The conformance testing of the GCL will be performed in accordance with the test methods and frequencies presented in the Technical Specifications. Conformance test results will be reviewed by the CQA Consultant before installation of the GCL. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a GCL sample fails a conformance test performed by the CQA Consultant.

- The Geosynthetic Installer will be required to replace all of the rolls of GCL within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetic Installer, GCL Manufacturer and the Project Manager all agree, then the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, then a sample from every roll of GCL from the batch/lot on-site and maybe conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the GCL manufacturer has identified all rolls of GCL with the following information:

- name of manufacturer;

- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record the above information for each roll delivered to the Site using a Material Inventory Log form for the GCL.

11 GEOCOMPOSITE

11.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the geocomposite component of the liner system or final cover system. Detailed GCL material and installation requirements are presented in Section 02715 of the Technical Specifications. The GCL will be supplied and installed by the Geosynthetics Installer, who may be retained by the Owner or as a subcontractor to the Contractor.

11.2 Geocomposite Unloading and Storage

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the geocomposite off unprepared ground and protect the geocomposite from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Technical Specifications require that the geocomposite rolls be shipped in opaque and watertight wrappings and stored on a prepared surface of at least 6-inches of a compacted clean sand, pea gravel, or AASHTO No. 57 stone.

The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Geosynthetics Installer. Any damaged rolls will be rejected by the Project Manager and CQA Consultant and required to be repaired or replaced by the Geosynthetics Installer.

11.3 Geocomposite Monitoring

The Geosynthetics Installer will be required to handle and deploy all geocomposite in such a manner as to ensure the geocomposite is not damaged. The CQA Consultant will verify compliance with the following:

- immediately prior to geocomposite placement, the underlying geomembrane surface is free of moisture or obstructions that could potentially damage the geocomposite;
- in the presence of wind, the geocomposite is weighted with sandbags (or equivalent ballast weight approved by the CQA Consultant), and that sandbags remain until replaced with the overlying protective cover soil layer;
- efforts are made to minimize the presence of wrinkles in the geocomposite, and if necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles;
- care is taken by the Geosynthetics Installer not to entrap stones, soil, dust, or moisture that could damage or cause clogging to the geocomposite;

- a visual examination of the geocomposite is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geocomposite is not left exposed for longer than the maximum allowable period (as set forth in the Technical Specifications) after placement unless a longer exposure period is approved by the Engineer.

The CQA Consultant will verify that the components of the geocomposite (i.e., geotextile-geonet-geotextile) are sewn, joined, and/or overlapped to like-components in adjacent geocomposite panels, as required in the Technical Specifications.

The CQA Consultant will verify that the Contractor and/or Geosynthetics Installer place soil or geosynthetic materials on top of geocomposite such that:

- the geocomposite and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geocomposite.

11.4 Geocomposite Conformance Testing

Conformance sampling of the geocomposite may be performed by the CQA Consultant either at the manufacturing plant or upon delivery of rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant across the entire width of the roll and will not include the first 3 ft along the length of the roll. Unless otherwise specified, samples will be 3-ft long by the full roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA Consultant personnel identification.Conformance testing will be performed in accordance with the test methods and frequencies presented in the Technical Specifications. Conformance test results will be reviewed by the CQA Consultant before

installation of the geocomposite. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetics Installer. The following procedure will apply whenever a geocomposite sample fails a conformance test conducted by the Geosynthetics CQA Laboratory.

- The Geosynthetics Installer will be required to replace all of the rolls of geocomposite within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetics Installer, Geocomposite Manufacturer, and the Project Manager all agree, the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite from the batch/lot on-site maybe conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the Geocomposite Manufacturer has identified all rolls of geocomposite with the following information:

- name of manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record all of the above information for each roll delivered to the Site using a Material Inventory Log form for the geocomposite.

12 HDPE PIPE AND FITTINGS

12.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to installation of HDPE pipe and fittings. Detailed HDPE pipe installation requirements are presented in Section 02081 of the Technical Specifications. The HDPE will be supplied and installed by the Contractor.

12.2 HDPE Pipe Supply, Unloading, and Storage

Prior to the shipment of the HDPE pipes and fittings to the Site the Contractor will be required to provide the CQA Site Manager and/or Engineer the quality control information and certifications from each manufacturer as required in the Technical Specifications.

The CQA Consultant will verify that the following information is printed at frequent intervals on, or otherwise clearly provided for the HDPE pipe used on the project:

- name and/or trademark of the pipe manufacturer;
- nominal pipe size, wall thickness, and SDR;
- manufacturing standard reference (e.g., ASTM D 2513); and

If any of the HDPE piping, fittings, and/or accessories that fails to meet the requirements of the Drawings and Technical Specifications, the CQA Consultant will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests or otherwise accepted by the Engineer.

The CQA Consultant will verify that the HDPE pipe and fittings are stored on clean level ground, free of conditions which could damage the pipe; and where necessary (e.g., due to muddy or sloping ground conditions) the pipe is stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

Material conformance testing of the HDPE pipes will not be required unless aspects of the prequalifying information are deficient or suspect, or if requested by the Engineer.

12.3 Monitoring of HDPE Pipe Installation

During construction, the CQA Consultant will monitor construction for the following:

- perforated pipe has the proper amount, correct size, and spacing of perforations, and that the perforations are oriented properly after the pipe is installed;
- ropes, fabric, or rubber-protected slings and straps are used when handling pipe;
- pipe or fittings are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed aggregate for the leachate collection and transmission systems are carefully placed under and around the pipe in accordance with the Drawings and Technical Specifications;
- pipe sections are properly joined using procedures recommended by the Manufacturer and/or allowed for in the Technical Specifications;
- joints are stable and in secure condition prior to and after backfilling;
- blocking is not used under the pipe unless pre-approved by the Engineer; and
- placement of backfill over the pipe is conducted in lifts meeting the requirements of the Technical Specifications, and in a manner that will not damage the pipe.

12.4 Field Testing of HDPE Pipe

The CQA Consultant will verify that the Contractor has performed the applicable pressure testing procedures required in the Technical Specifications for solid HDPE pipes. The CQA Consultant will monitor the Contractor's activities associate with all testing activities and will confirm that the Contractor follows the procedures required in the specifications. The CQA Consultant will either record the test results or will observe the Contractor recording the results and review the results upon submittal by the Contractor.