

# Project Specifications

## Cell 5 Earthwork & Liner Construction

### Western Regional Landfill

MARCH 2, 2023  
197-220036

#### PRESENTED TO

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**Western Regional Landfill**  
2595 North Sagebrush Road  
Huachuca City, Arizona 85616

#### SUBMITTED BY

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#### REPORT CERTIFICATION

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The material and data in this report were prepared under the supervision and direction of the undersigned.

  
3/2/2023

Carl Bueter, P.E.  
Project Manager



Expires 6/30/23

  
3/2/2023

Garth R. Bowers, P.E.  
Engineering Manager

Date

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### APPENDIX A – PROJECT DRAWINGS

**DIVISION 1**  
**GENERAL REQUIREMENTS**

**SECTION 01010  
SUMMARY OF WORK**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Contract Description
- B. Familiarization
- C. CONTRACTOR's Use of Premises
- D. Construction Water
- E. Description of Work
- F. Work Hours
- G. CONTRACTOR's Work Scope

**1.2 CONTRACT DESCRIPTION**

- A. Contract Type: Stipulated price as described in "Agreement for Professional Contracting Services," Standard Form of Agreement between OWNER and CONTRACTOR on the Basis of a Stipulated Price.

**1.3 FAMILIARIZATION**

- A. Prior to implementing any work, the CONTRACTOR shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Project and the CQA Plan.
- B. Inspection
  - 1. If the CONTRACTOR has any concerns regarding the site, the CONTRACTOR shall notify the ENGINEER and the OWNER in writing within 48 hours of the site visit. Failure to notify the OWNER or the ENGINEER prior to installation of all items shall be construed as CONTRACTOR's acceptance of the related work of all other Sections.
  - 2. The CONTRACTOR shall verify as-built conditions prior to placement and/or excavation of any material.

**1.4 CONTRACTOR'S USE OF PREMISES**

- B. The CONTRACTOR should limit activities to the project area, as shown on the Drawings, stockpiles, staging area, and haul road as identified by the OWNER.
- C. CONTRACTOR shall coordinate use of the premises, for their storage and the operation of their workmen, with OWNER and utility service companies.
- D. The CONTRACTOR cannot interfere with ongoing landfill operations, including the allowance of sufficient water supply for dust control and operational measures.
- E. The CONTRACTOR shall coordinate with OWNER regarding hours of construction activities and material deliveries to the Facility.

- F. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to CONTRACTOR. CONTRACTOR must operate entirely within the space allowed to them. The area allocated to the CONTRACTOR will be designated during the Pre-construction Meeting.
- G. CONTRACTOR shall be solely responsible for obtaining and paying all costs in connection with any additional work area, storage sites, and access to the site or temporary right-of-way that may be required for proper completion of the Work.
- H. It shall be understood that responsibility for protection and safe-keeping of equipment and materials on or near the site will be entirely that of CONTRACTOR and that no claim shall be made against the OWNER or their authorized representatives by reason of any act. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the ENGINEER shall direct CONTRACTOR owning or responsible for the stored materials and equipment to immediately move the same. No materials or equipment may be placed upon the property of the OWNER, other than in the designated areas as shown on the Drawings, unless the OWNER has agreed to the location contemplated by CONTRACTOR to be used for storage. All stored materials shall be labeled according to the appropriate CONTRACTOR or Subcontractor with the manufacturer's label as well. Appropriate material safety data sheets (i.e., MSDS) shall be provided.
- I. CONTRACTOR shall be required to share use of the premises with other Contractors whose services the OWNER has obtained or will obtain for construction of other facilities on the site.

#### **1.5 CONSTRUCTION WATER**

- A. Construction water is available on-site through the on-site well.
- B. CONTRACTOR shall obtain water directly from well and NOT extract water from the existing pressure tank.
- C. The CONTRACTOR shall coordinate with OWNER regarding placement of stand tank, connection to the well piping, and operational plan for water supply.

#### **1.6 DESCRIPTION OF WORK**

- A. The work to be performed for this contract includes, but is not necessarily limited to, surveying, Cell 5 excavation, subgrade preparation, liner system installation, the placement/extension of leachate lines, placement of operations layer, compacted soil berm construction, stormwater basin, temporary sump, screen berm, channel construction and riprap placement.
- B. The Cell 5 base liner system, from bottom to top, consists of the following constructed layers;
  - 1. Excavated and prepared subgrade
  - 2. Geosynthetic Clay Liner
  - 3. 60 mil, double-sided, textured HDPE geomembrane liner
  - 4. Geocomposite drainage material
  - 5. Two-foot thick operations layer.

- C. Upon completion and approval of subgrade preparation and prior to the placement of the operations layer, the CONTRACTOR shall provide the necessary time on the project schedule for the geosynthetic material installer to construct all geosynthetic components of the base lining system.
- D. CONTRACTOR shall provide support to the OWNER by supplying the equipment and personnel required to offload and store all geosynthetic materials delivered to the site in preparation for installation by the OWNER-hired installer. This shall be incidental to the project.
- E. The Contractor shall provide construction layout and control survey consistent with the survey control shown on the Drawings and Specifications and shall provide a final survey of the completed construction suitable for preparation of the record drawings for the project.
- F. All work must be carried out and maintained per the Drawings and Specifications subject to the approval of the Design ENGINEER and Quality Assurance/Quality Control consultant.
- G. All work must be performed in compliance with the Master Facility Plan Approval (MFPA) #02659800.05 issued by the Arizona Department of Environmental Quality for the Western Regional Landfill site. Contractor must be familiar with and comply with the requirements of the MFPA, particularly Sections 3.3 and 3.4.
- H. All work must be performed in compliance with other applicable environmental regulations, including but not limited to dust control in conformance with applicable air quality regulation and permit requirements, stormwater quality control in conformance with applicable Arizona Pollution Discharge Elimination System (AzPDES) requirements, and storage of fuels/lubricants/other oils in conformance with applicable Spill Prevention Control and Countermeasures (SPCC) requirements.
- I. Unless otherwise specified in the Specifications or Drawings developed for this project, all work shall be performed in conformance with the requirements of Standard Specifications for Public Improvements, Pima Association of Governments (PAG), latest edition.

#### 1.7 CONTRACTOR'S WORK SCOPE

- A. CONTRACTOR shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services required to complete the excavation, earth fills, liner installation, basin and access road development, and other construction described in these Specifications and the project Drawings.
  - 1 *Cell 5 Liner, Western Regional Landfill, Cochise County, Arizona*, sealed by Carl E. Bueter, P.E., Tetra Tech-BAS, Inc., on 3/2/2023.
- B. Unless otherwise specified in these specifications or the above-referenced drawings, all work shall be performed in conformance with the requirements of *Standard Specifications for Public Improvements*, Pima Association of Governments (PAG), latest edition.

#### PART 2 PRODUCTS

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01016  
HEALTH AND SAFETY CONSIDERATIONS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Preparing project site specific health and safety plan.
- B. Implementing project site specific health and safety plan.

**1.2 MEASUREMENT AND PAYMENT**

- A. Section will be considered part of cost of all other items of work. OWNER will not make separate payment for this section.

**1.3 OTHER**

- A. The exact nature of materials and wastes disposed of at the landfill is unknown. The possibility exists of encountering gases and/or other substances during the Work that may be potentially hazardous to the safety and health of personnel, especially those working in the vicinity of open excavations and pipes venting gases.
- B. The CONTRACTOR is advised that decomposing refuse produces landfill gas which is approximately 50 percent methane (natural gas) by volume. Landfill gas is colorless, can be odorless, may contain hydrogen sulfide, toxic or hazardous material, is combustible, and may contain no oxygen. Landfill gas can also migrate through several thousand feet of soil adjacent to landfills. The CONTRACTOR is therefore advised of the need for precautions against fire, explosion and asphyxiation when working on the landfill and in or near excavations on the project site.

**1.4 SUBMITTALS**

- A. CONTRACTOR shall submit with bid documents, a general Health and Safety Plan to the OWNER, for informational purposes only.
- B. CONTRACTOR shall submit, after Notice of Award but prior to pre-construction meeting, a Site-Specific Health & Safety Plan to be approved by OWNER (See Section 01300). Acceptance of the plan by the OWNER does not release the CONTRACTOR of liability in the event of an accident or injury, nor does it place any liability on the OWNER.
- C. Submittals may be completed electronically.

**PART 2 PRODUCTS**

Not Used.

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## **PART 3 EXECUTION**

### **3.1 CONSTRUCTION**

- A. CONTRACTOR shall be solely and completely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Take all necessary precautions for the safety of and provide the necessary protection to prevent injury or loss to all CONTRACTOR'S employees.
- B. CONTRACTOR shall comply with all applicable Federal and State of Arizona Occupational Safety and Health Administration (OSHA) regulations. The CONTRACTOR'S Health and Safety Plan does not supersede or in any way relieve the CONTRACTOR of obligations under any applicable OSHA regulations including (but not limited to) 29 CFR 1910: Occupational Safety and Health Standards and 29 CFR 1926: Health and Safety Regulations for Construction.
- C. CONTRACTOR shall be responsible for ensuring that all Subcontractors abide with the contents of this section.
- D. CONTRACTOR shall become familiar with potential hazardous health and safety conditions and risks associated with working in or near decomposing refuse at a landfill site and take the applicable precautions for work at the project site.
- E. CONTRACTOR shall be solely responsible for determining and providing an appropriate health and safety program, including monitoring, equipment, plans in event of problems and/or emergencies, and other related items as needed.

### **3.2 SITE RESTRICTIONS**

- A. Smoking will not be permitted at the project site unless a smoking area is designated and approved by OWNER.
- B. Reflective safety vests, hard hats and steel toed boots shall be worn by all personnel during work. Other personal protective equipment will be worn as necessary.
- C. CONTRACTOR shall adhere to the posted speed limit at all times. CONTRACTOR shall further limit vehicle speeds as necessary for safe operation based on road conditions and construction traffic.

### **3.3 SITE SPECIFIC HEALTH AND SAFETY PROGRAM**

- A. Develop and implement a Health and Safety Program in accordance with all applicable Arizona Health and Safety regulations, Federal OSHA regulations, 29 CFR 1910 and 29 CFR 1926, and any other applicable federal, state, or local agency regulations or requirements. If any of these requirements are in conflict, the more stringent requirement shall apply. The CONTRACTOR'S failure to be thoroughly familiarized with the aforementioned safety and health provisions shall not relieve the CONTRACTOR of responsibility for full compliance with the obligations and requirements set forth herein. The CONTRACTOR'S Health and Safety Plan shall include as appropriate, but shall not necessarily be limited to, the items required by OSHA 29 CFR 1910.120:
  - 1. Organizational structure.
  - 2. Comprehensive work plan.
  - 3. Hazard analysis for each site task.

4. Employee training.
  5. Personal protective equipment to be used for each task.
  6. Medical surveillance.
  7. Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used.
  8. Site control measures.
  9. Decontamination procedures.
  10. Emergency response plan.
  11. Confined space entry procedures (if part of scope of work).
  12. Spill containment program.
- B. Provide to the OWNER, prior to the start of any field activities, certification that requirements of this Section have been met. This certification shall include:
1. Documentation of the training required under OSHA 29 CFR 1910.120 for site personnel and supervisors.
  2. Documentation of current first aid and CPR training for at least two employees per work shift.
  3. Documentation of participation of all site personnel in a medical surveillance program in accordance with OSHA 29 CFR 1910.120.
  4. Documentation that all site personnel expected to wear respiratory protection have been medically examined and approved for wearing such equipment and have been fit tested in accordance with OSHA regulations.
- C. The CONTRACTOR shall maintain a copy of the plan at the site for the duration of work.
- D. If the OWNER observes any of the CONTRACTOR'S employees or Subcontractors engaging in an unsafe act or procedure that may result in serious injury or death to the person performing the act/procedure, or to any other person, the OWNER shall have the right, but not the duty, to stop the work until the condition is corrected. The CONTRACTOR shall be held responsible for any increased costs that result from this work stoppage.
- E. The CONTRACTOR shall be responsible for holding mandatory weekly safety meetings on the site. The OWNER shall be notified of the time and place for these meetings, so that they may attend if they desire. Meetings shall reiterate all safety measures to be taken and shall discuss any violations committed and preventive measures. The CONTRACTOR shall provide the OWNER with a copy of the minutes and the attendance upon request.
- F. The CONTRACTOR shall provide all personnel working on the project with required orientation and training on the potential hazards and the appropriate use of safety equipment.
- G. The CONTRACTOR shall meet applicable OSHA health and safety requirements at all times during drilling and excavations. The CONTRACTOR shall secure all work areas and close any open holes or excavations when not working by marking with ribbons and

cones and posting of signs indicating to the public to stay away due to the existence of deep open excavation.

**END OF SECTION**

**SECTION 01019  
CONTRACT CONSIDERATIONS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. References and abbreviations of various industry associations, trade associations, societies, organizations, and regulatory agencies, as referenced in the Contract Documents.

**1.2 DESCRIPTIONS**

- A. The Contract Documents contain references to various standard Specifications, codes, practices, and requirements for materials, workmanship, installation inspections, and tests. Which references are published and issued by the organizations, societies, and associations listed below by abbreviation and name. Such references are hereby made a part of the Contract Documents to the extent cited.
- B. Any material, method, or procedure specified by reference to the number, symbol, or title of a specific Specification or standard, such as a Commercial Standard, American National Standard, Federal or State Specification, Industry or Government Code, a trade association code or standard, or other similar standard, shall comply with the requirements of the edition in effect on the date of Notice to Proceed.
- C. The code, specification, or standard referred to, except as modified in these Specifications, shall have full force and effect as though printed in these Specifications. These Specifications and standards are not furnished to bidders since manufacturers and trades involved are assumed to be familiar with their requirements. The OWNER will furnish, upon request, information as to how copies of the Specifications and standards referred to may be obtained.

**1.3 ABBREVIATIONS**

- A. Whenever in the Contract the following abbreviations are used, their meanings shall be as follows:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASTM	ASTM International
AWWA	American Water Works Association
AZPDES	Arizona Pollution Discharge Elimination System
GRI	Geosynthetics Research Institute
FS	Federal Specifications
NPPP	Native Plant Preservation Plan
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PAG	Pima Association of Governments
PC/COT	Pima County/City of Tucson
PDEQ	Pima County Department of Environmental Quality

PPI	Plastic Pipe Institute
SPCC	Spill Prevention, Control, and Countermeasures
SWPPP	Stormwater Pollution Prevention Plan
WRLF	Western Regional Landfill

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01025  
MEASUREMENT AND PAYMENT**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Measurement and payment methods for contract bid items.

**1.2 MEASUREMENT OF QUANTITIES**

- A. Performed according to United States Measures.
- B. Based on actual units installed or neat line dimensions of work completed.

**1.3 CALCULATION OF QUANTITIES**

- A. Progress Payment Quantities:
- B. CONTRACTOR will compute all quantities of Work performed, or of materials and equipment delivered to the site for progress payment purposes.
- C. OWNER may at any time verify quantities calculated by CONTRACTOR.
- D. Final Payment Quantities: CONTRACTOR will compute all quantities of Work performed, or of materials and equipment delivered and installed for final payment purposes. OWNER may perform an independent computation of all quantities of work performed, and of materials and equipment installed.

**1.4 PAYMENT**

- A. In accordance with lump sum, unit prices, or force account rates shown on the CONTRACTOR'S final negotiated Bid Schedule.
- B. Includes all costs for overhead and profit and for supplying materials, labor, equipment, and tools, and all applicable Federal, State, County, City, and local taxes, necessary to complete the Work in accordance with the Specifications, Drawings, and Contract Conditions.

**1.5 VALUES OF UNIT PRICES**

- A. The number of units and quantities contained in the Bid Schedule are approximate only, and final payment will be made for the actual number of units and quantities incorporated in the work or made necessary to complete the project.
- B. In the event that work and materials or equipment are required to be furnished to a greater or lesser extent than is indicated by the Contract Documents, such work and materials or equipment shall be furnished in greater or lesser quantities.
- C. Where the quantity of a pay item in this contract is an estimated quantity and where the actual quantity of such pay item varies more than fifteen percent (15%) above or below the estimated quantity stated in this contract, an equitable adjustment in the contract price shall be made upon demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above one hundred fifteen percent (115%) or below eighty-five percent (85%) of the estimated

quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the OWNER shall, upon receipt of a written request for an extension of time within ten days from the beginning of such delay, or within such further period of time which may be granted by the OWNER prior to the date of final settlement of the contract, ascertain the facts and make such adjustment for extending the completion date as in his judgement the findings justify.

#### **1.6 CHANGES AND EXTRA WORK**

- A. Changes and extra work will be measured and paid for in accordance with the requirements of this Section after an approved change order has been issued to the CONTRACTOR.

#### **1.7 REJECTED MATERIALS**

- A. Quantities of material wasted or disposed in a manner not called for in the Specifications; rejected loads of material, including material rejected after it has been placed by reasons of the failure of CONTRACTOR to conform to the provisions of the Specifications; material not unloaded from the transporting vehicle; material placed outside the limits indicated by the Drawings or established by OWNER; or material remaining on hand after completion of the Work, will not be paid for, and such quantities will not be included in the final total quantities. No compensation will be made for loading, hauling, and disposing of rejected material.

#### **1.8 FORCE ACCOUNT WORK**

- A. Payment for Force Account work will be determined as follows:
- B. Labor.
  - 1. Payment for labor will be based on the Force Account Labor Rate Schedule submitted with the bid.
  - 2. Payment constitutes full compensation for labor including wages, benefits, overhead, and profit for each individual.
- C. Equipment.
  - 1. Payment for equipment will be based on the Force Account Equipment Rate Schedule submitted with the bid.
  - 2. Payment constitutes full compensation for supplying equipment and includes all costs for maintenance, fuel, insurance, overhead, profit and any other costs necessary to provide and operate the equipment. Payment does not include operator labor cost.
- D. Materials.
  - 1. Payment for materials will be paid for at CONTRACTOR's invoiced cost plus 10 percent.
  - 2. Payment will be based on invoices from suppliers documenting cost to CONTRACTOR.
  - 3. Where invoices are not available a unit cost must be approved by the OWNER prior to use of the material.

## 1.9 PAY ITEMS

- A. Mobilization/Demobilization **(Bid Item 1)**
1. Measurement by Lump Sum (LS), based on mobilizing of equipment and labor to perform work and demobilizing from and cleaning the site after all work and testing has been performed and accepted by the OWNER.
  2. Payment as follows: 50 percent of lump sum amount upon completion of 10 percent of the work, and 50 percent for demobilization and site cleanup; Payment includes all costs for mobilizing and demobilizing equipment, living expenses, insurance, office and field overhead, geosynthetic installer management, and any other administrative costs necessary to complete the work. Includes work described in Sections 01010, 01016, 01019, 01025, 01035, 01050, 01052, 01200, 01300, 01310, 01400, 01500, 01560, 01600, 01630, and 01700.. Payment will be limited to 10 percent of the total contract price.
- B. Excavation **(Bid Item 2)**
1. Measured by the bank Cubic Yard (CY). Measurement of excavation will be made by comparing pre-construction topography of the landfill cell construction, perimeter roads, retention basins, and diversion channel areas as depicted on the Drawings with post-excavation topography. Pre-construction topography will be established by field survey of existing grades. Survey will establish existing grades at a maximum 50-foot grid and establish major grade breaks. Post-construction topography will be established by similar survey at a maximum 50-foot grid and also establish major grade breaks. Post construction survey will not be performed until all earthwork on the project is complete. Earthwork post construction survey shall be completed prior to the installation of any overlying aggregate base, riprap, or other improvements. Calculations will be made on an average end area basis vertically by 2-foot contour interval.
  2. Payment includes all costs to excavate soil (both native and stockpiled/placed by previous activities at the site) within and around the cell area, load as described in Sections 02221 and as shown on the Drawings. No additional payment will be made for load of excavated material that is stockpiled and later relocated for use as fill. Also includes all construction facilities costs per Section 01500 and all clearing and stripping costs per Section 02100.
  3. Work items to be excavated include the cell, perimeter roads, retention basins, and diversion channel areas.
- C. Surveying **(Bid Item 3)**
1. Measured by Lump Sum (LS).
  2. Payment as follows: 40 percent of lump sum amount upon completion of 10 percent of the work, and 50 percent at Substantial Completion, and 10 percent upon acceptance of all as-built documents. Payment includes all costs to perform construction control and slope staking, surveys to compute quantities (i.e., pre- and post- construction), surveys to document as-built conditions of the Cell, and the preparation of Record Drawings as described in Sections 01050 and 01052.
- D. AZPDES **(Bid Item 4)**

1. Measured by Lump Sum (LS).
2. Payment includes all costs to prepare and submit the Construction Notice of Intent and Notice of Termination to the State and to prepare and implement the Storm Water Pollution Prevention Plan (SWPPP) for the site in accordance with the requirements of Section 01560.

E. Engineered Fill **(Bid Item 5)**

1. Measured by in-place Cubic Yard (CY). Measurement of in-place engineered fill will be made by comparing pre-construction topography with post-subgrade construction topography. Pre-construction topography will be established by field survey of existing grades. Survey will establish existing grades at a maximum 50-foot grid and establish major grade breaks. Post-construction topography will be established by similar survey at a maximum 50-foot grid and also establish major grade breaks. Calculations will be made on an average end area basis vertically by 2-foot contour interval.
2. Payment will be made by the Cubic Yard. Payment includes all costs to haul, place, moisture condition and compact as described in Sections 02221 and 02222, and as shown on the Drawings. Also includes all clearing and stripping costs per Section 02100.
3. Work items constructed of engineered fill include the filling of the existing stormwater retention basins, and embankment/grading of perimeter roads, and perimeter channel areas.

F. General Fill **(Bid Item 6)**

1. Measured by in-place Cubic Yard (CY). Measurement of in-place general fill will be made by comparing pre-construction topography with post-subgrade construction topography. Pre-construction topography will be established by field survey of existing grades. Survey will establish existing grades at a maximum 50-foot grid and establish major grade breaks. Post-construction topography will be established by similar survey at a maximum 50-foot grid and also establish major grade breaks. Calculations will be made on an average end area basis vertically by 2-foot contour interval.
2. Payment will be made by the Cubic Yard. Payment includes all costs to haul, place, moisture condition and compact as described in Sections 02221 and 02222, and as shown on the Drawings. Also includes all clearing and stripping costs per Section 02100.
3. Work items constructed of general fill include backfill between the access road and the top of the Cell 5 tipping pad, the safety berm along the access ramp and top edge of cell excavation.

G. Screen Berm Fill **(Bid Item 7)**

1. Measured by in-place Cubic Yard (CY). Measurement of in-place Screen Berm fill will be made by comparing pre-construction topography with post-subgrade construction topography. Pre-construction topography will be established by field survey of existing grades. Survey will establish existing grades at a maximum 50-foot grid and establish major grade breaks. Post-construction topography will be established by similar survey at a maximum 50-foot grid and also establish

- major grade breaks. Calculations will be made on an average end area basis vertically by 2-foot contour interval.
2. Payment will be made by the Cubic Yard. Payment includes all costs to haul, place, moisture condition and compact as described in Sections 02221 and 02222, and as shown on the Drawings. Also includes all clearing and stripping costs per Section 02100
- H. Stockpile Fill **(Bid Item 8)**
1. Measured by the difference of excavation volume (Bid Item 2) minus the sum of fill volumes (Bid Items 5, 6, 7, and 11) in Cubic Yard (CY).
  2. Payment will be made by the Cubic Yard. Payment includes all costs to haul and place as described in Sections 02221 and 02222, and as shown on the Drawings.
- I. Liner Subgrade Preparation **(Bid Item 9)**
1. Measured by the acre (AC). Measurement based on perimeter survey; sloped areas will be equated based on actual area, not plan area.
  2. Payment includes all costs to complete subgrade preparation for the landfill liner as described in Section 02223.
- J. Screen Berm Subgrade Preparation **(Bid Item 10)**
1. Measured by the square yard (SY). Measurement based on area to be scarified and recompacted; sloped areas will be equated based on actual area, not plan area.
  2. Payment includes all costs to complete subgrade preparation for the screen berm and as described in Section 02223.
- K. Operations Layer/Tipping Pad **(Bid Item 11)**
1. Measurement will be based on the surveyed area multiplied by the specified neat line thickness for the Operations Layer Material meeting the gradation requirements of Section 02222 and as shown on the Drawings. CONTRACTOR will be responsible for verifying specified thickness by survey methods. No adjustments will be made in the area for uneven contours.
  2. Payment will be by the Cubic Yard (CY) in-place. Payment includes all costs to furnish equipment and labor to load, haul and place on-site supplied material as shown on the Drawings and as described in Section 02222.
- L. Anchor Trench **(Bid Item 12)**
1. Measurement by the Lineal Foot (LF) of Anchor Trench installed along the west side of the Cell 5 area.
  2. Payment will be by Lineal Foot (LF). Payment includes all costs to locate, excavate, construct soil berm, prepare, shape, backfill and compact the Anchor Trench as shown on the Drawings and described in Section 02222.
- M. Base Liner Termination **(Bid Item 13)**
1. Measurement by the Lineal Foot (LF) of Liner Termination installed along the north and east sides of the Cell 5 base liner area.

2. Payment includes all costs to construct the liner termination as detailed on the Drawings and includes plywood, excavation for temporary turndowns, backfilling the temporary turndowns, installing the separation berm and installing the sacrificial geomembrane cap strip.
- N. Side Slope Liner Termination **(Bid Item 14)**
1. Measurement by the Lineal Foot (LF) of Liner Termination installed along the north side of the Cell 5 sideslope liner area.
  2. Payment includes all costs to construct the liner termination as detailed on the Drawings.
- O. Base Liner Tie-In **(Bid Item 15)**
1. Measurement by Lineal Foot (LF) of tie-in uncovered, based on the perimeter survey performed along the south edge of the bottom liner of the Cell 5 area.
  2. Payment will be by Lineal Foot (LF). Payment includes all costs to locate, excavate, remove plywood, and expose tie-in as shown on the Drawings and described in Sections 02225, 02771, 02778, and 02779.
- P. Side Slope Liner Tie-In **(Bid Item 16)**
1. Measurement and by Lineal Foot (LF) of tie-in uncovered, based on the perimeter survey performed along the south edge of the side slope liner of the Cell 5 area.
  2. Payment will be by Lineal Foot (LF). Payment includes all costs to locate, excavate, and expose tie-in, as shown on the Drawings and described in Sections 02778 and 02779.
- Q. Geosynthetic Clay Liner (GCL) **(Bid Item 17)**
1. Measurement by area installed excluding anchor trenches, measured by the slope-corrected square foot (SF) based on a perimeter survey of the completed installation. No adjustment will be made for uneven contours or for overlap at seams or wastage. No measurement will be made for geosynthetic clay liner lost due to damage resulting from either the fault or the negligence of the CONTRACTOR. The perimeter is defined as the neat line dimension of the liner limit shown on the anchor trench and perimeter details.
  2. Payment will be by the square foot (SF). Payment includes all costs to install GCL as shown on the Drawings and described in Section 02779.
  3. This item will also include all Construction Quality Control testing of the GCL.
- R. Geomembrane Liner (60-mil, double-sided textured) **(Bid Item 18)**
1. Measurement by area installed excluding anchor trenches, measured by the slope-corrected square foot (SF) based on a perimeter survey of the completed installation. No adjustment will be made for uneven contours or for overlap at seams, or wastage. No measurement will be made for geomembrane lost due to damage resulting from either the fault or the negligence of the CONTRACTOR. The perimeter is defined as the neat line dimension of the liner limits shown on the anchor trench and perimeter details.

2. Payment will be by the Square Foot (SF). Includes all costs to install geomembrane as shown on the Drawings and described in Section 02778.
  3. This item will also include all Construction Quality Control testing of the Geomembrane Liner.
- S. Geocomposite LCRS Drainage Layer **(Bid Item 19)**
1. Measurement by area installed, measured by the slope-corrected square foot (SF) based on a perimeter survey of the completed installation. No adjustment will be made for uneven contours or for overlap at seams, or wastage. The perimeter is defined as the neat line dimension of the floor liner limit and perimeter details.
  2. Payment will be by the Square Foot (SF). Includes all costs to install Geocomposite, fasten Geocomposite, and repair Geocomposite as shown on the drawings and described in Section 02225.
  3. This item will also include all Construction Quality Control testing of the Geocomposite LCRS Drainage Layer.
- T. 6" HDPE Leachate Collection Drain (Perforated and Solid) **(Bid Item 20, 21)**
1. Measurement based on actual length, based on survey performed by CONTRACTOR.
  2. Payment will be by Lineal Foot (LF). Payment includes all costs to furnish the material, equipment and labor necessary to install Leachate Collection Drains, including, but not limited to geotextile, perforated and solid HDPE pipe, and gravel fill.
  3. This item will also include all Construction Quality Control testing of the Leachate Collection Drain.
- U. 18" HDPE Pipe culverts **(Bid Item 22)**
1. Measured by the actual Linear Foot (LF), based on survey performed by CONTRACTOR.
  2. Payment includes all costs to furnish the material, equipment and labor necessary to install HDPE culvert, including, but not limited to excavation, compaction, and backfill.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01035  
MODIFICATION PROCEDURES**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Field Orders.
- B. Work Directive Changes.
- C. Change Orders.

**1.2 CHANGE PROCEDURES**

- A. OWNER will issue Field Orders for minor changes in the Work not involving an adjustment to Contract Price or Contract Time.
- B. OWNER may issue a Proposal Request which includes a detailed description of a proposed change with supplementary or revised Drawings and Specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required, and the period of time during which the requested price will be considered valid. CONTRACTOR shall prepare and submit a Proposal with estimate within 5 days.
- C. CONTRACTOR may request a change by submitting a Proposal to OWNER, describing the proposed change and its full effect on the Work. Include a statement describing the reason for the change, the effect on the Contract Price and Contract Time, and a statement describing the effect on Work by separate or other contractors in accordance with Section 00675 within the Project Manual.
- D. OWNER may issue a Work Change Directive for any change which, if not processed expeditiously, might delay the Project. This is not a Change Order, but only a directive to proceed with Work that may be included in a subsequent Change Order.
- E. Changes affecting Contract Price or Contract Time, resulting under Articles 1.2 B, C, and D of this Section, will be processed as a Change Order.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01050  
FIELD ENGINEERING**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. General requirements for survey work to be performed by CONTRACTOR to layout Work under this Contract.
- B. Requirements for surveys for measurement and payment, surveying accuracy, and survey tolerances.

**1.2 RELATED SECTIONS:**

- A. Section 01025 - Measurement and Payment.

**1.3 DESCRIPTION**

- A. Before commencing any surveys, CONTRACTOR will give OWNER two working days advance notice so that OWNER may witness such work.
- B. Reference points: Reference points to be provided by OWNER pursuant to the General Conditions will include referenced monuments and elevation benchmarks in the vicinity of the Project. If displaced by CONTRACTOR, replacement of these reference points will be at the expense of CONTRACTOR. All surveys for record drawings shall tie to a minimum of three of these reference points and shall use the site coordinate system previously established by the OWNER's survey and utilized in the design Drawings.
- C. CONTRACTOR will furnish all necessary detail surveys including all lines, grades, and elevation appropriate to control construction. At a minimum, construction surveys are required for top of subgrade and top of final surface.
- D. Use by OWNER: OWNER may at any time use line and grade points and markers established by CONTRACTOR. CONTRACTOR's surveys are a part of the Work and may be checked by OWNER at any time. CONTRACTOR is responsible for any lines, grades, or measurements which do not comply with specified or proper tolerances, or which are otherwise defective, and for any resultant defects in the Work. CONTRACTOR will be required to conduct re-surveys or check surveys to correct errors indicated by review of the field notebooks or otherwise detected.

**1.4 SURVEYS FOR MEASUREMENT FOR PAYMENT**

- A. When the Specifications or OWNER require Bid Schedule items of work to be measured by surveying methods, CONTRACTOR will perform the surveys. All such surveys, including control surveys for establishing the measurement reference lines, will be performed by a duly qualified and licensed surveyor in the presence of CONTRACTOR who will provide notice so OWNER may witness the surveying operation. OWNER may independently check calculations of final quantities for payment purposes. A duplicate of the note reductions and calculations will be given to OWNER. All calculated quantities shall be certified by surveyor as to accuracy.

**1.5 SURVEYING ACCURACY AND TOLERANCES IN SETTING OF SURVEY STAKES**

- A. Perform control traverse field surveys and computations to an accuracy of at least 1:10,000.
- B. The tolerances applicable in setting survey stakes are as set forth below. Such tolerances cannot supersede stricter tolerances required by the Drawings or Specifications, and cannot otherwise relieve the CONTRACTOR of responsibility for measurements in compliance therewith.

**TABLE 01050-1  
FIELD ENGINEERING**

<u>Type of Mark</u>	<u>Horizontal Position</u>	<u>Elevation</u>
Permanent reference points	1 in 10,000	±0.01 ft.
General excavation and earthwork	1 in 2,000	±0.10 ft.

- C. Tolerances for designed thickness shown on Drawings and for elevations shown on the Drawings are ±0.10 foot unless otherwise specified.
- D. Surveyor must be licensed in the State of Arizona.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01052  
LAYOUT OF WORK AND SURVEYS**

**PART 1        GENERAL**

**1.1        SECTION INCLUDES**

- A.        Requirements for survey work to be provided by the CONTRACTOR for the following:
  - 1.        Setting offset stakes, slope stakes, and grade stakes for field layout of features for performance of the Work.
  - 2.        Surveys for measurement of quantities for payment.
  - 3.        Record Drawings.

**1.2        DESCRIPTION**

- A.        **Reference Points.** The reference points provided by the OWNER include monuments and elevation bench marks in the vicinity of the Project. If displaced during the project, replacement of these reference points will be at the expense of the CONTRACTOR. All surveys for record drawings shall tie to a minimum of three of these reference points and shall use the site coordinate system previously established by the OWNER's survey and utilized in the Design Plan Drawings.
- B.        The OWNER reserves the right to perform any desired checking and correction of the CONTRACTOR's layout work relative to OWNER's surveys but this does not relieve the CONTRACTOR of the responsibility for adequate performance of their Work.
- C.        **Equipment and Personnel.** Provide instruments and other survey equipment that are accurate, suitable for the surveys required in accordance with recognized professional standards, and in proper condition and adjustment at all times. Perform surveys under the direct supervision of a licensed surveyor.
- D.        **Field Notes and Records.** Record surveys in field notebooks.
- E.        **Use by the OWNER.** The OWNER may at any time use line and grade points and markers established by the OWNER or CONTRACTOR. The CONTRACTOR's surveys are a part of the Work and may be checked by the OWNER or representatives of the OWNER at any time.

**1.3        RELATED SECTIONS**

- A.        Section 01025 – Measurement and Payment
- B.        Section 01050 – Field Engineering

**1.4        SURVEYS FOR LAYOUT AND PERFORMANCE OF WORK**

- A.        CONTRACTOR will perform all surveys for layout of the Work, reduce the field notes, make necessary calculations, and prepare drawings necessary to carry out such work. CONTRACTOR's layout work will include the following:
  - 1.        Slope staking for excavations at 50-foot grid, and grade breaks.
  - 2.        Blue top for subgrade at 50-foot grid and grade breaks.

3. Control staking for operations layer thickness at 50-foot grid, and grade breaks.
  4. All as-built surveys specified in Section 01052.
  5. Surveys to measure completed units of work specified in Section 01025.
- B. CONTRACTOR must perform all additional slope staking, off-setting and other control staking necessary to perform the Work.

#### **1.5 SURVEYS FOR RECORD DRAWINGS AND MEASUREMENT FOR PAYMENT**

- A. When the Specifications require items of work to be measured by surveying methods, the CONTRACTOR will perform the surveys and perform necessary calculations to determine payment quantities. The ENGINEER may perform independent checks.
- B. Items requiring surveys for determining pay quantities are given in Section 01025, Measurement and Payment.
- C. The Surveyor shall prepare drawings for each layer of the lining system (subgrade, top of compacted soil, and top of protective soil layer). Points shall provide a comparison of the design elevation against the actual elevation at each point. Points shall be established on a 50-foot maximum grid. Additionally, points shall be established at major changes in grade, changes in alignment, along flow lines, and at any specific points shown in the Drawings. The difference in design versus constructed elevation for each point shall not exceed the tolerance described in Section 01050 Article 1.5.B.
- D. Provide the OWNER with Record (As-Built) Drawings. Separate and distinct sheets shall be provided depicting existing conditions, top of subgrade/finished earth surface, top of containment system, and top of protective cover. Sheets shall include the following items:
1. Topography that depicts Cell 5 Earthwork grading at the start of construction and following excavation and fills. In the event the CONTRACTOR must excavate below the design subgrade as required by these specifications or to remove unsuitable material (at the direction and approval of the ENGINEER or OWNER), CONTRACTOR shall provide as-built survey of the final excavated limits and grades, the limits of fill and grades after placement of engineered fill to establish subgrade and the final grade.
  2. Staking points, grade breaks and limit lines of earthwork as shown in the Design Drawings.
  3. Staking points, grade breaks and limits of liner as shown in the Design Drawings. Where not coincident, limits shall be provided for geomembrane, GCL, geocomposite, and geotextile, including anchor trench alignment and temporary liner terminations (special attention to be given to specific as-built points as required in the Construction Drawings).
  4. Staking points, grade breaks and limits of operations layer as shown in the Design Drawings.
  5. Limits and Grades of earthwork in the perimeter berm. Include staking points, grade breaks, and points of change in surface material.
  6. Miscellaneous Items - CONTRACTOR's Surveyor shall include the following as-built information on one of the sheets identified above (as appropriate) or shall

- provide additional sheets, as needed. The specific sheet for each element shall be as approved by the OWNER.
- a. Location and alignment of buried utilities and buried culverts.
  - b. Initial and finish grades for storm water control features.
  - c. Limits of temporary or permanent access roads.
  - d. Subgrade and finished grade of temporary or permanent access roads.
  - e. Stockpile limits and grades (pre- and post-construction).
  - f. Final site as-builts showing contours and any other miscellaneous constructions including fence, wells, probes, electrical, etc.
  - g. OWNER-provided reference points shall be shown on all applicable as-built drawing sheets.
- E. Surveyor shall provide an AutoCAD file containing all collected as-built locations. As-built drawings shall depict all collected locations with an associated point reference number such that points in the provided Text/ASCII file can be referenced on the drawings.
- F. Surveyor shall submit certified top of subgrade as-built point drawings within 2 days of completion of the subgrade. Where applicable, Surveyor shall provide certified top of compacted soil as-built point drawings within 2 days of completion of this layer. These submittals must be approved by the OWNER before installation of the next liner component begins. In order to avoid project delays, the Surveyor may provide submittals for portions of each completed surface for approval; however, a final consolidated drawing of each surface shall be provided at the completion of each surface.
- G. All final as-built topographic survey drawings are due within 10 days after Substantial Completion date.
- H. Provide sealed as-built survey drawings electronically at same horizontal and vertical scale, same coordinate system, same stationing, and same orientation for each element as shown on the design drawings. Provide as-built survey information and associated point data on the same datum and coordinate basis as design drawings. All point data must have clear, easy to understand descriptions. Provide all point data in AutoCAD format along with list of descriptor abbreviations. Submit all survey information of any layer to the OWNER before that layer is covered.
- I. Surveyor shall provide all drawings in electronic format. Provide information in AutoCAD 2020 or higher format in accordance with OWNER's drafting standards. Surveyor shall also provide documents in Adobe .pdf format.
- J. Submit survey information for items listed above to the OWNER before the items are covered.
- K. Provide surveys to measure the following items:
1. Volume of Excavation
  2. Volume of Engineered Fill
  3. Volume of Unsuitable Material removed from the Cell 5 area below the design subgrade and replaced with Engineered Fill.
  4. Volume of General Fill

5. Volume of Screen Berm Fill
6. Area of Road Surfacing
7. Area of Liner Subgrade Preparation
8. Areas of Operations Layer/Tipping Pad
9. Area of Screen Berm Subgrade Preparation
10. Length of Anchor Trench
11. Length of Liner Termination (each type)
12. Length of Liner Tie-In (each type)
13. Area of GCL, HDPE Liner, Geotextile, and Geocomposite placement. Area will be to the hinge point/limit of waste as shown on the drawings only and will not include the material in the run-out or anchor trench itself.
14. Length of Leachate Collection Drain, for each diameter and material.
15. Any Measurement and Payment items indicated in Section 01025 as requiring surveying for purposes of payment.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01200  
PROJECT MEETINGS**

**PART 1 GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. Representatives of CONTRACTOR, subcontractors, and suppliers attending meetings must be authorized to act on behalf of organizations they represent.

**1.2 PRE-CONSTRUCTION MEETING**

- A. Meeting will be held at a location selected by OWNER.
- B. Attendance:
1. CONTRACTOR's Office Representative.
  2. CONTRACTOR's On-Site Field Superintendent.
  3. Any subcontractors or Supplier's representatives whom CONTRACTOR may desire to invite or OWNER may request.
  4. ENGINEER's Representatives.
  5. OWNER's Representatives. (Includes Design ENGINEER and CQA Personnel)
- C. A suggested format would include, but not be limited to, the following subjects:
1. Presentation of a proposed construction progress schedule and submittals as required by the Contract Documents.
  2. Staging location for contractor's equipment, office trailer, etc.
  3. Required bonds and insurance certifications prior to Notice to Proceed.
  4. Liquidated Damages.
  5. Procedures for handling submittals.
  6. Direction of correspondence and coordinating responsibility between CONTRACTOR and OWNER.
  7. Request or scheduling of a weekly job meeting for all involved.
  8. Laboratory testing of construction materials.
  9. Applications for payment, and progress payment procedures.
  10. Change Order procedures.
  11. OWNER's site regulations.
- D. The meeting will be documented by the OWNER or person designated by the OWNER. Copies of the minutes and relevant documents will be provided to all parties.

**1.3 WEEKLY PROGRESS MEETINGS**

- A. OWNER's Representative will schedule and administer progress meetings at a minimum of once per week and such additional meetings as required, or as requested by OWNER.

- B. Attendance:
  - 1. OWNER's Representative.
  - 2. ENGINEER, if requested by OWNER's Representative.
  - 3. CQA Officer.
  - 4. CONTRACTOR's superintendent.
  - 5. Subcontractor's as appropriate to agenda.
  - 6. Suppliers as appropriate to agenda.
- C. Meeting requirements:
  - 1. OWNER's Representative will administer the following general requirements for progress meetings:
    - a. Prepare agenda for meetings.
    - b. Make physical arrangements for meetings.
    - c. Preside at meetings.
    - d. Record significant proceedings and decisions of meeting.
    - e. Reproduce and distribute copies of meeting record within seven days after each meeting to participants in meeting and to parties affected by decisions made at meeting. Furnish one copy of minutes to participants. Revise and distribute revisions to meeting minutes as necessary.
  - 2. CONTRACTOR will administer the following general requirements for progress meetings:
    - a. Review meeting minutes and provide comments to OWNER's representative prior to the next meeting.
    - b. Provide information to the OWNER's representative required for the meeting agenda such as progress quantities, fuel usage, equipment hours, and water usage records.
- D. Suggested Agenda:
  - 1. Review of safety and any related issues or incidents since last meeting.
  - 2. Review and approval of record of previous meeting.
  - 3. Review of Work progress since previous meeting.
  - 4. Field observations, problems, and conflicts.
  - 5. Problems which impede Work Schedule.
  - 6. Review of off-site delivery schedules.
  - 7. Corrective measures and procedures to regain projected schedule if a review of the schedule deems it necessary.
  - 8. Revisions to Construction Progress Schedule.
  - 9. Coordination of schedules between CONTRACTORS.
  - 10. Review submittal schedules; expedite as required.

11. Maintenance of quality and safety standards.
12. Pending changes and substitutions.
13. Review proposed changes for effect on construction schedule and completion date, and on other contracts of projects.
14. Review of drawings and specifications that govern the next two weeks of work.
15. Review of bid item quantities relative to original estimates.
16. Review and update of as-built drawings.
17. Other business.

#### **1.4 DAILY PROGRESS MEETINGS**

- A. An informal progress meeting will be held daily before the start of work. At a minimum, this meeting will be attended by CONTRACTOR's Project Manager or Job Foreman. The purpose of this meeting is to:
  1. Safety – review status and issues, if any.
  2. Review scheduled work activities.
  3. Discuss problems and resolutions.
  4. Review test data.
  5. Discuss the CONTRACTOR's personnel and equipment assignments for the day.
  6. Review the previous day's activities and accomplishments.

#### **PART 2 PRODUCTS**

Not Used.

#### **PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01300  
SUBMITTALS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Submittal Procedures.
- B. Construction Progress Schedules.
- C. Proposed Products List.
- D. Shop Drawings.
- E. Product Data.
- F. Samples.
- G. Manufacturer Installation Instructions.
- H. Manufacturer Certificates.
- I. Liner Layout Plan
- J. As-built Documentation.

**1.2 RELATED SECTIONS**

- A. Section 01310 - Construction Schedule
- B. Section 01400 - Quality Control
- C. Section 01700 - Contract Closeout

**1.3 SUBMITTAL PROCEDURES**

- A. Transmit each submittal with a transmittal form. Submittals shall be provided electronically and be submitted to the OWNER and ENGINEER.
- B. Sequentially number the transmittal form. For revised submittals add an alphabetic suffix to the original number.
- C. Identify Project, CONTRACTOR, subcontractors or supplier; pertinent drawing and detail number, and specification section number, as appropriate.
- D. Apply CONTRACTOR's stamp, signed or initialed certifying review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite review by the OWNER and delivery in the time frame specified. Coordinate submission of related items.
- F. Allow 7 calendar days review time for each submittal excluding delivery time to and from the CONTRACTOR.
- G. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

- H. Provide space for CONTRACTOR, OWNER and/or OWNER's Representative review stamps.
- I. If revisions and re-submittals are required, identify all changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with provisions.
- K. Submittals not requested will not be recognized or processed.

#### **1.4 CONSTRUCTION PROGRESS SCHEDULES**

- A. Submit initial schedule in duplicate within 5 days after date of Agreement.
- B. Revise and resubmit as required but no less than every 7 days. The revised schedule must show the original target schedule.
- C. Submit revised schedules during weekly progress meetings. If revisions to the schedule affect work by others, the OWNER must be notified two weeks prior to the change. No changes may be initiated without the written approval of the OWNER.
- D. Submit a computer-generated schedule with separate line for each item of Work or operation identifying first work day of each week.
- E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the critical path, start, and finish, float dates, and duration.
- F. Indicate estimated percentage of completion for each item of Work at each submission.
- G. Indicate submittal dates and review periods required for shop drawings, product data, samples, and product delivery dates, including those furnished by OWNER.

#### **1.5 PROPOSED PRODUCTS LIST**

- A. Within 5 days after date of OWNER-CONTRACTOR Agreement, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

#### **1.6 SHOP DRAWINGS**

- A. Submit the number of opaque reproductions which CONTRACTOR requires, plus 2 copies which will be retained by OWNER.
- B. Shop Drawings: Submit for review. After review, produce copies and distribute in accordance with the SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01700.

#### **1.7 PRODUCT DATA**

- A. Submit the number of copies which the CONTRACTOR requires, plus submit an electronic copy to the OWNER.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.

- C. After review, distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01700.

## **1.8 SAMPLES**

- A. Submit a sample of any geosynthetics, imported gravel or riprap that represents the specified product(s). Coordinate sample submittals for interfacing work. Samples must be submitted to the ENGINEER at least two weeks prior to the start of construction and before any materials are delivered to the jobsite.
- B. For the soil samples, submit each sample in an air-tight sealed bucket and provide at least 50 pounds, unless otherwise stated in the individual specification sections.
- C. Include identification on each sample including source identification and full project information.
- D. Submit the number of samples specified in individual specification sections. The OWNER may retain all or a portion of each sample as a record of the submittal.

## **1.9 MANUFACTURER INSTALLATION INSTRUCTIONS**

- A. When specified in individual specification sections, submit two paper copies and one electronic copy of instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing to the OWNER.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

## **1.10 MANUFACTURER CERTIFICATES**

- A. When specified in individual specification sections, submit manufacturer's certificates in specified quantities.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting data, affidavits, certifications, and quality control testing.
- C. Certificates must be specific to the material or product delivered to the site. environmental criteria required for application or installation.

## **1.11 LINER LAYOUT PLAN**

- A. Provide layout plan for HDPE liner system drawn on AutoCAD format.
- B. The layout plan shall contain the entire panel layout with location and length of seams, seam detail, including overlap length.
- C. The layout plan shall indicate that seams on slopes shall not be horizontal and shall provide information on seam integrity tests and other requirements.
- D. The layout plan shall also include information on the seaming outline and qualifications of welders and other key personnel.
- E. Provide shop drawings of any details not conforming to Project Drawings.

## **1.12 AS-BUILT DOCUMENTATION**

- A. Perform and submit all record surveys necessary to show compliance with the Drawings and Specifications.
- B. Record and submit all red-line mark-ups showing changes to the Drawings, Details, and Specifications.
- C. Submit all results of testing performed during and in conjunction with construction.
- D. Submit all documentation as described in Section 01700.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01310  
CONSTRUCTION SCHEDULE**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Construction Schedule.
- B. Delays and Recovery.
- C. Project Updates.

**1.2 CONSTRUCTION SCHEDULE**

- A. Prepare and submit with Bid, a preliminary construction schedule in compliance with Section 01300.
- B. OWNER will review the preliminary construction schedule and incorporate it into their overall project schedule.

**1.3 DELAYS AND RECOVERY**

- A. If, at any time during Project, CONTRACTOR fails to complete an activity by its latest scheduled completion date, CONTRACTOR must submit within two working days a written statement as to how and when CONTRACTOR will reorganize work force to return to current construction schedule.
- B. Whenever it becomes apparent from progress evaluation and updated schedule data that milestone completion dates and/or contract completion dates will not be met, some or all of the following actions must be taken:
  - 1. Increase construction staffing in such quantities and crafts to substantially eliminate backlog of work.
  - 2. Increase number of working hours per shift, shifts per work day, work days per week, or amount of construction equipment, or combination of foregoing to substantially eliminate backlog of work.
  - 3. Reschedule work items to achieve concurrence of accomplishment.
- C. Under no circumstances will addition of equipment or construction forces, increasing working hours or any other method, manner or procedure to return to current Construction Progress Schedule be considered justification for contract modification or treated as an acceleration.

**1.4 PROJECT UPDATES**

- A. Update schedule weekly, or as requested by OWNER.
- B. Updates will show progress of work relative to the original schedule presented with the bid. It shall be prepared in a manner so that it is immediately obvious to the OWNER what tasks are ahead of, on, or behind schedule.
- C. Provide details for scheduled activities over the two weeks following the current day of the schedule. Changes affecting work by others shall be addressed per Section 01300, 1.4, C.

**PART 2      PRODUCTS**

Not Used.

**PART 3      EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01400  
QUALITY CONTROL**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Source of Materials
- B. Acceptance or quality assurance testing by OWNER.
- C. Quality control testing by CONTRACTOR
- D. Certificates of compliance.

**1.2 RELATED SECTIONS**

- A. Section 01300 – Submittals.

**1.3 SOURCE OF MATERIALS**

- A. CONTRACTOR must notify OWNER in writing of the sources from which it proposes to obtain material requiring approval, certification, or testing. Such notification must be made as soon as possible after award of Contract but no later than 5 days after receipt of the Notice to Proceed.

**1.4 ACCEPTANCE TESTING OR QUALITY ASSURANCE TESTING**

- A. Acceptance testing is the testing of materials prior to their use in the Work and also any testing deemed necessary by OWNER for acceptance of the completed Work. OWNER will perform acceptance testing of materials and workmanship in accordance with the Contract Documents and reserves the right to perform additional testing at any time to determine conformance with the requirements of the Contract Documents.
- B. Acceptance testing by OWNER is not to be considered as a replacement for control testing conducted by CONTRACTOR or a manufacturer producing materials for CONTRACTOR. Acceptance testing will be at the expense of OWNER.

**1.5 QUALITY CONTROL TESTING**

- A. Quality control testing is the testing of materials prior to their delivery from a manufacturer, or during construction, such as geomembrane liner seam testing, soil density testing, riprap gradation, and such other tests as are specified in the various sections of the Specifications to ensure compliance with the Contract Documents. CONTRACTOR must assume full responsibility for control testing and give sufficient notice to OWNER to permit it to witness the tests. Control testing is at the expense of CONTRACTOR and where specifically required, performed by an independent testing firm.
- B. Submit the name, address, and qualifications, together with the scope of proposed services, of the proposed testing firm(s) submit to OWNER for approval at least 5 days prior to the scheduled commencement of any work involving such testing.
- C. Within five days after completion of testing performed by or for CONTRACTOR, submit test results to OWNER. Identify test reports with the information specified for samples in

Section 01300 and additionally, the name and address of the organization performing the test, and the date of the tests.

- D. Quality Control testing performed under this section is primarily intended to allow the CONTRACTOR to determine that manufacturing and construction techniques are sufficient to provide a work product that is fully compliant with these specifications. It is independent from Quality Assurance testing, which is performed by the CQA organization, and which is primarily intended to confirm that the work product, as constructed, conforms to the specifications. The CONTRACTOR may need to perform Quality Control testing at frequencies greater than those specified in various sections of the specifications, or for items for which no Quality Control testing is specified, if, in their opinion, such testing is necessary to determine that their methods are sufficient to construct a compliant work product.
- E. No separate payment will be made for Quality Control testing performed per this subpart. The cost for Quality Control testing is incidental to the unit price bid for each applicable bid item.

### **1.6 CERTIFICATES OF COMPLIANCE**

- A. CONTRACTOR may use certificates of compliance for certain materials and products in lieu of the specified sampling and testing procedures. Submit certificates required to demonstrate proof of materials compliance with specification requirements. Submit certificates in duplicate with each lot of material delivered to the Work or prior to delivery as required by the Contract. The lots so certified must be clearly identified by the certificate. Certificates must be signed by an authorized representative of the producer or manufacturer, and state that the material complies in all respects with the requirements of the Contract Documents. In the case of multiple shipments, each shipment must be accompanied or preceded by a Certificate of Compliance.
- B. The Certificate of Compliance must be accompanied by a certified copy of tests results or state that such test results are on file with the producer or manufacturer and must be furnished to OWNER on request. The certificate must give the information specified for samples in Section 01300, the name and address of the organization performing the tests, the date of the tests, and the quantity of material shipped.
- C. Materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance does not relieve CONTRACTOR of responsibility for incorporating material in the Work which conforms to the requirements of the Contract. Any such material not conforming to such requirements will be subject to rejection, whether in place or not.
- D. OWNER reserves the right to refuse to permit the use of certain materials on the basis of a Certificate of Compliance.

### **PART 2 PRODUCTS**

Not Used.

### **PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01500  
CONSTRUCTION FACILITIES**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Construction facilities required for the construction of the permanent facilities specified under the Scope of Work of this Contract.
- B. Construction facilities include furnishing of all equipment, materials, tools, accessories, incidentals, labor, and performing all work for the installation of equipment and for construction of facilities, including their maintenance, operation, and removal, if required, at the completion of the Work under the Contract. The work under this section is incidental to the unit price bid item for excavation.

**1.2 RELATED SECTIONS**

- A. Section 01560 - Temporary Controls.

**1.3 DEFINITION**

- A. Construction facilities include, but are not be limited to, the following temporary offices, utilities, equipment, materials, facilities, areas, and services:
  - 1. Field Office
  - 2. Parking Areas
  - 3. Temporary Roads
  - 4. Storage of Materials and Equipment
  - 5. Construction Equipment
  - 6. Temporary Sanitary Facilities
  - 7. Temporary Electric Power
  - 8. Temporary Water
  - 9. First Aid Facilities
  - 10. Security

**1.4 REFERENCES**

- A. Construct/install, maintain and operate construction facilities in accordance with the applicable federal, state, and local laws, rules, and regulations.

**1.5 GENERAL REQUIREMENTS**

- A. The CONTRACTOR shall furnish, install and maintain required construction aids and barriers as required to prevent public entry, and to protect the Work, existing facilities, trees and plants from construction operations and other temporary facilities required to complete the Work.

- B. The CONTRACTOR shall not interfere with the normal business traffic and operations of the Western Regional Landfill.
- C. In addition to any other remedy available by law or equity to the OWNER, the parties expressly agree that the CONTRACTOR shall be liable for and shall pay to the OWNER the sum of five thousand dollars (\$5,000.00) for each notice of violation of a federal, state, county, city, agency, or administrative law, rule, regulation, ordinance or court order resulting from the CONTRACTOR's acts, errors, or omissions on the Project. This sum will be taken out of the CONTRACTOR's contract with the OWNER. This sum is in addition to any penalty, fine, or fee imposed by a court of law or administrative agency related to the notice of violation, and in addition to the CONTRACTOR's duty to defend and hold the OWNER harmless for the CONTRACTOR's acts, errors, or omissions on the Project. The parties expressly agree that the sum fixed above is reasonable and approximates the actual anticipated loss to the OWNER at the time and making of this agreement in the event that a notice of violation is levied on the Project. The parties expressly acknowledge and agree to the fixed sum set forth above because of the difficulty of proving the OWNER's actual damages in the event that a notice of violation is levied on the Project.
- D. CONTRACTOR is responsible for furnishing, installing, constructing, operating, maintaining, removing and disposing of the construction related facilities, as specified in this Specification, and as required by OWNER for the completion of the Work under the Contract.
- E. Locate and maintain construction facilities in a clean, safe and sanitary condition at all times until completion of the Contract.
- F. The requirements specified herein are in addition to any requirements specified elsewhere in the Contract Documents. Construction facilities must meet the requirements for all-weather service.
- G. Minimize land disturbances related to the construction facilities to the greatest extent possible and restore land to the extent reasonable and practical, to its original contours by grading to provide positive drainage and by seeding the area to match with existing vegetation, or as specified elsewhere. All debris or other disturbances resulting from the CONTRACTOR's actions shall be removed by the CONTRACTOR to the satisfaction of the OWNER.
- H. Design and construct utilities to provide uninterrupted service.

#### **1.6 FIELD OFFICE**

- A. CONTRACTOR may provide an office for their own staff and for the purpose of conducting meetings in support of the project. Office shall have electricity and air conditioning sufficient to comfortably conduct productive meetings.
- B. The location of the office must be approved by OWNER.

#### **1.7 PARKING AREAS**

- A. OWNER will provide parking area for maintenance and delivery vehicles, the OWNER's, ENGINEER's, and CONTRACTOR's representatives, and other authorized visitors.

## **1.8 TEMPORARY ROADS**

- A. General.
- B. Temporary roads are existing roads that are improved, or new roads constructed by CONTRACTOR for convenience of CONTRACTOR in the performance of the Work under the Contract.
- C. Coordinate construction with OWNER.
- D. If applicable, coordinate all road construction activities with local utilities, fire and police departments.
- E. Keep erosion to a minimum and maintain suitable grade and radii of curves to facilitate ease of movement of vehicles and equipment.
- F. Furnish and install longitudinal and cross drainage facilities including, but not limited to, the ditches, structures, pipes and the like.
- G. Clean equipment so that mud or dirt is not carried onto public roads. Clean any mud or dirt transported by equipment onto paved roads both on site and off site.

## **1.9 STORAGE OF MATERIALS AND EQUIPMENT**

- A. Make arrangements for storage areas for materials and equipment. Locations and configurations of such facilities are subject to the acceptance of OWNER.
- B. Confine all operations, including storage of materials, to approved area. CONTRACTOR is liable for any and all damage caused during such use of property of the OWNER or others. Store materials in accordance with manufacturer's instructions when applicable.
- C. Store construction materials and equipment within boundaries of designated areas. Storage of gasoline or similar fuels must conform to federal, state, and local regulations and be limited to the areas approved for this purpose by the OWNER.

## **1.10 CONSTRUCTION EQUIPMENT**

- A. Erect, equip, and maintain all construction equipment in accordance with all applicable statutes, laws, ordinances, rules, and regulations of OWNER or other authority having jurisdiction.
- B. Provide and maintain scaffolding, staging, runways, hoists, barricades, and similar equipment required for performance of the Contract. Provide hoists or similar equipment with operators and signals, as required.
- C. Provide, maintain, and remove upon completion of the Work, all temporary rigging, scaffolding, hoisting equipment, debris boxes, barricades around openings and excavations, fences, ladders, and all other temporary work, as required for all work hereunder unless otherwise directed by OWNER.
- D. Construction equipment and temporary work must conform to all the requirements of state, county, local authorities, Occupational Safety and Health Administration (OSHA), and underwriters which pertain to operation, safety, and fire hazard. Furnish and install all items necessary for conformity with such requirements, whether or not called for under separate sections of these Specifications.

### **1.11 TEMPORARY SANITARY FACILITIES**

- A. Provide temporary sanitary facilities for use by all employees and persons engaged in the work, including subcontractors, their employees and authorized visitors.
- B. Sanitary facilities include enclosed chemical toilets and washing facilities. These facilities must meet the requirements of local public health standards. Open pit or trench latrines are not permitted.
- C. Locate sanitary facilities as approved by OWNER, and maintain in a sanitary condition during the entire course of the work.

### **1.12 TEMPORARY ELECTRIC POWER**

- A. Provide and maintain during the course and progress of the Work all electrical power and wiring requirements to facilitate the work of all trades and services associated with the work. Make arrangements with the applicable serving utility company or provide generators and pay all charges for providing and maintaining electrical service including usage costs at the site unless otherwise approved by the OWNER. Furnish all temporary wiring, feeders, and connections.
- B. Routing of temporary conductors, including welding leads, must not create a safety hazard nor interfere with operation and maintenance of existing facilities.
- C. Install all temporary wiring in accordance with the applicable requirements of the local electrical code.
- D. Provide power and lighting to field office, and for Work as required, at no extra cost to OWNER.

### **1.13 TEMPORARY WATER**

- A. Potable water is not available on-site. CONTRACTOR must supply their own potable water for employees. For construction water, refer to Section 01010.
- B. Make all arrangements for water needs from an off-site supplier for emergencies.

### **1.14 FIRST AID FACILITIES**

- A. Provide first aid equipment and supplies to serve all CONTRACTOR personnel at the site.

### **1.15 SECURITY**

- A. Make all necessary provisions and be responsible for the security of the Work and the site until final inspection and acceptance of the Work unless otherwise approved by the OWNER. In no case shall the OWNER be responsible for the security of the CONTRACTOR's supplies, property, or equipment.

### **1.16 SHUT-DOWN TIME OF SERVICES**

- A. Do not disconnect or shut down any part of existing utilities and services, except by express permission of OWNER.

**1.17 MAINTENANCE**

- A. Maintain all construction facilities, utilities, temporary roads, services to office, and the like in good working condition as required by OWNER during the term of the Contract.

**1.18 STATUS AT COMPLETION**

- A. Upon completion of the Work, or prior thereto, when so required by OWNER:
- B. Repair damage to roads caused by or resulting from the CONTRACTOR's work.
- C. Remove and dispose of all construction facilities including office trailers, and other facilities and utilities including all concrete foundations. Similarly, return all areas utilized for temporary facilities to substantially their near original, natural state, or as otherwise indicated or directed.
- D. Obliterate temporary roads built for CONTRACTOR's convenience and restore the area to near original conditions to the extent practicable unless otherwise approved by the OWNER.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01560  
TEMPORARY CONTROLS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Temporary controls required during the term of the Contract for the protection of the environment and the health and safety of workers and general public.
- B. Furnishing all equipment, materials, tools, accessories, incidentals, and labor, and performing all work for the installation of equipment and construction of facilities, including their maintenance and operation during the term of the Contract.
- C. Temporary controls include, but are not limited, to the following:
  - 1. Dust Control
  - 2. Pollution Control
  - 3. Traffic and Safety Controls
- D. Perform work as specified in this Specification and as required by OWNER. Maintain equipment and accessories in clean, safe and sanitary condition at all times until completion of the Contract.

**1.2 RELATED SECTIONS**

- A. Section 01500 — Construction Facilities.

**1.3 DUST CONTROL**

- A. Provide dust control measures if specified in the Contract.
- B. CONTRACTOR RESPONSIBILITY – The CONTRACTOR will be responsible for all permits and review fees. The CONTRACTOR is specifically reminded of the need to obtain the necessary environmental permits or file the necessary environmental notices.
- C. Dust control consists of transporting water, furnishing required equipment, additives, accessories and incidentals, carrying out proper and efficient measures wherever and as often as necessary to reduce dust nuisance, and to prevent dust originating from construction operations throughout the duration of the Contract, as required by OWNER.
- D. Apply water by means of pressure-type distributors or pipelines equipped with a spray system or hoses with nozzles that will insure a uniform application of water.
- E. Provide all equipment used for the application of water with a positive means of shut-off.
- F. Unless otherwise permitted by OWNER or unless all the water is applied by means of pipelines, provide at least one operations mobile unit with a minimum capacity of 3,500 gallons for applying water at the site during construction.
- G. The CONTRACTOR must place a sign for public viewing, with a telephone number that can be used by the public to make complaints to the Arizona Department of Environmental Quality (ADEQ). Such a call will result in a visit to the site by the ADEQ Air Quality personnel and may result in a Notice of Violation. Notices of Violation are issued to the holder of the Grading Permit (the Contractor), but they reflect unfavorably

on the OWNER. Note: Contractor shall obtain an Earthmoving, or Grading permit if required by the County or Arizona Department of Environmental Quality.

- H. The Contractor shall be prepared to spend as much time as may be required to keep dust under control. The air contaminant emission at the work area shall not exceed 20 percent opacity during the contract period. Local regulatory requirements may be more stringent than the maximum allowable stated above. The CONTRACTOR is responsible for identifying and complying with all applicable regulatory levels. If dust clouds can be seen by the naked eye, rising from the operation, the CONTRACTOR is in violation of these specifications. If the Contractor fails to provide the necessary dust control, to the ENGINEER's satisfaction, the project will be shut down, at the CONTRACTOR's expense, until the contractor presents satisfactory evidence to the Engineer that they can continue work and prevent dust as required.

#### 1.4 POLLUTION CONTROL

- A. Erosion Control: Control sediment transport on sloped surfaces. Submit a NOI as required by AZDPES regulations. CONTRACTOR shall maintain and implement a Storm Water Pollution Prevention Plan (SWPPP) which complies with all requirements of the applicable stormwater AZDPES permit for construction activities.
- B. Pollution of Waterways: Perform work using methods that prevent entrance or accidental spillage of solid or liquid matter, contaminants, debris and other objectionable pollutants and wastes into streams, watercourses, flowing or dry, and underground water sources. Such pollutants and wastes will include, but will not be restricted to refuse, earth and earth products, garbage, cement, concrete, sewage effluent, industrial waste, radioactive substances, hazardous chemicals, oil and other petroleum products, aggregate processing tailings, and mineral salts. Dispose of pollutants and wastes in accordance with applicable permit provisions or in a manner acceptable to and approved by the OWNER.
- C. Storage and Disposal of Petroleum Products:
1. Petroleum products covered by this section include gasoline, diesel fuel, hydraulic fluids, lubricants, heating oils, and refined and used oil. During project construction, store all petroleum products in such a way as to prevent contamination of all ground and surface waters.
  2. Lubricating oil may be brought into the project area in steel drums or other means, as CONTRACTOR elects. Store used lubricating oil in steel drums, or other approved means, and return to the supplier for disposal. Do not burn or otherwise dispose of at the project area.
  3. If the total capacity volume of stored petroleum products is greater than 1,320 gallons in total and these products are stored above ground, CONTRACTOR shall prepare and adhere to a Spill Prevention Control and Countermeasure Plan (SPCC Plan) in accordance with applicable EPA and other state regulations.
- D. All chemicals stored on-site must be appropriately labeled as to its content and hazard rating.

## 1.5 TRAFFIC AND SAFETY CONTROLS

- A. Use existing haul roads between excavation location and stockpile location. Avoid crossing roads used by the public as part of landfill operations.
- B. Post construction areas and roads with traffic control signs or devices used for protection of workmen, the public and equipment. The signs or devices must conform to the US Department of Transportation (USDOT), Federal Highway Administration (FHWA), Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.
- C. Remove signs or traffic control devices as soon as they have served their purpose. It is particularly important to remove any markings on road surfaces which under conditions of poor visibility could cause a driver to turn off the road or into traffic moving in the opposite direction.
- D. Barricades for protection of employees must conform to the portions of the U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA), MUTCD, relating to barricades.
- E. Material Haul on Public Roads: Follow all requirements stated in the permits for using public roads for hauling materials to the site.
- F. Provide flag persons, properly equipped with International Orange or High Visibility Yellow protective clothing and flags, as necessary, to direct or divert pedestrian or vehicular traffic.
- G. Construct and maintain fences, planking, barricades, lights, shoring, and warning signs as required by local authorities, federal and state safety ordinances, and as required to protect OWNER's property from injury or loss, and as necessary for the protection of the public, and provide walks around any obstructions made in a public place for carrying on the Work covered in this Contract. Leave all such protection in place and maintained until removal is authorized.
- H. Guard and protect all workers, pedestrians, and the public from excavations, blasting operations, construction equipment, all obstructions, and other dangerous items or areas by means of adequate railings, guard rails, temporary walks, barricades, warning signs, sirens, directional signs, overhead protection, planking, decking, danger lights, etc.

## 1.6 WATER CONTROL

- A. The CONTRACTOR shall provide methods to control surface water to prevent damage to the Project, the site, or adjoining properties. The CONTRACTOR shall control fill, grading and ditching to direct surface drainage away from excavations, pits, tunnels and other construction areas; and to direct drainage to proper runoff.
- B. The CONTRACTOR shall provide, operate, and maintain equipment of adequate capacity to control surface erosion.
- C. The CONTRACTOR shall dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the site or to adjoining areas.

**1.7 MAINTENANCE**

- A. Maintain all temporary controls in good working conditions during the term of the Contract for the safe and efficient transport of equipment and supplies, and for construction of permanent works, as required by OWNER.

**1.8 STATUS AT COMPLETION**

- A. Upon completion of the Work, or prior thereto, when so required by OWNER, remove all temporary controls and restore disturbed areas as required by OWNER.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01600  
MATERIAL AND EQUIPMENT**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Products.
- B. Transportation and Handling.
- C. Storage and Protection.

**1.2 PRODUCTS**

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer, for similar components.

**1.3 TRANSPORTATION AND HANDLING**

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, and/or damage.
- D. Any damaged materials, whether as originally shipped or as a result of handling, shall be replaced at no additional cost to the OWNER and with no extension of contract time.

**1.4 STORAGE AND PROTECTION**

- A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
- B. For exterior storage of fabricated products, place aboveground on sloped supports, if in accord with manufacturer's handling instructions.
- C. Place delivered GCL material rolls on storage pad without damaging the protective wrap around each roll and cover with a CONTRACTOR-supplied watertight tarp to provide sufficient protection from weather conditions including rain and wind. Ballast tarp with sandbags or approved equal to prevent wind uplift.
- D. Provide off-site storage and protection when site does not permit on-site storage or protection.
- E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

- F. Store loose granular materials on solid flat surfaces in a well-drained area.
- G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- H. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.
- I. Any products that become damaged during storage shall be replaced at no additional cost to the OWNER and with no extension of contract time.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01630  
PRODUCT OPTIONS AND SUBSTITUTIONS**

**PART 1 GENERAL**

**1.1 SUMMARY**

- A. This Section describes CONTRACTOR procedures for securing approval of proposed product options and substitutions.

**1.2 PRODUCT OPTIONS**

- A. The Contract is based on standards of quality established in the Contract Documents.
1. In agreeing to the terms and conditions of the Contract, the CONTRACTOR has accepted a responsibility to verify that the specified products will be available and to place orders for all required materials in such a timely manner as is needed to meet their agreed construction schedule.
  2. The OWNER does not agree to the substitution of materials or methods called for in the Contract Documents, except as they may specifically otherwise state in writing.
- B. Materials and/or methods specified by name:
1. Where materials and/or methods are specified by naming one single manufacturer and/or model number, without stating that equal products will be considered, only the material and/or method named is approved for incorporation into the Work.
  2. Should the CONTRACTOR demonstrate to the approval of the OWNER that a specified material or method was ordered in a timely manner and will not be available in time for incorporation into this Work, the CONTRACTOR shall submit to the OWNER such data on proposed substitute materials and/or methods as are needed to help the OWNER determine suitability of the proposed substitution.
- C. Where materials and/or methods are specified by name and/or model number, followed by the words "or an equal approved in advance by the OWNER" or similar wording:
1. The material and/or method specified by name establishes the required standard of quality;
  2. Materials and/or methods proposed by the CONTRACTOR to be used in lieu of materials and/or methods so specified by name must in all ways be equal or exceed the qualities of the named materials and/or methods;
  3. Proposed substitutions must be described in the CONTRACTOR'S General Contract bid.
- D. The following products do not require further approval except for interface within the Work:
1. Products specified by reference to standard specifications such as ASTM International (ASTM) and similar standards;

- 2. Products specified by manufacturer's name and catalog model number.
- E. Where the phrase "or equal," or "or equal as approved by the OWNER," occurs in the Contract Documents, do not assume that the materials, equipment, or methods will be approved as equal unless the item has been specifically so approved in writing for this Work by the OWNER.
- F. The decision of the OWNER shall be final.

**1.3 DELAYS**

- A. Delays in construction arising by virtue of the non-availability of a specified material and/or method will not be considered by the OWNER as justifying of an extension of the agreed Time of Completion.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01700  
CONTRACT CLOSEOUT**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Preparation, maintenance, completion, and submission of all project record drawings, specifications and related documents.

**1.2 RELATED SECTIONS**

- A. Section 01300 — Submittals.
- B. Section 01560 — Temporary Controls.

**1.3 MAINTENANCE OF RECORD DOCUMENTS**

- A. Maintain at the job site one copy of the following Project or Contract Documents for record purposes:
  - 1. Drawings;
  - 2. Specifications;
  - 3. Addenda;
  - 4. Change Orders and Work Change Directives;
  - 5. Field Orders;
  - 6. Reviewed Shop Drawings;
  - 7. Clarifications or Explanatory Drawings and Specifications;
  - 8. Inspection Reports;
  - 9. Laboratory Test Records;
  - 10. Field Test Records; and
  - 11. All documents required by permit, SWPPPs, SPCCs plans, dust control permits, etc., will be maintained on site as applicable to the appropriate permit requirements.
- B. Store documents used for record purposes in the field office or other approved location, apart from documents used for construction.
- C. File documents in accordance with the Construction Specification sections.
- D. Maintain documents in clean, dry, legible condition.
- E. Do not use record documents for construction purposes.
- F. Make documents available at all times for inspection by the OWNER and their authorized representatives.

**1.4 RECORD DRAWINGS**

- A. Project Drawings:

1. Maintain record drawings of all work and subcontracts continuously as the job progresses. Keep a separate set of prints, for this purpose only and at the job site at all times.
  2. Keep these drawings up-to-date.
  3. During the course of construction identify on the drawings, the actual locations for all runs of mechanical and electrical work, including all site utilities and services installed underground or otherwise concealed. Show deviations from the drawings in detail. Locate all main runs, whether piping, or drain lines by dimension and elevation.
  4. During the course of the construction record as-built information outlined in Section 01300.
  5. Deliver the final and record set of "as-built" drawings to the OWNER prior to the OWNER's acceptance of the Project. The final set of as-built drawings shall be sealed by the CONTRACTOR'S surveyor and provided to the OWNER in hard copy or PDF format and in an electronic (AutoCAD .dwg) format.
- B. Addenda and Change Orders:
1. Incorporate changes to the Drawings affected by Addenda, Change Orders, or Field Orders. Identify change by Addendum, Change Order, or Field Order number and effective date.
  2. When revised drawings are issued as the basis of or along with addenda or change order, incorporate these revised drawings into the record set with appropriate annotation.
- C. Shop Drawings:
1. Collect and maintain one complete set of reviewed shop drawings, including manufacturer's printed catalog cuts and data, for record purposes.
  2. Shop drawings must be filed and maintained separate from project drawings. Shop drawings must be filed in 9 inch by 12 inch file folders to the greatest extent possible and be indexed in accordance with the format as herein specified.

## 1.5 RECORD SPECIFICATIONS

- A. Project Specifications:
1. Information, changes, and notes must be recorded in the specifications in blank areas, such as page margins or the backs of opposite pages, or on separate sheets inserted in the binder. All such information, changes, and notes must be recorded in red.
  2. In each section, in an appropriate location, record the manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
  3. The record specifications book must be complete and include all documents and forms listed under Bidding Requirements, Contract Forms, Contract Conditions, and Specifications.
- B. Addenda, Change Orders, Work Change Directives, and Field Orders

1. All Addenda, Change Orders, Work Change Directives, and Field Orders must be incorporated into the front of the specifications book in reverse chronological order. Use appropriate page dividers to identify addenda, change orders, and to separate addenda from the specifications.
2. In addition, the changes to the specifications effected by Addenda, Change Order, Work Change Directives, or Field Order must be annotated on the affected page or pages of the specifications, or adjacent thereto.

**1.6 SUBMISSION OF DOCUMENTS**

- A. At completion of the project, and before submitting invoice for final payment, deliver record documents to OWNER.
- B. Record documents must be delivered neatly and efficiently packaged.
- C. Submission of record documents must be accompanied with a transmittal letter, in duplicate, containing the following information:
  1. Date of submission.
  2. Project title and number.
  3. CONTRACTOR's name and address.
  4. Title and number of each record document. (Shop drawings may be grouped in basic categories or divisions of work.)
  5. Certification that each document as submitted is complete and accurate.
  6. Signature of CONTRACTOR or their authorized representative.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

**END OF SECTION**

**DIVISION 2**

**SITWORK**

**SECTION 02100  
CLEARING AND GRUBBING**

**PART 1        GENERAL**

**1.1        SECTION INCLUDES**

- A.        Removal of surface debris.
- B.        Clearing and stripping vegetation, grass and other organic material from project construction areas.
- C.        Stockpile or dispose of stripped material.

**1.2        RELATED SECTIONS**

- A.        Section 02221 – Excavating and Stockpiling.
- B.        Section 02222 – Earth Fills
- C.        Section 02223 – Subgrade Preparation
- D.        Section 02224 – Trenching, Backfilling, and Compacting

**1.3        REGULATORY REQUIREMENTS**

- A.        Conform to applicable codes for disposal of debris and dust control.
- B.        Coordinate clearing work with local utility companies and landfill site operator.
- C.        Any activity that disturbs one acre or more, shall obtain coverage under a Construction General Permit Arizona Pollution Discharge Elimination System (AZPDES) from the ADEQ, prior to such activity. As a condition on this permit, CONTRACTOR shall prepare and implement a Storm Water Pollution Prevention Plan (SWPPP).

**PART 2        PRODUCTS**

Not used.

**PART 3        EXECUTION**

**3.1        PREPARATION**

Not used.

**3.2        PROTECTION**

- A.        Protect survey benchmarks from damage or displacement.
- B.        Protect areas to remain undisturbed as designated on the Project Plans.
- C.        Protect existing utilities in the work area.

### **3.3 STRIPPING FOR LANDFILL CELL AND SCREEN BERM**

- A. Strip vegetation, roots, organic soils, and other deleterious materials prior to excavating.
- B. Strip to a maximum depth of 6 inches below existing ground surface.
- C. CONTRACTOR to haul all stripped material to the landfill working face and placed for disposal unless approved otherwise by the OWNER.

**END OF SECTION**

**SECTION 02221  
EXCAVATING AND STOCKPILING**

**PART 1        GENERAL**

**1.1        SECTION INCLUDES**

- A.        Preparation.
- B.        Landfill Cell Area.
- C.        Soil Stockpiling.

**1.2        RELATED SECTIONS**

- A.        Section 02222 –Earth Fills
- B.        Section 02223 – Subgrade Preparation
- C.        Section 02224 – Trenching, Backfilling, and Compacting

**PART 2        PRODUCTS**

**2.1        ENGINEERED FILL**

- A.        Soil meeting requirements of Section 0222, Part 2.1.

**2.2        GENERAL FILL**

- A.        Soil meeting requirements of Section 02222, Part 2.2.

**2.3        SCREEN BERM FILL**

- A.        Soil meeting requirements of Section 02222, Part 2.3.

**2.4        OPERATIONS LAYER**

- A.        Soil meeting requirements of Section 02222, Part 2.4.

**2.5        ANCHOR TRENCH BACKFILL**

- A.        Soil meeting requirements of Section 02222, Part 2.5.

**2.6        SURPLUS SOILS**

- A.        Remaining soils excavated.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Establish required lines, levels, contours, and datum by construction staking.
- B. Notify utility company to locate utilities, if applicable.
- C. Provide for dust control including applicable permits.
- D. Coordinate excavation operations with landfill operations.
- E. Protect benchmarks and fences from excavation equipment and vehicular traffic.
- F. Provide for dewatering as necessary for finish excavation and place fill.
- G. Note that topography shown on Drawings may differ from topography at time of construction. A pre-construction survey shall be performed by the CONTRACTOR and provided to the OWNER to document site conditions prior to starting work.

### **3.2 LANDFILL CELL AREA**

- A. Excavate soil as required to the lines, grades, and elevations to construct the landfill cell subgrade.
- B. Machine grade slopes and base of landfill cell to design grades.
- C. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- D. Remove lumped subsoil, boulders, and rock from completed subgrade elevation as necessary to comply with Section 02779.3.1 of these specifications.
- E. Notify OWNER of unexpected subsurface conditions such as significant sand lenses at or near subgrade surface and discontinue affected work in area until notified to resume work.
- F. Selectively excavate engineered fill, general fill, screen berm fill, operations layer, and anchor trench backfill.
- G. Haul remaining material, surplus soils, to stockpile(s) designated on the Drawings or approved by OWNER.

### **3.3 SOIL STOCKPILING**

- A. Excavated soil not used for the Screen Berm or other fill operations shall be placed into stockpile in the area shown on the drawings. Stockpile shall be within the defined boundaries and the height shall not exceed the slope and top deck elevations shown unless approved prior to by the OWNER.
- B. Coordinate selective soil stockpiling with OWNER.
- C. Place soil such that maximum slope is 2H:1V, and minimum slope is 5 percent.
- D. Placement and mass configuration of soil stockpiles shall be performed at the direction of the OWNER.
- E. Provide uniform final graded surface for the soil stockpile(s).
- F. Provide erosion/sedimentation controls around perimeter of stockpile per requirements of the Stormwater Pollution Prevention Plan (SWPPP).

- G. Outboard slopes shall be continuously track-walked and maintained in good appearance. Grouser marks should be used to minimize erosion.

**END OF SECTION**

**SECTION 02222  
EARTH FILLS**

**PART 1        GENERAL**

**1.1        SECTION INCLUDES**

- A.        Engineered Fill.
- B.        General Fill.
- C.        Screen Berm Fill.
- D.        Operations Layer.
- E.        Anchor Trench Backfill.
- F.        LCRS Trench Gravel.

**1.2        RELATED SECTIONS**

- A.        Section 02221 – Excavating and Stockpiling.
- B.        Section 02223 –Subgrade Preparation.
- C.        Section 02224 – Trenching, Backfilling, and Compacting

**1.3        REFERENCES**

- A.        Latest ASTM International (ASTM)Standards or other recognized agency standards at the time construction documents are issued for the following items:
  - 1.        ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand Cone Method
  - 2.        ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>)(600 kN-m/m<sup>3</sup>)
  - 3.        ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
  - 4.        ASTM D7830 - Standard Test Method for In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge
  - 5.        ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)
  - 6.        ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
  - 7.        ASTM D6938 - Test Methods for Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
  - 8.        ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 9.        ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

## **PART 2      PRODUCTS**

### **2.1      ENGINEERED FILL**

- A.      Predominantly cohesionless or low-plastic soil obtained from on-site excavations.
- B.      Free of organic material.
- C.      Maximum particle dimension: 3 inches, 1 inch for near surface material within 6 inches of the top of subgrade.
- D.      Free of frozen material, ice, snow, or excessive moisture.

### **2.2      GENERAL FILL**

- A.      Predominantly cohesionless or low-plastic soil obtained from on-site excavations.
- B.      Free of organic material.
- C.      Maximum particle dimension: 3 inches
- D.      Free of frozen material, ice, snow, or excessive moisture.

### **2.3      SCREEN BERM FILL**

- A.      Predominantly cohesionless or low-plastic soil obtained from on-site excavations.
- B.      Free of organic material.
- C.      Maximum particle dimension: 3 inches
- D.      Free of frozen material, ice, snow, or excessive moisture.

### **2.4      OPERATIONS LAYER**

- A.      Operations layer material shall be obtained from on-site sources identified by the OWNER.
- B.      Operations layer shall meet the following requirements:
  - 1.      Maximum particle size of 2 inch.
  - 2.      Particles larger than ¼ inch shall be sub-rounded to rounded, and free of sharp edges that could damage underlying geomembrane liner.

### **2.5      ANCHOR TRENCH BACKFILL**

- A.      Predominantly cohesionless or low-plastic soil obtained from on-site excavations.
- B.      Free of organic material.
- C.      Maximum particle size 1 inch.

### **2.6      LCRS TRENCH GRAVEL**

- A.      Free of organic or other deleterious material.
- B.      Having a hydraulic conductivity of greater than or equal to 0.5 cm/sec when placed in accordance with this section.
- C.      Material greater than ½ inch in largest dimension must be rounded to sub-rounded as defined in ASTM D2488.

- D. Meeting the following gradation:

<b>TABLE 02222-1 LCRS TRENCH GRAVEL MATERIAL REQUIREMENTS</b>	
<b>U.S. Sieve Size</b>	<b>Percent Passing</b>
2-inch	100
1-1/2-inch	85-95
1-inch	50-85
3/4-inch	0 – 25
1/2 inch	0 – 5
#4	0 – 3
#40	0 – 3
#200	0 – 2

- E. Gradation requirements are an index test. Gradation of materials below the 1-inch dimension and above the #200 sieve can be modified if the hydraulic conductivity requirements are met. If used around LCRS piping, rock must be of a gradation such that D<sub>50</sub> size is greater than ½-inch.

- F. Using the following testing frequencies:

<b>TABLE 02222-2 MATERIAL EVALUATION OF GRAVEL DRAINAGE MATERIAL SOURCE EVALUATION TESTING FREQUENCIES</b>		
<b>Test</b>	<b>Test Method</b>	<b>Frequency</b>
Particle Size (Without Hydrometer)	ASTM D6913	1 Per 2,500 cy
Permeability Test >1 x10 <sup>-2</sup> cm/sec	ASTM D2434	1 Per 2,500 cy
Notes: <sup>1</sup> Material changes, suspect areas, or other field conditions may require the ENGINEER to increase testing and sampling frequencies.		

### **PART 3 EXECUTION**

#### **3.1 ENGINEERED FILL PREPARATION**

- A. Scarify subgrade soils to a 6-inch depth prior to soil placement.
- B. Begin engineered fill placement only when underlying subgrade has been accepted by the OWNER.
- C. Prior to placement of engineered fill verify that no substantial thickness of loose or uncompacted soil is present in the fill area.

### **3.2 ENGINEERED FILL PLACEMENT**

- A. Place Engineered Fill to the lines and grades shown on the Drawings.
- B. Place in loose lift thickness not exceeding 8 inches.
- C. Unless a more stringent compaction requirement is specified on the drawings, compact each lift to a minimum of 95 percent relative compaction at a moisture content from 4 percent below to 4 percent above optimum as determined by ASTM D698. Completed lifts of fill cannot yield under equipment loads.
- D. Grade final surface to a vertical tolerance of 0.1 foot.

### **3.3 GENERAL FILL PREPARATION**

- A. Begin General Fill placement only when underlying subgrade has been accepted by the OWNER.
- C. Prior to placement of General Fill, verify that no substantial thickness of loose or uncompacted soil is present in the fill area.

### **3.4 GENERAL FILL PLACEMENT**

- A. Place General Fill to the lines and grades shown on the Drawings.
- B. Place in loose lift thickness not exceeding 8 inches.
- C. Compact each lift to a minimum of 90 percent relative compaction at a moisture content from 4 percent below to 4 percent above optimum as determined by ASTM D698. Completed lifts of fill cannot yield under equipment loads.
- D. Grade final surface to a vertical tolerance of 0.1 foot.

### **3.5 SCREEN BERM FILL PREPARATION**

- A. Scarify subgrade soils to a 6-inch depth and re-compact subgrade soils to a minimum of 95 percent relative compaction as determined by ASTM D698 prior to soil placement.
- B. Begin Screen Berm Fill placement only when underlying subgrade has been accepted by the OWNER.
- C. Prior to placement of Screen Berm Fill verify that no substantial thickness of loose or uncompacted soil is present in the fill area.

### **3.6 SCREEN BERM FILL PLACEMENT**

- A. Place Screen Berm Fill to the lines and grades shown on the Drawings.
- B. Place in loose lift thickness not exceeding 8 inches.
- C. Compact each lift to a minimum of 92 percent relative compaction at a moisture content from 4 percent below to 4 percent above optimum as determined by ASTM D698. Completed lifts of fill cannot yield under equipment loads.
- D. Grade final surface to a vertical tolerance of 0.1 foot.

- E. Track-walk and hydroseed final surface of Screen Berm with landscape rock.

**3.7 OPERATIONS LAYER PREPARATION**

- A. Verify the liner and leachate collection geocomposite is installed and all CQC and CQA documentation verifies installation in accordance with these specifications.
- B. Verify borrow source meets specified requirements of this section and has been approved for use by the OWNER.

**3.8 OPERATIONS LAYER PLACEMENT**

- A. Backfill and compact geosynthetics anchor trenches prior to placing operations layer on sideslopes.
- B. Do not put any equipment on the operations layer unless there is a minimum of 12 inches of operations layer covering the geocomposite. Minimum thickness may be greater depending on the associated ground pressure for the specified placement equipment as defined in Table 02222-3, below.
- C. Place in a single lift to the thickness indicated on the drawings.
- D. Place and grade material up slope, do not push material downslope.
- E. Use as few passes as possible. There are no compaction requirements.
- F. Place without damaging underlying installations.
- G. CONTRACTOR shall provide spotter to observe operations layer placement operation. This spotter shall ensure that the placement operation is not inducing folds or other damage in the underlying geosynthetics and that any oversized particles in the operations layer material are picked out and hauled to an appropriate stockpile location.
- H. Do not exceed allowable ground pressure as specified below:

<b>TABLE 02222-3 MAX. ALLOWABLE GROUND PRESSURE OVER GEOSYNTHETICS</b>	
<b>Allowable Equipment Ground Pressure (psi)</b>	<b>Thickness of Material Above Geocomposite (in.)</b>
<5	12
<10	18
<20	24
>20	36

- I. Construct haul routes over geocomposite having a minimum material thickness of 24 to 36 inches. The 24-inch minimum coverage includes the initial material dumping and

spreading areas, haul roads and stockpile areas that cover the geomembrane and are utilized by rubber-tired vehicles.

- J. When placing operations layer to its final thickness over the geomembrane use low ground pressure track-mounted equipment with a maximum allowable ground pressure equal to or less than a LGP D-6 dozer unless the tracks of the equipment are continually operating on a thicker soil layer than the specified final thickness, deploying soil ahead of the equipment in a manner that does not create folds or excessive stresses on the liner components, and the maximum equipment ground pressure does not exceed the values shown in Table 02222-3 above.
- K. Maximum equipment speed over operations layer: 5 miles per hour.
- L. Do not make sharp turns when placing operations layer.

### **3.9 BACKFILL FOR ANCHOR TRENCH**

- A. Begin only when geosynthetic installations have been completed in accordance with deployment and seaming criteria.
- B. Place earthfill to the lines and grades shown on the Drawings.
- C. Place in loose lift thickness not exceeding 12 inches; no scarification is required.
- D. Compact each lift to a minimum of 95 percent relative compaction as determined by wheel rolling with rubber-tired equipment, or similar.
- E. Do not damage geosynthetic installation.
- F. Grade final surface to a vertical tolerance of plus or minus 0.10 feet.

### **3.10 PLACEMENT OF LCRS TRENCH GRAVEL**

- A. Place only when underlying geosynthetic installations are complete in accordance with Specifications.
- B. Prior to beginning material placement, demonstrate that gravel layer placement techniques will not damage the underlying geosynthetic materials.
- C. Place to the lines, grades and dimensions indicated on the Drawings.
- D. Place in a single lift without damaging underlying geosynthetics.

### **3.11 FIELD QUALITY ASSURANCE (BY OWNER)**

- A. Field quality assurance procedures will follow the facility's Construction Quality Assurance Plan "CQA Plan"; however, alternate test methods and frequencies (both lesser or greater) may be utilized as warranted and approved by the Engineer and the CQA Officer. Such changes will not be considered as a change in Contract conditions.
- B. The OWNER will collect and test samples of soil materials covered in this Section in accordance with the procedures outlined in the CQA Plan. In-place density and moisture content will be measured during construction by the OWNER in accordance with the procedures outlined in the CQA Plan.

**END OF SECTION**

**SECTION 02223  
SUBGRADE PREPARATION**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Final grading and compaction of finished subgrade in preparation for GCL placement or engineered fill. or screening berm fill.

**1.2 RELATED SECTIONS**

- A. Section 02221 – Excavating and Stockpiling.
- B. Section 02222 – Earth Fills.
- C. Section 02779 – Geosynthetic Clay Layer.

**1.3 REFERENCES**

- A. Latest ASTM International (ASTM) Standards or other recognized agency standards at the time construction documents are issued for the following items:
  - 1. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand Cone Method
  - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>)(600 kN-m/m<sup>3</sup>)
  - 3. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
  - 4. ASTM D7830 - Standard Test Method for In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge
  - 5. ASTM D2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

**PART 2 PRODUCTS**

**2.1 ENGINEERED FILL SUBGRADE**

- A. See Section 02222.

**2.2 SCREENING BERM SUBGRADE**

- A. See Section 02222.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

- A. Verify that excavation is complete and in compliance with slopes and dimensions shown on the Drawings.
- B. If excavation of unsuitable material is required prior to replacement with engineered fill, coordinate excavation with OWNER.

- C. Verify surface is free of ponded water before fill is placed.
- D. Screening Berm Subgrade.

Scarify and recompact upper 6-inches of subgrade to 92% minimum relative compaction as determined by ASTM D698.

### **3.2 FINISHED GRADING AND COMPACTION OF SUBGRADE**

#### **A. Liner Subgrade Soils**

1. Moisture condition engineered fills or liner subgrade soils from 4 percent below to 4 percent over optimum moisture, then compact to a minimum of 95 percent relative compaction as determined by ASTM D698.
2. Finish grade compacted within a vertical tolerance of plus or minus 0.1 feet of design grade.
3. Subgrade shall be rolled with a smooth-drummed compactor to a smooth and level surface.
4. Surface shall be free of stones or protrusions greater than 0.50-inch diameter and organics or other deleterious material.
5. Fill voids and cracks.
6. Ruts shall be limited to 1-inch maximum depth.
7. The CONTRACTOR may use a scraper or other heavy equipment to verify compaction of subgrade materials by proof-rolling. The subgrade surface will be accepted by the ENGINEER if the specified compaction is obtained, and no materials greater than one inch in dimension are visible. It should be noted that areas of the subgrade may be unsuitable and require removal and replacement with engineered fill.
8. Ultimately, CONTRACTOR shall provide a subgrade surface that warrants preparation of a subgrade acceptance certification by the geosynthetics liner installer. Certification may be issued in phases to facilitate project completion.

#### **B. Screening Berm Subgrade**

1. Scarify and recompact upper 6-inches of subgrade to 92% minimum relative compaction as determined by ASTM D698.

### **3.3 FIELD QUALITY ASSURANCE (BY OWNER)**

- A. The OWNER will collect samples of subgrade materials to determine the material's optimum moisture content and maximum density (ASTM D5993).
- B. The OWNER will measure in-place density and moisture content of the subgrade (by one or more of the following methods: ASTM D6938, ASTM D1556, and ASTM D2216), at the frequencies outlined in the CQA Plan.
- C. For liner subgrade excavated into native soil (i.e., not including filled areas) conditions only, if in the opinion of the CQA Monitor the subgrade is comprised of unyielding, firm soils, the testing requirements listed above in paragraph (B) may be replaced with the following field verification test:

1. Following smooth drum compaction of the subgrade, the CQA Monitor and OWNER shall observe the CONTRACTOR “proof-rolling” the subgrade with a fully-loaded scraper. If the subgrade appears firm and no “pumping” or soft spots areas are observed, the CQA Monitor can certify that the subgrade soils are approved for placement.
- D. CONTRACTOR shall cooperate fully with the OWNER in performing compaction control tests. Include costs for assistance in unit or lump sum prices.

**END OF SECTION**

**SECTION 02224**  
**TRENCHING, BACKFILLING, & COMPACTING**

**PART 1      GENERAL**

**2.1      SECTION INCLUDES**

- A.      Excavating trenches for utilities, leachate lines, landfill gas collection and conveyance lines.
- B.      Compacted fill from top of utility bedding to subgrade elevations.
- C.      Backfilling and compaction.

**2.2      RELATED SECTIONS**

- A.      Section 02221 – Excavation.
- B.      Section 02222 – Engineered Fill and Stockpiling.
- C.      Section 02711 – Polyethylene Pipe.

**2.3      QUALITY CONTROL**

- A.      Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- B.      Comply with all requirements of governmental agencies having jurisdiction, particularly as it relates to trench safety systems.

**2.4      REFERENCES**

- A.      OSHA Safety Requirements for Trenching and Shoring.
- B.      ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>)(600 kN-m/m<sup>3</sup>).
- C.      ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
- D.      ASTM D6938- Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- E.      ASTM D2216 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
- F.      ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
- G.      Solid Waste Facility Plan

## **2.5 DEFINITIONS**

- A. Utility: Any buried pipe, duct, conduit, or cable.

## **2.6 FIELD MEASUREMENTS**

- A. Verify that survey benchmarks, control points, and intended elevations for the Work are as shown on drawings.

## **2.7 COORDINATION**

- A. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

## **PART 2 PRODUCTS**

### **2.1 BACKFILL AND BEDDING MATERIALS**

- A. Utility trench backfill: Cohesive soil free from organic matter and deleterious substances, containing no rocks or lumps over 3 inches in greatest dimension. Backfill material is subject to the acceptance of the OWNER, and is that material removed from excavations or imported from on-site borrow areas, and is soil free from roots and other deleterious matter.
- B. Pipe Bedding: Clean sand with a maximum grain size of 3/8-inch.

## **PART 3 EXECUTION**

### **2.1 PREPARATION**

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

### **2.2 FINISHED ELEVATIONS AND LINES**

- A. Comply with pertinent provisions of the Drawings and Specifications.

### **2.3 PROCEDURES**

- A. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the CONTRACTOR prior to trenching. If damaged, repair or replace at no additional cost to the OWNER.
- B. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the CONTRACTOR, promptly take necessary steps to assure that service is not interrupted. Identify the location, size, grade, and type of utility encountered and document its location on as-built drawings.
- C. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the OWNER.
- D. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the OWNER and secure his instructions.

- E. Do not proceed with permanent relocation of utilities until written instructions are received from the OWNER.
- F. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.
- G. Maintain access to adjacent areas at all times.

## **2.4 PROTECTION OF PERSONS AND PROPERTY**

- A. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or within public access.
- B. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
- C. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.

## **2.5 DEWATERING**

- A. Remove all water, including storm water, encountered during trench and sub-structure work to an approved location by pumps, drains, and other approved methods.
- B. Keep trenches and site construction area free from water.

## **2.6 TRENCHING**

- A. Comply with pertinent provisions of this Section.
- B. Provide sheeting and shoring necessary for protection of the Work and for the safety of personnel. Provide shoring where required for safe entry.
- C. Prior to backfilling, remove all sheeting.
- D. Do not permit sheeting to remain in the trenches except when, in the opinion of the ENGINEER, field conditions or the type of sheeting or methods of construction such as use of concrete bedding are such as to make removal of sheeting impracticable. In such cases, the OWNER may permit portions of sheeting to be cut off and remain in the trench.

## **2.7 OPEN CUT TRENCH**

- A. Excavate for utilities by open trench.
- B. Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, backfill the voids remaining after removal of the objects.
- C. When the void is below the subgrade for the utility bedding, use suitable earth materials and compact to a minimum relative density of 95 percent of ASTM D1557.

- D. When the void is in the side of the utility trench or open cut, use suitable bedding to fill the void.
- E. Remove boulders and other interfering objects, and backfill voids left by such removals.

## **2.8 EXCAVATING FOR APPURTENANCES**

- A. Over excavation beyond such appurtenances that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as directed by the OWNER, and at no additional cost to the OWNER.
- B. Trench to the minimum width necessary for proper installation of the utility, with sides as nearly vertical as possible. Accurately grade the bottom to provide uniform bearing for the utility.

## **2.9 DEPRESSIONS**

- A. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
- B. Except where rock is encountered, do not excavate below the depth indicated or specified.
- C. Where rock is encountered, excavate rock to a minimum over depth of 4 inches below the trench depth indicated or specified.
- D. Where utility runs traverse to public property or are subject to governmental or utility company jurisdiction, provide depth, bedding, cover, and other requirements as set forth by legally constituted authority having jurisdiction, but in no case less than the depth shown on the Drawings.

## **2.10 COVER**

- A. Provide minimum trench depth to maintain a minimum cover over the top of the installed item below the finish grade or subgrade.
- B. Where utilities are under a concrete structure slab or pavement, unless otherwise indicated on the Drawings the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, and electrical long-radius rigid metal conduit riser, provided it would not interfere with the structural integrity of the slab or pavement.

## **2.11 BEDDING**

- A. Provide a minimum 4-inch bedding, as approved by the OWNER, under pipe, or as shown on plans. Hand grade the bedding to proper grade ahead of pipe laying. Provide a firm, unyielding support along the entire pipe length.

## **2.12 BACKFILLING**

- A. Do not completely backfill trenches until required pressure and leakage tests have been performed, and until the utilities systems as installed conform to the requirements specified in the pertinent Sections of these Specifications.

- B. Place backfill material in layers not greater than 6 inches thick and in a manner that equalizes pressures on the structure and minimizes stresses. Moisture condition material to achieve 0 to plus 4 percent of optimum moisture content as determined by the Modified Proctor test method (ASTM D1557). Thoroughly tamp and compact all trench backfill with machine or pneumatic operated tampers of a size and type that will obtain the required density.
- C. Reopen trenches that have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified, or otherwise correct to the approval of the ENGINEER.
- D. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, tests, and approvals.
- E. Should any of the Work be so enclosed or covered up before it has been approved, uncover all such Work and, after approvals have been made, refill and compact as specified, all at no additional cost to the OWNER.
- F. Backfill the pipe zone with material hand placed simultaneously on both sides of the pipe for the full trench width and hand tamp with approved tamping sticks supplemented by "walking in" and slicing with a shovel.
- G. Consolidation of backfill by jetting is prohibited.

#### **2.13 FIELD QUALITY CONTROL**

- A. The OWNER will inspect open cuts and trenches before installation of utilities.
- B. Assure that trenches are not backfilled until all tests have been completed.
- C. Check backfilling for proper layer thickness and compaction.
- D. Verify that test results conform to the specified requirements, and that sufficient tests are performed.
- E. Assure that defective work is removed and properly replaced.

#### **2.14 FIELD QUALITY ASSURANCE**

- A. The OWNER may determine optimum moisture content and maximum density for trench backfill. Maximum dry density and optimum moisture will be determined in accordance with ASTM D1557.
- B. The OWNER may determine in-place density and moisture content by one or more of the following methods: ASTM D2937, and ASTM D6938.
- C. Cooperate fully with the OWNER in performing compaction control tests. Include costs for assistance in unit or lump sum prices.

**END OF SECTION**

**SECTION 02225  
GEOCOMPOSITE**

**PART 1        GENERAL**

**1.1        SECTION INCLUDES**

- A.        Placement of single-sided geocomposite as part of leachate collection system and liner system for the landfill.

**1.2        RELATED SECTIONS**

- A.        Section 02222 – Earth Fills.
- B.        Section 02711 – Polyethylene Pipe.
- C.        Section 02771 – Geotextile.
- D.        Section 02778 – Geomembrane.

**1.3        REFERENCES**

Latest ASTM International (ASTM) Standards or other recognized agency standards at the time construction documents are issued for the following items:

- A.        ASTM D5199– Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- B.        ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics
- C.        ASTM D1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D.        ASTM D1603 – Standard Test Method for Carbon Black in Olefin Plastics
- E.        ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- F.        ASTM 7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
- G.        ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
- H.        ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- I.        ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
  
- J.        ASTM D4716– Standard Test Methods for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- K.        ASTM D6241– Static Puncture Strength
- L.        ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile

#### 1.4 DEFINITIONS

- A. Manufacturer: Responsible for the production of geocomposite rolls.
- B. Installer: The party responsible for field handling, storing, deploying, seaming, repairing, anchoring, and any other aspects of installing the geocomposite. The installer is also responsible for the transportation of the material to the site.
- C. Construction Quality Assurance Consultant (CQAC): The party, independent from the manufacturer or installer, responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic components of the geocomposite. Also responsible for issuing a construction management report and certification sealed by a Registered Professional Engineer.

#### 1.5 MANUFACTURER SUBMITTALS FOR REVIEW

- A. Submit the following 7 days prior to scheduled installation:
  - 1. Manufacturer's certificates of compliance with specified product requirements.
  - 2. Manufacturer's Quality Control (MQC) test results performed on materials produced for this project.

#### 1.6 TRANSMISSIVITY VERIFICATION MQC TESTING (PERFORMED BY MANUFACTURER)

- A. The Manufacturer must provide transmissivity test results for the geocomposite proposed for the primary leachate collection system to qualify its use on this project. Refer to Article 2.1 of this Section for other product requirements for the components of the geocomposite (geotextile and geonet) as well as the geocomposite itself.
- B. Testing: Test with liner system components in contact with each side of the geocomposite as shown on the drawings. Tests must be performed by a GRI accredited lab or as approved by the ENGINEER.
- C. Test as described below:
  - 1. Transmissivity shall be measured in a 12-inch x 12-inch box using the same boundary conditions, load, duration and gradient as those used by the manufacturer to establish the min. avg. for the required test value.
  - 2. Minimum transmissivity required:
    - a. Primary Leachate Collection: 10 GPM/ft
- D. Test report shall indicate the orientation relative to flow of the ribs of the geonet in contact with the geomembrane.

#### 1.7 CONFORMANCE TESTING (PERFORMED BY OWNER)

- A. The OWNER will perform conformance testing on geocomposites as outlined in Table 02225-1 and 2 and in the CQA Plan.
- B. Allow a minimum of 7 calendar days for conformance tests to be performed and data to be reviewed.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect geocomposite from ultraviolet light exposure, precipitation, inundation, mud, dirt, dust, puncture, cutting, and other damaging or deleterious conditions.
- B. Immediately restore damaged protective covering.

## PART 2 PRODUCTS

### 2.1 MANUFACTURED GEOCOMPOSITE FOR PRIMARY LEACHATE COLLECTION SYSTEM

- A. Description: A drainage geocomposite manufactured by heat-bonding non-woven needle punched geotextile to one side of a polyethylene geonet.
- B. Provided in roll lengths that accommodate the maximum slope lengths on 3:1 or steeper slopes without requiring butt seams.
- C. Manufactured with a thickness adequate to meet specified flow capacity.
- D. Manufactured with a non-collapsible waterway for unrestricted flow.
- E. Manufactured with core material made of polyethylene that maintains the required flow under specified loads.
- F. Manufactured and installed with geotextile overlapped at the upstream end of the geocomposite drain to prevent soil intrusion.
- G. Interface shear strength for the geocomposite as part of the liner system shall be tested per the requirements of Section 02779 Article 2.2.
- H. Manufactured to meet or exceed the following product requirements based on minimum average roll values:

### 2.1 GEONET COMPONENT OF GEOCOMPOSITE PRIMARY LEACHATE COLLECTION SYSTEM

<b>TABLE 02225-1 GEONET COMPONENT PROPERTIES AND TESTING FREQUENCIES</b>				
<b>Test<sup>(1)</sup></b>	<b>ASTM Test Designation</b>	<b>Minimum MQC Test Frequency<sup>(1)</sup></b>	<b>Minimum Conformance Test Frequency</b>	<b>Required Test Values</b>
Thickness (min. avg.)	D5199	1/100,000 sf	1/250,000	200 mil <sup>(2)</sup>
Density (min. avg.)	D792 or D1505	1/100,000 sf	1/250,000	0.940 g/cm <sup>3</sup>
Carbon Black Content (range)	D1603 <sup>(3)</sup>	1/100,000 sf	1/250,000	2-3%

**TABLE 02225-1  
GEONET COMPONENT PROPERTIES AND  
TESTING FREQUENCIES**

<b>Test<sup>(1)</sup></b>	<b>ASTM Test Designation</b>	<b>Minimum MQC Test Frequency<sup>(1)</sup></b>	<b>Minimum Conformance Test Frequency</b>	<b>Required Test Values</b>
Mass/Unit Area (min. ave.)	D5261	1/100,000 sf	1/250,000	lbs/sf <sup>(2)</sup>

1. Testing the geonet component shall be performed in accordance with the upper portion of this table. The geotextile component shall meet the required test values and the manufacturer's QC test frequency requirements from the Geotextile Separator (see Section 02771, 2.1). Tracking of the frequency of the Manufacturer's QC testing and Conformance QA testing shall be based on the geocomposite roll numbers.
2. Required value shall be taken from manufacturer's standard material specifications sheet for the selected geonet/Geocomposite material. Geonet/Geocomposite selection shall be based on the material's ability to meet or exceed the transmissivity identified in the site's design.
3. Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

**2.3 GEOTEXTILE COMPONENT OF GEOCOMPOSITE FOR PRIMARY LEACHATE COLLECTION SYSTEM**

A. Per Article 2.1, Section 02771.

**2.4 MANUFACTURED GEOCOMPOSITE FOR PRIMARY LEACHATE COLLECTION SYSTEM**

**TABLE 02225-2  
GEOCOMPOSITE PROPERTIES AND  
TESTING FREQUENCIES**

<b>Test</b>	<b>ASTM Test Designation</b>	<b>Minimum MQC Test Frequency<sup>(1)</sup></b>	<b>Minimum Conformance Test Frequency</b>	<b>Required Test Values</b>
Peel Strength (min. avg.)	D7005	1/100,000 sf	1/250,000	1.0 lb/in
Transmissivity <sup>(2)</sup>	D4716	1/Project	1/Project	10 gal/min/ft

1. Unless otherwise noted, all values represent minimum average roll values (MARV), (i.e. any roll in a lot should meet or exceed the values in this table)
2. Transmissivity shall be measured in a 12-inch x 12-inch box using the same boundary conditions, load, duration and gradient as those used by the manufacturer to establish the min. avg. for the required test value.

**2.5 MANUFACTURER SOURCE**

**2.5 MANUFACTURER SOURCE QUALITY CONTROL**

A. Perform Manufacturer's Quality Control (MQC) tests for geocomposites manufactured for this project. Perform tests necessary to verify geocomposites meet specified product requirements. Perform each MQC test at a minimum of the frequencies defined in this Section.

- B. Provide the following information with MQC test data:
  - 1. Roll numbers and identification
  - 2. Results of quality control tests, including a description of test methods used.
- C. OWNER will reject rolls for which quality control requirements are not met.

## **2.6 LABELING**

- A. Mark or tag geocomposite rolls with the following information:
  - 1. Manufacturer's name
  - 2. Product identification
  - 3. Lot number
  - 4. Roll number
  - 5. Roll dimensions
- B. Mark special handling requirements on rolls.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Prior to installation of geocomposite, examine underlying construction for conformance with specifications. Verify the following:
  - 1. Underlying installations are complete, installed as designed, and as-built documentation has been obtained.
  - 2. There is no debris, excessive dust or rocks on the geomembrane in areas where geocomposite will be deployed.

### **3.2 PROTECTION**

- A. When placing other geosynthetics over the geocomposite ensure the following:
  - 1. No damage occurs to the geocomposite.
  - 2. The geocomposite does not slip on the underlying geosynthetics.
  - 3. There are no excessive tensile stresses in the geocomposite.

### **3.3 DEPLOYMENT**

- A. Follow manufacturer's recommendations, standards, and guidelines.
- B. Deploy geocomposite as indicating in Drawings.
- C. Do not entrap excessive dust, stones or moisture in geocomposite that could damage or clog drains or filters or hamper subsequent seaming.
- D. Deploy geocomposite such that the orientation of the ribs on the lower surface of the geocomposite matches that of the transmissivity testing performed under Article 1.6 of this Section.
- E. Deploy rolls down slope not across slope.
- F. Lay smooth with no wrinkles and free of stresses.

- G. Examine geocomposite over entire installed surface to ensure that no potentially harmful foreign objects, such as needles, are present. Remove any foreign objects.
- H. Do not drag geocomposite across rough or textured surfaces to avoid damage to the geocomposite. Use a smooth geosynthetic slip sheet or rub sheet as necessary to reduce friction damage during deployment.

### **3.4 PANEL SEAMS (IF REQUIRED)**

- A. Ensure that no soil is present between geocomposite seams.
- B. Overlap geonet 4 inches along panel edges and tie at five-foot intervals with plastic ties of contrasting color to the geonet material.
- . Overlap geotextile and sew or heat bond.

### **3.5 BUTT SEAMS (IF REQUIRED)**

- A. In areas with greater than 10% slope, overlap geonet 2 feet along panel ends and tie in two staggered rows at 12-inch intervals with plastic ties of contrasting color to the geonet material. In areas with less than 10% slope, overlap geonet 1 foot along panel ends and tie at 5-foot intervals with plastic ties of contrasting color to the geonet material.
- B. Overlap geotextile and sew.

### **3.7 REPAIRS**

- A. Repair with same geocomposite product overlapped 12 inches beyond the repair area and secure with plastic ties of contrasting color to the geonet material spaced 12 inches on center. Overlap geotextile and sew or heat bond.

### **3.8 FIELD QUALITY ASSURANCE**

- A. The CQAC will collect sample of geocomposite delivered to the site, for conformance testing at a minimum frequency of one (1) per 250,000 thousand square feet of geocomposite and perform tests as outlined in the CQA Plan to determine product compliance with specified values.

### **3.9 ACCEPTANCE**

- A. CONTRACTOR retains all ownership and responsibility for geocomposite until acceptance by OWNER.
- B. OWNER accepts geocomposite when:
  - 1. The installation is complete.
  - 2. Conformance tests verify product requirements.
  - 3. Documentation of installation is complete including the CQAC's final report.
  - 4. Verification of the adequacy of all seams and repairs, including associated testing, is completed.
  - 5. Written certification documents have been received by the OWNER.

**END OF SECTION**

## **SECTION 02711 POLYETHYLENE PIPE**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Installation of high-density polyethylene (HDPE) pipe in locations shown on the drawings.
- B. Installation of all HDPE pipe fittings and appurtenances.

#### **1.2 RELATED SECTIONS**

- A. Section 02771 – Geotextile.
- B. Section 02225 – Geocomposite.

#### **1.3 REFERENCES**

Latest ASTM International (ASTM) Standards or other recognized agency standards at the time construction documents are issued for the following items:

- A. ASTM D4976 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
- B. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

#### **1.4 DEFINITIONS**

- A. Standard Dimensional Ratio (SDR): The actual outside pipe diameter divided by the wall thickness.

### **PART 2 PRODUCTS**

#### **2.1 PIPE AND FITTINGS**

- A. All pipe sizes shown on the Drawings and specified in this Section reference nominal diameter, unless otherwise indicated on the Drawings or in this Section. Pipe sizing in accordance with ASTM F714, and ASTM D3035.
- B. All pipes: as shown in Drawings.
- C. Designated as PE4710 and classified as 445474C (ASTM D3350).
- D. Conforming to the following requirements:

**TABLE 02711-1  
PROPERTIES FOR POLYETHYLENE PIPE**

<b>Property</b>	<b>Test Procedures</b>	<b>Values</b>
Density (gm/cm <sup>3</sup> )	ASTM D1505	0.955
Melt Index (gm/10 min)	ASTM D1238, (E)	min. 0.1
Flexural Modulus (psi)	ASTM D790	min. 133,000
Tensile Strength (psi)	ASTM D638	min. 3,200
Environmental Stress Crack (hrs)	ASTM D1693	> 5,000
Hydrostatic Design Basis (psi)	ASTM D2837	min. 1,600
UV Stabilizer (% Carbon Black)	ASTM D1603	2-3%

- E. Containing no recycled compound except that generated in the manufacturer's own plant and from resin of the same specification as the raw material supplier.
- F. Resin for pipe and fittings listed by both N.S.F. and P.P.I. and manufactured in accordance with ASTM D305.
- G. Homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects; Being uniform in color, capacity, density, and other physical properties.
- H. Provide the following information continuously marked on the pipe or spaced at intervals not exceeding 5 feet.
  1. Name and/or trademark of the pipe manufacturer.
  2. Nominal pipe size.
  3. Standard Dimensional Ratio (SDR).
  4. PE 4710.
  5. Manufacturer's Standard Reference.
  6. A production code from which the date and place of manufacturer can be determined.

**2.2 PIPE COUPLINGS**

- A. Where required, provide HDPE blind flange adapters, molded stub ends, and molded end caps and other fittings in accordance with the drawings.

**2.3 FABRICATED FITTINGS**

- A. Provide fabricated or molded fittings as shown on the drawings.

**2.4 PIPE PERFORATIONS AND LEACHATE COLLECTION PIPES**

- A. Where plans call for perforated leachate collection pipe, perforate with 3/8-inch diameter holes. Drill four equally spaced holes around pipe perimeter, a minimum of every six inches along the pipe lengths.

- B. See Drawings for perforation details for sump collector pipe.

## **PART 3 EXECUTION**

### **3.1 GENERAL**

- A. When shipping, delivering, and installing pipe, fittings and accessories, do so to ensure a sound, undamaged installation.
- B. Provide adequate storage for all materials and equipment delivered to the job site.
- C. Handle and store pipe and fittings in accordance with the manufacturer's recommendations.

### **3.2 PLACING AND LAYING PIPE**

- A. Provide maintenance of all such material and equipment.
- B. Follow the manufacturer's recommendations when hauling, unloading, and stringing of the pipe.
- C. Do not push or pull pipe and fittings over sharp projections, drop, or have objects dropped on it.
- D. Inspect for defects before installation.
- E. Any piping showing kinks, buckles, cuts, gouges, or any other damage which in the opinion of the OWNER will affect performance of the pipe must be removed from the site.
- F. Replace material found to be defective before or after laying with sound material without additional expense to the OWNER.

### **3.3 FUSION WELDING PIPE**

- A. Join the polyethylene pipe by the method of thermal butt or side wall fusion, outlined in ASTM D2657. Perform fusion joining of pipe and fittings in accordance with the procedures established by the pipe manufacturer. Of particular importance is the use of proper interface pressures and heater plate temperatures. Ensure that shavings generated during butt surface preparation are cleaned from interior of piping prior to fusing.
- B. Use fusion pressures, temperatures, and cycle times according to pipe manufacturer's recommendations. Use personnel adequately trained and qualified in the technique involved.
- C. Do not perform pipe fusion in water when trench conditions are unsuitable for the work. Keep water out of the trench until joining is completed. Secure open ends of pipe and close valves when work is not in progress, so that no trench water, earth, or other substance will enter the pipe or the fittings. Plug or cap or valve pipe ends left for future connections.
- D. Clear welding and grade sites, if necessary, to provide enough space for pipe storage and fusion. Keep the site free of rocks, stumps, and debris which could cut, scar, or gouge the pipe. In order to allow the joining operation to continue in adverse weather

conditions, a shelter may be required for the joining machine. Particular caution should be exercised to prevent the pipe from becoming wet, and to prevent the heater plate from coming in contact with water.

- E. Polyethylene Fusion Qualification: All pipe fusion must be performed by a supplier, or a factory supplied and/or certified fusion operator.
- F. Provide training sessions as required to train welding personnel, and quality control personnel in polyethylene fusion machine operation as applicable for the project. Only fully trained personnel will be allowed to perform the installation, supervision, or inspection of polyethylene-fusion joints. Submit a listing of those authorized/instructed for polyethylene fusion welding for review by the OWNER. Make all on-site training sessions during this contract available to quality assurance personnel at no charge to the OWNER.
- G. Training: Provide assistance from the manufacturer/supplier in instructing welding personnel in proper fusion procedures and techniques. Notifications will be required in writing, listing the names of those persons so familiarized. A manufacturer's representative shall be certified in writing by the manufacturer to be technically qualified and experienced.

**END OF SECTION**

## **SECTION 02771 GEOTEXTILE**

### **PART 1      GENERAL**

#### **1.1      SECTION INCLUDES**

- A.      Installation of geotextile around gravel fill, over trench fills, as a separation or cushion medium, or as a component of a geocomposite drainage layer.

#### **1.2      RELATED SECTIONS**

- A.      Section 02278 – Geomembrane.
- B.      Section 02224 – Trenching, Backfilling, and Compacting
- C.      Section 02225 – Geocomposite
- D.      Section 02222 – Earth Fills.

#### **1.3      REFERENCES**

Latest ASTM International (ASTM) Standards or other recognized agency standards at the time construction documents are issued for the following items:

- A.      ASTM D2497 - Standard Tolerances for Manufactured Organic-Base Filament Single Yarns.
- B.      ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- F.      ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
- G.      ASTM D4632 - Grab Breaking Load and Elongation of Geotextiles.
- H.      ASTM D6241 - Static Puncture Strength
- G.      ASTM D4751 - Apparent Opening Size of a Geotextile.
- H.      ASTM D5261 - Measuring Mass per Unit Area of Geotextiles.

#### **1.4      DEFINITIONS**

- A.      Manufacturer: Responsible for the production of geotextile rolls.
- B.      Installer: The party responsible for field handling, storing, deploying, repairing, anchoring, and any other aspects of installing the geotextile. The installer is also responsible for transportation of the material to the site.
- C.      Construction Quality Assurance Consultant (CQAC): The party, independent from the manufacturer or installer, responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic components of the geotextile. Also responsible for issuing a construction monitoring report, and certification sealed by a Registered Professional Engineer.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect geotextile from ultraviolet light exposure, precipitation, inundation, mud, dirt, dust, puncture, cutting, and other damaging or deleterious condition.
- B. Ship geotextile in closed trailer.
- C. Immediately restore damaged protective covering.
- D. Comply with manufacturer’s instructions.

**PART 2 PRODUCTS**

**2.1 GEOTEXTILE**

- A. Products comprised of non-woven, continuous-filament or staple fiber needle punched polypropylene or polyester fabric; oriented into a stable network that maintains its structure during handling, placement, and long-term service.
- B. The product cannot be heat burnished.
- C. Resistant to soil chemicals.
- D. New product made from virgin materials.
- E. Geotextile used for filtration conforming to the following minimum average roll values (MARV) for the properties listed.

<b>Table 02771-1 CONTRACTOR’S CONFORMANCE TESTING PRIOR TO DELIVERY GEOTEXTILE (NEEDLE PUNCHED NONWOVEN)</b>				
<b>Test</b>	<b>ASTM Test Designation</b>	<b>Minimum MQC Test Frequency<sup>(2)</sup></b>	<b>Conformance QA Test Frequency</b>	<b>Required Test Values</b>
1. Apparent Opening Size <sup>(1)</sup>	D4751	1/540,000 sf	1/project <sup>(3)</sup>	.15 - .212 mm
2. Grab Tensile Strength (min. avg.)	D4632	1/100,000 sf	1/250,000	200 lbs.
3. Trapezoidal Tear	D4533	1/100,000 sf	1/250,000	75 lbs
4. Puncture Strength (min. avg.)	D4833	1/100,000 sf	1/250,000	100 lbs.
5. UV Resistance (500 hours)	D4355	1 per resin formulation	N/A	70% <sup>(3)</sup>
6. Permittivity (min.) <sup>(1)</sup>	D4491	1/540,000 sf	1/project <sup>(3)</sup>	1.0 sec <sup>-1</sup>

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.

## **2.2 MANUFACTURER SOURCE QUALITY CONTROL**

- A. Perform quality control tests of geotextile, at a minimum of once for every one hundred thousand (100,000) square feet to evaluate materials conformance to published material properties.
- B. Reject rolls for which quality control requirements are not met.
- C. Certify the quality of the rolls of geotextile.
- D. Provide quality control certificates for each lot and each shift's production. The quality control certificates shall include:
  - 1. Roll numbers and identification.
  - 2. Sampling procedures
  - 3. Results of quality control tests, including a description of test methods used

## **2.3 LABELING**

- A. Mark or tag geotextile rolls with the following information:
  - 1. Manufacturer's name
  - 2. Product identification
  - 3. Lot number
  - 4. Roll number
  - 5. Roll Dimensions
- B. Mark special handling requirements on rolls.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Prior to installation of geotextile, examine underlying construction for conformance with specifications. Verify the following:
  - 1. Underlying installations are complete, installed as designed, and as-built documentation has been obtained.

### **3.2 PROTECTION**

- A. When placing soil materials over geotextile, ensure the following:
  - 1. No damage to geotextile.
  - 2. No slippage of geotextile on underlying layers.
  - 3. No excessive tensile stresses in the geotextile.

### **3.3 DEPLOYMENT**

- A. Follow manufacturer's recommendations, standards, and guidelines.

- B. Anchor geotextile in anchor trenches on slopes greater than 20 percent. Roll geotextile down slope in such a manner as to continually keep the geotextile sheet in sufficient tension to preclude folds and wrinkles.
- C. Weight geotextile with sandbags or equivalent as ballast during deployment. Leave ballast in place until geotextile is covered with succeeding construction layer.
- D. Cut geotextile using approved cutter only. Take care to protect other in-place geosynthetic materials when cutting geotextile.
- E. Do not entrap in geotextile excessive dust, stones, or moisture that could damage or clog drains of filters or hamper subsequent seaming.
- F. Examine geotextile over entire completed surface to ensure that no potentially harmful foreign objects, such as needles, are present. Remove any foreign objects.
- G. Do not drag geotextile across rough or textured surfaces to avoid damage to the geotextile. Use a smooth geosynthetic slip sheet or rub sheet as necessary to reduce friction damage during deployment.
- H. For blanket-drain geotextiles, deploy machine direction parallel to the flowline direction.

### **3.4 SEAMS AND OVERLAPS**

- A. Sew all seams for geotextiles used in separation and cushion applications. Overlap geotextile 3 inches minimum prior to seaming. Do not seam horizontal on slopes steeper than 10 percent (i.e., seam along, not across slopes). Stagger horizontal butt seams.
- A. Ensure that no soil materials are inadvertently inserted into the seams of geotextiles.
- B. Sew with polymeric thread having chemical resistance and strength properties equal to or exceeding those of geotextile.
- C. For sewing, use a 401 two-thread chain stitch, or equivalent.
- D. Stitching material to be in a contrasting color.

### **3.5 REPAIRS**

- A. Repair holes or tears in a geotextile with a patch from the same geotextile material, seamed in place with a minimum seam overlap of 12 inches in all directions.
- B. Remove any soil or other material that may have penetrated the torn geotextile.

### **3.6 FIELD QUALITY ASSURANCE**

- A. The CQAC will collect samples of geotextile delivered to the site for conformance testing at a minimum frequency as identified in the CQA Plan, and perform tests to determine product compliance with specified values.
- B. Samples will be taken across the entire width excluding the first three feet of the roll unless otherwise approved. Sample size will be three feet long by the roll width.

### **3.7 ACCEPTANCE**

- A. CONTRACTOR retains all ownership and responsibility for geotextile until acceptance by OWNER.

- B. OWNER accepts geotextile when:
1. The installation is complete.
  2. Conformance tests verify product requirements.
  3. Documentation of installation is complete, including the CQAC's final report.
  4. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
  5. Written certification documents have been received by the OWNER.

**END OF SECTION**

## **SECTION 02778 GEOMEMBRANE**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Installation of textured surface High Density Polyethylene (HDPE) geomembrane for the landfill composite liner.

#### **1.2 REFERENCES**

Latest ASTM International (ASTM) Standards or other recognized agency standards at the time construction documents are issued for the following items:

- A. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
- B. ASTM D792 – Standard Test Methods for Density and Specific Gravity of Plastics by Displacement.
- C. ASTM D1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
- D. ASTM D1238 – Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
- E. ASTM D1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.
- F. ASTM D1603 – Standard Test Method for Carbon Black Content in Olefin Plastics.
- G. ASTM D8117 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry.
- H. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
- I. ASTM D5994 – Standard Test Method for Measuring Core Thickness of Textured Geomembranes.
- J. ASTM - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- K. ASTM-D3895 - Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- L. ASTM-D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
- M. ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembrane
- N. ASTM D5397 – Standard Test Method for Evaluation of Stress Crack of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
- O. ASTM D5596 – Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
- P. ASTM D5617 – Standard Test Method for Multi-Axial Tension Test for Geosynthetics.

- Q. ASTM D5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
- R. ASTM D6392 – Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
- S. ASTM D7466– Asperity Height
- T. ASTM D7238 - UV Resistance

### 1.3 DEFINITIONS

**Batch:** A quantity of resin, usually the capacity of one rail car, used in the manufacture of high-density polyethylene (HDPE) geomembrane sheet. The finished sheet will be identified by a roll number corresponding to the particular lot of resin used.

**Bridging:** The condition when geomembrane becomes suspended over its subgrade due to contraction of the material or poor installation.

**Construction Quality Assurance Consultant (CQAC):** The party, independent from Manufacturer or Installer, that is responsible for observing and documenting activities related to the quality assurance of production and installation of the geosynthetic components of the lining system.

**Construction Quality Assurance (CQA) Laboratory:** The party, independent from the OWNER, Manufacturer, Fabricator, and Installer, responsible for conducting tests on samples of geosynthetics obtained at the site.

**Construction Quality Assurance (CQA) Monitor:** The site representative of the CQAC. Also referred to as the CQA ENGINEER or CQA Officer.

**Extrudate:** The molten polymer, which is emitted from an extruder during seaming using either extrusion fillet or extrusion flat methods. The polymer is initially in the form of a ribbon rod, bead or pellets.

**Fabricator:** The party responsible for the fabrication of geomembrane panels constructed from rolls received from the manufacturer.

**Geomembrane Manufacturer:** The party responsible for the production of the geomembrane rolls from resin and for the quality of the resin.

**Geomembrane:** An essentially impermeable membrane used as a solid or liquid barrier. Synonymous term for flexible membrane liner (FML).

**Geomembrane Subsurface:** The soil or geosynthetic surface on which the geomembrane lies.

**Installer:** The party responsible for field handling, transporting, storing, deploying, seaming, temporary restraining (against wind), and installation of the geomembrane.

**Panel:** The unit area of geomembrane that will be seamed in the field. If the geomembrane is not fabricated into panels in a factory, a panel is identified as a roll or portion of a roll without any seams.

### 1.4 SUBMITTALS (MANUFACTURER AND INSTALLER)

- A. Submit the following to the OWNER, 7 days prior to receiving material at site.
- B. Resin Data (Manufacturer)
  - 1. Statement of production date or dates.

2. Certification stating that the resin meets the product requirements (see Article 2.3 of this Section).
  3. Certification stating that all resin is from the same manufacturer.
  4. Copy of quality control certificates issued by manufacturer.
  5. Test reports from manufacturer.
- C. Geomembrane Roll (Manufacturer)
1. Statement of production date or dates.
  2. Laboratory test results and certification stating that the geomembrane meets the product requirements (see Article 2.3 of this Section).
  3. Certification stating that all geomembrane rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.
  4. Copy of quality control certificates issued by manufacturer.
  5. Test reports from the manufacturer.
  6. Typical test results of complete notched constant tensile load test (ASTM D5397) for specified resin and sheet thickness.
  7. Statement certifying that no reclaimed polymer is added to the resin.
  8. Statement listing percentages of processing aids, antioxidants, and other additives other than carbon black added to or in the resin.
  9. Geomembrane delivery, storage, and handling instructions.
  10. Geomembrane installation instructions.
  11. Sample warranties for review.
- D. Extrudate Beads and/or Rod (Manufacturer)
1. Statement of production date or dates.
  2. Laboratory certification stating that the extrudate meets the product requirements (see Article 2.4 of this Section).
  3. Certification stating that all extrudate is manufactured by one manufacturer and resin is supplied from one supplier.
  4. Copy of quality control certificates issued by manufacturer.
  5. Test reports from the manufacturer.
  6. Certification stating that the extrudate bead or rod resin is the same type, from the same manufacturer and compatible with the resin used to manufacture the geomembrane supplied for this project.
- E. Schedules and Drawings (Installer)
1. Submit installation schedule one week prior to installation. Include hours worked per day, week and per shift. Indicate all weather delays built into schedule.
  2. Installation layout drawings: Two weeks prior to installation of geomembrane, submit drawings showing the panel layout indicating both fabricated (if

applicable) and field seams, and details not conforming to the Contract Drawings. Upon acceptance, use these drawings for installation of geomembrane.

- F. Qualifications (Installer)
  - 1. Submit, two weeks prior to installation, name of installer, and resume of installation supervisor/field ENGINEER to be assigned to the project.
  - 2. Submit, two weeks prior to installation, resume of master seamer.
- G. Equipment and Personnel: Submit the following two weeks prior to installation: (Installer)
  - 1. Equipment List Stating Quantity and Types.
  - 2. List of personnel to perform field-seaming operations.

### **1.5 SUBMITTALS DURING CONSTRUCTION (INSTALLER)**

- A. Submit quality control documentation prepared during installation.

### **1.6 SUBMIT UPON COMPLETION OF THE INSTALLATION (INSTALLER)**

- A. Certificate stating the liner has been installed in accordance with the plans and specifications.
- B. The warranty obtained from the manufacturer/fabricator and the installation warranty.
- C. As-built drawings showing location of panels, seams, repairs, patches, and destructive samples, including measurements.
- D. Copies of seam test results and statistical analysis of each welder's performance.

### **1.7 QUALIFICATIONS**

- A. Installer: Must have successfully installed a minimum of 10,000,000 square feet of welded polyethylene geomembrane with documented references.
- B. Master Welder Qualifications: Must have completed a minimum of 5,000,000 square feet of polyethylene geomembrane seaming work using the same type of seaming apparatus proposed for use on this project.
- C. Other Seamers Qualifications: Must have seamed a minimum of 1,000,000 square feet of HDPE geomembrane.

### **1.8 QUALITY ASSURANCE**

- A. All work shall be constructed, monitored, and tested in accordance with the requirements of the CQA Plan.
- B. The OWNER will engage and pay for the services of (1) Construction Quality Assurance Consultant (CQAC), and (2) Construction Quality Assurance (CQA) Laboratory for monitoring the quality and installation of geomembrane material being installed unless otherwise specified.
- C. The Geosynthetics Installer shall be aware of all activities outlined in the CQA Plan, and the CONTRACTOR shall account for these activities in the construction schedule.

- D. The OWNER shall assure that the geomembrane is delivered to the site at least 14 calendar days prior to installation to allow sufficient time for conformance testing.
- E. Any geomembrane rolls that do not meet the requirements of this Specification will be rejected. The Geosynthetics Installation CONTRACTOR shall replace the rejected material with new material that conforms to the Specification requirements, at no additional cost to the OWNER.
- F. Personnel Qualifications
  - 1. Ensure that all personnel performing geomembrane seaming operations are qualified by experience or by successfully passing seaming tests (see Article 3.3 of this Section).
  - 2. Personnel qualifications in accordance with Article 1.7 of this Section.
- G. Field Samples
  - 1. Geomembrane sampling shall be conducted in accordance with those specifications and the CQA Plan for the following:
    - a) Conformance Testing (Article 3.1 A of this Section)
    - b) Destructive Seam Testing (Article 3.3 D of this Section)
- H. In order to prevent wind-damaged geomembranes from being placed, the following Quality Assurance procedures shall be followed:
  - 1. The Geosynthetics Installation CONTRACTOR shall perform their work to prevent wind damage to the geomembrane.
  - 2. Wind damage shall be determined by the CQA Monitor during deployment of the geomembrane. Wind damage to the geomembrane will include wrinkles, creases, and tears, as determined by the CQA ENGINEER.
  - 3. Repair of the wind-damaged geomembrane shall be completed by the Geosynthetics Installation CONTRACTOR at no additional cost to the OWNER.
  - 4. As determined by the CQA Monitor, the geomembrane panel may be rejected and shall be replaced by the geosynthetics installation CONTRACTOR at no cost to the OWNER.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Packing and Shipping
  - 1. Labels on each roll delivered to site shall identify the following.
    - a) Manufacturer's name
    - b) Product Identification
    - c) Thickness
    - d) Roll number
    - e) Batch or lot number
    - f) Panel number (when applicable)

- g) Roll dimensions
  - 2. Ensure that geomembrane rolls are properly loaded and secured to prevent damage during transit.
  - 3. Protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions.
  - 4. Ensure personnel responsible for loading, transport and unloading of geomembrane are fully aware of the consequences of damage to geomembrane and are familiar with handling and transport constraints imposed by manufacturer.
- B. Delivery
- 1. Deliver materials to the site only after the OWNER accepts required submittals.
  - 2. Separate damaged rolls from undamaged rolls and store in locations designated by the OWNER until proper disposition of material is determined by OWNER.
  - 3. OWNER will determine the extent of damage to geomembrane.
  - 4. Delivery in rolls, do not fold.
- C. Acceptance at Site
- 1. Perform inventory and surface inspection for defects and damage of all geomembrane rolls upon delivery.
  - 2. Unroll and inspect any geomembrane roll that shows signs of internal damage.
  - 3. Damage resulting from handling and transport of geomembranes shall be repaired at no cost to OWNER. If irreparable, in the opinion of the CQA ENGINEER, damaged materials shall be replaced at no cost to OWNER.
- D. Storage and Protection
- 1. OWNER will provide on-site storage area for geomembrane rolls from time of delivery until installation.
  - 2. The storage of the materials is the responsibility of the CONTRACTOR from the time the materials are off-loaded until used by the Geosynthetic Installer.
  - 3. After Geosynthetic Installer has removed material from storage area, protect geomembrane from puncture, dirt, grease, water, moisture, mud, mechanical, abrasion, excessive heat and other sources of damage.
  - 4. Preserve integrity and readability of geomembrane roll labels.
  - 5. Store geomembrane rolls on prepared surface (not on wooden pallets).
  - 6. Stack no more than three rolls high.

## 1.10 SITE CONDITIONS

- A. Geomembrane Deployment
- 1. Do not proceed with deployment at an ambient temperature below 40 degrees F or above 110 degrees F unless otherwise authorized, in writing, by OWNER. If

surface temperatures exceed 140 degrees F, regardless of ambient temperature, deployment shall continue only if CQA Monitor allows after testing trial welds.

2. Do not deploy during precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.
1. Do not undertake deployment if weather conditions will preclude material seaming on same day as deployment.
2. At the end of each day, the Geosynthetic Installer will weight down the leading edge of the geomembrane using sandbags or other approved measures provided by the Geosynthetic Installer.
3. The final sideslope liner termination will be completed by the Geosynthetic Installer using sandbags placed every 10 feet (or other spacing as approved by ENGINEER) along the exposed edge of the geomembrane.

**B. Seaming**

1. Normal seaming procedures may take place if the following weather conditions exist:
  - a) Ambient temperature, measured 6 inches above the liner surface, shall be between 40 degrees F and 105 degrees F. Do not seam if ambient temperature is below or above 40 degrees F and 105 degrees F, respectively, unless approved by the CQA Monitor.
  - b) Dry conditions (i.e., no precipitation or other excessive moisture, such as fog or dew).
  - c) No excessive winds.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

**A. Geomembrane Liner**

1. Geomembrane shall be 60-mil high-density polyethylene (HDPE), textured as indicated on the Drawings.
2. Only geomembranes and resins that meet these specifications.
3. Geomembrane shall be manufactured from new polyethylene resin.
4. Geomembrane manufactured from non-complying resin shall be rejected.
5. Resin shall be designed and manufactured specifically for use in geomembranes.
6. The geomembrane shall have the following characteristics:
  - a) Contain a maximum of 2 percent by weight of additives, fillers, or extenders (not including carbon black).
  - b) Contain between 2 percent and 3 percent carbon black for ultra-violet light resistance. This shall be added to the otherwise pure polyethylene resin as part of resin manufacturing or roll manufacturing processes.

- c) No thin spots, striations, pinholes, or bubbles on surface. Free of blisters, undispersed raw materials, or other signs of contamination by foreign matter.
- d) The geomembrane is to be roughened or textured during the manufacturing process.

## 2.2 SEAMING AND TESTING EQUIPMENT

### A. Welding

1. Maintain on-site a minimum of two spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.
2. Seaming equipment shall not damage geomembrane.
3. No solvent or adhesive is used unless the product is approved in writing by the OWNER prior to use.
4. Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus.
5. Use fusion welding apparatus which are self-propelled devices equipped with the following:
  - a) A gauge indicating temperature of heating element.
  - b) A method of monitoring relative pressure applied to geomembrane.
6. Use power source capable of providing constant voltage under combined line load.
7. Provide protective lining and splash pad large enough to catch spilled fuel under electric generator, if located on liner.
8. Provide tensiometers capable of measuring seam strength, calibrated and accurate within 2 pounds.
9. Provide dies for cutting seam samples.

### B. Vacuum Testing

The equipment shall consist of the following:

1. Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing, port hole or valve assembly, and vacuum gauge.
2. Pump assembly equipped with pressure controller and pipe connections.
3. Rubber pressure/vacuum hose with fittings and connections.
4. Bucket of soapy solution.
5. Wide paint brush, or other means of applying soap solution.

### C. Air Pressure Testing (for double fusion seam only)

The equipment shall consist of the following:

1. Air pump (manual or motor driven), equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 24 and 35 psi and mounted on a cushion to protect geomembrane.
2. Rubber hose with fittings and connections.
3. Sharp hollow needle, or other approved pressure feed device.
4. An air pressure-monitoring device.

## 2.3 SOURCE QUALITY CONTROL TESTING

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

### A. Tests and Inspection

1. Geomembranes shall be tested by geomembrane manufacturer for quality control to demonstrate that resin meets specifications in Table 02778-1.
2. Geomembrane manufacturer shall continuously monitor during manufacturing process for inclusions, bubbles, or other defects. Geomembranes which exhibit defects shall not be acceptable for installation.
3. Geomembrane manufacturer shall monitor thickness continuously during manufacturing process. No geomembrane which fails to meet specified values shall be acceptable for installation.
4. At a minimum, the following tests shall be performed in accordance with test methods specified in Table 02778-2:
  - a) Density;
  - b) Carbon black content;
  - c) Carbon black dispersion;
  - d) Puncture resistance;
  - e) Tear resistance; and
  - f) Tensile properties.

Geomembrane manufacturer shall perform these tests on geomembrane, at a minimum of once every 50,000 ft<sup>2</sup>. Samples not satisfying specifications shall result in rejection of the rolls represented by the tests. At the geomembrane manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify the non-complying rolls and to qualify individual rolls.

5. The Environmental stress crack resistance test need not be run at 1 per 50,000 ft<sup>2</sup> frequency. Geomembrane manufacturer shall certify that these tests have been performed for each resin in accordance with test methods specified in Table 02778-1.

Table 02778-1 PROPERTIES FOR HIGH DENSITY POLYETHYLENE RESIN		
Test	Test Method	Requirement
Specific Gravity (Density)	ASTM D792	>0.94
Melt Index	ASTM D1238	<1.0 g/10 min

Table 02778-2 PROPERTIES FOR HIGH DENSITY POLYETHYLENE LINER (60 MIL)				
Properties	Test Method	Manufacturer QC Test Frequency	Conformance QA Test Frequency	Required Test Values <sup>(13)</sup>
Thickness (min. ave.) <ul style="list-style-type: none"> <li>• Lowest individual for 8 out of 10 values</li> <li>• Lowest individual for any of the 10 values</li> </ul>	ASTM D5994	1 per Roll	1 per 250,000 sf	57 mil 54 mil 51 mil
Asperity Height (min. ave.) <sup>(1)(2)</sup>	ASTM D7466	every 2nd roll <sup>(1)</sup>	1 per 250,000 sf	20 mil
Sheet Density (min.)	ASTM D792 or ASTM D1505	1 per 680,000 sf	1 per 250,000 sf	0.940 g/cc
Tensile Properties <sup>(3)</sup> (min. ave.) <ul style="list-style-type: none"> <li>• Yield Strength</li> <li>• Break Strength</li> <li>• Yield Elongation</li> <li>• Break Elongation</li> </ul>	ASTM D6693	1 per 68,000 sf	1 per 250,000 sf	126 lb/in 90 lb/in 12% 100%
Tear Resistance (min. ave.)	ASTM D1004 Die C	1 per 100,000 sf	N/A	42 lbs
Puncture Resistance (min. ave.)	ASTM D4833	1 per 100,000 sf	1 per 250,000 sf	90 lbs
Stress Crack Resistance <sup>(4)</sup>	ASTM D5397 (App.)	<sup>(12)</sup>	N/A	500 hours
Carbon Black Content (range)	ASTM D4218 <sup>(5)</sup>	1 per 68,000 sf	1 per 250,000 sf	2-3%
Carbon Black Dispersion <sup>(6)</sup>	ASTM D5596	1 per 100,000 sf	1 per 250,000 sf	Category 1, 2, or 3 <sup>(6)</sup>
Oxidative Induction Time (OIT) (min. ave.) <sup>(7)</sup>	ASTM D8117	<sup>(12)</sup>	N/A	

**Table 02778-2  
PROPERTIES FOR HIGH DENSITY POLYETHYLENE LINER (60 MIL)**

Properties	Test Method	Manufacturer QC Test Frequency	Conformance QA Test Frequency	Required Test Values <sup>(13)</sup>
<ul style="list-style-type: none"> <li>Std. OIT, or</li> <li>High Pressure OIT</li> </ul>	ASTM D3895 ASTM D5885			100 min 400 min
Oven Aging at 85°C <sup>(5)(6)</sup> <ul style="list-style-type: none"> <li>Std. OIT (min. ave.), % retained after 90 days, or</li> <li>High Pressure OIT(min. ave.), % retained after 90 days</li> </ul>	ASTM D5721  ASTM D3895  ASTM D5885	(12)	N/A	55%  80%
UV Resistance <sup>(9)</sup> <ul style="list-style-type: none"> <li>Std. OIT (min. ave.), or</li> <li>High Pressure OIT(min. ave.), % retained after 1600 hrs<sup>(11)</sup></li> </ul>	ASTM D7238 ASTM D3895  ASTM D5885	(12)	N/A	(10)  50%
Min. Seam Strengths Shear, ppi	ASTM D6392	1/1000 LF of seam	1/1000 LF of seam	120 <sup>(14)</sup>
Peel, ppi		1/1000 LF of seam	1/1000 LF of seam	88 for wedge seams <sup>(14)</sup> 78 for extrusion seams <sup>(14)</sup>

**Notes:**

- (1) Alternate the measurement side for double sided textured sheet. The lowest individual reading must be ≥ 17 mils
- (2) Test each side of the textured geomembrane recording a measurement every lineal foot of textured roll width.
- (3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
  - Elongation is calculated using a gage length of 1.3 inches.
  - Break elongation is calculated using a gage length of 2.0 inches.

**Table 02778-2  
PROPERTIES FOR HIGH DENSITY POLYETHYLENE LINER (60 MIL)**

Properties	Test Method	Manufacturer QC Test Frequency	Conformance QA Test Frequency	Required Test Values <sup>(13)</sup>
(4)	The SP-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.			
(5)	Other methods such as D1603 (tube furnace) can be use if an appropriate correlation to D4218 (muffle furnace) can be established.			
(6)	Carbon black dispersion (only near spherical agglomerates) for different views: <ul style="list-style-type: none"> <li>• 9 in Categories 1 or 2, and</li> <li>• 1 in Category 3.</li> </ul>			
(7)	The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant in the geomembrane.			
(8)	It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.			
(9)	The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.			
(10)	Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.			
(11)	UV resistance is based on percent retained value regardless of the original HP-OIT value.			
(12)	Manufacturer may provide certification letter.			
(13)	Based on GRI GM13, Rev. 15, 9/9/2019.			
(14)	Failure is also if more than one out of five test coupons fail in a non-FTD failure mode.			

**2.4 EXTRUDATE ROD OR BEAD**

- A. Meeting the geomembrane manufacturer requirements.
- B. Made from same resin as the geomembrane.
- C. Thoroughly disperse additives throughout rod or bead.
- D. Containing 2 to 3 percent carbon black.
- E. Free of contamination by moisture or foreign matter.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

- A. Conformance Testing
  - 1. The CQA ENGINEER shall collect samples of geomembrane for conformance testing, as outlined in the CQA Plan and as described herein.
  - 2. The following tests shall be performed by the CQA Consultant using the test methods listed in Table 02778-2 at the frequency specified in the CQA Plan:
    - a) Thickness (minimum);

- b) Density;
  - c) Tensile properties (all); and
  - d) Carbon black content.
3. Geomembrane shall be rejected if conformance test results do not meet or exceed the values presented in Table 02778-2.

## 3.2 INSTALLATION

### A. Panel Layout

Any anticipated modification to the geomembrane panel layout, particularly at penetrations, or other critical locations should be presented to the OWNER in writing or by drawing by the Geosynthetic Installer a minimum of three (3) working days in advance of the Work requiring the modification.

### B. Panel Nomenclature

1. A field panel is defined as a unit of geomembrane that is to be seamed in the field (i.e., a field panel is a roll or a portion of roll cut in the field).
2. Identify each field panel with an identification code (number or letter-number) consistent with Geosynthetics Installer's layout plan. This identification code shall be agreed upon by the OWNER, Geosynthetic Installer, and CQA ENGINEER.
3. The Geosynthetics Installer shall be responsible for labeling each panel as it is installed in bold print which is easily visible. The labels shall include, as a minimum: identification code, which indicates the sequence of deployment, the roll number from which the panel was obtained and the date the panel was placed. The OWNER may refuse to accept any panel, portion of panel, or roll which is not correctly labeled.

### C. Protection

1. Do not use equipment or tools that damage geomembrane or GCL by handling, trafficking, excessive tear, leakage of hydrocarbons, or other means.
2. Ensure prepared surface underlying geomembrane and GCL has not deteriorated since previous acceptance and remains acceptable immediately prior to geomembrane and GCL deployment.
3. Keep geosynthetic elements immediately underlying the geomembrane clean and free of debris.
4. Do not permit personnel to smoke or wear damaging shoes while working on geomembrane.
5. Unroll panels in a manner which does not cause excessive scratches or crimps in geomembrane and does not damage the underlying GCL or subgrade. Rub sheets must be used when deploying textured geomembrane over GCL or prepared subgrade.
6. Place panels in a manner which minimizes wrinkles (especially differential wrinkles between adjacent panels.).

7. Prevent wind uplift by providing adequate temporary loading and/or anchoring (e.g., sandbags, tires) that will not damage geomembrane. In case of high winds, continuous loading along panel edges is recommended. It is the responsibility of the Geosynthetic Installer to prevent wind damage to liner components.
  8. Minimize direct contact with geomembrane.
  9. Protect geomembrane in areas where excessive traffic is expected with geotextiles, extra geomembrane, or other suitable materials, as approved by the CQA ENGINEER.
  10. Install material to account for shrinkage and contraction while avoiding wrinkles. Install material stress-free with no bridging before it is covered. Add material as needed to avoid bridging.
  11. Do not drive over the GCL, unless a proper demonstration has been performed to assure survivability of the GCL.
- D. Field Panel Deployment
1. Install field panels at locations indicated on the Geosynthetics Installer's layout plan, as approved by OWNER.
  2. Replace damaged (torn, twisted, or crimped) field panels, or portions thereof, at no cost to OWNER. Repair lesser damage according to Article 3.2 I of this Section. CQA ENGINEER shall determine if material is to be repaired or replaced.
  3. Remove damaged panels or portions of damaged panels which have been rejected from Work area.
  4. Do not deploy more geomembrane field panels in one day than can be seamed during that day.
- E. Seam Layout
1. When possible, orient seams parallel to line of maximum slope (i.e., oriented along, not across or at an angle to the slope).
  2. No horizontal seam shall be on a slope or less than 5 feet (1.5m) from the toe of a slope, without prior acceptance by the CQA ENGINEER.
  3. Do not locate seams in areas of potential stress concentrations, unless otherwise authorized by OWNER.
  4. In general, maximize lengths of field panels and minimize number of field seams.
  5. Use seam numbering system compatible with panel numbering system.
- F. Temporary Bonding
1. Hot air device ("Lister") may be used to temporarily bond geomembrane panels that are to be extrusion welded.
  2. Do not damage geomembrane when temporarily bonding adjacent panels. Apply minimal amount of heat to lightly tack geomembrane panels together. Control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.

3. Do not use solvent or adhesive unless product is approved for use, in writing, by the OWNER.

G. Seaming Methods

Approved processes for field seaming are extrusion welding and dual-track fusion welding. Proposed alternate processes shall be documented and submitted to OWNER for approval.

1. Align geomembrane panels to have a nominal overlap of 3 inches for extrusion welding and 4 inches for fusion welding. The Geosynthetics Installation CONTRACTOR shall indicate the lap by making reference marks prior to seaming at an interval of not more than fifty (50) feet. The location and type of reference mark shall be agreed upon by all parties at the pre-construction meeting.
2. After seaming operations have occurred, the remaining overlap(s) shall be enough to destructively test. If insufficient overlap for destructive testing is determined to exist on a portion of a seam, that portion of the seam shall be reconstructed by the procedures described in Article 3.2 I.
3. Use double-fusion welding as primary method of seaming adjacent field panels.
  - a) For cross seam tees associated with fusion welding, extrusion weld to a minimum distance of 4 inches on each side of tee. The edge of the cross seam is ground to an incline prior to welding.
  - b) Place electric generator on a smooth base such that no damage occurs to geomembrane.
  - c) Place a protective layer (e.g., insulating plate or fabric) beneath hot welding apparatus after usage.
  - d) When subgrade conditions dictate, use a movable protective layer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers.
4. Use conventional extrusion welding as a secondary method for seaming between adjacent panels and as a primary method of welding for detail and repair Work.
  - a) Purge heat-degraded extrudate from barrel of extruder under the following conditions:
    - 1) Prior to beginning a seam.
    - 2) Whenever extruder has been inactive.
  - b) Place electric generator on a smooth base such that no damage occurs to geomembrane.
  - c) Place a smooth insulating plate or fabric beneath hot welding apparatus after usage.
  - d) Use clean and dry welding rods or extrudate pellets.
  - e) Complete grinding process without damaging geomembrane according to manufacturer's instructions within 1 hour of seaming operation.

- f) Minimize exposed grinding marks adjacent to an extrusion weld. Do not extend exposed grinding marks more than 1/4 inch from seam area. The OWNER may request that all abraded areas be covered with extrudate.
- g) Extrusion weld all cross-seam tees to a minimize distance of 4 inches on each side of the tee.

#### H. Seaming Procedures

##### 1. General Seaming Procedures; Ensure That:

- a) Spare operable seaming equipment is on-site at all times.
- b) Equipment used for seaming will not damage the geomembrane.
- c) The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.
- d) A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.
- e) The geomembrane is protected from damage in heavily trafficked areas, using a method approved by the CQA ENGINEER.
- f) No solvent or adhesive is used unless the product is approved in writing by the OWNER prior to use.
- g) Areas to be seamed shall be cleaned and free of moisture, debris, or any marking on the geomembrane.
- h) Use a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support, if required.
- i) Cut fishmouths or wrinkles at the seam overlap along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.
- j) Provide adequate illumination if seaming operations are carried out at night.
- k) Extend seaming to the outside edge of panels placed in the anchor trench.
- l) No field seaming shall be performed without the Seaming Supervisor being present.
- m) The welding process (Restart/Reseaming procedures) shall start with grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least two (2) inches. Reseaming over an existing seam without regrinding shall not be permitted.

#### I. Repair Procedures

All seams and non-seam areas of the geomembrane shall be inspected by the CQA Officer for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to

detect defects, the surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be brushed, blown, or washed by the Installer if the amount of dust or mud inhibits inspection. The CQA Officer shall decide if cleaning of the geomembrane is needed to facilitate inspection.

1. Repair portions of geomembrane exhibiting a flaw or failing a destructive or nondestructive test.
2. Final decision as to appropriate repair procedure shall be agreed upon between OWNER, Geosynthetics Installation CONTRACTOR, and CQA ENGINEER.
3. Available repair procedures include the following:
  - a) Patching: A piece of geomembrane extrusion welded into place. Use to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
  - b) Spot welding or seaming: A bead of molten extrudate placed on flaw. Use to repair small tears, pinholes, or other minor, localized flaws.
  - c) Capping: A strip of geomembrane extrusion welded into place over an inadequate seam. Use to repair large lengths of failed seams.
  - d) Extrusion welding the flap: A bead of molten extrudate placed on exposed flap of fusion weld. Use to repair areas of inadequate fusion seams which have an exposed edge. Repairs of this type shall be reviewed by CQA ENGINEER and shall not exceed 50 feet in length.
  - e) Removal and replacement: Remove defective seams and replace with a strip of new material welded into place. Use to repair large lengths of failed seams.
  - f) Acceptable wrinkle size and extent shall be determined and agreed upon by all parties during the pre-construction meeting. Wrinkles larger than that specified shall be cut and seamed, if the overlap is sufficient, or cut and patched or capped.
4. For any repair method, satisfy the following:
  - a) Surfaces of the geomembrane that are to be repaired using extrusion methods shall be abraded no more than one (1) hour prior to the repair. No more than 10 percent of the thickness shall be removed.
  - b) Ensure surfaces are clean and dry at time of repair.
  - c) Ensure seaming equipment used in repairing procedures meets requirements of this section.
  - d) Extend patches or caps at least 6 inches beyond edge of defect. Round corners of patches with a radius of approximately 3 inches.
5. Do not place overlying layers over locations which have been repaired until appropriately passing nondestructive and laboratory test results are obtained.

J. Anchor Trench

1. Earthwork CONTRACTOR shall excavate anchor trenches, unless otherwise specified, to lines and grades shown on design Drawings, prior to geomembrane placement.
2. Provide slightly rounded corners in anchor trench to avoid sharp bends in geomembrane.
3. If anchor trench is excavated in clay material susceptible to desiccation, the amount of trench open at any time shall be minimized, subject to the approval of the CQA ENGINEER.
4. Earthwork CONTRACTOR shall backfill and compact anchor trench as described in Section 02222 and 02224. Care shall be taken when backfilling trenches to prevent any damage to geosynthetics.
5. Earthwork CONTRACTOR will ensure that the anchor trench will be adequately drained to prevent ponding or softening of adjacent soils while trench is open.

### **3.3 FIELD QUALITY CONTROL**

#### **A. Visual Inspection**

1. CQA ENGINEER shall examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
2. Clean and wash geomembrane surface if CQA ENGINEER determines that the amount of dust or mud inhibits examination.
3. Do not seam any geomembrane panels that have not been examined for flaws by CQA ENGINEER.
4. Nondestructively test each suspect location of seam and non-seam areas using methods described in Article 3.3 C of this Section, as appropriate.

#### **B. Trial Seams**

1. Make trial seams on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming.
2. Make trial seams at beginning of each seaming period, at the CQA ENGINEER's direction and at least once each four (4) hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. The CQA ENGINEER may, at their sole discretion, require additional trial seams if surface temperatures exceed 140 degrees Fahrenheit.
3. Make trial seams under same conditions as actual seams.
4. Make trial seams only under observation by CQA ENGINEER.
5. Overlap seam of geomembrane pieces as indicated in Article 3.2 G of the Section.
6. Make trial seam sample at least 5 feet long by 1 foot wide (after seaming) with seam centered lengthwise.
7. Cut two specimens from sample with a 1-inch wide die. These specimen locations shall be selected randomly along the trial seam sample by the CQA ENGINEER. Test specimens in peel using a field tensiometer. The tensiometer

shall be capable of maintaining a constant jaw separation rate of 2 inches per minute. These tests shall not fail according to criteria in Table 02778-2.

8. If a specimen fails, repeat the entire operation. If the additional specimen fails, do not use seaming apparatus and seamer until the deficiencies are corrected and two consecutive successful trial seams are achieved.
9. Cut remainder of successful trial seam into three pieces; one to be retained in OWNER's archives, one to be retained by Geosynthetics Installation CONTRACTOR, and one to be retained by CQA ENGINEER for possible laboratory testing. Alternatively, if required by OWNER, remaining portion of trial seam sample may be subjected to destructive testing as discussed in Article 3.3 D of this Section.

C. Nondestructive Seam Testing

1. General

The purpose of nondestructive tests is to check the continuity of the seams. It does not provide quantitative information on seam strength. Nondestructively test field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), or other method approved by the CQA ENGINEER. Perform nondestructive testing as seaming Work progresses, not at the completion of all field seaming.

2. Vacuum Testing

- a) Vacuum test in accordance with Article 3.3 of this Section. Energize vacuum pump and reduce tank pressure to approximately 5 psi (10 inches of Hg) gauge pressure.
- b) Wet strip of seam area approximately 12 inches by 48 inches with soapy solution.
- c) Place box over wetted area.
- d) Close bleed valve and open vacuum valve.
- e) Ensure that a leak tight seal is created.
- f) For a period of not less than 10 seconds, apply vacuum and examine seam area through viewing window for presence of soap bubbles.
- g) If no bubbles appear within 10 seconds, close vacuum valve and open bleed valve, move box over to next adjoining area with a minimize 3-inch overlap and repeat process.
- h) Mark and repair areas where soap bubbles appear in accordance with Article 3.2 I of this Section.

3. Air Pressure Testing (for double fusion seam only)

- a) Temporarily seal both ends of seam to be tested using locking pliers or other similar devices.
- b) Insert needle or other approved pressure feed device into air channel created by fusion weld.
- c) Place a protective layer between air pump and geomembrane.

- d) Pressurize air channel to a pressure of approximately 30 psi. Close valve and allow pressure to stabilize for approximately 2 minutes. Ensure after 2-minute stabilization period that the pressure is between 27 and 33 psi.
- e) Observe the air pressure 5 minutes after the initial 2-minute stabilization period ends. If pressure loss exceeds 3 psi or the pressure does not stabilize, locate the faulty area and repair in accordance with Article 3.2 I.
- f) Once pressure testing is completed, cut end of tested seam area opposite to needle insertion end to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel in accordance with Article 3.2 I of this Section.
- g) Remove needle or other approved pressure feed device and seal hole in geomembrane with extrusion weld.

4. Inaccessible Seams

- a) Install cap strip over any seam that cannot be nondestructively tested. Cap strip material shall be composed of the same type and thickness geomembrane as the geomembrane to be capped.
- b) CQA ENGINEER shall observe cap stripping operations for uniformity and completeness.

D. Destructive Seam Testing

1. General

The purpose of destructive seam testing is to evaluate seam strength. Perform destructive seam tests as seaming progresses, not at the completion of all field work. A failed destructive seam sample shall result if grips of testing machine cannot be closed on sample test flap due to excessive temporary welding.

2. Frequency

- a) A minimum frequency of one test location per 500 feet of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire facility.
- b) OWNER reserves the right to increase the frequency of testing in accordance with performance results of samples previously tested.

3. Sampling Procedures

- a) Cut samples at locations as directed by CQA ENGINEER. CQA ENGINEER shall number each sample and record sample number and location on the panel layout Drawing.
- b) Repair holes in geomembrane resulting from destructive seam sampling immediately in accordance with repair procedures described in Article 3.2 I of this Section.
- c) Nondestructively test continuity of new seams in the repaired area according to Article 3.3 C of this Section.

4. Sample Dimensions

Take the following two types of samples at each sampling location:

- a) Take two samples for field testing. Cut each of these samples with a 1-inch-wide die, with seam centered parallel to width. The distance between these two samples shall be 42 inches. If both samples pass the field test described in Article 3.3, D-5 of this Section, take a sample for laboratory testing as described in paragraph b below.
- b) The sample for laboratory testing shall be located between the samples cut for field testing. Cut sample for laboratory testing 12 inches wide by 42 inches long with seam centered lengthwise. Cut this sample into three parts. CQA ENGINEER shall distribute the parts as follows:
  - 1) One portion to Geosynthetics Installation CONTRACTOR for optional laboratory testing, 12 inches by 12 inches.
  - 2) One portion to Geosynthetic Quality Assurance Laboratory for testing, 12 inches by 18 inches.
  - 3) One portion to OWNER for archive storage, 12 inches by 12 inches.
  - 4) Final determination of sample sizes shall be agreed upon at the pre-construction meeting.

5. Field Testing

- a) Test the two 1-inch-wide strips described in Article 3.3, D4a for peel strength. Use a tensiometer as described in paragraph (b) below to conduct these tests. These tests shall exceed the strength criteria in Table 02278-2.
- b) Use a tensiometer capable of maintaining a constant jaw separation rate of two inches per minute.
- c) Test field samples only under CQA ENGINEER's observation.
- d) If test sample passes in accordance with the Section, the seam qualifies for laboratory testing. If any field test sample fails to pass, the follow procedures outlined in Article 3.3 D 5 of this Section.
- e) Final judgment regarding seam acceptability, based on failure criteria in these specifications, rests with CQA ENGINEER.

6. Destructive Test Failure Procedures

Apply following procedures when a sample fails destructive testing, when conducted by CQA Laboratory or by the Geosynthetics CONTRACTOR using a field tensiometer.

- a) Geosynthetics CONTRACTOR has the following options:
  - 1) Repair seam between any two passing destructive test locations, or
  - 2) Trace welding path to an intermediate point (10 feet minimum from point of failed test in each direction) and take a small sample

at each location with a 1-inch-wide die for an additional field test. If these additional samples pass the test, take full laboratory samples. If these laboratory samples pass the tests, repair seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.

- b) Acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples, taken as indicated in Article 3.3 D 4, may be used as a boundary for the failing seam. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which seam has been repaired shall pass destructive testing. Make repairs in accordance with Article 3.2 I.
- c) When a sample fails, OWNER may require additional testing of seams that were welded by the same welder and/or welding apparatus during the same time shift.

E. Repair Verification

- 1. Nondestructively test each repair using methods described in Article 3.3 C, as appropriate. CQA ENGINEER shall number and log each repair.
- 2. Passing nondestructive test results indicate an adequate repair.
- 3. Repairs more than 150 feet long require destructive test sampling, in accordance with Article 3.3 D of this Section.
- 4. Failed destructive or nondestructive tests indicate that the repair shall be redone and retested until a passing test result.

F. Large Wrinkles

Wrinkles are considered to be large when a geomembrane can be folded over onto itself.

- 1. Cut and reseam all wrinkles identified by CQA ENGINEER. Test repair seams in accordance with Article 3.3 E.

### 3.4 PROTECTION OF WORK

- A. The Geosynthetics Installation CONTRACTOR shall use all means necessary to protect all materials and all partially completed and completed Work of these Specifications.
- B. In the event of damage, the Geosynthetics Installation CONTRACTOR shall make all repairs and replacements necessary to the approval of the CQA ENGINEER and at no additional cost to the OWNER.
- C. The CQA ENGINEER will issue an approval of the geomembrane liner installation and inspection to the OWNER prior to placement of any material over the geomembrane. However, the geomembrane installation will not be considered complete and the Contractor retains responsibility for the geomembrane until the geomembrane cover materials (geocomposite, LCRS gravel, geotextile, and operations soil, as applicable) have been fully installed, all testing is complete and passing, and all required documentation including as-built drawings have been submitted and approved.

### **3.5 RECORD DRAWINGS**

- A. After the completion of installation of geomembrane liner, the installer shall complete an “as-built” record drawing. The plan shall be prepared by the installer and reviewed/approved by the CQA ENGINEER and shall be at a scale of no less than 1 inch = 100 feet. It shall indicate the limits of geomembrane installed, panel layout with panel identification per Article 3.2.B.2 of this Section, location of destructive seam testing samples, and location of repairs. Additionally, the limits of geomembrane will be surveyed by CONTRACTOR.

**END OF SECTION**

**SECTION 02779  
GEOSYNTHETIC CLAY LINER**

**PART 1        GENERAL**

**1.1        SECTION INCLUDES**

- A.        Installation of Geosynthetic Clay Liner (GCL) by geosynthetics installation CONTRACTOR. Contractor shall furnish all labor, materials, tools, equipment supervision, transportation, and installation services necessary for the installation of the GCL of the cell. The Work shall be carried out in accordance with these Specifications, the CQA Plan, and the Construction Drawings.

**1.2        RELATED SECTIONS**

- A.        Section 02221 – Excavating and Stockpiling.
- B.        Section 02222 – Earth Fills.
- C.        Section 02223 – Subgrade Preparation.
- D.        Section 02778 – Geomembrane.

**1.3        REFERENCES**

Latest ASTM International (ASTM) Standards or other recognized agency standards at the time construction documents are issued for the following items:

- A.        ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
- B.        ASTM D5519 – Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials.
- C.        ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
- D.        ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>)(600 kN-m/m<sup>3</sup>).
- E.        ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
- F.        ASTM D1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
- G.        ASTM D6938 – Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- H.        ASTM D5261 - Measuring Mass per Unit Area of Geotextiles.
- I.        ASTM D4354 – Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing.
- J.        ASTM D4632 - Grab Breaking Load and Elongation of Geotextiles.
- K.        ASTM D2216 – Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

- L. ASTM D4759 – Standard Practice for Determining Specification Conformance of Geosynthetics.
- M. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
- N. ASTM D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
- O. ASTM D5199 – Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
- Q. ASTM D5321 – Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
- R. ASTM D5887 – Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
- S. ASTM D5888 – Standard Guide for Storage and Handling of Geosynthetic Clay Liners.
- T. ASTM D5889 – Standard Practice for Quality Control of Geosynthetic Clay Liners.
- U. ASTM D5891 – Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
- V. ASTM D5993 – Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.
- W. ASTM D6243 – Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method, Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction.
- X. ASTM D6241 – Static Puncture Strength
- Y. ASTM-D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
- Z. ASTM D6768-04 – Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
- AA. ASTM D6496 - Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners

#### **1.4 DEFINITIONS**

**Bentonite:** Clay soil, comprised primarily of sodium montmorillonite, characterized by high-swelling potential and low-hydraulic conductivity.

**Construction Quality Assurance (CQA) Consultant:** The OWNER or the monitoring firm responsible for implementation of the CQA plan.

**Construction Quality Assurance (CQA) Laboratory:** The party, independent from the OWNER, Manufacturer, Fabricator, and Installer, responsible for conducting tests on samples of geosynthetics obtained at the site. Also referred to as the Geosynthetics Laboratory.

Construction Quality Assurance (CQA) Officer: The professional representative of the CQA monitoring firm who shall be responsible for implementation of the CQA plan.

Construction Quality Assurance (CQA) Monitor: Site representative of the CQA Monitor responsible for documenting field observations and tests.

Engineer: The individual or firm responsible for the design and preparation of the project Construction Drawings and Specifications.

Geomembrane: An essentially impermeable synthetic membrane used as a solid or liquid barrier. Synonymous term for flexible membrane layer (FML).

Geosynthetic Clay Liner: Relatively thin factory-manufactured liner material consisting of bentonite supported by textile backing or geomembrane held together by needling, stitching, or chemical adhesives.

Installer: The party responsible for field handling, transporting, storing, deploying, and temporary restraining (against wind) of the GCL.

Lot: Group of consecutively numbered rolls from the same manufacturing line.

GCL Manufacturer (Manufacturer): The party responsible for the production and quality of GCL.

Minimum Average Roll Value (MARV): Minimum value of a limited series of tests that represents a value two standard deviations lower than the overall average value. Ninety-five percent of any individual samples will have greater than the MARV for any given property.

Textile Backing (textile or geotextile): Geosynthetic support material consisting of woven slit film, needle-punched nonwoven, or spunlaced polymer fabric, used for supporting bentonite in a GCL.

## **1.5 SUBMITTALS**

- A. Product Data (Manufacturer): Submit the following 7 days prior to shipping material to the site.
  - 1. Textile Backing
    - a) Certification stating that the textiles meet the product requirements and are needle-free.
    - b) Copy of quality control tests performed by textile supplier (if different from GCL manufacturer).
    - c) Copy of quality control tests performed by GCL manufacturer.
  - 2. Bentonite
    - a) Certification stating that the bentonite meets the product requirements (Table 02779-1).
    - b) Copy of quality control tests performed by bentonite supplier.
    - c) Copy of quality control tests performed by GCL manufacturer (if different than supplier).
  - 3. GCL
    - a) Certification stating that the GCL meets the product requirements (Table 02779-1).
    - b) Copy of quality control tests performed by GCL manufacturer.

- c) Permeability testing on typical product by independent laboratory (not necessarily for product delivered to site).
- d) Laboratory test data on typical product for:
  - 1) Swell
  - 2) Permeability of overlapped GCL
  - 3) Freeze-thaw behavior of GCL
- e) Supply 3-foot by 12-foot sample to CQA organization for testing.

## **1.6 QUALITY ASSURANCE**

- A. The OWNER will engage and pay for the services of (1) Construction Quality Assurance Monitor, and (2) Construction Quality Assurance (CQA) Laboratory to monitor the quality and installation of the GCL unless otherwise specified.
- B. The manufacturer shall not charge any time or material expenses to the OWNER, related to a plant visit by the OWNER/ENGINEER representations, the CQA Monitor, or designated representative to visit the plant during manufacturing.
- C. The GCL Installer shall aid the CQA Monitor in product sampling by providing personnel and equipment necessary to move, cut, and protect GCL rolls.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. General: Conform to the manufacturer's requirements unless otherwise specified.
- B. Delivery
  - 1. Deliver materials to the site only after the CQA Monitor accepts required submittals.
  - 2. Material shall be covered with a waterproof, tightly-fitting, plastic covering resistant to ultraviolet degradation.
  - 3. Ship less than one month prior to scheduled installation.
  - 4. Ship in closed trailer or securely tarped flat bed.
  - 5. Each roll shall be marked with the following information:
    - a) Manufacturer's name
    - b) Product identification
    - c) Lot and roll numbers
    - d) Roll dimensions and weight
- C. Storage
  - 1. Store rolls in the GCL storage pad location indicated on the drawings.
  - 2. Stack no more than three (3) rolls high and provide continuous support under each roll.
  - 3. Protect rolls from precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.
  - 4. Preserve integrity and readability of roll labels.

- D. Handling
1. Use appropriate handling equipment to load, move, or deploy GCL rolls. A 3-inch Schedule 120 steel support pipe, long enough to go through the entire roll core, mounted on a forklift or lifted with a wide spreader bar, shall be used. If a spreader bar is used, it shall be wide enough to prevent damage to the edges of the rolls from the lifting strap or chain.
  2. Handling of rolls shall be done in a competent manner such that damage does not occur to the product or to its protective wrapping. Follow handling procedures outlined in ASTM D4873.
  3. Damage to protective covering due to mishandling or sampling must be repaired immediately. Repairs shall be such that the GCL roll is protected from moisture or other deleterious conditions.
  4. Installer is responsible for off-loading, storage, and transporting material from storage area to installation site.

## **PART 2: PRODUCTS**

### **2.1 GEOSYNTHETIC CLAY LINER (GCL)**

- A. The GCL shall consist of a layer of bentonite encapsulated between two geotextiles, meeting characteristics as indicated on the Drawings. The bentonite shall be a high quality, natural sodium bentonite composed of a minimum of 80 percent montmorillonite, by dry weight, when tested by X-ray diffraction methods.
- B. The GCL shall be internally reinforced through a process such as needle punching through the top and bottom layers of geotextile and the bentonite. The reinforcing fibers shall be a polypropylene thread.
- C. Continuous water-proof laplines and matchlines shall be printed directly on the geotextile-type GCL at 6 and 9 inches from the edges of the rolls, respectively.
- D. Wrapped around structurally-sound core that can support weight of GCL without excessive bending or buckling. The core shall be accessible to stingers or rods placed full-length within the core.
- E. Meet the requirements of Table 02779-1.

### **2.2 MANUFACTURER SOURCE QUALITY CONTROL**

- A. Perform the quality control tests at the frequencies meeting, at a minimum, the requirements of Geosynthetic Research Institute (GRI) Test Method GRI-GCL3. Provide a certification letter that states all quality control tests were performed in accordance with this Specification and all properties met or exceeded the requirements listed in Table 02779-1.
- B. Supply copies of testing data, results, and certification letter to CQA Monitor.

**Table 02779-1  
PROPERTIES FOR GEOSYNTHETIC CLAY LINER**

<b>Test</b>	<b>Test Designation<sup>(1)</sup></b>	<b>Manufacturer QC Test Frequency</b>	<b>Conformance QA Test Frequency</b>	<b>Requirement</b>										
<u>Bentonite</u>														
Moisture Content	ASTM D2216	1 per 100,000 sf <sup>(8)</sup>	1 per 100,000 sf	<40% when installed for geotextile-type GCL <20% passing #200 U.S. sieve >25 ml/2 g										
Particle Size	ASTM D6913													
Swell Index	ASTM D5890													
Bentonite Mass per Unit Area	ASTM D5993	1 per 50,000 sf	1 per 100,000 sf	>0.75 pounds <sup>(3)</sup>										
Fluid Loss, max.	ASTM D5891	1 per 100,000 lbs	N/A	18 ml										
<u>Geotextile<sup>(2)</sup></u>														
Mass per Unit Area	ASTM D3776	1 per 50,000 sf	1 per 100,000 sf	>5.0 oz/yd <sup>2</sup>										
Grab Strength	ASTM D4632	1 per 50,000 sf	1 per 250,000 sf	> 90 lb										
<u>GCL<sup>(2)</sup></u>														
Tensile Strength	ASTM D6768	1 per 50,000 sf	1 per 250,000 sf	>23 pounds/in										
Peel Strength	ASTM D6496	1 per 50,000 sf	1 per 250,000 sf	<sup>(6)</sup>										
Puncture <sup>(7)</sup>	ASTM D4833	1 per 100,000 sf	1 per 250,000 sf	90 lbs										
Hydraulic Conductivity	ASTM D5887	1 per 100,000 sf	1 per 250,000 sf	<5.0 x 10 <sup>-9</sup> cm/sec <sup>(4)</sup>										
Internal Shear Strength (min)	ASTM D6243	1 per project	N/A	Lbs/sf <sup>(6)</sup>										
Residual Shear Strength <sup>(5)</sup>	ASTM D6243/D5321	N/A	<sup>(5)</sup>	<table border="0"> <tr> <td>Confining Stress</td> <td>Shear Stress</td> </tr> <tr> <td>psf</td> <td>psf</td> </tr> <tr> <td>2,750</td> <td>1,000</td> </tr> <tr> <td>4,000</td> <td>1,070</td> </tr> <tr> <td>9,000</td> <td>1,370</td> </tr> </table>	Confining Stress	Shear Stress	psf	psf	2,750	1,000	4,000	1,070	9,000	1,370
Confining Stress	Shear Stress													
psf	psf													
2,750	1,000													
4,000	1,070													
9,000	1,370													

**Notes:**

- (1) Alternate tests are allowed only with prior written approval of the ENGINEER.
- (2) Required values for geotextile and GCL are MARV.
- (3) Weight of GCL minus weight of geotextiles or geomembrane and corrected to 0 percent bentonite moisture content.
- (4) Measured at 5 - 10 psi confining pressure and 2 psi head pressure.
- (5) As a performance test for the liner system materials, determine residual shear strength (at each confining stress level) of the liner system with shear failure possible via the following mechanisms: (1) internal GCL strength, (2) HDPE geomembrane/GCL interface strength, (3) GCL/soil subgrade interface strength and (4) geomembrane/geocomposite interface strength. Failure should occur first within the geomembrane/geocomposite interface. As an alternative,

**Table 02779-1  
PROPERTIES FOR GEOSYNTHETIC CLAY LINER**

<b>Test</b>	<b>Test Designation<sup>(1)</sup></b>	<b>Manufacturer QC Test Frequency</b>	<b>Conformance QA Test Frequency</b>	<b>Requirement</b>
<p>and upon approval by the ENGINEER, each interface may be tested separately at each confining stress level. The interface with the lowest peak shear strength at each confining stress level shall be deemed to control and the residual strength of the interface shall be compared to the values listed to identify conformance with this Section.</p> <p>(6) Required value shall be taken from manufacturer's standard material specification sheet for the selected GCL material. GCL selection shall be based on material's ability to meet or exceed the requirements identified in the site's design.</p> <p>(7) Puncture test to be performed on GCL material used in base liner applications where material is placed directly on subgrade.</p> <p>(8) Provide a certification letter that states all quality control tests were performed in accordance with this Specification and all properties met or exceeded the requirements listed in Table 02779-1.</p>				

**PART 3: EXECUTION**

**3.1 PREPARATION OF SUBGRADE**

- A. The Earthwork CONTRACTOR shall be responsible for preparing the supporting subgrade for placement of the geosynthetics. The OWNER shall coordinate the Work of the earthwork CONTRACTOR and the Geosynthetic Installation CONTRACTOR so that the requirements of the specifications and the project CQA Plan are met.
- B. Subgrade shall be compacted as specified in Section 02223.
- C. Subgrade shall be rolled to a smooth and level surface.
- D. Surface shall be free of stones greater than 0.5-inch diameter, protrusions or sharp objects that may damage the GCL, and organics or other deleterious material.
- E. Fill voids and cracks.
- F. Ruts shall be limited to 1-inch maximum depth.

**3.2 SUBGRADE CONFORMANCE REVIEW**

- A. Before the geomembrane installation begins, the CQA ENGINEER shall verify that:
  - 1. A qualified land surveyor has verified all lines and grades.
  - 2. A qualified ENGINEER has verified that the supporting subgrade meets all requirements in the project specifications.
  - 3. The surface to be lined has been rolled, compacted, or handworked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.
  - 4. Round edges of Anchor Trenches or cushion with geotextiles.
  - 5. The surface to be lined does not contain stones which may be damaging to the geosynthetics.

6. There is no area excessively softened by high water content.
7. The Geosynthetic Installer, on a daily basis, shall certify in writing that the surface on which the geosynthetics will be installed is acceptable. A certificate of acceptance shall be given to the Geosynthetic Installer and to the CQA ENGINEER prior to commencement of liner deployment in the area under consideration. The OWNER shall be given a copy of this certificate by the CQA ENGINEER.
8. After the supporting subgrade has been accepted by the Geosynthetic Installer, it is the Geosynthetic Installer's responsibility to indicate to the OWNER any change in the support subgrade condition that may require repair Work. The surface to be lined must exhibit adequate strength, as required by the OWNER, prior to liner deployment. Any damage to the subgrade caused by installation activities shall be repaired at the Geosynthetic Installer's expense. The OWNER may consult the CQA ENGINEER regarding the need for repairs. If the CQA ENGINEER concurs with the Geosynthetic Installer, the OWNER shall confirm that the supporting subgrade is repaired.
9. At any time before or during the liner installation, the CQA ENGINEER shall indicate to the OWNER any locations, which may not be adequately prepared for the liner.

### **3.3 DEPLOYMENT**

#### **A. General**

1. Deploy only after subgrade is accepted by CQA Monitor.
2. Place nonwoven side up, or in accordance with Manufacturer's recommendation.
3. Deploy manually or by use of spreader bar attached to loader or backhoe with support rod through entire roll width.
4. Take care not to entrap objects or moisture beneath GCL.
5. Beginning deployment implies acceptance of subgrade by installer.
6. To avoid damage to the GCL Do not drag textured geomembrane over the installed GCL. Use a smooth geosynthetic slip sheet or rub sheet as necessary to reduce friction damage during deployment.

### **3.4 JOINING**

#### **A. Overlaps**

1. Using the lapline and matchline as guides, overlap a minimum of 6 inches along length and 18 inches along width (butt seams).
2. Overlap a minimum of 12 inches along width and in sump areas.
3. Overlaps or seams are not allowed perpendicular (horizontal seams) to slopes greater than 10 percent. In these areas, GCLs must be placed in one piece along the entire slope.
4. If length of slope is greater than manufactured length, horizontal seams will be allowed at the direction of the OWNER.

B. Seams

1. Spread granular bentonite at the rate of 4 ounces per lineal foot of overlap. Bentonite along overlaps is not required if manufacturer can document (through GRI GCL-3 or similar testing) that the permeability at the overlaps is no greater than the permeability of the GCL material. Approval to forego the use of additional bentonite along seams must be received in writing from the design ENGINEER before installation begins.
2. Bentonite shall be same material used in the GCL.
3. Use lime spreader for powder bentonite to reduce wind-blown particles.
4. Do not sew or use mechanical connections (except for repairs).

**3.5 RESTRAINING AND PROTECTING**

- A. Restrain GCL against wind using sandbags filled with fine-grained material, or other approved methods. Protect GCL from water intrusion in the event of precipitation.
- B. Sandbags must remain until GCL is covered.
- C. GCL must be fully covered with geomembrane the day it is installed. No more than two acres will be exposed prior to covering to minimize GCL hydration from wet weather. If overlying geomembrane is not seamed the same day, the Monitor may request geomembrane edges to be pulled back to inspect GCL at no additional cost to OWNER. Torn, punctured, or hydrated material shall be removed and replaced in accordance with Article 3.6 of this Section at no additional cost to OWNER.
- D. GCL bentonite material that becomes hydrated to a moisture content greater than 40 percent before being covered by a seamed geomembrane may be rejected. Rejected material shall be removed and replaced at no additional cost to the OWNER.

**3.6 REPAIR PROCEDURES**

- A. Remove punctured, torn, or hydrated material, and as instructed by the CQA Monitor.
- B. Repair subgrade, if necessary.
- C. Cover area with same type of GCL material with same side up.
- D. Overlap defective area by a minimum of 12 inches in all directions.
- E. Adhesion tape or wood glue may be used to keep patch in place.
- F. Apply granular bentonite as with normal overlaps at 4 ounces per lineal foot.

**3.7 FIELD QUALITY CONTROL AND QUALITY ASSURANCE**

- A. General
  1. Field quality control is the responsibility of the GCL Installer who must document that the installation proceeds in accordance with this specification.
  2. Field quality assurance is the responsibility of the CQA Monitor.

- B. The GCL Installer and CQA Monitor shall inspect:
1. The underlying surface for entrapped particles that may impact the GCL.
  2. The surface of the GCL for needles, punctures, tears, thinning, or other evidence that the material may not meet specification requirements.
  3. The GCL for evidence of premature hydration such as wet areas or swelling. Hydrated areas (moisture content >40%) shall be removed and replaced with dry material.
  4. Overlaps using the laplines and matchlines as a guide. The Monitor shall periodically measure the distance of the laplines and matchlines from the edge of the GCL.
  5. The bentonite seam (if necessary) to check the location of the seams over the overlap and the amount of bentonite being used.
  6. The Monitor must approve each section of the GCL before the GCL is covered.
- C. The GCL Installer shall aid the CQA Monitor in collecting samples for testing. The collection of samples shall be conducted in accordance with the CQA Plan, this specification, and the manufacturer's requirements.
1. Any roll that cannot be identified shall be rejected.
  2. Samples shall be tested at a minimum frequency as specified in the CQA Plan for mass per unit area, grab strength, and permeability. Only one sample per GCL type is required for interface shear and internal shear testing.
  3. A minimum of one sample shall be taken from each lot.
  4. Sample shall be a minimum of two (2) feet long and run the entire width of the roll.
  5. Mark the roll number and machine direction on each sample.
- D. Quality Assurance Laboratory Testing (by CQA Monitor)
1. The following laboratory tests shall be conducted by the CQA Monitor at the frequencies identified in the CQA Plan:
    - a) Mass per unit area (ASTM D5993);
    - b) GCL Grab strength (ASTM D4632);
    - c) Permeability (ASTM D5887);
    - d) Moisture Content (ASTM D2216); and
    - e) Internal Shear Strength (ASTM D6243), see note 2 below.
  2. Test specimens shall be hydrated under 200 psf normal load for 24 hours, and subsequently tested for shear strength at normal loads of 5,000, 10,000 and 15,000 pounds per square foot.
  3. The test results shall be evaluated according to ASTM D4759 and must meet the minimum requirements stated in Table 02779-1.

### **3.8 ACCEPTANCE**

- A. CONTRACTOR shall retain ownership and responsibility of GCL until acceptance by the OWNER.
- B. OWNER will accept GCL installation when:
  - 1. All required documentation from the manufacturer and installer has been received and accepted.
  - 2. Test reports verifying material properties have been received and accepted.
  - 3. The CQA Monitor has completed final inspection and any noted defects have been repaired.
  - 4. The material is in place and covered with seamed and anchored geomembrane.

**END OF SECTION**

**APPENDIX A**  
**PROJECT DRAWINGS**